The Department of Biological Sciences,

Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjhunwala College

Ghatkopar, Mumbai - 400 086

PROCEEDINGS OF NATIONAL SEMINAR

ON

Biodiversity and Conservation of Coastal and Marine Ecosystems of India

13th to 15th September 2012

ISBN 978-81-925489-0-6

- - COLLABORATORS - -

Bombay Natural History Society (BNHS)

Association of Teachers in Biological Sciences (ATBS)

International Union for the Conservation of Nature (IUCN)

Mangroves For the Future (MFF)

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1. Hindi VidyaPracharSamiti, Ghatkopar, Mumbai
2. Bombay Natural History Society (BNHS)
3. Association of Teachers in Biological Sciences (ATBS)
4. International Union for Conservation of Nature and Natural Resources (IUCN)
5. Mangroves for the Future (MFF)

Advisory Committee for the Conference

1. Dr. S. M. Karmarkar, President, ATBS and Hon. Dir., C B Patel Research Institute, Mumbai
2. Dr. Sharad Chaphekar, Prof. Emeritus, Univ. of Mumbai
3. Dr. Asad Rehmani, Director, BNHS, Mumbi
4. Dr. A. M. Bhagwat, Director, C B Patel Research Centre, Mumbai
5. Dr. Naresh Chandra, Pro-V. C., University of Mumbai
6. Dr. R. S. Hande. Director, BCUD, University of Mumbai
7. Dr. Madhuri Pejaver, Dean, Faculty of Science, University of Mumbai
8. Dr. Vinay Deshmukh, Sr. Scientist, CMFRI, Mumbai
9. Dr. Vinayak Dalvie, Chairman, BoS in Zoology, University of Mumbai
10. Dr. Sasikumar Menon, Dy. Dir., Therapeutic Drug Monitoring Centre, Mumbai
11. Dr, Sanjay Deshmukh, Head, Dept. of Life Sciences, University of Mumbai
12. Dr. S. T. Ingale, Vice-Principal, R. J. College, Ghatkopar
13. Dr. Rekha Vartak, Head, Biology Cell, HBCSE, Mumbai
14. Dr. S. S. Barve, Head, Dept. of Botany, Vaze College, Mumbai
15. Dr. Satish Bhalerao, Head, Dept. of Botany, Wilson College

Organizing Committee

1. Convenor- Dr. Usha Mukundan, Principal, R. J. College
2. Co-convenor- Deepak Apte, Dy. Director, BNHS
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4. Treasurer- Prof. Pravin Nayak
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Members- Dr. Veena Kelkar
Mrs. Sushma Singh
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Mrs. M. P. Kale

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Mr. Deepak Poojary
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Mrs. Shamala Kulkarni

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Celebrating Year of Marine Biodiversity and CBD COP 11

RamniranjanJhunjhunwala College, BNHS and ATBS announce
a National Seminar on

" BIODIVERSITY AND CONSERVATION OF COASTAL AND MARINE ECOSYSTEM OF INDIA"

13th – 15th September 2012

CBD or the Convention on Biological Diversity (CBD) is a comprehensive, binding global agreement aiming at conservation and sustainable use of the elements of biological diversity. At the 1992 Earth Summit in Rio de Janeiro, world leaders agreed on a comprehensive strategy for "sustainable development" – meeting our needs while ensuring that we leave a healthy and viable world for future generations. One of the key agreements adopted at Rio was the Convention of Biological Diversity (CBD). This pact among the vast majority of the world's governments sets out commitments for maintaining the world's ecological underpinnings as we go about the business of economic development.

The Convention establishes three main goals:

- The conservation of biological diversity
- The sustainable use of its components, and
- The fair and equitable sharing of the benefits from the use of genetic resources.

The Convention's success depends on the joint and cumulative efforts of the individual countries, who have committed towards conservation and sustainable use of biodiversity. In order to facilitate compliance to the convention the Convention has created a global forum where governments, non-governmental organizations, academics, the private sector, and other interested groups or individuals share ideas and compare strategies. The Convention's ultimate authority is the Conference of the Parties (COP), consisting of all governments (and regional economic integration organizations) that have ratified the treaty. The COP reviews progress under the Convention, identifies new priorities, and sets work plans for members.

CBD COP 11 is being organized against the backdrop of India's decision to host the Eleventh Conference of the Parties (COP11) of the Convention of Biological Diversity (CBD) in Hyderabad, in October 2012. Significantly, the CBD has identified that the theme for the International Day for Biological Diversity in 2012 will be "marine and coastal biodiversity".

Various decisions of CBD's Conference of Parties (COP) have recognized that marine and coastal protected areas (MCPAs), implemented as part of a wider marine and coastal area management framework, are one of the important tools for the conservation and sustainable use of marine and coastal biodiversity. They have also recognized the importance of addressing issues related to

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governance, participation, equity and benefit-sharing, and of securing the full and effective participation of indigenous and local communities in the management of existing, and the establishment and management of new, protected areas.

The proposed national conference is arranged by RamniranjanJhunjhunwala College in collaboration with BNHS and the Association of Teachers in Biological Sciences in a view to spread awareness among and to engage youth in marine biodiversity conservation. The involved organizations envisage playing the role of catalyzing and facilitating Civil Society Organization (CSO), youth groups and other relevant stakeholder inputs to the COP11 process, starting from mid-2011 so that there is adequate time to make preparations, and involve a large number of relevant groups.

Background

The sea around India is part of the great Indian Ocean and the Indian subcontinent forms a major physical division between the Arabian Sea and the Bay of Bengal of the Indian Ocean. India is also one of 17 mega bio-diverse countries in the world, with 7.8% of the recorded species of the world including 45,500 recorded species of plants and 91,000 recorded species of animals. India has a vast coastline of 8000 km, of which, 5, 423 km belong to Peninsular India and 2, 094 km to the Andaman, Nicobar, and Lakshadweep Islands, and with an EEZ of 2.02 million sq. km. There are about 13,000 recorded species belong to marine environment in India. The figure is grossly underestimated and that more number of species might be living in coastal and marine environment of India that needs to be explored. Indian coastal zones have a variety of habitats like mangrove, estuarine, coral reefs, sea grass beds, lagoons, sand dunes, rocky shore, cliffs, intertidal mud flats, etc. Coastline of India has also supports nearly 250 million people within the swath of 50 km from the coastline; therefore, the ecological services of marine and coastal ecosystems of India play a vital role in India's economy growth.

Coastal and Marine Biodiversity of India

Coral reefs are diverse and most vulnerable ecosystem in India. The reef bio-composition is quite significant and includes about 180 species of benthic algae, 14 species of seaweeds, 12 species of sea grasses, 108 species of sponges, 4 species of lobsters, 103 species of echinoderms, 800 species of fin fishes and also a good number of species of crabs, bivalves, gastropods and cephalopods. About 844 species of marine algae are recorded from India. Of these, several species are exploited commercially on a large scale in the region. Marine invertebrate diversity is also high in India, and many are harvested and are of economic importance; there is evidence that some molluscs and crustaceans have been overexploited, and species such as the coconut crab, horseshoe crabs, and certain molluscs are of conservation concern. Commercial and subsistence fisheries are important in India. In India the bulk of the catch is subsistence or artisanal.

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Threatened Marine Species of India

So far, there was no systematic assessment on the conservation status of coastal and marine species of India using the IUCN Regional Red Listing Guideline. However, based on experts opinions, there are ten species of sharks and rays including whale shark, all species of sea horses, giant grouper, all cetaceans, dugong, nine species of shells, five species of sea turtles, one species of otter, all species of corals, all species of sponges and all holothurians that occur in coastal and marine areas of India are considered under threat, therefore, protected under the Wildlife (Protection) Act, 1972 by listing them in the Schedule.

Threats, Challenges and Conservation Gaps

Despite tremendous ecological and economic importance and the existence of a policy and regulatory framework, India's coastal and marine biodiversity is under threat. Numerous direct and indirect pressures arising from different types of economic development and associated activities and climate change have adverse impacts. Rise in the sea level is likely to have significant implications on the coastal populations and agricultural productivity. Most importantly, lack of scientific information exacerbates the situation. Link between the management authorities of marine sources, local communities and other stakeholders is weak and has resulted in poor resources management and continuous diminishing of biodiversity due to over exploitation. Further, lack of understanding of the sustainability of coastal ecosystem with respect to economic development is also a major hurdle. The major scientific areas of research in the coastal and marine biodiversity in India include Fisheries, Aquaculture, Seaweed and Mangrove research but these studies have considered marine biodiversity as commercial products and failed to appreciate their ecological roles. Moreover, recent threats such as climate change, invasive species, faster economic development etc are posing major challenges for conservation of marine biodiversity which need to be addressed immediately through scientific research. Important ecological information on habitat and resource needs of threatened species to fulfill their normal life-cycle is lacking in India. Further, not many youths involved in the marine conservation as compared to terrestrial biota.

Way forward

There are 18 Marine Protected Areas (MPAs) present in the Peninsular India and more than 100 MPAs in its Islands. Of the 18 MPAs in the peninsula, Gulf of Mannar Marine National Park, Sundarbans National Park, Gulf of Kutchch National Park, Bhitrakanika National Park, Coringa Wildlife Sanctuary, Chilika Wildlife Sanctuary have unique marine biodiversity and provide a range of services to local communities around these MPAs. The success of MPAs largely rest with acceptance of local communities. Therefore, involving local communities and other stakeholders in governance of MPAs is pivotal. Youth should be involved actively in conservation efforts of the country. Coordination among institutions working in this area is also required. India has taken several steps for achieving Aichi Biodiversity Targets -- 106 coastal and marine sites have been identified and prioritized as Important Coastal and Marine Areas (ICMBA). These sites have also

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been proposed as Conservation or Communities Reserves with parti1cipation of local communities. Efforts are currently underway in securing and strengthening community participation in management of the MPA Network in India.

Engaging youth in marine biodiversity conservation is another important dimension. The proposed conference will provide the post graduate and graduate students with fresh insights to the issues of marine biodiversity research and conservation.

The technical sessions in the conference will be on carefully chosen areas as under

1. Biodiversity of Coastal and Marine Ecosystems
2. Tools for assessing and Techniques for Conservation of Marine Biodiversity
3. Threats to Marine Biodiversity
4. Harvesting Marine Resources- Issues of Sustainability and Conservation
5. Marine Disasters and their Management
6. Regulation of Coastal Activities and Integrated Coastal Zone Management (ICZM).

The organizers plan to have globally known scientists in the area of Marine Sciences for key note address and as lead speakers on each day. Further, the chairman for each session and a lead speaker will guide the researchers and students in attendance about that special area. The conference is sure to bring about a change in the outlook of research scholars as well as PG students towards marine bio- resources and their conservation.

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Hindi VidyaPracharSamiti's

RamniranjanJhunjhunwala College,

Ghatkopar, Mumbai - 400086

On the auspicious day of Shri Krishna Janmashtami, 15th August 1938, the people of Ghatkopar and the surrounding suburbs witnessed the birth of Hindi VidyaPracharSamiti, a brain child of a visionary Late ShriNandkishore Singh Jairamji. The Samiti was established with the objectives of catering to the educational needs of the Hindi speaking community. It made a humble beginning by starting a primary school, which gradually expanded into a full fledged secondary school.

The Hindi High School with its high academic standards has carved for itself a place not only among leading Secondary schools in Mumbai but also educational institutions imparting instructions in Hindi throughout Maharashtra. With its primary objectives achieved the Samiti decided to extend its frontiers and broaden its horizons. As a result, RamniranjanJhunjhunwala College came into existence in 1963, enabling a larger section of the society to take advantage of the facilities provided for higher education.

In 1976 the Junior College section was introduced and in 1981 the Commerce faculty commenced both at the Junior and Degree College level.

From 1999-2000 onwards the College has added a number of self-financing courses like BMS, B.B.I, B.Sc. in C.S.,I.T., Biotech, M.Sc. in Computer Science. and Biotechnology as well as add on courses, which further hone the special skills of the students.

In the past few years the college has scaled new heights of excellence. It has been reaccredited with 'A' Grade by NAAC in 2009 with a CGPA 3.33 and received the Best College Award (2007-2008) of the University of Mumbai. College has been bestowed with IMC RAMKRISHNA BAJAJ PERFORMANCE EXCELLENCE TROPHY in 2010. Dr. UshaMukundan was awarded as "BEST TEACHER" for 2010 by Maharashtra Government in the year 2011.

AIMS & OBJECTIVES:

The RAMNIRANJAN JHUNJHUNWALA COLLEGE basically aims at not onlycatering to the academic excellence of the students but also providing them withfacilities to develop their other inherent talents. Under the guidance of dedicated anddevoted teachers, the students are able to achieve academic excellence at theUniversity Examinations.

The College is efficiently managed by the HINDI VIDYA PRACHAR SAMITI through the PRINCIPAL and her team of VICE PRINCIPAL'S and Junior College SUPERVISOR. They are ably assisted by devoted and courteous non-teaching staff.

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For the overall development of the students, various Associations conduct debates, elocutions, essay competitions, quiz etc. The Gymkhana provides appropriate facilities for students in indoor games and to participate in various sports both at the collegiate and inter collegiate level.

The College also has a Career Counseling and Placement Cell to help students to find Job Opportunities both during vacations and after graduation.

Golden Jubliee Message

Hindi VidyaPracharSamiti'sRamniranjanJhunjhunwala College is ushering into its Golden Jubilee year in 2012-13, It's time to look back to thank all those who have been part of this journey but more importantly tolook ahead as what we can offer to all our stakeholders. Our alumni have been our brand ambassadors and their continued support in various ways is highly appreciated. The student community and their parents have made teaching experiencehighly fulfilling. The selfless and enthusiastic supporting staff, ensure that the functioning of the college is meticulous 24x7. The strength of our college is the illustrious faculty who have rendered yeomen services to shape the future of our students. The extremely supporting management that is theHindiVidyaPracharSamiti is highly responsive, motivated and encouraging which has made us tread smoothly in this path of Knowledge. We welcome all the students for this academic year 2012-13 to be a part of the Golden Jubilee celebration year.

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PROBLEMS AND PROSPECTS OF COASTAL AND MARINE BIODIVERSITY CONSERVATION IN INDIA

B. C. Choudhury
Head, Endangered Species Management Department, Wildlife Institute of India (WII), Dehradun

ABSTRACT

The Arabian Sea and Bay of Bengal, two of the major Large Marine Ecosystems (LME) and over 10,000 kms. of coastal zone in India to be conserved and managed is a major challenge and there are constraints as well as opportunities. The deltaic mangroves of the Gangetic, Mahanadi, Godavari, Krishna and Cauveri in the East Coast and other mangroves of the West coast support the Indo-Malayan floristic and faunistic components and are the "bio shield" from the vagaries of coastal storms and cyclones. A large number of productive riverine estuaries on which coastal fisheries and livelihood options of coastal communities depend on are also major hotspots for biodiversity. The off-shore coral reefs of Gulf of Kutchch, Gulf of Mannar, Malvan, Netrani, Andaman Nicobar and Lakshadweep Islands support a diversity of corals and reef fish with affinity to Indo-Pacific reef systems. Coastal lagoons and back waters such as Chilika, Pulicat, Kolleru, and Vembanad are only a representative few which support millions of migratory water fowl. Inter tidal mud flats, sand dunes, sea grass beds, little and great Rann of Kutch – all coastal and marine connected habitats are repository of diverse and unique biota providing a host of ecological goods and services. All these coastal and marine habitats of India are to be properly inventorised, their ecological integrity and threats assessed and conservation and management plans developed and implemented. In the absence of a Coastal and Marine Conservation Policy and Action Plan and a cross sectoral, uncaring and destructive exploitation approaches of coastal and marine resources by several agencies combined with ill planned coastal and marine development programmes, the recent awareness of addressing concern for the coastal and marine environment provides an opportunity. It would be prudent to follow a bottoms-up "maritime state coastal and marine zone planning approach" with the involvement of academic and professional organization that will pave the way for sustainable conservation and management of the dynamic and no-cost investment based renewable resource generating coastal and marine habitats. Instead of a top down federal policy and plan of "one size fits all" approach, the need for different west coast, east coast and island ecosystem conservation plan may need to be emphasized. Coastal and marine conservation being one of the major themes of the forthcoming CBD COP-11, all forums need to suggest ways and means of dealing with coastal and marine region conservation where half of India's human population, urban growth and metropolis and tax payers developmental investments are located.

ABOUT

PROF. B. C. CHOUDHURY

Professor B.C. Choudhury, a well known herpetologist, wildlifer and a coastal and marine ecologist formerly was the Head of the Endangered Species Management Department of the Wildlife Institute of India (WII), Dehradun. He has worked on several inland, coastal and marine wetland projects in the country and is known for his works on aquatic species such as Crocodiles, Dolphins, River Turtles, Marine Turtles and migratory waterfowls. He has also worked for establishing a network of Inland Wetland and Coastal and Marine Protected Area in the country as well as to develop a National Wetland Conservation Policy and Strategy. He coordinated the WII's freshwater and marine wetland research and management programmes and has spear headed coastal and marine conservation related projects. While working with the freshwater dependent wildlife, he has emphasized the need for maintenance of critical minimum environmental flows in our natural and manmade aquatic systems. In his coastal and marine initiatives, an expected outcome will be the ICMBA (Important Coastal and Marine Biodiversity Areas) Atlas for India that will help maritime states plan conservation areas along their coastal zone which includes considerable areas of coastal and off-shore marine water bodies. The other projects in which he is involved includes development of management plans for Wetland Protected Areas, Marine National Parks and planning a network of Marine Protected Areas for India. He has assisted the MoEF, GOI in developing the regulatory regimes for Wetlands, Marine Conservation Programme and Marine Species Recovery Plans. He is a member of several IUCN SSC Species Specialist and the Sustainable Use Specialist Group. He was awarded the prestigious Society for Conservation Biology (SCB) Global Achievement Award during the year 2005 for his works on aquatic endangered fauna and ecosystems and science based aquatic area conservation advocacy works.

THE NEED FOR AN INTEGRATED APPROACH TO COASTAL MANAGEMENT

Wenresti G. Gallardo, PhD
Aquaculture and Aquatic Resources Management
School of Environment Resources and Development
Asian Institute of Technology
Thailand

ABSTRACT

Coastal resources such as mangroves, seagrasses and coral reefs provide valuable goods and services for people, other organisms and the environment. However, the increasing human population results in overexploitation of resources, conflicts in the use of the resources and degradation of the environment. Management of coastal resources has usually been sectoral and has not been very effective. Since problems and issues are complex involving various sectors and stakeholders, there is a need for an integrated approach to coastal management.

This paper presents the status of coastal resources, coastal management issues, challenges to sustainable coastal development, various coastal management approaches, strategies, principles and processes.

The integrated approach to coastal management considers several dimensions, namely: inter-sectoral integration, inter-governmental integration, spatial integration, science-management integration, and international integration.

There is a need to build a strong cadre of coastal practitioners and policy makers with the knowledge, skills, and tools to set wise policy and plan, design and implement successful and sustainable integrated coastal management programs for countries in the Asia region, thus, the Asian Institute of Technology (AIT) offers a postgraduate course on Integrated Coastal Management (ICM). AIT's ICM program is appropriate for management and operational staff who are actively working in the field of coastal management and those with interest in management of issues inherent to the coastal areas.

MARINE RESOURCES- POTENTIAL AND ISSUES RELATED TO HARVESTING, SUSTAINABILITY AND CONSERVATIONMENT

V. S. Somvanshi

ABSTRACT

India is endowed with rich marine bio-diversity due to her advantageous geo-morphology as well as geo-location. Recent efforts to explore seas around the country , have enabled us to acquire greater knowledge about our marine wealth. Besides the richness of the biodiversity of marine fish, the potential of theses resources is analitically assessed as 3.92 million tonnes which could be harevested annually from the area within 200 nautical miles Indian EEZ. Apart from the yeoman effort put in by the coastal fishermen community in increasing the marine fish production, the Govt of India have been engaged in giving necessary push to increase the fish production with emphasis on deep sea fishing with little success both in capacity and fleet building. It is but certain that these activities often resulting in excessive fishing have been adding to human interventions altering the biodiversity and ecological balance. Hence the conservation of marine biodiversity and sustainable fisheries and livelihood are the today's challenges before the scientists and technologists.The EEZ regimewill also provide ample opportunities to explore the rich biodivesity of marine microbes and develop its applications in food, medicines and cosmetics

BIO-DATA

Academic Qualification:
M.Sc. Zoology (Fishery Science);
Ph.D. Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

Institutions Served :
(i) Central Marine Fisheries Research Institute(CMFRI) - 1976-1980
(ii) Fishery Survey of India (FSI) - 1980-2009; retiered on 31st May 2009.

Inernational Engagements:
(i)Vice Chairman, Scientific Committee, Indian Ocean Tuna Commission (IOTC)
(ii) Vice Chairman, Indian Ocean Tuna Commission (IOTC)

Countries Visited :
Kenya, Canada, Mexico, Japan, China, Marutius, Oman, Seychelles, Bangladesh, Norway, Malaysia

Experience:
Research over 26 years covering
(i) Inland fisheries,
(ii) Esturine fisheries and
(iii) Marine fisheries

Guiding Research as Recognised P.G.Teacher
(i) University of Mumbai,
(ii) University of Madras and
(iii) Andhra University

Adminstrative activities at Local, Regional and National levels

Publications: Research papers: 145 and Books Edited: 4

CORAL REHABILITATION - ROLE ON CONSERVATION AND MANAGEMENT

J. K. Patterson Edward
Suganthi Devadaon Marine Research Institute
44-Beach Road, Tuticorin – 628 001, Tamil Nadu
E.mail: edwardjkpatterson@sdmri.in

ABSTRACT

The coral reefs are most diversified and complex ecologically sensitive coastal habitats and their associated biodiversity are one of the greatest natural treasures. The reefs provide humans with various benefits including food from reef fish, recreation for tourists and coastal protection. The reefs are ideal habitat as well as good feeding and breeding ground for various animals and thereby enhance fishery production.

The injudicious disturbances by the humans and deleterious effect by natural events created immeasurable loss to coral habitats and its beneficiaries. The human induced threats like destructive and unsustainable fishing practices such as trawling, shore seine, purse seine and push net operation, dynamite fishing, trap fishing, seaweed and other resource collection in reef areas, coral mining, untreated sewage disposal and coastal development activities such as salt pans, shrimp culture and industries caused damage to productive reef habitats and associated marine life. The steady increase of coastal population and its dependence on the ecosystem through fishing, tourism, industry and other coastal development activities has accelerated the damage further. The natural threats like climate change, cyclone, tsunami and storms also placed the coral reefs in a highly stressful state.

The natural recovery of reefs damaged by destructive fishing practices, mining, dynamite fishing etc. is often very slow due unconsolidated substrata that are unsuitable for settlement of new recruits. Hence, rehabilitation of the damaged / degraded reef areas is considered that would not only help to bring back the near original status and conserve threatened species, but also support the natural recovery process. The coral rehabilitation by following low tech and low cost transplantation technique has been practiced successfully in the Gulf of Mannar, Southeast coast of India since 2002 and certain protocols have been standardized. Precise and efficient techniques and proper monitoring are responsible for good survival and growth and minimal use of donor sites. The rehabilitation activity along with other conservation initiatives helped substantially in the conservation and management of coral reefs in the Gulf of Mannar, in particular the increase of live coral cover of about 5% in 6 years.

DEEPAK APTE

Deputy Director - Conservation, BNHS (PI)
E.mail: spiderconch@gmail.com

EDUCATIONAL QUALIFICATION: M.Sc. (By Research); PhD (synopsis submitted)

Fellowship and Awards

· Department of Ocean Development, Government of India
Title of the project: Nutritional value of low cost fishes off Bombay coast.
· Whitley Conservation Award by Shears Foundation in 2008 of Rs. 25,00,000/- for outstanding work in marine protected areas in Lakshadweep, India.

International Fellowships

1)Fellow LEAD India Cohort 9;
2)Fellow Duke University, USA;
3) Fellow Smithsonian Institution, USA;
4) Darwin Fellow, UK;
5) Whitley Fellow, UK

Work Experience (23 years)

Working atthe Bombay Natural History Society since January 1993

Present Designation

Deputy Director - Conservation

Job Involved

Research, Conservation action and advocacy
Established full fledge Marine Conservation Programme in BNHS

Research Projects ongoing / completed as Principal Scientist

1. All India Coordinated Project on Taxonomy-Mollusca: Funded by Ministry of Environment and Forests, Government of India. (Ongoing since 2000)
2. Establishment of Marine Protected Areas network in Lakshadweep Archipelago by Whitley Fund for Nature, UK (Ongoing since 2004)
3. Population ecology of Giant Clams funded by Whitley Funds for Nature (Ongoing since 2004)
4. Giant Clam Species Recovery Action Plan (Developed for MoEF, 2010-2020).
5. Marine biodiversity hotspot prioritization along Maharashtra coast (Ongoing)
6. Taxonomy of Opisthobranchs along Indian coast (Ongoing)
7. Preparation of Biodiversity Conservation Plan for Welspun Maxsteel (Ongoing)
8. Establishment of Marine Biodiversity Monitoring Protocols supported by Tata Power (Completed)
9. Conserving Giant Clams through establishment of a Community Reserve in the Lakshadweep Archipelago supported by Darwin Initiative, Government of United Kingdom (Completed)
10. Preparation of Management Plan for Yawal Wildlife Sanctuary supported by Maharashtra State Minor Irrigation Department (Completed)
11. Socio-economic status of coastal fishing community at Malvan Marine Sanctuary and proposed National Park- supported. (Completed)

Conservation Projects ongoing / completed as Principal Scientist

1. Satpuda Landscape Tiger Project (SLTP): Funded by Born Free Foundation, UK (Ongoing)
2. Mangrove Restoration and Education Project: Funded by ONGC (Ongoing)
3. City Forests (Ongoing)
4. BNHS Green Governance Programme (Completed)
5. BNHS Armed Forces Cell (Ongoing)

DEEPAK APTE

Deputy Director - Conservation, BNHS (PI)
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EIA/Campaigns ongoing / Completed as Principal Scientist

1. Mangrove habitat management and restoration for Tata Power (Ongoing)
2. Social and Ecological viability of Human River Project in Central India supported by SANCF (completed).
3. Impact of Uranium mining on Nagarjunasagar Wildlife Sanctuary supported by SANCF (completed). EIA critique sent to MoEF
4. Rapid surveys for habitat evaluation and corridor connectivity in Central India for conserving Wild Buffalo. (Completed)
5. NHAI Kaziranga Highway widening project (Completed)
6. Tata Power Transmission line EIA at Mumbai (Completed)

Research Publications

Full papers- 19, Short Papers- 11 and 3 manuscripts under review, in different peer reviewed National and International Journals.

Books published/under preparation

1. APTE, D.A. (1998) Book of Indian Shells published by Bombay Natural History Society, pp 191 with 15 coloured pates illustrating 313 species
2. APTE, D.A. (2009) Field Guide to the Marine Life of India (Under Publication by Bombay Natural History Society).

Technical Monographs Peer Reviewed/ Technical Reviewer

1. Global Coral Reef Monitoring Network (GCRMN) 2008 Node Summary – South Asia for IUCN
2. Marine Conservation Protected Areas (MCPA) Tool Kit for managers. Peer Reviewed for IUCN
3. Invited reviewer for journal 'Tropical Ecology' and 'Systematic and Biodiversity'
4. Invited reviewer for projects by Ministry of Environment and Forests in the field of Molluscan biodiversity

Monographs/Manuals Developed

1. APTE, D.A.et al (2005): Eco-Tour guide Training Manual for Lakshadweep
2. APTE, D.A.et al (2007): Setting up an MPA in Agatti, Training Manual.
3. APTE, D.A.et al (2008): Marine Protected Area Management in Agatti, Training Manual.
4. APTE, D.A.et al (2008): MPA Management Plan for the Agatti Conservation Reserve.
5. APTE, D.A.et al (2008): Eco-Tourism Guidelines in Agatti.
6. Dr. ARUN JOSHI and APTE, D.A.(2008): Environmental Education, In-service Teacher Training Resource Kit on Coral Reef

INTERNATIONAL EXPERIENCE

Participated in 23 Conferences, Training programmes and seminars

Professional Skills

PADI Advance Open Water Diving and Underwater Photography

CONSERVATION FOR SUSTAINABLE MANAGEMENT OF MARINE AND COASTAL BIODIVERSITY IN THE COTEXT OF COP 11

Sanjay Deshmukh, PhD
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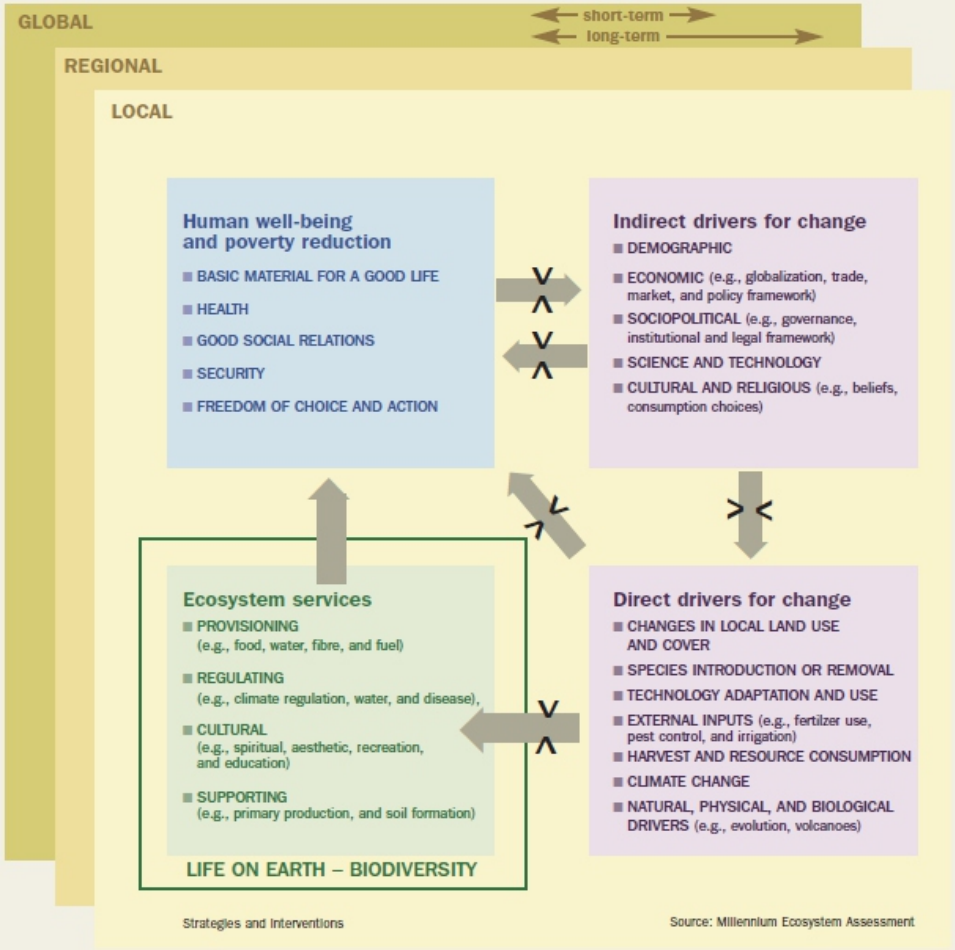
Introduction to Ecosystem and Ecosystem Services:

An *ecosystem* is a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit. The conceptual framework for the MA assumes that people are integral parts of ecosystems and the Report focuses on examining the linkages between ecosystems and human well-being and in particular on 'ecosystem services', which are the benefits that people obtain from ecosystems.

- ***provisioning services*** such as food, water, timber, and fibre;
- ***regulating services*** such as the regulation of climate, floods, disease, wastes and water quality;
- ***cultural services*** such as recreational, aesthetic, and spiritual benefits; and
- ***supporting services*** such as soil formation, photosynthesis, and nutrient cycling.



Ecosystem services include (see figure): Changes in drivers that indirectly affect biodiversity, such as population, technology, and lifestyle (upper right corner), can lead to changes in drivers directly affecting biodiversity, such as the catch of fish or the application of fertilizers to increase food production (lower right corner). These result in changes to biodiversity and ecosystems services (lower left corner), thereby affecting human well-being. These interactions can take place at more than one scale and can cross scales. For example, international demand for timber may lead to a regional loss of forest cover, which increases flood magnitude along a local stretch of a river. Similarly, the interactions can take place across different time scales. Actions can be taken either to respond to negative changes or to enhance positive changes at almost all points in this framework. Local scales refer to communities or ecosystems and regional scales refer to nations or biomes, all of which are nested within global-scale processes.

Marine and Coastal ecosystems and their Services:

Coastal and marine ecosystems are amongst the most productive ecosystems in the world and provide many services to human society; however, many of these ecosystems have become degraded. Food provisioning in the form of fisheries catch is one of the most important services derived from coastal and marine ecosystems. With more than a billion people relying on fish as their main or sole source of animal protein, fisheries in developing countries are a particularly important source of protein. Fisheries and fish products provide direct employment to 38 million people, with a further 162 million people indirectly involved in the fisheries industry (FAO 2004). The state of industrial fisheries is of concern as many people depend on their existence for food and employment, with many fisheries being over exploited.

Aquaculture is the fastest-growing food producing sector, accounting for 30% of total fish consumption. Other provisioning services from these ecosystems include curios and ornamentals for the aquarium trade, building materials (for example, for boat construction and house construction), and bioprospecting (the exploration of biodiversity for new biological resources, such as pharmaceuticals).

The seas and coasts around the world are of great spiritual importance to many people, providing cultural and spiritual services. Coastal tourism is one of the fastest growing sectors of global tourism and is an essential component of the economies of many small island developing states (SIDS). Much of the economic value of coral reefs is generated from nature-based and dive tourism, with net benefits estimated at nearly $30 billion annually. The cultures of many peoples are closely connected to coasts and oceans, and traditional knowledge has become an integral part of the dynamics of island and coastal ecosystems and their management. In addition, coastal and marine habitats are areas of research and efforts in education and public awareness.

Marine and coastal ecosystems provide supporting services in the form of a wide range of habitats. Estuaries, mangroves, lagoons, sea grasses, and kelp forests serve as nurseries for both inshore and offshore fish and other species, many of which are commercially significant. Other habitats such as beaches, dunes, salt marshes, estuaries and mud flats play an important role in the life cycle of, for example, fish, shellfish and migratory birds. Marine and coastal ecosystems play an important role in photosynthesis and productivity. Through mixing nutrients from upstream and tidal sources, estuaries are one of the most fertile coastal environments**.**

Convention on Biological Diversity:

CBD was adopted at Rio Earth Summit in 1992 and has now 193 countries as its Parties. The three main objective of CBD are: i) Conservation of biological diversity; ii) Sustainable use of the components of biological diversity and iii) Fair and equitable sharing of the benefits arising out of the utilization of genetic resources. Cartagena Protocol on Bio-safety adopted under CBD, governs movement of living modified organisms (LMOs) resulting from modern bio-technology from one country to another. This supplementary Protocol to CBD entered into force on 11 Sept 2003. CoP is the governing body of CBD and Meeting of the CoP serving as MoP to the Cartagena Protocol on Bio-safety. CoP and MoP meet once in two years to take decisions for the implementation of CBD and is attended by member governments, international organizations, civil society, academia and research institutions, private sector, media and others. India is incoming CoP President, will become CoP President at Hyderabad which will stay for the next two years – thus, providing a unique opportunity to strengthen the voices of developing countries in the global biodiversity agenda. Biodiversity conservation has an important role in poverty alleviation, achieving equity, national economic growth and assured happiness of millions of people. On biological diversity conservation and management, India speaks from the position of strength on issues which affect the developing world. India has also proposed five issues for discussion during High Level Segment of CBD CoP-11 and these are as follows:

a) Biodiversity and Livelihoods
b) Integration of value of Biodiversity in National Planning and Accounting Process
c) Strategy for Resource Mobilization
d) Coastal and Marine Biodiversity
e) Operationalisation of Nagoya Protocol

The Ministry of Environment and Forests (MoEF), Government of India (GoI) is hosting the sixth meeting of the Conference of the Parties serving as meeting of the Parties (CoP-MoP 6) to the Cartagena Protocol on Bio-safety and eleventh Conference of the Parties (CoP 11) to the Convention on Biological Diversity (CBD) at Hyderabad, southern state Andhra Pradesh from October 1-19, 2012. These meetings are being organized in collaboration with the Secretariat of CBD and State Government of Andhra Pradesh. Besides, the Ministry is also organizing a series of national and international events as run up to CoP-MoP 6 and CoP 11.

Given the fact that India is host to 11th Conference of Parties on CBD in October 2012, and that the decade of 2011 to 2020 has been declared decade of Biodiversity, as well as the decade on combating desertification and land degradation, an all inclusive communication strategy could not have found a better timing.

Biodiversity and Policy issues

It has been recognized that biodiversity contributes directly to poverty reduction by enhancing food security, ensuring health, sustaining income, reducing vulnerability and creating social safety net particularly during natural disaster through ecosystem components and services. This relationship is well recognized by Agenda 21 of the Earth Summit held in Rio de Janeiro in 1992, which declared that combating poverty involves promoting sustainable livelihoods. To achieve this, Agenda 21 calls for states to integrate environment and development at the policy, planning and management levels. However, recent assessment indicates that the total number of people living in poverty did not fall much below and a large proportion of poor people live in biodiversity rich areas.

The World Summit on Sustainable Development (WSSD) held in 2002 reaffirmed sustainable development as a central element of the international agenda and gave new impetus to global action to fight poverty and protect the environment. However, a study conducted by the Netherlands Environment Assessment Agency (Anonymous, 2009) shows challenging situation; decreasing poverty usually coincides with decreasing biodiversity, creating a 'win-lose' situation. Over-exploitation can lead to a collapse of the system and an increase in poverty with even more loss of biodiversity, and become a 'lose-lose' situation. Reducing poverty while conserving biodiversity - a 'win-win' can be achieved on a local scale. How to realize this win-win situation at large scale - at least at regional scale -is challenging.

Marine and coastal biodiversity and bioresearches

Marine and coastal areas, which include nearshore land and coastal waters up to continental shelf or to depth of 250m are rich in biodiversity and resources and play a key role in maintaining earth system functions including the regulation of weather, climate and hydrological cycle, as well as providing food materials and energy for human use. Coastal ecosystems such as the mangroves, coral reefs, sea grasses support a high diversity of species and are biologically productive. They act as bioshields and are the first line of defense in mitigating disasters.

It is a well-known fact that human settlements are highly concentrated in the coastal zone. The South Asian coastline alone is home to more than 400 million people, making it one of the most densely populated regions of the world. A large number of people, including poor communities, are dependent on the coastal and marine ecosystems for livelihood. There is intensification of resource use, driven by market pressures and rising consumption requirements.

These pressures are now being overtaken by large-scale land use changes and construction of infrastructure. There has been a rapid increase in the number of ports, offshore oil/gas exploration, thermal power stations, and manufacturing units. Large-scale commercial fisheries and agriculture too have exerted enormous pressure on the coastal and marine ecosystem. These activities can undermine the survival of coastal and marine ecosystems and the sustainability of services provided by the coastal and marine ecosystems. The threat is further compounded by the rise in sea level and occurrence of extreme weather events that have an adverse impact on the coastal populations leaving them vulnerable to disasters. As is often the case, it is the poor that have immense difficulties in coping with the impacts of natural disasters. Studies indicate that women and children are especially vulnerable.

In India, there are multiple governance frameworks and structures that administer the coastal and marine environment. While these are intended to have positive outcomes, overlapping jurisdictions, contradictory mandates and limited coordination hinders multiple agencies from working effectively in coastal India. Given this scenario, the challenge lies in reconciling livelihood needs and development vis-a-vis conservation.

Marine Biodiversity Conservation: National and International Issues:

Though human impacts on marine and coastal biodiversity are less understood and publicized than those on terrestrial systems, their potential effects are no less threatening. The major direct threats to marine and coastal biodiversity can be divided into five interrelated categories: pollution (from land based and other sources), over exploitation of marine living resources, introduction of alien species, habitat degradation caused by coastal development, and global climate change and ozone depletion. Some of the harmful human impacts on marine biodiversity stem from ignorance and lack of understanding of the importance of marine biodiversity and how it can be affected, which put marine resources on a lower priority level vis-à-vis land biodiversity. Unregulated use of resources, increase in demand for the resources and rapidly expanding coastal development put the marine resources at considerable risk. The belated realization of the need for action after the damage becomes apparent (and often when it is too late) perpetuates this destructive cycle. Communities that depend on marine resources face the long-term challenge of sustainability yet are often confronted with immediate economic hardship. For the developing country like India, action is hardly ever preventive, but is usually undertaken only after irreversible damage has occurred.

In the face of this increasing uncertainty, the adoption of a precautionary approach is a *sine qua non* to the conservation of marine and coastal biodiversity. The precautionary principle, which is now widely recognized as the emerging part of customary international environmental law, requires that no harmful action be undertaken until all the effects on marine and coastal biodiversity have been clearly identified and weighed against the expected benefits. Moreover, this precautionary approach should cover all the activities of past, present and future, bearing in mind the cumulative impact that these activities combined will have on marine biodiversity.

The following are the important instruments with greatest potential for synergy with the Convention on Biological Diversity.

1. United Nations Convention on the law of the Sea, Montego Bay, (UNICLOS). Agenda 21, Rio de Janeiro, 1992.
2. UN Agreement on Straddling and Highly Migratory Fish Stocks, New York, 1995, and FAO Code of Conduct for Responsible Fishers, Room 1995.
3. The UN General Assembly Drift-Net Resolution 46/15, 1991
4. UNEP Conference on Protection of the Marine Environment from Land Based activities, Washington, 1995.
5. Protocol on Substances that Deplete the Ozone Layer, 1987 (Montreal Protocol).
6. The Framework Convention on Climate Change, Rio de Janeiro, (FCCC).
7. United Nations Conference on the Sustainable Development of Small Island Developing States, Bridgetown, 1994.
8. Convention on International Trade in Endangered species, Washington, 1973 (CITES)
9. International Convention for the Prevention of pollution from Ships (MARPOL), 1973-1978.
10. The Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, London, 1972 (London Convention).
11. Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar, 1971 (Ramsar Convention).
12. International Convention for the Regulation of Whaling, Washington, 1946 (ICRW).

Action under the Convention on Biological Diversity:
The Conference of the Parties first addressed marine and costal biodiversity in a comprehensive way at its second meeting, establishing the “Jakarta mandate”. Renewed efforts are needed now to implement the Programme of Work on Marine and Coastal Biodiversity. This will involve cooperation with various partners at multiple levels, including FAO and other UN-Ocean members, regional seas organizations and conventions, regional fisheries management organizations, and other partners, all consistent with the United Nations Convention on the Law of the Sea.

The Strategic Plan for Biodiversity 2011-2020 adopted at COP-10 includes the Aichi Biodiversity Targets, with specific commitments for marine and coastal areas, thus providing additional impetus for the action on marine and costal biodiversity. These include:

Target 6 on the sustainable management of fish and other marine organisms:
“By 2020, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.”

Target 7 on sustainable aquaculture:
“By 2020, areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.”

Target 10 on the need to minimize, by 2015, the multiple anthropogenic pressures on coral reefs and other vulnerable ecosystems impacted by climate change or ocean acidification:
“By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.”

Target 11 on the protection of at least 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services:
“By 2020, at least 17 per cent of terrestrial and inland water areas, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.”

Livelihood and development vis-à-vis conservation

India's coastline is inhabited by 63 million people and the population is expected to rise to almost three quarters of the national population by 2020. At the same time, the coastline is pivotal to the country's economic development – there are a number of production activities taking place along the coasts for fisheries, aquaculture, agriculture, mining, tourism, ports, etc. It is well documented that these different resource uses have a negative impact on biodiversity. Considering the alarming rate of loss of biodiversity and increasing pressure on coastal resources, many management tools have been developed for the conservation and sustainable use of marine biodiversity. One of these tools is establishment of Marine Protected Areas and second major one is declaration of biodiversity rich areas as Marine Biosphere Reserve. These Protected Areas are declared under the Wild Life (Protection) Act, 1972 and the Wild Life (Protection) (Amendment) Act, 1991. Another tool is the declaration of biodiversity rich areas as Critically Vulnerable Coastal Areas (Ecologically Sensitive Areas) under the Coastal Zone Regulation Notification of 2011. The Marine Protected Areas are not extractive in the sense community is not allowed to use any of the resources in these areas, whereas in ecologically sensitive areas communities are permitted to use resources, with certain conditions. At the same time, the number of MPAs in India is limited and do not adequately represent or cover significant coastal and marine biodiversity. In addition, legal frameworks are inadequate to cover the livelihood aspirations of people and weak to development pressure.

Challenges to conservation of marine and coastal biodiversity

The improved conservation and sustainable use of marine and coastal biodiversity presents a number of challenges:

1. Habitat destruction: The driving force behind coastal degradation has been large development and infrastructure projects along the coast as well as unplanned and unregulated growth in coastal areas. Ecosystems and critical habitats that are constantly being challenged are mangrove forests, estuaries, mud-flats, coral reefs, small island ecosystems, coastal headlands and cliffs, coastal wetlands, sand dunes, etc.
2. Over-exploitation of bio-resources: Living bio-resources found in the coastal zone are heavily exploited, and often the exploitation is unsustainable. This includes banned species such as sea cucumbers, molluscs and sea horses. There is practically no data available on the exploitation of any of these species.
3. Pollution: The coastal zone receives waste generated by a number of point and non-point sources, especially sewage, industrial effluents, sediment, and agricultural chemicals, notably fertilisers and pesticides. These contribute to the degradation of the quality of coastal waters
4. Reduce impacts of natural and anthropogenic pressures on Ecological and Biological Sensitive areas (EBSAs).
5. Insufficient awareness by people of benefits they derive from marine and coastal biodiversity;
6. Governance challenges due to sectoral and fragmented approaches including those associated with the management of common property resources;
7. Poor integration of marine and coastal biodiversity concerns in the legal aspects of Environment Impact Assessment processes, and lack of awareness and sensitivity towards the issue of marine and coastal biodiversity among the judiciary, policymakers, decision-makers and administrators.
8. Additional challenges due to governance gap on biodiversity conservation in areas beyond national jurisdiction;
9. The inherent complexity of addressing multiple drivers of biodiversity loss with the spatial separation of causes and consequences;
10. Multiple and often competing interests (eg: fishing; extractive industries; tourism; conservation; land-based industry and agriculture);
11. Lack of capacity to address these challenges.

The Conference of Parties (CoP 11)

India is hosting the Eleventh Conference of the Parties (CoP11) of the Convention of Biological Diversity (CBD) in Hyderabad, in October 2012 and the CBD has identified that the themes for the International Day for Biological Diversity in 2012 is Marine and Coastal Biodiversity. It is expected that deliberations during CoP 11 will address and find answers to following questions:

a) How the present tools of conservation marine and coastal biodiversity are effective in conserving biodiversity?
b) Are these tools promoting integration of biodiversity conservation and livelihood enhancement?

c) Are these tools based on an adequate understanding of the impact on biodiversity of industrial/extractive/urban growth?
d) What are the current policy and governance challenges to coastal and marine biodiversity conservation? What is the role of community in the governance and management of marine protected areas and ecologically sensitive coastal areas?
e) What is the challenge posed by industrial/extraction/urban growth to the coastal and marine ecosystems and what measures can be taken to balance such development with conservation?

CoP 11 will also provide a platform to engage communities and policymakers on a range of issues that impact the coastal biodiversity. In this regard, the event will focus on the following themes:
a) Policy and Governance
b) Conservation
c) Livelihoods
d) Emerging Issues.

Topics for discussion during High Level Segment (HLS)
1. How can countries reduce the various land-based and sea-based threats to marine and coastal biodiversity and manage the multiple and often competing interests and demands? What legal frameworks, incentives and governance approaches work in practice?
2. How can countries cooperate regionally and globally to reduce various threats to marine and coastal biodiversity and effectively apply the ecosystem based integrated marine management? What area-based management tools, including marine protected areas, and other tools work in practice?
3. How can experience in establishing and managing marine and coastal protected areas in territorial waters be extended to the wider exclusive economic areas and to areas beyond national jurisdiction?
4. Besides supporting implementation of the work programme under the CBD on coastal and marine biodiversity, how does one evolve/ establish a long term review process for sustainable management of coastal and marine biodiversity?
5. How do we use available platforms such as Indian Ocean Rim Association for Regional Cooperation (IOR-ARC) to enhance cooperation among member states to share expertise and experience on coastal and marine biodiversity management?
6. How do we initiate efforts to implement the Nagoya Protocol on ABS and use the same to explore options for using ABS frameworks for dealing with coastal and marine resource management?
7. What further steps can be taken under the CBD, in cooperation with regional seas organizations, RFMOs and other international bodies and in full conformity with UNCLOS, to facilitate the achievement of the marine-related Aichi Biodiversity Targets as well as the commitments contained in the Johannesburg Plan of Implementation?
8. How do we strengthen the environmental and strategic impact assessment processes for coastal and marine areas that would be recognised both, in areas within the EEZ as well as in areas beyond national jurisdiction?
9. How do we create a policy and action dialogue space between CBD, UNCLOS, and the Ad Hoc Open Ended Informal Working Group on Study Issues Relating to the Conservation and Sustainable Use of Marine Biological Diversity beyond Areas of National Jurisdiction?

India is now very close to hosting COP-11 in October 2012. The COP-11 will be significant as it will mark the 10th anniversary of Johannesburg World Summit on Sustainable Development, 20th anniversary of the Rio Earth Summit and 40th anniversary of Stockholm Conference. We are confident India would provide through its Presidentship of CoP 11, the much needed leadership in conservation for sustainable management of global marine and coastal biodiversity.

SANJAY DESHMUKH, PhD
Professor of Life Sciences & Head, University Dept of Life Sciences
University of Mumbai

At the age of 37, Dr. Sanjay Deshmukh was selected as Professor of Life Sciences at the University Department of Life Sciences in 155 year old University of Mumbai (estd. 1857). He is he only Faculty of the University to have been recognised Teacher of the University to supervise research leading to PhD Degree in three Subjects, i.e., Botany, Life Sciences and Environmental Sciences. He is currently Chairman - Board of Studies in Life Sciences of the University of Mumbai.

Sanjay holds a PhD Degree in Science, which he obtained at the age of 25 from the University of Mumbai. At 30, he became a Recognised PhD Teacher of University of Mumbai as well as Ohio State University, Ohio, USA.

Sanjay was trained in China in 1991, in United Kingdom in 1993 and at IIM - Ahmadabad in 1996 in areas of farm forestry, global biodiversity management, and management of CPR (common property resources) respectively.

Sanjay has extensively travelled throughout the World (except Antarctica) spanning 43 countries for research and inter-governmental collaborations. He holds life memberships and elected fellowships of several prestigious Societies and Organisations.

Professor Sanjay is Elected Fellow of Scientific Bodies such as International Society for Biotechnologists, Society for Biosciences and is also recipient of several prestigious Awards such as IDRC - Canada Fellowship for Farm Forestry Research in China, the Colombo Plan Award (1993) by Govt. of United Kingdom, Indradhanu Yuvonmesh Puraskar (2004) constituted jointly by Indradhanu (a Cultural Organisation in Thane) and Loksatta Newspaper, Mumbai, LEAD Fellowship (2005) by LEAD International, UK, Fellowship of IIM-A, Ahmedabad, India (2006) for Studies in Management of Common Property Resources (CPR), Talented Scientist Award (2012) by International Society for Research on Medicinal Plants and Herbal Products, Johns Hopkins University, Rockville, MD, USA

Professor Sanjay has acclaimed wide recognition among global scientific community through his research. He has executed 26 research projects (with 3 on-going) with cumulative grants of 14 Crore and 80 Lakh Indian Rupees. He has to his credit, 172 publications, which include scientific papers, reports of research projects as well as science articles in newspapers.

Sanjay has so far, successfully supervised research of (a) 05 Students leading to PhD Degree, (b) 01 Student leading to MSc (by Research) Degree and (c) 68 Final Year M.Sc. Students leading to M.Sc. Degree (by Papers) in Environmental Sciences and (d) 45 Final Year M.Sc. Students leading to M.Sc. Degree (by Papers) in Life Sciences.

Professor Sanjay has been Member of Senate, University of Mumbai as Hon'ble Vice Chancellor's Nominee (2008-10). During 2008-2011, he held several important academic positions within the University system such as Chairman of the Board of Studies in Environmental Sciences (July 2008 - July 2011); Member of (a) BCUD (Board of Colleges and University Development), (b) RRC of Board of Studies in Life Sciences, (c) Academic Council, (e) Faculty of Sciences, (e) Standing Committee for M.M. Sharma Endowment Grants as well as University's Staff Welfare Committee, and (f) Library Committee of the University of Mumbai.

University Department of Life Sciences of the University of Mumbai under the leadership of Prof. Sanjay became only 4th Post-graduate Department of the University to have been selected by the University Grants Commission (UGC) of Govt. of India under its Special Assistance Programme (SAP), with a total Grant of Rs. 62 Lakh for the period 2009-2014. Professor Sanjay was Coordinator for re- accreditation of University of Mumbai by NAAC (National Assessment and Re-accrediation Council), Govt. of India.

In 2001, Professor Sanjay and his friends established a voluntary organisation called Konkan Nisarg Manch (KONIM), and was Chairman of the same from 2007 to 2012. KONIM with its subsidiary organizations works primarily in the areas of Medicinal Plants, Bamboo and Fruit processing - all linked with entrepreneurship development and livelihood enhancement of rural communities of Konkan region in Maharashtra. KONIM has acclaimed wide recognition in the form of following awards:

1. Best Cluster in India (Western Region) Award (2009): This Award, constituted by the Ministry of Micro, Small and Medium-scale Industries (MSMI), Govt. of India was conferred at the august hands of Hon'ble Prime Minister of India. This Village Industries Development Project in the area of Fruit processing was executed in 30 villages of Sindhudurg District, by Konkan Nisarg Manch.

2. Best Village Development Award (through Bamboo plantation) in NGO Category (2010): The Best Village Development Award (through Bamboo plantation) in NGO Category was awarded by the Ministry of Environment and Forests, Govt. of Maharashtra at the august hands of Hon'ble Chief Minister Mr. Prithviraj Chavan.

Professor Sanjay's research interests are Climate Change implications on coastal, inland, and agricultural biodiversity, ICT for rural development, Genetic resources conservation and their sustainable management, Environmental economics, Protected Area Management, CDM Technologies, Human Genetics, Neurological responses of humans to various stresses that lead to sleep disorders. Environmental Planning for Development of new cities, EIA of mega-projects, Management of Research and Administration, design and management of developmental organisations, to name a few. He would particularly like to use his professional skills to closely work with corporate leaders and policymakers and influence peoples' representatives to develop a political will for achieving sustainable development.

Dr. S. Balachandran
Assistant Director, BNHS (Co-PI)

Profile

Professional Bird Watcher and Scientist
Marine Biologist
Wetland conservation and Water birds specialist, Bird migration specialist

Employment and Work Experiences

Total Research Experience: 29 years

1. Assessment of wetland ecosystems including Tanks
2. Habitat evaluation of ChilikaLake with Special reference to birds as bio-indicators
3. Wader population and the habitat assessments in Kanyakumari saltpans
4. Impacts of climate change on avifauna of Point Calimere wetland
5. Habitat restoration of GreatVedaranyamSwamp for the benefit of migratory waders and fishery

Ph D. Guide/ External Referee

Ph D Guide MumbaiUniversity (since 2000)

External Referee

1. ManonmaniyamSundaranarUniverisy, Tirunelveli Tamil Nadu; .
2. PondicherryUniversity, Pondicherry

Qualifications

Ph D. AnnamalaiUniversity, Chidambaram, Tamil Nadu
Master Degree in Marine Biology, AnnamalaiUniversity, Chidambaram, Tamil Nadu

Externally Funded Research

1. 2010-2015: Waterbird population monitoring at ChilikaLake with special reference to wild birds disease surveillance.
2. 2010-2011: Satellite tracking of Greater Flamingos Phoenicopterusroseus at Point Calimere Wildlife Sanctuary. Funded by Ministry of Environment and Forests, Government of India.
3. 2009-2010: Elucidating international migration routes of priority waterbird species in India and the Central Asian Flyway to evaluate their potential to transmit highly pathogenic avian influenza Part – II Assam and West Bengal. Funded by UN Food and Agriculture Organization.
4. 2008-2009: Elucidating international migration routes of priority waterbird species in India and the Central Asian Flyway to evaluate their potential to transmit highly pathogenic avian influenza. Funded by Wildlife Conservation Society through UN Food and Agriculture Organization.
5. 2007-2008: Training for veterinarians and wildlife officials, avian influenza surveillance and waterbird monitoring in India, funded by Wildlife Conservation Society through Wetlands International, South Asia.
6. 2006-2010: An assessment of the impact of hydrological intervention on the bird population of Chilika. Funded by Chilika Development Authority, Government of Orissa.
7. 2006-2009: Restoration of Point Calimere (The Great Vedaranyam Swamp), a designated Ramsar site, for the Benefit of Fisheries and migrant Waterbirds. Funded by Ministry of Environment and Forests
8. 2006-2008: Bird Flu and waterbird population monitoring in India. Funded by Ministry of Environment and Forests
9. 2005-2007: A preliminary assessment of the Environmental Economics of the birds and Dugong Habitats of the Gulf of Mannar. Funded by the Ministry of Environment & Forests, Government of India.
10. 2005-2006: Habitat improvement measures for the birds of Pong Wetland. Funded by the State Council for Science Technology and environment (one year). Government Himachal Pradesh.

Dr. S. Balachandran
Assistant Director, BNHS (Co-PI)

11. 2005-2006: Population monitoring of migratory waterbirds in Chilika and Bhitarkanika with special reference to Avian Influenza. Funded by Wildlife Department, Government of Orissa
12. 2004-2005: A preliminary assessment of the Environmental Economics of the Pong Dam. Funded by the State Council for Science Technology and environment. Government Himachal Pradesh.
13. 2001-2005: Revaluation of Bird community Structure in the Palni Hills with special reference to the endemic and threatened birds- funded by the Ministry of Environment and Forests, Government of India
14. 2001-2005: Habitat Evaluation of Chilika Lake with special reference to birds as bio-indicators. Funded by Chilika Development Authority, Government of Orissa
15. 2001-2002: Habitat enrichment of the salt marshes of Bharat Petroleum Corporation Limited for birds. Funded by the Bharat Petroleum Corporation Limited

Contributions to Research Environment
Journal papers: 13, Short notes : 35; Symposium papers : 26 ; Reports : 34; Books : 5 and Workshop Proceedings : 2

Books published
1. Indian Bird banding Manual,
2. Birds of Point Calimere,
3. Bird Atlas of Chilika
4. Annotated Bibliography of Point Calimere
5. Status of water birds in Tamil Ndau wetlands (both in English and Tamil)

Workshop organised
- 2008: One day workshop on Point Calimere past, present and future- sponsored by National Biodiversity Authority, and Tamil nadu forest Department- 2008
- 2010. Two days National seminar on ""Management issues of Ramsar Sites in India and Prioritization of identified potential Ramsar Sites in Southern States- Sponsored by TamilnaduForestDepartment-

Workshop attended
National - 14; International- 15 ; Countries Visited - 10

Achievement in Research Environment
- Established India's first "Bird Migration Study Centre" at Point Calimere.
- Undertaking the first large scale satellite tracking studies in India in collaboration with the UN Food and Agriculture Organization (FAO).

Advisory Role
- 2007-211: State wildlife advisory board member of Orissa state
- 2009: Member to the National Biodiversity Authority to prepare the Guidelines for the State biodiversity Heritage Sites.

Contributions to wider community
- Organized 43 training programmes for volunteers, researchers, NGOs and amateurs across India.
- 25 Waterbird census programmes across India veterinarians in wild bird handling
- Organized two national workshops on wetland conservation and Management in India
- Organized one international training programme in Bangladesh
- Organized 12 training programmes for the wildlife staff across India in Bird Migration and wetland Management.

Felicitation
Felicitated by Government of Tamil Nadu for serving for the Conservation of Birds more than a quarter century

NEW APPROACH TO MARINE FISH STOCK ASSESSMENT

Dr. E. Vivekanandan
Madras Research Centre of Central Marine Fisheries Research Institute, Chennai 600 028
Email: evivekanandan@hotmail.com

ABSTRACT

Information from stock assessment is a fundamental need for managing marine fish resources. The assessments are useful for understanding the status of stock biomass vis-à-vis fishery yields, regulation of fishing efforts, fixing catch quotas and for estimating fishing capacity and optimum fleet size. With growing concerns on sustaining the marine fish resources, the need for stock assessment has assumed great importance as never before. After the path breaking mathematical model developed by Beverton and Holt in 1957, several innovations and advancements have happened in fish stock assessments with an objective to achieve realistic and accurate estimates. The exemplary works by Daniel Pauly & his team and the scientists of CMFRI since the early 1980s to extend temperate-fish-centric approach to tropical fish stocks paved the way for assessing a number Indian fish stocks in the last three decades. The models such as cohort analysis, yield-per-recruit model, Thomson & Bell model, which existed much before 1957, were applied to tropical stocks not only to understand the existing stock status, but also for fishery predictions. Emergence of computer packages such as ELEFAN, FiSAT, YIELD etc aided easy handling and quick analysis of large volumes of data. These models, known as analytical models, based essentially on estimation of growth and mortality of single species, are applied extensively by Indian scientists. Parallel to these methods, holistic models such as surplus production model and swept area method, which do not demand biological data, are also used. Most of these models, known as single-species models, do not take into account that fish are embedded in the ecosystem with strong trophic linkages. Hence, for multispecies fisheries that exists in India, fisheries management plans could not be formulated based on these assessments. As a result, most of the assessments turned out to be simple scientific exercise without application value.

In the early 1970s, following terrestrial ecosystem models, Polovino and his team developed a coral-reef ecosystem model, which comprised of commercially harvested fish groups. In the 1990s, Pauly and his team improved this model and developed a software programme called Ecopath with Ecosim. This is a mass-balance, trophic model with an ecosystem approach in which fish constitute functional groups. As growth, mortality and biomass estimates from single species assessments are major inputs into this model, it is not considered as a replacement, but as advancement over the conventional single-species models. The model accounts for energy flow between different functional groups within the ecosystem. The output of the model includes biomass estimates and fisheries simulations with reference to different attributes such as fishing effort. With more importance given to Ecosystem Approach to Fisheries (EAF) management, which emphasizes the need for spatial management of the ecosystem several other models with an ecosystem approach have been developed. SEAPODYM, developed by Patrick Lehodey, is also a trophic model aimed specifically at highly-migratory tunas. Recognising the central principle that fishery yields are ultimately limited by ecosystem primary production, in the year 2012, Friedland and his team has evaluated pathways between primary production and fishery yields. As data on these pathways are gathered from remotely-sensed satellites, a quick evaluation and forecast on fishery yields from large marine ecosystems are possible. On one hand, scientific advancements in gaining insights into fisheries and ecosystem assessments are gaining momentum, and on the other hand, concerns are raised on the relevance of these models in future years as evidences are accumulating that climate change is altering fish distribution pattern, abundance and composition, thereby changing the structure and function of marine ecosystems.

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Biography

Dr. E. Vivekanandan acquired M.Sc. degree (Marine Biology, Annamalai University) in 1972 and Ph.D. degree (Fish Energetics, Madurai University) in 1976. He joined Indian Agricultural Research Service as Scientist in Central Marine Fisheries Research Institute in 1976. Since then, he served CMFRI as Senior Scientist and Principal Scientist and in different capacities for 35 years, which include Head, demersal Fisheries Division and Scientist-in-Charge, Madras Research Centre of CMFRI.

His core areas of research were fish stock assessment, marine ecosystem modeling, marine mammals, coastal fisheries management, and climate change. His contributions include fisheries management advisories, regional collaboration on marine fisheries in south and southeast Asia with organizations such as FAO, Bay of Bengal Large Marine Ecosystems, Bay of Bengal Programme – Intergovernmental Organisation and World Fish Center. On invitation, he served as Fisheries Team Leader in the UN Project "Oceanographic Survey in Support of Damage Assessment" at King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia for one year in 2003. He has widely travelled and has served in several government constituted committees He was Editor, Journal of Marine Biological Association of India during 2008-2011. He has supervised Ph.D. research programmes and five students acquired doctoral degree of Madras University under his guidance. He has authored 157 publications, which include 67 research papers in peer-reviewed journals, 15 books/chapters and a number of national and international technical reports. He retired on superannuation as Principal Scientist & Scientist-in-Charge, Madras Research Centre of CMFRI on April 30, 2012; and rejoined in the same Centre as Consultant & Emeritus Scientist.

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EDUCATION:
M.Sc. - Microbiology, University of Pune, India.
Ph.D. - Molecular Biophysics Unit, Indian Institute of Science, Bangalore, India.

POSTDOCTORAL RESEARCH:
Department of Microbiology, GBF (National Research Center for Biotechnology), Germany. Feb. 1993 – Dec. 94.

CURRENT POSITION
Scientist 'F', National Center for Cell Science, Pune, India. Feb. 2004 – present. &
In Charge, Microbial Culture Collection

RESEARCH INTERESTS:
Molecular and evolutionary biology. Comparative Microbial Genomics. Insect Diversity and Genomics, microbial diversity of insects.
Currently Principal Investigator of Microbial Culture Collection project at NCCS

PUBLICATIONS:
Journal and Review articles: 125
Abstracts: 150
Invited Talks: 50
Popular Science Talks: 30

RESEARCH GRANTS:
Several peer-reviewed grants on molecular and evolutionary biology and genomics. CSIR, DBT, LSRB, ICMR, DRDO, ISRO, and DST.
International grants like UKIERI, SIDA and FIRCA

OTHER ACADEMIC RESPONSIBILITIES:
Teaching:
Microbial Genetics, Genomics, Molecular Taxonomy and Molecular Biology.

Research Guidance (past and present):
Post-doctoral fellows: 4; MS/PhD students: 15; Project/summer trainees: 30;
Project JRF's/assistants: 20; Visiting Scientists: 5.

Meeting/Symposia/Conferences:
Organized: 6, Attended: 17; Invited Lectures: 50

BIODIVERSITY INCLUSIVE IMPACT ASSESSMENT

Dr. Prasad Modak
Ms Sreemoyee Chakraborty, Senior Environmental Specialist and
Dr Prasad Modak, Executive President, Environmental Management Centre LLP

ABSTRACT

Impact Assessment (IA) is a procedure used for identifying future consequences of current or proposed actions. IA is used to ensure that projects, programmes and policies are economically viable, socially equitable and environmentally sustainable. Environmental Impact Assessment (EIA) (carried out for individual projects) and Strategic Environmental Assessment (SEA) (carried out for policies, programmes and projects) are the two primary approaches that are taken to accomplish conservation, sustainable use and equitable sharing of natural resources during any anthropogenic activity which entail resource exploitation and discharge of pollution.

Due to the increasing entropy caused in the ecosystem by anthropogenic disorders, a need was seen to address biodiversity related issues on explicit basis. The Conference of Parties (COP), at its sixth meeting had endorsed draft guidelines for incorporating biodiversity related issues into EIA legislation and/or processes and also in SEA taking into account the ecosystem approach. These guidelines were adopted with annotations on their relevance to the Ramsar Convention by the eighth meeting of the Conference of the Contracting Parties to the Convention on Wetlands. The seventh meeting of the COP to the Convention on the Conservation of Migratory Species of Wild Animals welcomed the endorsement by the CBD-COP of the guidelines and urged its Parties to make use of them as appropriate (Resolution VII.2).

Thus the integration of biodiversity related issues at each stage of EIA and SEA gave rise to an approach termed as 'Biodiversity Inclusive Impact Assessment'(BIA). The procedure was defined by incorporating biodiversity related issues at each stage of an EIA or SEA process.

BIA puts forth key questions such as

- Does the intended activity affect the physical environment in such a manner or cause such biological losses that it influences the chance of extinction of cultivars, varieties, populations of species, or the chance of loss of habitats or ecosystems?
- Does the intended activity affect the physical environment in such a manner or cause such biological losses that it influences the chance of extinction of cultivars, varieties, populations of species, or the chance of loss of habitats or ecosystems?
- Does the intended activity surpass the maximal sustainable yield, the carrying capacity of a habitat/ecosystem or the maximum and minimum allowable disturbance level of a resource, population or ecosystem?
- Does the intended activity result in changes to the access to and rights over biological resources

The Indian EIA system today lacks both SEA and BIA related perspectives and procedures. Hence, aspects related to biodiversity are not emphasized and are weak when it comes to development of protection, conservation, adaptation as well as remediation plans. This paper presents a framework with procedures that integrates SEA and BIA in the EIA Notification for consideration of the Ministry of Environment and Forests (MoEF)

Key words: biodiversity-related issues, conservation, sustainable use, equitable sharing, Convention on Biological Diversity, Environmental Impact Assessment, Strategic Environmental Assessment, Conference of Parties

BIODIVERSITY INCLUSIVE IMPACT ASSESSMENT

Dr. Prasad Modak
Ms Sreemoyee Chakraborty, Senior Environmental Specialist and
Dr Prasad Modak, Executive President, Environmental Management Centre LLP

ABOUT

Dr. Prasad Modak is the Executive President of Environmental Management Centre LLP (EMC). He has worked with almost all key UN, multi-lateral and bi-lateral development institutions in the world as well as various Governments on environmental policy and management. Dr Modak's work over the past three decades has influenced environmental policies, investments and practices on a global basis.

He has been working in the field of Environmental Impact Assessment (EIA) and has conducted numerous training programmes in India and various countries.

He has co-authored a book on EIA with UN University and Oxford University Press that has been translated in Chinese and Japanese. He has been extensively working with institutions such as the World Bank and Asian Development Bank on Environmental and Social Safeguards. In addition to the helms at EMC, Dr Modak is Professor (Adjunct) at IIT Bombay and Corporate Consultant (Environment & Infrastructure) for IL&FS Ltd.

Ms. Sreemoyee works as a Senior Environmental Specialist at Environmental Management Centre LLP (EMC). She is gold-medalist post graduate (M.Sc) in Environmental System Management from Department of Applied Geology and Environment Management, Presidency College, Kolkata. She has a Bachelor of Science in Zoology Hons., from the University of Calcutta. Sreemoyee has work experience of over 2 years in the areas of Environmental Management Systems, Awareness and Capacity Building, Sustainability, Research and Development, Environmental Education and Conservation Initiatives in India.

Sreemoyee was awarded the 'Young India Environmentalist Award 2010' by Rotary International, India for her outstanding initiatives environment. She had also received the 'Ekoaward 2008-09' from EMC, Mumbai for her topic of research: 'Local Preferences of Ethnobotanic Species and its Implications in Environmental Conservation'.

MARINE BIOINVASION AND INCURSION MANAGEMENT

Dr. A. C. Anil
Chief Scientist, CSIR- National Institute of Oceanography, Dona Paula, Goa

ABSTRACT

Marine bioinvasion is one of the serious threat to global biodiversity. Organisms in their native environment live in semblance and biodiversity is governed by ecosystem interactions. Introduced in an alien environment, organisms can bring about undesired imbalances in the ecosystem. Such a scenario points out bioinvasion concern is a two-way traffic i.e. what is native to one environment can be alien to others and vice versa. In addition, there are human health related issues that is interconnected with spread of invasive alien species. Unlike other marine pollutions, the impact of bioinvasion increases with time. In the marine environment, invasions can be facilitated by the activities that are related to ships, fisheries, marine structures, altering habitats and even careless release of organisms either intentional or accidental. The talk will provide an overview of marine bioinvasion and incursion management.

ABOUT

Dr. Arga Chandrashekar Anil

Positions held (in chronological order):

Position	Duration	Employer
Scientist	Aug.1991 Onwards	National Institute of Oceanography, Dona-Paula, Goa- 403 004, India
Monbusho Fellow University of Tokyo Japan.	Oct.1986-Mar.1991	Govt. of India & Govt. of Japan
Research Fellow	Dec.1981-Sept.1986	National Institute of Oceanography, Dona-Paula, Goa- 403 004, India

Academic qualifications (Bachelor's degree onwards):

Degree	Subjects	University/Institute
Doctor of Agr. (Fisheries Oceanography)	Marine Ecology*[2]	University of Tokyo, Japan
Ph.D.	Marine Biofouling *[1]	National Institute of Oceanography (Karnataka University)
M.Sc.	Marine Biology, Karnataka University	
B.Sc.	Chemistry, Botany & Zoology, Mysore University	

MARINE BIOINVASION AND INCURSION MANAGEMENT

Dr. A. C. Anil
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Theses :
*1 Studies on marine biofouling in the Zuari estuary (Goa), west coast of India.
*2 Studies on macrofouling ecology of cirripedes in Hamana Bay, Japan.
(Title In Japanese: Hamana -Ko-Ni Okeru Fujitsubo Rui No Seitai Gakuteki Kenkyu)

Research Publications:
In National and International Peer Reviewed Journals- 84

Research Supervision Ph.D.
9. Studies on Phytoplankton ecology with special reference to Harmful Algal Blooms.
(Maria Shamina D'Silva - Thesis Submitted to Goa University)
8. Studies on settlement and recruitment of the barnacle *Balanus amphitrite*
(Chetan A. Gaonkar, 2011 – Goa University)
7. Complexity and Population Regulation in Unicellular Algal Cultures of *Tetraselmis*: An Insight into Individual and Social Interactions.
(Mani Arora, 2011 – New Castle University, UK)
6. Studies on phytoplankton with reference to dinoflagellates.
(Ravidas K. Naik, 2011 – Goa University)
5. Studies on phytoplankton - bacterial interactions.
(Ms. Priya D'Costa, 2011 – Goa University)
4.Studies on ecology of epibiotic diatoms.
(J.S. Patil, 2004 – Goa University)
3.Eco-biology of marine diatoms with emphasis on the influence of physico-chemical parameters.
(S. Mitbavkar, 2003 – Goa University)
2. Studies on some ecological aspects of *Balanus amphitrite* (Cirripedia: Thoracica)
(D.V. Desai, 2002 – Goa University)
1. Studies on some bio-activity aspects of selected marine organisms
(N.L. Thakur, 2001 – Goa University)

Contribution to review in journals
- Member Editorial Board for the Journal Marine Ecology Progress Series (MEPS, published by Inter Research)
- Reviewer for Journals: Marine Biology, Journal of Experimental Marine Biology and Ecology, Scientia Marina, Biofouling, Microbial Ecology, Indian Journal of Marine Sciences
- Invited member of the reader panel of the journal Nature. (October 2008-2009)

Contribution to delegations / R&D activities.
- Represented India as a delegate to the Marine Environment Protection Committee Meeting for MEPC 52, 53, 55, 56, 57, 58, 59 60 & 62 sessions of International Maritime Organization (IMO).(2004 – 2011)
- As a member of Indian delegation for the 3rd CSIR-NSFC Workshop "Estuaries of China and India". Shanghai, China from 22nd to 24th November 2010.
- Member - Organizing committee for 76th Annual Meeting of the Indian Academy of Sciences
- Participated in the working group meeting as a Member of the Land-Based Pollution Source Working Group (for IW-Science project executed by UNU-INWEH and implemented by UNEP.), Athens, Greece from October 05th to 07th 2010
- Keynote speaker at the VIII Meeting in Biofouling Bio Corrosion and Benthic Ecology at Instituto De Estudos Do Mar Almirante Paulo Moreira, Brazil,
- Convener, International Conference on Biofouling and Ballast Water Management, at NIO, Goa, 5-7 February, 2008.
- As a member of Indian delegation for the 2nd Joint CSIR-NSFC Workshop on "Ocean Processes in relation to changing climate in Asia-Oceania" at Qingdao China from 20-22 November 2007
- Member, Country Project Task Force (India) for GEF project, administered by International Maritime Organization (IMO): Global Ballast Water Management Programme
- Represented Global Ballast Water Management Program (IMO) in the 12th International Conference on Aquatic Invasive Species, Windsor, Ontario, Canada June 2003

STATUS OF MANGROVES IN MAHARASHTRA WITH HIGHLIGHTS ON THE RECENT OIL SPILLS

Dr. Swapna Prabhu
Systematic Botanist, BNHS (Co-PI)

ABSTRACT

Majority of the mangrove forests of Maharashtra have vanished due to anthropogenic pressures in the recent years. During the last 25 years, about 40% reduction in the mangrove cover of Maharashtra has been due to human interference and State Kharland Development Board (Shindikar 2002). Wood felling and habitat conversion under tremendous pressure of urbanization and industrialization are the two major threats observed for the mangroves of Maharashtra. Pollution of the brackish water due to the industrial and sewerage discharge is another serious factor along the coastal belt of Maharashtra.

The extent of coverage, diversity and the high level of threats make mangroves of Maharashtra highly sensitive ecosystems. Owing to the absence of detailed documentation and awareness among local communities these mangroves are far away from recognition as special habitats and their conservation is largely impeded. With this background BNHS has started detailed documentation of ecological status of mangroves of Maharashtra and locale- specific major threats to their conservation.

As a part of this the recent oil spill incident (that occurred as a result of collision between the cargo vessels MSC Chitra and MV Khalija near Uran in August 2010) was studied to analyse its impact on mangrove communities of affected coastal areas of Mumbai and Raigad Districts. The objectives were (i) To characterize the Mangrove Habitats along the coast of Mumbai and Raigad District as affected by the oil spills, (ii) To map and quantify Mangrove and other coastal habitats affected by oil spill, (iii) To assess likely damage to the mangrove habitats and regeneration due to the oil spill, (iv) To recommend mitigation plans, compensatory measures for losses to mangrove habitats.

This one year study showed partial recovery in absence of repeated events of spills. However, more seasonal observations would help to know the recovery profile and chronic effects on the species assemblages, phenology or overall wellbeing of the ecosystem.

ABOUT

Dr. Swapna D. Prabhu, Systematic Botanist, BNHS (Co-PI)
Educational Qualifications: M.Sc, PhD.

Professional experience and training

1. Studies onprimitive Konyak Nagas of MonDistrict, Nagaland, India by Applied Environmental Research Foundation, Pune with financial aid from MISEREOR, Germany

2. Study of sacred groves from northern Western Ghats, India by Applied Environmental Research Foundation, Pune, financial aid from Earth Love Fund, UK

3. Study on impact of human activities on the buffer zone ecosystems of Nokrek Biosphere Reserve in Meghalaya, India by North-Eastern Hill University, Shillong, India, sponsored By Ministry of Environment and Forests, Government of India

4. Environmental Impact Assessment of Hydroelectric Project on Teesta River at Chungthang, Sikkim

5. IndFauna, the Electronic Catalogue of known Indian fauna by National Chemical Laboratory, project funded by Department of Biotechnology

6. IndOBIS, the Ocean Biodiversity Information System for Indian Ocean by National Chemical Laboratory, project funded by Department of Biotechnology.

Training course

- GBIF III Ecological Niche Modelling Workshop organized by University of Kansas (KU, Kansas) and The Autonomous University of Mexico (UNAM, Mexico), in close collaboration with Ashoka Trust for Research in Ecology and the Environment (ATREE, Bangalore, India), American Museum of Natural History (AMNH, New York, USA) and National Chemical Laboratory (NCL, Pune, India).

STATUS OF MANGROVES IN MAHARASHTRA WITH HIGHLIGHTS ON THE RECENT OIL SPILLS

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Research Articles

1. Godbole, A., Watve A., Prabhu, S. and SarnaikJ.1998. Role of Sacred Groves in Biodiversity Conservation With Local People's Participation : A Case Study From Ratnagiri District, Maharashtra. In: Ramakrishnan, P.S., Saxena, K.S., and Chandrashekhara, U.M. (Ed.) Conserving The Sacred For Biodiversity Management. UNESCO, Oxford & IBH Publishing Co. Pvt. Ltd., N. Delhi.
2. Godbole A. Prabhu, S. and Konyak, L. 1997. Indigenous Knowledge Used For Sustainable Livelihood By Primitive Konyak Nagas From Northern Nagaland, India. Proceedings of the XI World Forestry Congress, Antalya, Turkey.

3. Godbole, A., Sarnaik, J. and Prabhu, S. 2000. Revival of tradition of sacred groves with people's participation: Experiences from India. Proceedings of National Workshop on Community Strategies on the Managementof Natural Resources, IGRMS, Bhopal.

4. Ralte, V., Pandey, H.N., Barik, S.K., Tripathi, R. S. and Prabhu, S. D. 2005. Changes in microbial biomass and activity in relation to shifting cultivation and horticultural practices in subtropical evergreen forest ecosystem of north-east India. Acta Oecologica 28(2):163-172.

5. Barik, S. K., Prabhu, S. D. and Pandey, H. N. 2006. Ecosystem and taxonomic diversity in Nokrek Biosphere Reserve in northeastern India G. B. Pant Himalayan Biosphere Reserve Bulletin.

6. Barbhuiya, A. R., Arunachalam A., Khan M. L., Prabhu, S. D. and Chavan, V. 2008. Traditional beliefs, species composition and conservation sacred groves in Arunachal Pradesh. In: Arunachalam A. and Arunacham K. (eds) Biodiversity Utilization and Conservation. Avishkar Publication, India.

7. Chavan, V., Prabhu, S. D. and Navlakhe A. R. 2008. Sacred Groves Information System. In: Krishna N. (ed) "Ecological Traditions of Maharashtra". CPR Environmental Education Centre, Coimbatore, India.

8. Prabhu, S. 2008. Special habitats and threatened plants of Meghalaya. In: Rawat G. S. (ed) Special Habitats and Threatened plants of India. ENVIS Bulletin, WII. Vol. 11(1): 83-90.

9. Barbhuiya, A.R., Khan, M.L., Arunachalam, A., Prabhu, S. D. and Chavan, V. 2009. Sacred groves: informal protected areas in the high altitudes of Eastern Himalaya, Arunachal Pradesh, NortheastIndia: traditional beliefs, biodiversity and conservation. In: Frank Columbus (ed). "National Parks, Biodiversity, Conservation and Tourism. Nova Science Publisher, Inc., Hauppauge, NY.

10. Prabhu, S. D., Barik, S. K., Pandey, H. N. and Tripathi, R.S. 2011. Impact of landuse changes on plant species diversity of Nokrek Biosphere Reserve, Meghalaya, India. JBNHS (Accepted).

Reports

1. Apte, D. and Prabhu S. 2009. 'Environmental Impact Assessment of Proposed Transmission Lines by Tata Power at Mahul Creek, Trombay' submitted to Tata Power Corporation, Mumbai.

2. Apte, D. and Prabhu S. and Parasharya D. 2009. 'Marine Biodiversity Benchmarking for CGPL UMPP at Mandvi-MundraCoast' submitted to Coastal Gujarat Power Ltd., Gujarat.

3. Apte, D. and Prabhu S. 2011. 'Study of Impact of Oilspill on Mangroves and Fauna of Mumbai and RaigadCoast' submitted to the Ministry of Environment & Forest, New Delhi.

MONITORING MANGROVES AND DEVELOPMENTAL ACTIVITIES ON ALIABET, BHARUCH DISTRICT FROM 1975-2012

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ABSTRACT

Aliabet was an island representing a long linear sandy river mouth bar in Narmada River. Over a period of time this land mass has shown substantial changes in terms of its configuration and vegetation. The main objective of this study is to evaluate the changes in mangrove cover and developmental activities along an island over a period of time by using remotely sensed satellite data. The area is covered in 1:50,000 scale SOI(Survey of India) toposheets numbers 46C/10, 46C/11 and 46C/14.The changes were studied based on the comparison of data retrieved from the toposheets (Base line information) and satellite data of different time scale such as1978, 1987,1997, 2004 and 2012. The recent satellite image was georeferenced with help of GCP points collected at the time of field. The other images were georeferenced with referenced image and then subjected to analysis. The analysis was done using visual interpretation technique in which the mangrove vegetation and industries were marked for different year. The comparison of the satellite data of the different time scale shows substantial changes in the configuration, vegetation cover and development of an area. Aliabet which was earlier an island in the Narmada estuary has got merged with the main land. The major portion of it is mudflat which shows both erosional and depositional features on the northern and southern flank respectively. This change in the geomorphology has led to considerable change in the overall vegetation especially in the mangrove which is going to play a very important role in improving slope stability, consolidating sediments and to protect the shoreline. The mangroves vegetation has decreased drastically compare to the area retrieved from the toposheets and year 1997. The developmental activity mainly includes the development of industries such as saltpan, aquaculture ponds and oil based industries. Till year 1995 Aliabet was not encroached by any industries but in 1997 saltpans were developed at the northern side of Ambheta village. Later on in year 2002 oil excavation started and in recent past aquaculture industries have come up in the area. This development had indirectly leaded the development of the road network and thus the area is easily approachable which was not possible earlier because of the muddy substratum and dense creek network. Thus, changing configuration, decreasing mangrove cover and increasing industries in the area are of great concern for the environmentalist in order to protect the coastal environment.

Key words: Mangroves, Remote sensing, Aliabet,

INTRODUCTION

Mangroves are a group of highly evolved halophytes occupying the intertidal zone in estuaries, lagoons and coastal mudflats along tropical and sub tropical coastlines. They are considered to be one of the most productive and biodiverse wetlands on earth (Mitsch and Gosselink, 1993; Odum *et al.,* 1982). But, till about 1960s, mangroves were largely viewed as “economically unproductive areas” and were therefore destroyed for reclaiming land for various economic activities (Hirway and Goswami, 2004). However, mangroves play a crucial role in the balancing coastal ecosystem. They are “protector of shoreline” and play an important role in reducing the coastal erosion. They act as breeding and nursery ground for a number of commercially important marine organisms such as crabs, shrimps and fish species. Mangroves trees are very well known site for the collection of honey and tannin. They also provide fodder, wood for the construction of houses, boats and even as fuel and in this way mangrove give livelihood to the coastal community. Thus, although they are of great economic and ecological values, their importance was not appreciated till December, 2004. The attack of Indian Ocean Tsunami on 26th December, 2004 have raised the value of mangrove substantially as “bioshield” (Kar and Kar, 2005 and Kathiresan and Rajendran, 2005) and hence, their conservation and plantation activities have been increased over south east Asia (Feagin *et al*.,2010). The increase in the awareness and plantation activities can be retrieved from the report of Forest Survey of India 2011, which suggests that in India mangrove cover has been increased to 4662.56 sq km over a period of time (Anon, 2011). The report has also mentioned about the rise of 12 sq km in mangrove cover of Gujarat state. But the massive development along the coast has put a tremendous pressure on the coastal ecosystem. This has threatened not only to mangrove but also to coral reef, algal beds, estuaries and mud flats which are important constituents of the coastal ecosystem (Nayak, 2000). In the present investigation one such location is selected which faces substantial change in its configurational, vegetational and developmental aspects. The present paper focuses on the monitoring mangroves

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and developmental aspects of an Aliabet which was an island at the mouth of Narmada river in the past and now has lost its identity as an island and got merged with the mainland.

The present study area falls under the Vagra taluka, Bharuch District of the south central Gujarat and constitutes a marginal strip of the southern Gujarat alluvial plain. Aliabet was an island representing a long linear sandy river mouth bar in Narmada, trending parallel to the tidal flow. It is located between 72°32'0"E to72°50'0"E Latitude and 21°30'0"N to 21°40'0"N Longitude (Fig.1). Aliabet was about 30 km in length 13 km in width and east-west aligned island. It was an unturned liver shaped island whose central part was well stabilized. The Aliabet was covered by dense forest of marine trees (mangroves) growing upon dark clayey soil, different from the siliceous deposit left by the floods higher up in the channel of the river (Anon, 1961). It contains no springs of fresh water and the greater part of its surface is liable to be covered by the tide. Over a period of time Aliabet has increased in size and thus changed in its shape. The unique position, changing mangrove cover and its selection under the Special Industrial Region (SIR) has created keen interest to monitor the developmental activities and mangroves over a period of 37 years.

MATERIALS AND METHODS

To monitor the area for any change detection study an accurate, up-to-date and comprehensive scientific database is required. The data can be obtained either by conventional methods or through geospatial technology. Conventional methods require a lot of time, effort and funds, and present information of only a small area where as, remote sensing with its synoptic, multispectral and repetitive coverage, is very useful in the study of mapping mangrove areas, biomass estimation, its association with other plant communities and changes in their conditions, through time and space (Nayak, 1994). In the last few years a considerable work has been carried out in mapping and assessing mangrove ecologies along the coastal regions of the world using the remote sensing techniques (Hardisky *et al*., 1986; Green *et al*., 1996; Perez *et al*., 2002). In India, a large number of workers have worked on the change detection studies with special emphasis on the mangrove (Ramachandran *et al*., 1998, Nayak and Bahuguna, 2001, Tattu *et al*., 2008). In the present study the remote sensing technique has been used to monitor changes in the mangrove and developmental aspects of an Aliabet.

Historical data of the area was obtained from the Survey of India (SOI), topographic sheet index 46C/10, 46C/11 and 46C/14, having scale of 1:50,000 while the satellite data was obtained from National Remote Sensing Centre (NRSC). Remotely sensed satellite data of low tide condition and for different time scale such as 1978(Landsat-MSS), 1987(Landsat-TM), 1997(IRS 1C-LISSIII), 2004(IRS P6-LISS III) and 2012(IRS P6LISS III) was used for the study. The recent satellite image was georeferenced with help of GCP points collected at the time of field. A second order polynomial model with Geographic Lat/Long as the projection and Everest as the datum and spheroid was used to geocorrect the image. This corrected image was later used as the reference image for the correction of the subsequent data. The subsequent analysis of the data was accomplished using the visual interpretation technique by including different elements such as tone, colour, shape, size, pattern, texture, association etc (Chauhan and Nayak, 2005). The classification system developed at the Space Applications Centre (ISRO), Ahmedabad was followed for mapping different features. With the knowledge of different elements for the interpretation, the onscreen digitization methodology given by Chauhan and Nayak (2005) was carried out in which mudflats, mangrove, water, agriculture land and different industries were digitized. This was followed by the coding, the process of giving a distinct code to each digitized feature. A thematic map was generated for each year and the map of recent year was verified on ground during the several field visits and necessary modifications were incorporated.

In the present study, the post classification change detection method has been followed where thematic maps of different years were compared to bring out the changes in the mangrove cover and developmental over a period of time. The statistics were generated for mangrove cover of each year and compared to bring out the changes over a period of 37 years.

RESULTS AND DISCUSSION

The comparison of different data sets over a period of 37 years indicates substantial change in the configuration, mangrove cover and developmental activities (Fig.2).

Change in the Mangrove cover from 1975-2012:

The comparison of the data obtained from topographic sheets and satellite data shows the decreasing trend in the mangrove cover of Aliabet (Fig.3). There is a noteworthy decrease in the mangrove cover from 10338.51 ha (1975) to 8.0 ha (2012). The comparison of the satellite data over a period of time indicates that mangrove cover compare to the year 1978(728.61ha) was decreased drastically in the 1987 (6.21 ha). But in the subsequence years the mangrove cover was increased to 47 ha in 1997 and 232.55 ha in 2004. This increase is again followed by the sudden drop in the

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mangrove cover in 2012. In 2004 large patch of mangrove was found on the southern part of the Aliabet which was reduced to a very small patch (8.0 ha) in 2012.

Change in the Developmental activities from 1975-2012:

The comparison of the data set of 37 years suggests substantial increase in the developmental activities. An Aliabet was not encroached by any industries till the year 1995. In 1997 first saltpan industry was set up at the southern part of Aliabet. This was followed by the development of the oil rigs for the excavation of oil and by 2012 a large amount of aquaculture industries have been developed along the southern part of the Aliabet (Fig.4). Thus, till date three major industries namely saltpan, oil based industries and Aquaculture have developed along Aliabet. But, development of new industries in the area cannot be neglected as the area is selected under the special scheme i.e. Special Investment Region (SIR). Other than this it is located just opposite to the highly industrialized area i.e. Dahej which comprise of 2 SEZ, 1 PCPIR (Petroleum, Chemicals and Petrochemicals Investment region) large number of other industries such as port and ship buildings. This has amplified the chances for the increase in the developmental activities in the area.

The Aliabet has also developed in term of its road network. The area which was not approachable earlier because of a very dense creek network in the area is becomes very accessible due to the development of the road network. The area is now easily accessible till its northern, southern and its western end. Thus, because of the growth of new industries in the area and increasing transport network the whole picture of an area has changed noticeably.

But, along with this developmental activities, the configuration of an area also changes with a time. Aliabet, an island in 1975 was separated from the mainland through a prominent channel of the Narmada river in the eastern side. But in the subsequent years, due to the high rate of sedimentation, the channel on the eastern side narrowed down and gets completely filled by over a period of time (Nayak et al., 1989). The area is still changes because of the considerable erosion along the northern flank of an Aliabet. The road which was going towards the northern end has eroded completely and erosion can easily record by the comparison of the satellite images. The southern flank of Aliabet shows the high rate of sedimentation due to which the stream of river Narmada flowing towards the south of Aliabet has narrowed down considerably. The development of the aquaculture industries on the southern part by cutting down the mangroves is of great concern. In this area the development of industries has caused a considerable threat to the mangroves and could be the reason for the reduction in the mangrove cover.

CONCLUSION

Aliabet has changed substantially over a period of time in terms of configuration, mangroves and developmental aspects. The mangroves have decreased drastically. The industries have been developed substantially which has resulted in to better road network. But, the erosional environment and decrease in the mangrove are issues of great concern to the policy maker for development of that area.

References:

- Anon, 1961. Gazetteer of India. Gujarat State. Broach District (Revised Edition) 1961.Directorrate of Government printing, stationary and publications, Gujarat State.
- Anon, 2011.State of Forest Report, 2011. Published by Forest Survey of India. Ministry of Environment and Forests Dehradun.35-40.
- Chauhan ,H. B. and Nayak , S., 2005. Land use / Land cover Changes Near Hazira Region, Gujarat Using Remote Sensing Satellite Data. Journal of the Indian Society of Remote Sensing, 33(3):413 – 420.
- Feagin, R. A., Mukherjee, N., Shanker, K., Baird, A. H., Cinner, J., Kerr, A.M., Koedam, N., Sridhar, A., Arhtur, R., Jayatissa, L.P., Seen, D. L., Menon, M., Rodriguez, S., Shamsuddoha, Md., Dahdouh- Guebas, F., 2010.Shelter from the storm? Use and misuse of coastal vegetation bioshield for managing natural disasters. Conservation letters, 3, 1-11.
- Green, E. P., Mumby, P. J., Edwards, A.J. and Clarke, C.D., 1996. A review of Remote sensing for the assessment and management of tropical coastal resources. Coastal management, 24(1): 1-40.
- Hardisky, M. A., Gross, M. F. and Klemas, V., 1986. Remote sensing of coastal wetlands. Bioscience, 36: 453–460.
- Hirway, I. and Goswami, S., 2004. Valuation of mangroves in Gujarat. Published by Centre for Development Alternatives, Ahmedabad. 1-97.
- Kar, R., Kar, R.K., 2005. Mangroves can check the wrath of tsunami. Current Science ,88, 675.
- Kathiresan, K., Rajendran, N., 2005. Coastal mangrove forests mitigated tsunami. Estuar Coast Shelf Sci., 65:601–606.
- Mitsch, W.J. and Gosselink, J.G., 1993. Wetlands. 2nd edn. Van Nostrand Reinhold, New York.582p
- Nayak, S. and Bahuguna, A., 2001. Application of remote sensing data to monitor mangroves and other coastal vegetation of India. Indian Journal of Marine Sciences, 30(4):195-213.

ISBN 978-81-925489-0-6

- Nayak, S., 1994. Application of remote sensing in the study of Mangrove ecosystems. Conservation of Mangrove Forest Genetic Resources: A Training Manual.203-220.
- Nayak, S., 2000. Role of remote sensing to integrated coastal zone management. Commission VII, Th S 18, 1-12.
- Odum, W. E., McIvor C. C., and Smith T. J.,1982. The Ecology of the Mangroves of South Florida: A Community Profile. A final report by the U.S. Fish and Wildlife Service for the U.S. Department of the Interior, Minerals Management Service Gulf of Mexico OCS Office, Metairie, LA.
- Perez, A.C., Damen, M. C. J., Geneletti, D. and Hobma,T. W., 2002. Monitoring a recent delta formation in a tropical wetland using remote sensing and GIS. Case study: Guapo river delta, Laguna De Tacarigua, Venezuela. Environment, Development and Sustainability, 4: 201- 219.
- Ramachandran, S., Sundraramoorty, S., Krishnamoorthy, R., Devasenapathy, J. and Thanikachalam, M., 1998. Application of remote sensing and GIS to coastal wetland ecology of Tamil Nadu and Andaman and Nicobar group of islands with special reference to mangroves. Current Science, 75: 236-244.
- Shaikh, M.G., Nayak, S., Shah, P.N. and Jambusaria, B.B., 1989. Coastal landform mapping around the gulf of Khambhat using Landsat Tm Data. Journal of the Indian Society of Remote Sensing, 17(1), 41-48.
- Tattu, S., Shah, D. G., Desai, N.D., 2008.Land use changes in Vagra taluka, Bharuch District - Gujarat: an analysis with the application of Remote Sensing Data. Indian Cartographer, 28:485-489.

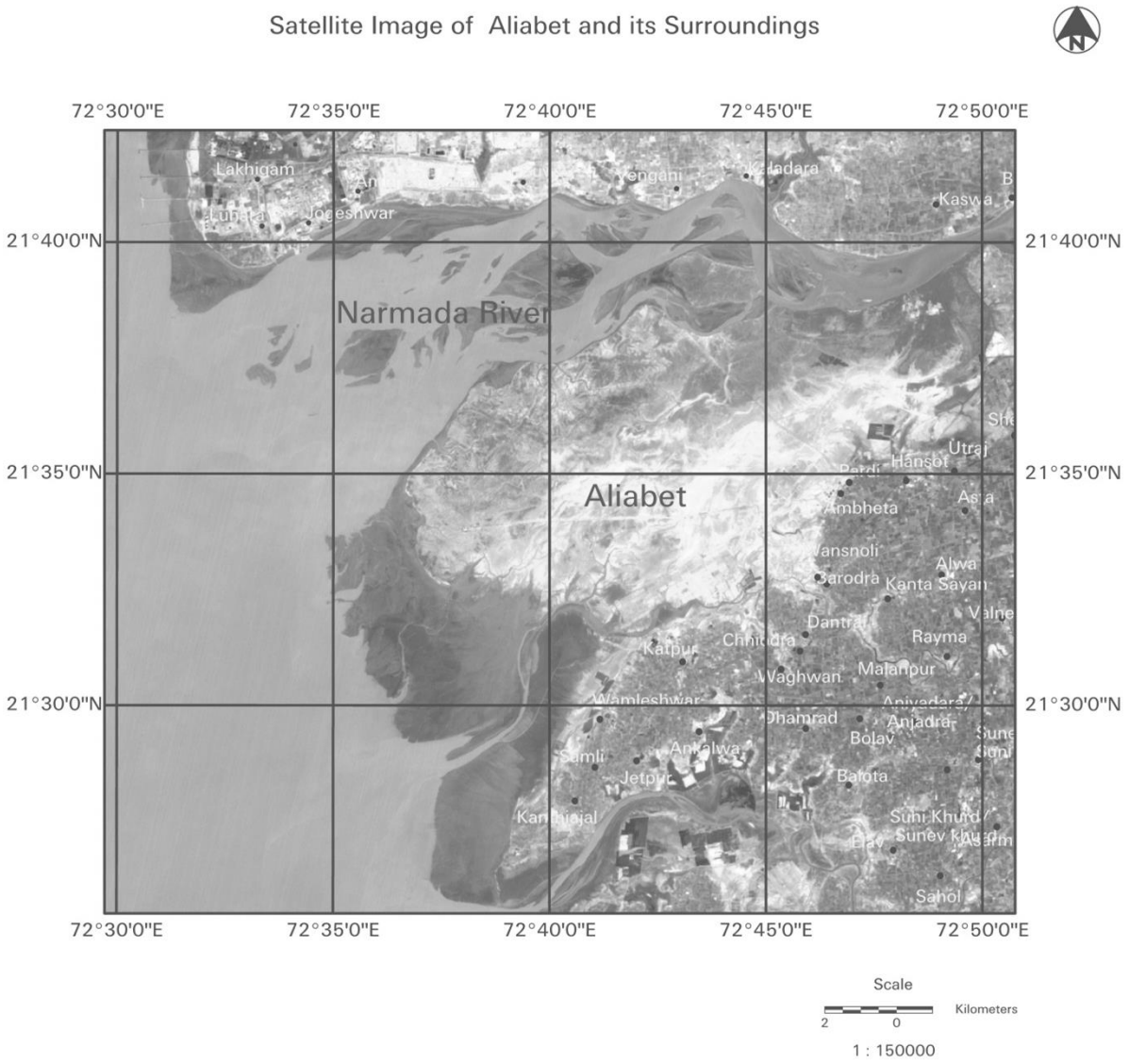

Figure 1: Satellite image of Study area

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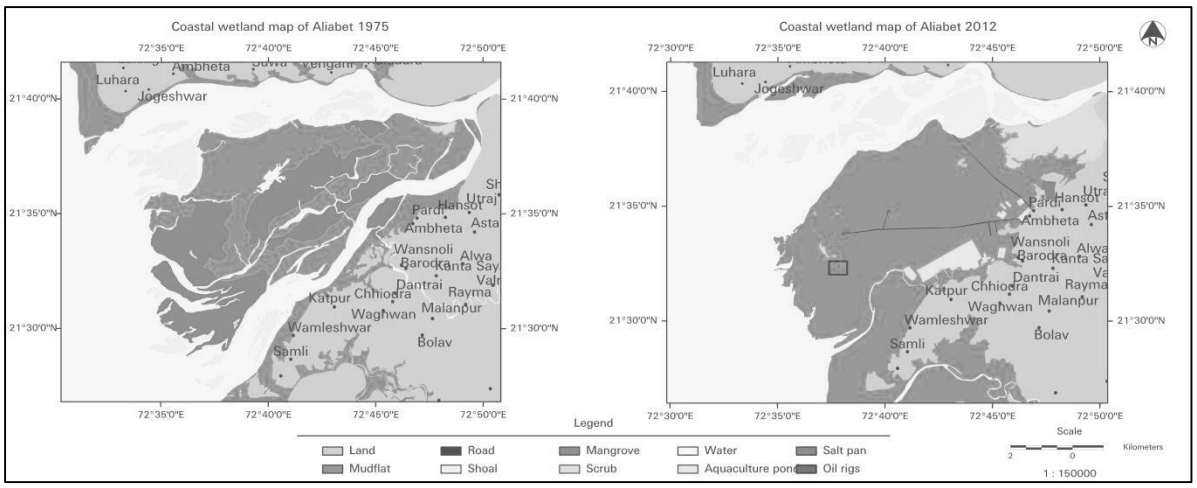

Figure 2: Coastal wetland for Aliabet

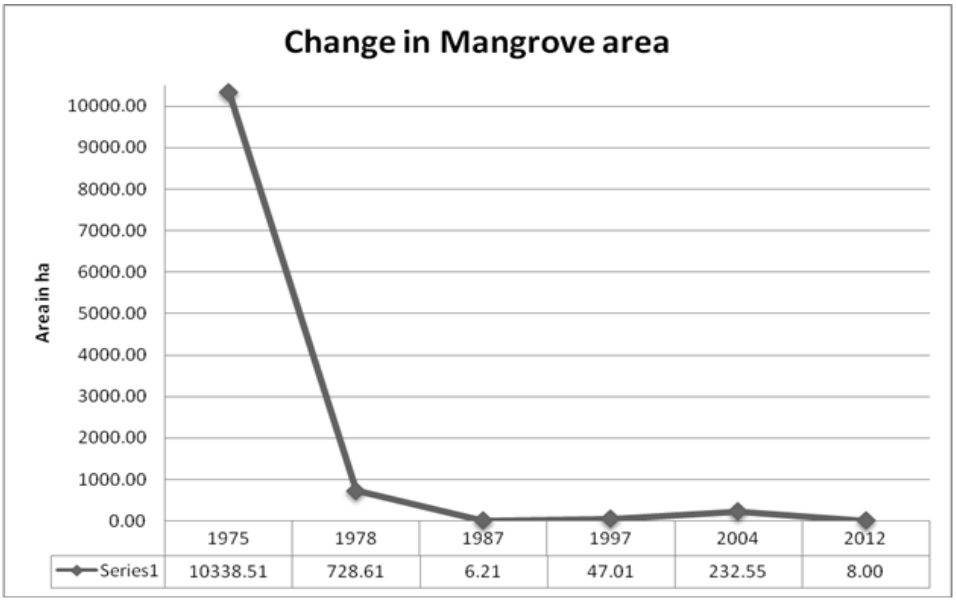

Figure 3: Change in mangrove area over a period of time

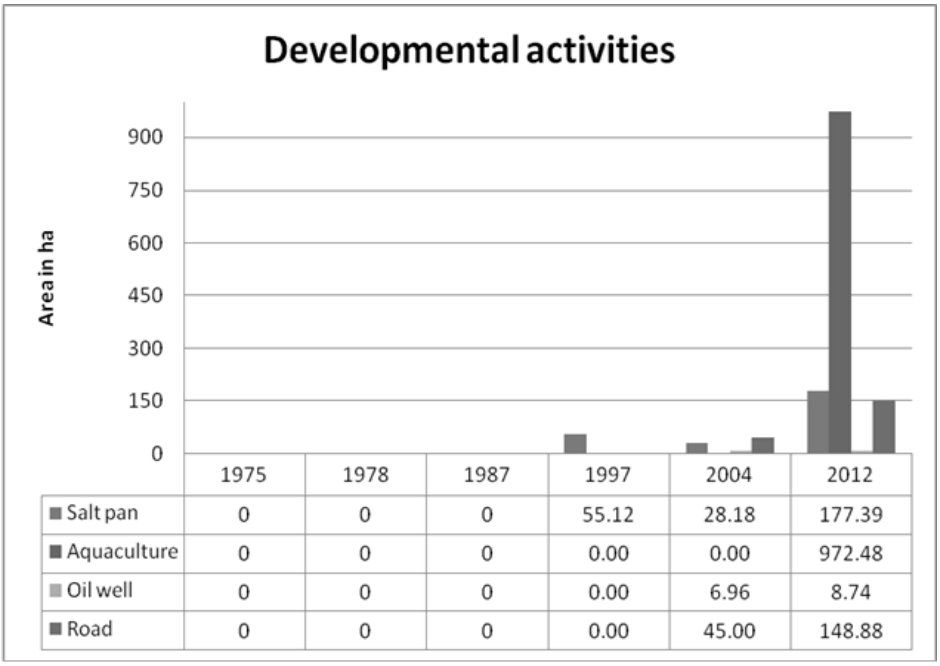

Figure 4: Change in Developmental activities over a period of time

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DISTRIBUTION AND DIVERSITY OF BRACHYURAN CRABS ALONG THE COASTAL REGION OF JUNAGADH DISTRICT, GUJARAT

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Abstract

The benthic macro fauna of the Saurashtra coast have been studied in detail but amongst them the brachyuran crab fauna is neglected. Present study investigates the brachyuran fauna of coastal region of Junagadh district. The study was carried out at intertidal area of four different sites viz. Veraval, Sutrapada, Dhamlej and Kodinar. The average width of intertidal area ranges from 60 m to 131 m. evident zonation pattern was observed and total four zones including sandy shore, algal zone, Playthoa zone and Zoanthus zone were identified. In species account of brachyuran crab total 23 species belonging to 10 families and 19 genera were recorded. Families like xanthidae, portunidae and eriphiidae were found to be dominant. Zonation wise distribution of brachyuran crab was also studied and total 4 zones were identified. Algal zone was found to be diverse and utilized by maximum species of crab while sandy shore and subtidal zone were utilized by specialized species. Playthoa and Zoanthus zones were mostly utilized by poisonous crabs of genus *Atergatis* and *Eriphia*. Microhabitat preference of brachyuran crabs was also taken in to the study account and total 8 different micro habitats were identified. Shallow tide pools with different animal and plant community was found to be most common microhabitat utilized by crab species while microhabitats like sandy shore, under rock deep tide pools, rock crevices, under rock and deep water were utilized by specialized species. Bray Curtis percentage similarity was also calculated to find out habitat preference of brachyuran crabs.

Key words: Brachyuran crabs, Intertidal area, Habitat selection, Coastal Saurashtra

Introduction

Information on species composition and habitat preference of marine invertebrates is the fundamental requirement to understand the presence of difference species in benthic communities, which on the other hand provides base line information for successful conservation of the habitat and benthic fauna (Braga *et al*., 2005). Studies on the distribution and diversity of local fauna are of great importance because these studies lead to the best understanding of structure, function and problems of the local animal community (Fransozo et al., 1992; Hebling et al., 1994). Particularly, a marine ecosystem requires specific attention and understanding of ecology because it provides shelter to unique and rare animal communities (MacArthur, 1972). The marine intertidal zone is formed within the transition from land to sea and in this particular area organisms experience both marine and terrestrial conditions during high tide and low tide respectively. Organisms living in the intertidal area have to develop different kind of adaptations because they experience a wide range of physical stresses, including fluctuations in temperature, aerial exposure, salinity, and hydrodynamic forces (Vernberg and Vernberg, 1972; Newell, 1979; Denny, 1988). Amongst all the species inhabiting intertidal zone, decapod crustaceans are one of the most common groups of marine organisms. They dwell in variety of habitats like mudflat, sandy shores, mangroves and rocky shores and majority of the species occur in tropical and subtropical regions (Boschi 2000). Brachyuran Crabs are a highly important group of marine decapods, with approximately 5,000 species and 700 genera described worldwide (Melo, 1996).

Gujarat being the western proximity of the country harbors a longest coastline which is of 1650 km. The total coastal area is covered by different kinds of marine habitats which include 29 % of muddy flats followed by 28 % of sandy beaches, 22 % of marshy coast, and 21 % of rocky coast. The intertidal area of Saurashtra coast is narrow in width and rocky in nature, which is made of milliolite lime stones (Vaghela, 2010). Saurashtra coast is very diverse in case of marine biota and studies on distribution and diversity of marine invertebrates have been carried out by different organizations and researchers (Raghunathan, et al, 2004; Mishra and Kundu, 2005; Joshi, 2010; Vaghela, 2010). The brachyuran crab fauna of Saurashtra coast is least studied or rather neglected; except the work of Chhapgar (1957) no literature is available on the status of brachyuran crabs of Saurashtra coast. So to fulfill the lacunae of information, present study has been carried out.

Materials and Methods

Study area:

The study was conducted at four different sites of coastal area of Junagadh district, Viz. Veraval (20^0 54’ 37" N, 70^0 21’ 04” E), Sutrapada (20^0 49’ 53" N, 70^0 29’ 17” E) Dhamlej (20^0 46’ 29" N, 70^0 36’ 19” E), and Kodinar (20^0 45’ 29" N, 70^0

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39' 39" E). The intertidal area is mostly rocky in nature with upper portion made up of sandy shore. The exposure area or width of the intertidal zone varies from 60 meters to 150 meters. The width of the intertidal zone also varies with the tide cycle. Evident zonation pattern in intertidal area was observed at all the study sites. The study has been carried out for the period of nine months (November, 2011 to July, 2012).

Sampling methods:

Zonation is the most important phenomena observed on the intertidal area. Here in the present study, different zones have been identified on the basis of presence of dominant animal or plant community. For the survey of dominant animal or plant species, quadrate sampling method was adopted. Total 60 quadrates of 25 cm × 25 cm were laid randomly at each site and percentage coverage area for plant species and percentage density for animal species were calculated. Belt transect method was adopted for the survey of brachyuran crabs. Total 10 belt transects were laid randomly at each site. The length of the belt transect was considered from the high tide mark to the low tide mark while the width of transect (10 m) was kept constant for all the sites. The transect area was surveyed thoroughly for the presence of the crab species. On the sighting of animal, micro habitat type and zone type were recorded. Hand picking method was adopted for the collection of intertidal specimen while specimen from subtidal or deep water zone were collected through trawl catch with the help of local fishermen. All the specimen were brought to the lab and preserved in 10% formalin for further study and deposition in the Department of Zoology museum. The specimens were identified to the species level using different identification keys and monograms (Chhapgar, 1957; Sethuramalingam and Ajmal Khan, 1991; Jeyabaskaran, et al., 2000). For further confirmation of species, all the specimens were examined and compared with the photographs and identification information available on Marine Species Identification Portal website (www. speciesidentification.org) and NIO marine fauna information website (Jeyabaskaran et al., 2002). The classification of brachyuran crabs was adopted from WORMS website (www. marinespecies.org). A Bray-Curtis similarity index was calculated for similarity in different micro habitats.

Results

The main characteristic of rocky intertidal area is the prominent vertical zonation or vertical band which differs in the terms of biodiversity from upper to lower intertidal area (Ellis, 2003). In the present study an evident zonation pattern was observed throughout the study area. The size or width of different zones varies with the total width of intertidal zone. Maximum length of the intertidal area was observed at Dhamlej (131 m) followed by Sutrapada (120 m), Kodinar (105 m) and Veraval (60 m). Four different zones were identified from upper intertidal to lower intertidal area which include: Sandy shore zone which is dominated by brachyuran crab species *Ocypode ceraptothelma*, followed by Algal zone which is dominated by green algae *Ulva* sp., Playthoa zone which is dominated by two zoanthid species, *Palythoa mutuki* and *Playthoa tuberculosa* and Zoanthus zone which is dominated by different *Zoanthus* sp. Polythoa and Zoanthus zones were not observed at Veraval although these species were distributed randomly without zone specific congregations. The Algal zone was observed to be the most dominant zone type followed by Sandy, Palythoa and Zoanthus zones (Table: 1).

Table 1: Zonation pattern at different study sites

Zone No.	Zone type	Veraval (meter)	Sutrapada (meter)	Dhamlej (meter)	Kodinar (meter)
1	Sandy	20	20	22	25
2	Algal	37	75	82	45
3	Palythoa	---	15	20	20
4	Zoanthus	---	10	7	15
	Total width	57	120	131	105

Total 23 species of brachyuran crabs belonging to 10 families and 19 genera were recorded from study area. Families like xanthidae and portunidae which are typically found on rocky shores contributed 7 and 5 species to the species account respectively. Three and two species were added to the species account by families' eriphiIdae and grapsidae respectively, while rest of the families like pilumnidae, parthenopidae, matutidae, ocypodidae, majidae and plagusidae contributed only one species each to the total species account. Crab species like *Ocypode ceraptothelma, Charybdis helleri, Charybdis annulata, Etisus laevimanus, Mayomenippe hardwicki, Pilumnus vespertilio* were recorded from all the four study sites while few crab species like *Atergatis roseus, Demania buccalipes, Zozymodes pumilies, Charybdis lucifera, Epixanthus frontalis, Metopograpsus messor, Plagusia squamosa, Cryptopodia angulata* and *Schizophrys aspera* were recorded from only single study site of the entire study area. Maximum number of species were recorded from Sutrapada (20 species) followed by Dhamlej (12 species) while 8 species were recorded from Veraval and Kodinar each (Table - 2).

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Table 2: Brachyuran crab diversity of different study sites

No.	Family/species	Study sites			
		Veraval	Sutrapada	Dhamlej	Kodinar
	Xanthidae				
1	*Atergatis intergerrimus*		√		
2	*Platypodia cristata*		√	√	
3	*Atergatis floridus*		√	√	√
4	*Atergatis roseus*	√			
5	*Zozymodes pumilis*		√		
6	*Etisus laevimanus*	√	√	√	√
7	*Demania baccalipes*		√		
	Portunidae				
8	*Charybdis helleri*	√	√	√	√
9	*Charybdis annulata*	√	√	√	√
10	*Portunus pelagicus*	√	√		
11	*Thalamita crenata*		√	√	
12	*Charybdis lucifera*		√		
	Eriphiidae				
13	*Epixanthus frontalis*				√
14	*Eriphia smithii*		√	√	
15	*Myomennipe hardwicki*	√	√	√	√
	Grapsidae				
16	*Grapsus albioneatus*		√	√	
17	*metapograpsus messor*			√	
	Ocypodidae				
18	*Ocypode ceratophthalma*	√	√	√	√
	Pilumnidae				
19	*Pilumnus vespertilio*	√	√	√	√
	Matutidae				
20	*Matuta planipes*		√		
	Plagusidae				
21	*Plagusia squamosa*		√		
	Parthenopidae				
22	*Cryptopodia angulata*		√		
	Majidae				
23	*Schizophrys aspera*		√		
Total	23	8	20	12	8

As stated earlier, evident zonation pattern was observed at each study site. Brachyuran crabs also shows preference to difference zones as they fulfill their requirements of microhabitats to perform different activities. Only one species of brachyuran crab *Ocypode ceraptothelma* was observed in sandy shore or zone. The species utilizes sandy shore habitat for feeding and burrowing. Peculiar pattern has been observed in burrow distribution on sandy shore in which high density of burrow with large openings were observed on the upper part of the zone while density and opening diameter of burrows decrease drastically as one goes towards lower part of the zone. Total 10 species were recorded from algal zone which makes it most preferable by brachyuran crabs. The algal zone also consist of different kinds of micro habitats like shallow tide pools, deep tide pools, rock boulders and rock crevices and these micro habitats provide shelter to different brachyuran crab species. Family portunidae was dominantly observed in the algal zone (4 species) followed by family xanthidae and eriphiidae (3 species each). Species belonging to Family grapsidae and

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plagusidae were observed only in algal zone because they utilize specific kind of micro habitats like rock crevices and deep tide pool which are available in the algal zone only. Shallow tide pool with algal assemblage was most diverse micro habitat utilized by different crab species as compare to others. Species like *Thalamita crenata, Portunus pelagicus, Grapsus albioneatus, Plagusia squamosa, Etisus laevimanus, Zozymodes pumilis* utilize the algal assemblage for feeding and breeding grounds, while species of family eriphiidae which are carnivore in diet use shallow tide pool with algal assemble and under rock habitat as hiding site to ambush prey. Only one species of genus *Atergatis, A. roseus,* was found in algal zone at Veraval.

Palythoa zone and Zoanthus zone were mostly utilized by carnivore crabs and family xanthidae was observed to be the dominant with 3 species followed by family portunidae (2 species) and eriphiidae (1 species). Genus *Atergatis* was observed to be dominant. Few species of Crabs like *Atergais floridus, Atergatis integarrimus, Platypodia cristata* were found only in these two zones because they utilize specific kind of microhabitats like shallow tide pool with *Palythoa* and *Zoanthus*. Species like *Pilumnus vespertilio, Charybdis helleri, Charybdis annulata* are the most common species observed in different zones as they utilize wide range of micro habitat for feeding and breeding (Table- 3, 4).

Five species of crabs belonging to five different families were recorded from subtidal zone. Members of families like majidae and parthenopidae observed mostly in the deep water or lower intertidal area. Distribution of crab species like *Cryptopodia angulata, Demania buccalipes, Matuta planipes* ranges from 1 to 30 meter in deep water. These species were collected during the trawl catch near Sutrapada.

Table 3: Brachyuran crab diversity of different intertidal zones

No.	Family/species	Zones of intertidal area				
		Sandy	Algal zone	Palythoa zone	Zoanthus zone	Subtidal
	Xanthidae					
1	*Atergatis intergerrimus*			√	√	
2	*Platypodia cristata*			√	√	
3	*Atergatis floridus*			√	√	
4	*Atergatis roseus*		√			
5	*Zozymodes pumilis*		√			
6	*Etisus laevimanus*		√			
7	*Demania baccalipes*					√
	Portunidae					
8	*Charybdis helleri*		√	√	√	
9	*Charybdis annulata*		√	√	√	
10	*Portunus pelagicus*		√			
11	*Thalamita crenata*		√			
12	*Charybdis lucifera*					√
	Eriphiidae					
13	*Epixanthus frontalis*		√			
14	*Eriphia smithii*		√	√		
15	*Myomennipe hardwicki*		√			
	Grapsidae					
16	*Grapsus albioneatus*		√			
17	*metapograpsus messor*		√			
	Ocypodidae					
18	*Ocypode ceratophthalma*	√				
	Pilumnidae					
19	*Pilumnus vespertilio*		√	√	√	
	Matutidae					
20	*Matuta planipes*					√
	Plagusidae					
21	*Plagusia squamosa*		√			
	Parthenopidae					
22	*Cryptopodia angulata*					√
	Majidae					
23	*Schizophrys aspera*					√
Total	23	1	10	3	2	4

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Table 4: Microhabitat preference of brachyuran crabs

No.	Family/species	Micro habitat types							
		Sandy	STA	STP	STZ	DTP	RC	UR	DP
	Xanthidae								
1	*Atergatis intergerrimus*			√	√				
2	*Platypodia cristata*			√					
3	*Atergatis floridus*			√	√				
4	*Atergatis roseus*					√			
5	*Zozymodes pumilis*		√					√	
6	*Etisus laevimanus*		√					√	
7	*Demania baccalipes*								√
	Portunidae								
8	*Charybdis helleri*		√	√	√			√	
9	*Charybdis annulata*		√	√	√			√	
10	*Portunus pelagicus*		√						
11	*Thalamita crenata*		√					√	
12	*Charybdis lucifera*								√
	Eriphiidae								
13	*Epixanthus frontalis*		√						
14	*Eriphia smithii*		√	√				√	
15	*Myomennipe hardwicki*					√			
	Grapsidae								
16	*Grapsus albioneatus*					√			
17	*metapograpsus messor*						√		
	Ocypodidae								
18	*Ocypode ceratophthalma*	√							
	Pilumnidae								
19	*Pilumnus vespertilio*		√	√	√				
	Matutidae								
20	*Matuta planipes*								√
	Plagusidae								
21	*Plagusia squamosa*					√	√		
	Parthenopidae								
22	*Cryptopodia angulata*								√
	Majidae								
23	*Schizophrys aspera*								√
Total	23	1	6	3	2	3	2	3	4

(STA- Shallow tide Pool with algal assemblage, STP- Shallow tide pool with *Palythoa*, STZ- Shallow tide pool with *Zoanthus*, DTP- Deep tide pool, RC- Rock crevices, UR- Under rock, DP- Deep water)

Bray- Curtis similarity percentage was calculated to find out similarity in species diversity between different kinds of micro habitat. Results revealed that the similarity in species composition between different microhabitats ranges from 85.5% to 32.3% (Fig. 1). Microhabitats like sandy shore and deep water contain their own species diversity and form separate groups. Maximum similarity was observed between microhabitats like shallow tide pool with *Palythoa* and *zoanthus* respectively (85.5%) followed by shallow tide pool with algal assemblage and under rock habitat form a separate group with 80% similarity in species diversity. Both separate groups join each other with 43.4% similarity in species composition. Microhabitats like deep tide pool and rock crevices also form a separate group and join each other with 40% similarity.

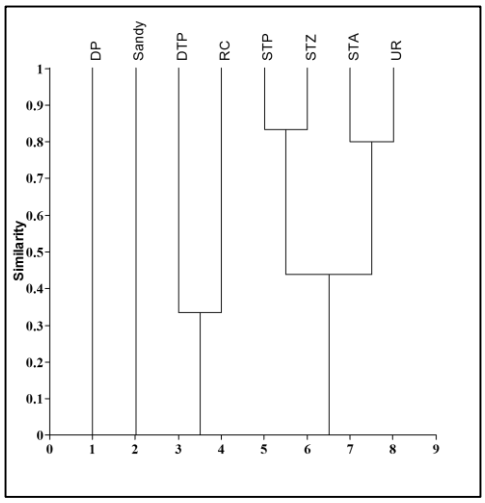

Figure 1: Bray- Curtis similarity indices for brachyuran crab diversity of different microhabitats

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Discussion

The intertidal area of Saurashtra coast is narrow due to its steep slope still it harbors unique kind of marine diversity. Earlier studies carried out along the coastal Saurashtra on the distribution of marine benthic macro fauna reported a total of 127 species which include groups like coelenterate, mollusca, crustacea, echinodermata etc. (Joshi, 2010, Vaghela, 2010). The area also shows good coral diversity, total five species of hard corals were recorded from the area but their distribution and population is very sparse (Raghunathan *et al.,* 2004). However, the brachyuran crab diversity of the concerned area has not been studied in detail. Rocky intertidal areas are known for their brachyuran crab diversity. Kumaralingam *et al.* (2012) recorded 51 species of brachyuran crabs belonging to 20 genera and 5 families from Ritchieo's Archipelago of Andoman Nicobar Islands and Kumar and Wesely (2010) have recorded 47 species of brachyuran crabs from Laamu Atoll of Maldives. In the present study, we recorded 23 species of crabs belonging to 10 different families and 19 genera from the rocky intertidal zone which is comparatively less in number of species and genera but in case of family diversity the area is very diverse as compared to the above studies.

The rocky intertidal zonation has been studied in detail by many researchers and the results revealed that seasonal fluctuation cause effect on the abundance of marine organisms of different zones (Stephenson and Stephenson, 1972). The intertidal zonation pattern was studied in detail for marine invertebrates like barnacles, mussels, snails and limpets (Chavanich and Wilson, 2000) but only few studies are available on the zonation pattern of brachyuran crabs (Joel *et al.,* 1985; Lohrer *et al.,* 2000; Mantelatto *et al.* 2004; Kumar and Wesely, 2010; Pandya, 2011 and Pohle *et al.,* 2011). In present study we also observed the intertidal zonation pattern of brachyuran crabs. The algal zone has maximum coverage on intertidal area and harbors maximum diversity of brachyuran crab due to availability of different kinds of microhabitats. Other zones like sandy shore, Palythoa zone, Zoanthus zone and subtidal zone show specific kinds of habitat characteristics and support their own brachyuran crab diversity. Brachyuran crab also shows micro habitat preference to perform different kind of activities like feeding, burrowing and reproduction (Pandya and Vachhrajani, 2010; Trivedi *et al.,* 2012). In present study we have described the microhabitat utilization by different brachyuran crabs. The shallow tide pools with different plant and animal communities were commonly utilized by many brachyuran crab species, while microhabitats like rock crevices, undersurfaces of rock, sandy shore, deep tide pools and deep water were utilized by selected species.

Gujarat possesses longest coastline in the country and the coastal areas are very rich in marine biodiversity. Brachyuran crabs play important role in the maintenance of different kind of marine ecosystems like mangroves (Golly *et al.,* 1962), esturine (Pandya and Vachhrajani, 2011), sandy shore (Strachan *et al.,* 1999) and rocky shore (Siddon and Witman, 2004). So detailed study on diversity, distribution and ecology of brachyuran crabs on Saurashtra coast is needed to make an effective conservation strategy.

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The authors are thankful to Mr. Ravi Vasava, Mr. Vishal Pankhania, Mr. Kalpesh Gohel, Mr. Trinayan Borgohain and Mr. Umang Trivedi for their technical support during field surveys. The authors are also thankful to Miss. Sumedha Arya for help in species identification and local villagers of study area for crab collection in subtidal area.

References:

Boschi, E.E. 2000. Biodiversity of marine decapods brachyurans of the Americas. J. Crustacean. Biol. 20 (2): 337-342.

1. Chavanich, S., Wilson, K.A. 2000. Rocky intertidal zonation of gammaridean amphipods in Long Island Sound, Connecticut. Crustaceana 73: 835–846.
2. Chhapgar, B.F. 1957. Marine Crabs of Bombay State. Contribution No. 1 of the Taraporevala Marine Biological Station. Marine Biological Station, Department of Fisheries, Mumbai, India.
3. Denny, M. W. 1988. Biology and the mechanics of the wave-swept environment. Princeton University Press.
4. Ellis, D. V. 2003. Rocky shore intertidal zonation as a means of monitoring and assessing shoreline biodiversity recovery. Marine Pollution Bulletin 46: 305–307.
5. Fransozo, A., Negreiros-Fransozo, M.L., Mantelatto, F.L., et al. 1992. Composição e distribuição dos Brachyura (Crustacea,Decapoda) do sublitoral não consolidado na Enseada da Fortaleza, Ubatuba (SP). Revista Brasileira de Zoologia, 52(4): 667-675.
6. Golley, F., Odum, H.T., Wilson, R.L. 1962. The structure and metabolism of Puertrican and mangrove forest in May. Ecology, 43: 9–18.
7. Hebling, N. J., Mantelatto, F. L., Negreiros-Fransozo, M. L., et al. 1994. Levantamento edistribuição de braquiúros e Anomuros (Crustacea, Decapoda) dos sedimentos sublitorais da região da Ilha Anchieta, Ubatuba (SP). Bolm. Inst. Pesca, 21, 1-9.
8. Jeyabaskaran, R., khan, A.S., Ramaiyan, V. 2000. Biodiversity Project on Gulf of Mannar Biosphere Reserve. Centre of Advanced Study in Marine Biology, Annamalai University, Parangipettai, India.

ISBN 978-81-925489-0-6

9. Jeyabaskaran, R.S., Wafar, M. 2002. CD on Brachyuran Crabs of West Coast, India. National Institute of Oceanography, Dona Paula, Goa, India.
10. Joel, D.R., Sanjeeva Raj, P.J. and Raghavan, R. 1985. Distribution and zonation of shore crabs in the Pulicat Lake. Proc. Indian Acad. Anim. Sci. 95: 437-445.
11. Joshi, K. A. 2010. Spatial and temporal variations in population dynamics of few key rocky intertidal macrofauna at tourism influenced intertidal shoreline, PhD thesis, Saurashtra University, Gujarat, India.
12. Kumar, A. A. J. and Wesley, S. G. 2010. Spatio- temporal distribution of assemblages of brachyuran crabs at Lammu atoll, Maldives. Atoll Research Bulletin 588: 1-16.
13. Kumaralingam, S., Sivaperuman, C. and Raghunathan, C. 2012 Diversity and Distribution of Brachyuran Crabs from Ritchieo's Archipelago. International Journal of Oceanography and Marine Ecological System. 1: 60-66.
14. Lohrer, A. M., Fukui,Y., Wada,K., Whitlatch, R. B. 2000. Structural complexity and vertical zonation of intertidal crabs, with focus on habitat requirements of the invasive Asian shore crab, *Hemigrapsus sanguineus* (de Haan). Journal of Experimental Marine Biology and Ecology. 244: 203–217.
15. MacArthur, R. H. 1972. *Geographical ecology: patterns in distribution of species*. New York : Harper and Row.Mantelatto, F. L., Fabíola C. R. F., Biagi, Rand Melo. G. A. S. 2004. Majoid Crabs Community (Crustacea: Decapoda) from Infralittoral Rocky/sandy Bottom of Anchieta Island, Ubatuba. Brazilian Archives of Biology and Technology. 47 (2): 273-279.
16. Marine species identification portal developed by ETI bioinformatics. www.species-identification.org.com
17. Melo, G. A. S. 1996. Manual de identificação dos Brachyura (caranguejos e siris) do litoral brasileiro. Editora Plêiade, São Paulo, Brasil.
18. Mishra, S. and Kundu, R. 2005. Seasonal variations in population dynamics of key intertidal mollusks at two contrasting locations. Aquatic Ecology. 39:315–324.
19. Newell, R. C. 1979. Biology of intertidal animals. Marine Ecological Surveys, Ltd., Kent.
20. Pandya, P. J. 2011. Benthic community structure of Mahi River estuary with special reference to animalsediment relationship. PhD Thesis, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, India.
21. Pandya, P. J., Vachharajani, K. D. 2010. Spatial distribution and substratum preference of brachyuran crab *Macrophthalmus depressus* (Decapoda: Ocypodidae) along the lower estuarine mudflats of Mahi River, Gujarat, India. Crustaceana. 83: 1055-1067.
22. Pandya, P. J., Vachharajani, K. D. 2011. Life under ecological stress: An estuarine case study. In: Animal Diversity,Natural History and Conservation (Vol. 1) (Gupta VK, Verma AK, eds). 427-436, Daya Publication House,New Delhi, India.
23. Pohle, G., Iken, K., Clarke, K. R., et al. 2011. Aspects of benthic decapode diversity and distribution from rocky near shore habitat of geographically widely dispersed sites PLoS ONE, 6(4): 1-11.
24. Raghunathan, C., Sen Gupta, R., Wangikar, U. and Lakhmapurkar, J.2004. A record of live corals along the Saurashtra coast of Gujarat, Arabian Sea. Current science. 87(8): 1131-1138.
25. Sethuramalingam, S, Khan, A. S. 1991. Brachyuran Crabs of Parangipettai Centre of Advance Study in Marine Biology, Annamalai University, India.
26. Siddon, C. E., Witman, J. D. 2004. Behavioral indirect interactions: multiple predators effects and prey switching in the rocky subtidal. Ecology, 85: 2938-2945.
27. Stephenson, T.A., Stephenson, A. 1972. Life between tidemarks on rocky shores. W.H.Freeman and Company, San Francisco.
28. Strachan, P. H., Smith, R. C., Hamilton, D. A. B., Taylor, A. C. and Atkinson, R. J. A. 1999. Studies on ecology and behaviour of the ghost crab *Ocypode cursor* (L.) in northern Cyprus. Scientia marina. 63(1): 51-60.
29. Trivedi, J. N., Gadhavi, M. K and. Vachhrajani, K. D. 2012. Diversity and habitat preference of brachyuran crabs in Gulf of Kutch, Gujarat, India. Arthropods. 1(1):13-23.
30. World register of marine species. www.marinespecies.org

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INFLUENCE OF TEMPERATURE ON BIOLOGY, DENSITY AND DISTRIBUTION OF MANGROVES WITH RESPECT TO CRABS OF KOLLAM DISTRICT, KERALA

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Abstract

The importance of mangrove ecosystem functioning and viability, little is known on the expected effects of climate change on these animals. The temperature, salinity, sea-level rise and low pH value have effect on animals resident in mangrove sediment. To determine thermal tolerance of adults and eggs of *Perisesarma guttatum* and *Uca urvillei* crabs which were maintained at different temperatures between 17-37°C and respiration measured using a closed chamber system. After 8 and 3 hours acclimation at 27°C for adults and eggs respectively, respiration rates were recorded and used as a proxy for their basal metabolism. Crabs were counted in $1m^2$ quadrats while megalopae were collected using air-filter traps in *Rhizophora mucronata, Ceriops tagal* and *Avicennia marina* zones. The results suggest that males of *P. guttatum* and *U. urvillei* had a temperature range of 27-31°C and 27-33°C (P>0.05) respectively in both air and water media and temperature show significance at 35°C (P<0.0004) beyond which the crabs got stressed as indicated by increased metabolism suggesting that the former is more sensitive to temperature variation than the latter which has a wide thermal tolerance window. *U.urvillei* and *P. guttatum* recorded highest densities of 66.25/m² and 11.75/m² respectively in the *R.mucronata* zone although *P. guttatum* density in *C. tagal* and *R. mucronata* wasn't significant (P>0.05*).U urvillei* density was lowest in *C. tagal* and landward *A. marina*. Full moon day and the transition phase between the North East and South West Monsoon revealed significant effect on megalopae density (P<0.000). These results are crucial in understanding and predicting of future physiological responses of mangrove crab populations to climate change affecting mangroves.

Keywords: mangrove crabs, thermal sensitivity, density, megalopae,

INTRODUCTION

Mangroves are a diverse group of unrelated trees, palms, shrubs, vines and ferns that share a common ability to live in waterlogged saline soils subjected to regular flooding. They are highly specialised plants that have developed unusual adaptations to the unique environmental conditions in which they are found. There are around 80 species of mangroves found throughout the world (Saenger *et al*., 1983). Most commonly they occur within tropical and subtropical sheltered coastal areas subjected to tidal influences. An area influenced by tide can be interpreted to mean a shoreline inundated by the extremes of tides, or it can more widely refer to river-bank communities where tides cause some fluctuation in water level but no change in salinity (Tomlinson, 1986).Therefore, mangroves can be found not only inhabiting extensive tidal mud flats but also along freshwater riverbanks.

Mangrove forests are recognised as complex and highly productive areas of many coastal ecosystems, providing the basis of many estuarine food webs, and nursery habitats for a number of fish and invertebrates. Brachyuran crabs often dominate the intertidal zones of Indo-Pacific systems in terms of overall abundance and biomass, with crabs of the Grapsidae and Ocypodidae families being key components (Lee 1998). The ubiquitous fiddler crabs (Ocypodidae: Uca) can have significant effects on the mangrove forest floor by altering the sediment topography (Warren & Underwood 1986) as well as the composition of the sediment microflora (Olafsson&Ndaro1997). The burrowing and feeding activities of sesarmids (Grapsidae: Sesarminae) is, likewise, able to impact on mangrove ecosystems, influencing mangrove primary productivity (Smith *et al*., 1991) tree colonisation (Dahdouh-Guebas *et al*., 1997) nutrient cycling and energy flow (Lee 1999). However, due to the inability to adequately estimate mangrove crab density by conventional methods, the importance of the crabs in trophic dynamics of mangrove systems has not been effectively determined (Lee 1998).

A number of techniques have been used to estimate the abundance and diversity of crabs in mangrove forests, but rarely has it been possible to quantify mangrove crab density by direct means due to the nature of the habitat and the burrowing habit of the crabs. Direct quantification through digging or burrow excavation can be rather time consuming and labour-intensive, in addition to being unsuitably destructive in these sensitive areas. Repeated measures are also not possible (Skov *et al*.**,**2002). The indirect methods of pitfall trapping (Frusher *et al.,* 1994) burrow opening counts (Mouton & Felder 1996), mark-release-recapture (Hockett&Kritzler 1972) and binocular counts of surface-active individuals (Golley*et al.,*1962) offer alternatives to the inappropriate direct methods.

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However, these techniques are not without inherent problems. Although these various methods have been used on a number of occasions and in structurally different mangrove systems, few studies have investigated the efficacy of, nor compared the estimates of abundance and diversity obtained from, these different methods. Mangrove forests, particularly those in urban areas, are facing increasing threat from human disturbance. Since habitat complexities have been inferred as a source of bias in the population assessment of mangrove species, it is necessary to determine the effects of habitat structure on methods used to assess crab abundance. An area of mangrove forest was, therefore, structurally manipulated to represent a range of forest habitat, which had been exposed to different levels of human disturbance. The effect of this manipulated habitat was then experimentally evaluated on the activity and abundance of an intertidal mangrove crab community by means of pitfall traps and binocular counts.

METHODS & MATERIALS

The study was conducted at Ayiramthengu area of Kollam District, Kerala, primarily dominated by *Avicennia marina* with a small number of *Rhizophora mucronata* and *Ceriops tagal*. The investigation was repeated on two separate occasions one month apart during spring tides of March and April 2012. A 20x20 m area was marked and the habitat structure characterised according to Boggan & Skilleter. Thereafter, twenty one plots of 1 m^2 were demarcated. Burrow density was quantified in all plots.Observations were recorded as small, medium or large sized burrow openings. Two 2-litre pitfall traps were placed in each plot. The seven triplicate experimental plots are detailed and measures the temperature.

The control plots were undisturbed, except for the placement of the pitfall traps. The disturbance control received little structural manipulation, slight agitation of the litter cover and nicking of the pneumatophores to emulate disturbance associated with the act of plot manipulation. Pneumatophores were removed to ground level with the aid of a pair of secateurs, while pneumatophore algae were removed by hand. Litter, which consisted of leaves and twigs, was removed from the plots by gently scraping the sediment surface.

No binocular counts were conducted on the day of manipulation, and lids were placed on the traps for two days for the mangrove community to become adjusted to the habitat manipulation and disturbance. On the third day, three observers conducted binocular counts for 10 minutes after the first crab was observed in each plot at a distance of at least two metres. This process was repeated to yield two to three observations for each plot on the day. Observations consisted of monitoring the number of crabs active in the site and the determination of specific activity (i.e. walking, sitting, feeding, socialising or a combination thereof). On completion on the binocular counts, the lids of the traps were removed and left for two days. On the fifth day, the process of binocular counts was repeated before pitfall traps were removed and captured crabs were examined. Crabs from each trap were identified, measured and sexed, with the results from the two traps in each site being pooled for statistical analysis.

Statistical tests were performed using the software package STATISTICA version 7.

RESULTS & DISCUSSION

The physical characteristics of the two experimental sites are described in Table 2.2. A significant difference was found between the sites (Non-metric Multi-dimensional Scaling $p<0.05$). The leaf litter, twig litter, pneumatophore density and pneumatophore algae were responsible for the differences observed between the two sites (ANOSIM $p<0.05$), hence the sites were analysed separately.

A total of four species of crabs were observed during binocular counts and recovered in pitfall traps. The sesarmids, Helograpsus haswellianus and Parasesarma erythrodactyla, and the ocypodids, Austro*plax* t*ridentata* and P*aracleistostoma*(Cleistostoma) wardii, were encountered at both sites during the study at Fisherman Island, but no A. tridentata were caught in the pitfall traps at site 1.

The medium size burrows were consistently found to be the most abundant size of burrows in all the treatments (Fig.1). The large burrows made up the lowest proportion of the burrows in each treatment. The non-parametric Kruskal-Wallis statistical test recorded no significant difference for the total number of burrows among the treatments at site 1 ($p<0.05$).

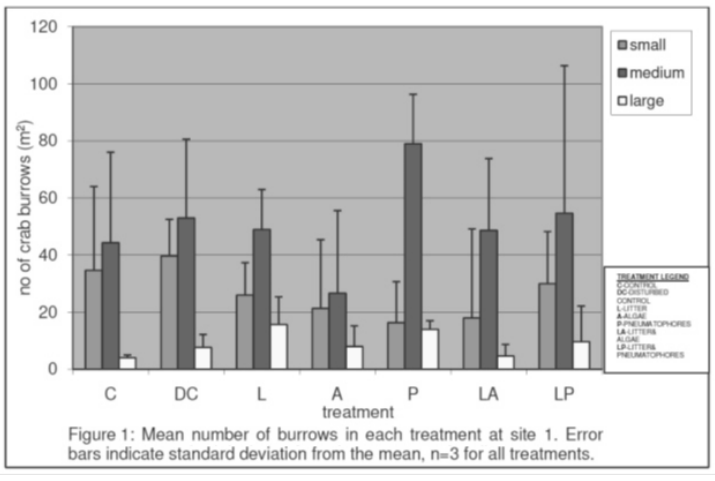

Figure 1: Mean number of burrows in each treatment at site 1. Error bars indicate standard deviation from the mean, n=3 for all treatments.

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The medium sized burrows once again formed the highest proportion of burrows in all treatments (Fig. 2). No statistical difference was found for the total number of crab burrows among the various treatments (Kruskal-Wallis ($p>0.05$).

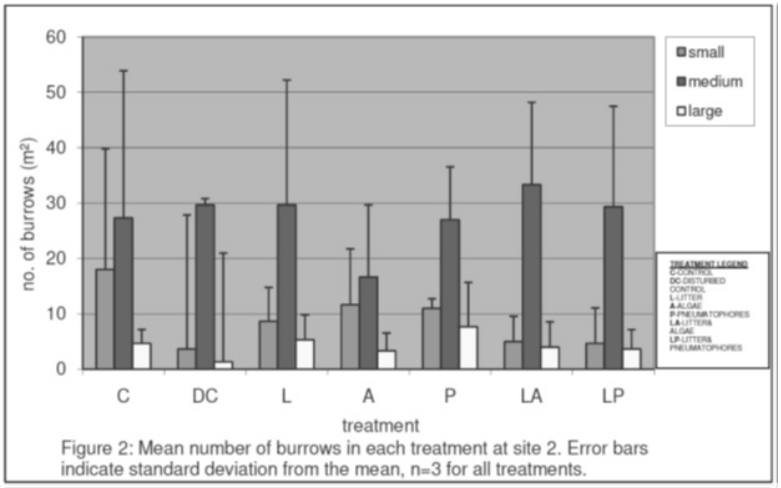

Figure 2: Mean number of burrows in each treatment at site 2. Error bars indicate standard deviation from the mean, n=3 for all treatments.

The mean number of crabs is very similar across the treatments with an average of 15 crabs per m^2 treatment (Fig.3). The treatment where pneumatophores were removed appears to yield a higher number of crabs, but this difference is not statistically significant (Kruskal-Wallis $p>0.05$). The standard deviation in each treatment is fairly consistent.

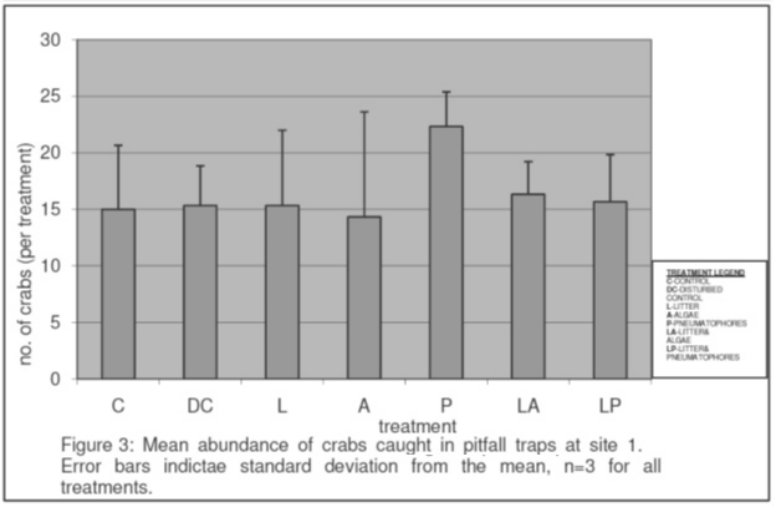

Figure 3: Mean abundance of crabs caught in pitfall traps at site 1. Error bars indictae standard deviation from the mean, n=3 for all treatments.

The results of the mean abundance of crabs caught in the pitfall traps at site 2 are rather variable across the treatments (Fig.4).A large standard deviation was recorded for certain treatments such as the control (17.58) and algae removal (22.85). However, no statistical difference was recorded among the various treatments (Kruskal-Wallis $p>0.05$).

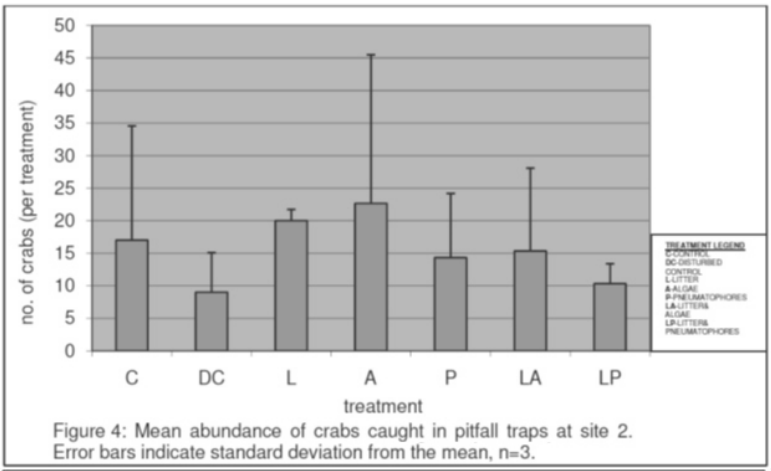

Figure 4: Mean abundance of crabs caught in pitfall traps at site 2. Error bars indicate standard deviation from the mean, n=3.

No obvious trend in overall behavioural activity was evident due to microhabitat alteration at site 1 (Fig.5).The non-parametric Kruskal-Wallis statistical test yielded no significant difference for the total activity among the different treatments ($p>0.05$). Although it would seem that the removal of leaf litter alone (treatment L, Fig. 2.6) had an effect on the crab activity, no statistical difference was found in crab abundance between treatments. Generally the activity in all treatments at site 1 was dominated by

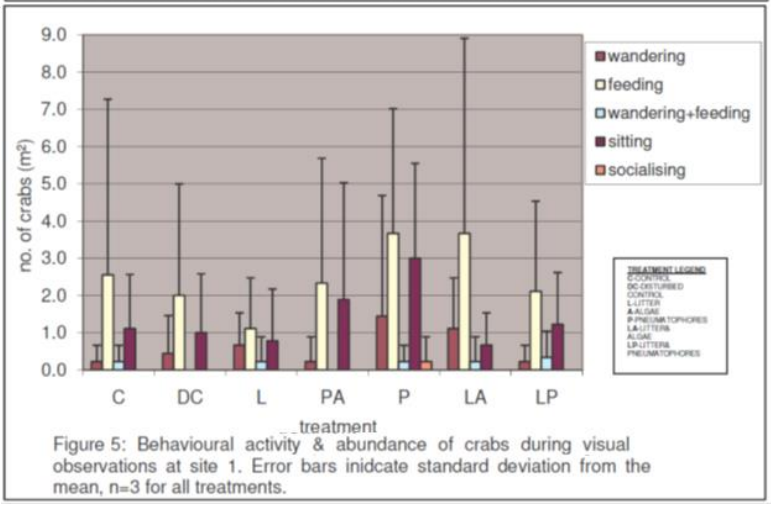

Figure 5: Behavioural activity & abundance of crabs during visual observations at site 1. Error bars inidcate standard deviation from the mean, n=3 for all treatments.

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feeding, followed by resting, and wandering. Both intra- and inter-specific interaction was observed between crabs. The standard deviation for each activity in all treatments was fairly high relative to the observation. A one- ANOVA recorded no significant difference ($p>0.05$, $F=0.89944$) for specific behavioural activities among treatments.

Feeding was not the dominant activity in all treatments as was the case at site 1. Feeding was recorded as the highest activity in the Control, Pneumatophore, Litter & Pneumatophore Algae, and Litter & Pneumatophore treatments. Many crabs were also found to be merely sitting, or wandering within the treatment. Again, little intra- or inter- interaction was seen between the crabs (Fig.6).No statistical difference was recorded for the overall activity of the crabs among the treatments (Kruskal-Wallis $p>0.05$). Similarly, no statistical difference was recorded specific behavioural activity among treatments at site 2 (one-way ANOVA $p>0.05$, $F=1.14007$).

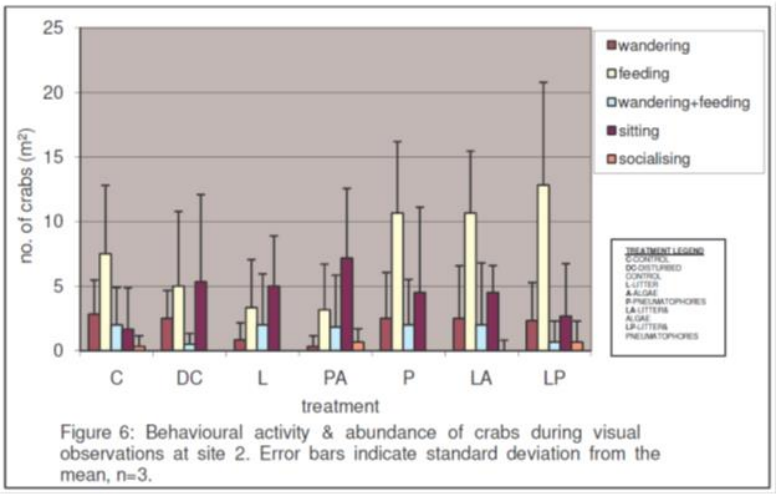

Figure 6: Behavioural activity & abundance of crabs during visual observations at site 2. Error bars indicate standard deviation from the mean, n=3.

When comparing the three methods tested at site 1, burrow counts yielded consistently higher values than both pitfall traps and visual counts (Fig.7). A posthoc Dunn's Multiple Comparison Test was performed after a Kruskal-Wallis test recorded a significant difference between the methods employed at site 1. The results of the post-hoc test showed that all three methods tested significantly different from each other in terms of estimating crab abundance ($p<0.05$).

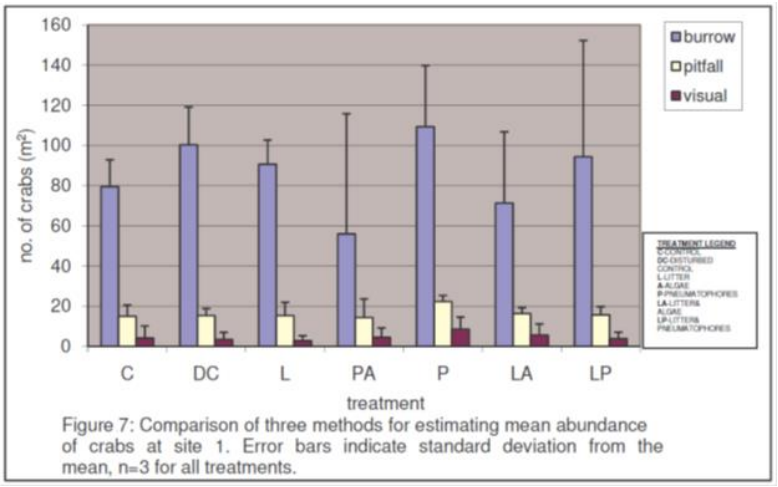

Figure 7: Comparison of three methods for estimating mean abundance of crabs at site 1. Error bars indicate standard deviation from the mean, n=3 for all treatments.

For all methods, the control and disturbed control treatments had fairly high standard deviations, consistent with those of the other treatments (Fig.8). A significant difference was recorded for the crab numbers between the three methods tested at site 2 (Kruskal-Wallis $p<0.05$). A Dunn's Multiple Comparison Test showed that the burrow counts differed significantly from both the pitfall traps and visual counts ($p<0.05$).

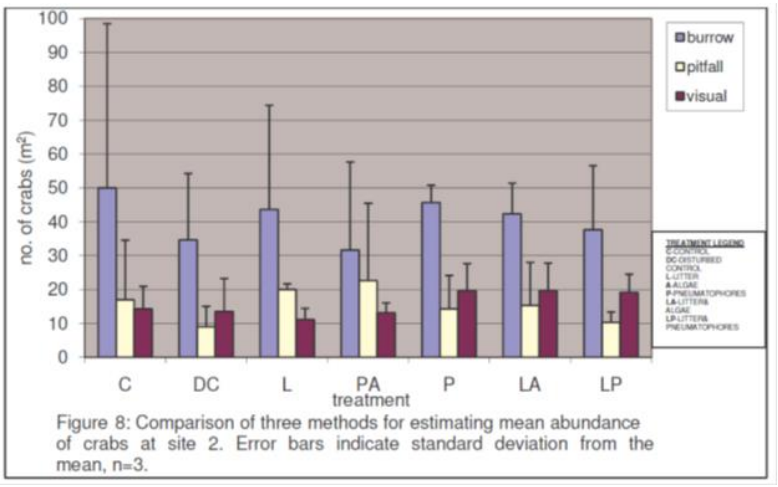

Figure 8: Comparison of three methods for estimating mean abundance of crabs at site 2. Error bars indicate standard deviation from the mean, n=3.

Results of the Mann-Whitney statistical analyses showed that although the burrow counts and the visual counts were significantly different between the two sites ($p<0.05$), the amount of the crabs caught in the pitfall traps were the same ($p>0.05$).

DISCUSSION

Several methods, both direct and indirect, have been used to estimate the absolute abundance of brachyuran crabs in soft sediments, but virtually all of these have disadvantages as well as advantages, particularly in mangrove habitats (Nobbs& McGuiness 1999). The structural complexity of the mangrove habitat is one of the factors which has hindered the absolute quantification of the macrofaunal abundance in these habitats. The occurrence of structures

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such as prop roots, knee-joints and pneumatophores, which defines a mangrove habitat, is often irregular and contributes to the complexity and heterogeneity of the habitat (Lee 2008).

The highly productive mangrove ecosystems are facing ever-increasing pressures from anthropogenic influences which may result in the alteration, deterioration or loss of these important habitats (Zann 1995). Chronic disturbances may lead to modifications of the ecosystem structure and function, affecting the communities in these habitats and may compromise the long-term sustainability of the mangrove ecosystems. Studies by various authors have found that chronic disturbances may result in the modification of the structural habitat with a concomitant change in the faunal assemblages (Skilleter 1996, Kelaher et al. 1998a, Kelaher et al. 1998b, Skilleter & Warren 2000). The specific habitat preferences of crabs in mangrove systems remain uncertain, as does their response to modifications to the habitat structure due to disturbance. There is some evidence to suggest that even small-scale structural modifications may affect crab abundances in mangroves (Kelaher et al.,1998b, Skilleter & Warren, 2000).

Boggon & Skilleter (2002) found that the habitat structure of mangrove forests in Australia varied along a gradient of increasing human impact. Factors such as soil compaction, pneumatophore density and biomass of branch litter were primarily responsible for the differences in habitat structure between the study sites. These factors, as well as pneumatophore algal biomass, also distinguished the sites in the present study. Pneumatophores are able to provide some protection to crabs from predators (Wilson, 1989), the attached algae is a potential source of food (Wada & Wowor, 1989), while a change in the soil compaction will likely affect the burrowing of the crabs Bertness & Miller 1984). Although the sites studied by Boggan & Skilleter (2002) differed with respect to a number of structural characteristics, the abundances and species of crabs present were similar between the sites. This was attributed to the fact that either the relationships between the mangrove habitat structure and its associated crab assemblages cannot simply be inferred from small to larger spatial scales (Bell & Westoby 1986a, 1986b, Kelaher et al., 1998b, Skilleter & Warren, 2000), or that other factors, which were not investigated in the study, were responsible for the separation of habitats in terms of structure and human impact.

The mean number of burrows recorded at both site 1 and 2 before the manipulation of the physical structure, were consistent throughout each of the study sites indicating that the crabs were evenly dispersed throughout habitat before the ensuing experimental plots were demarcated and manipulated. After the alteration of the microhabitat, the pitfall traps and the visual counts recorded no change in the abundance of the crabs in the different treatment plots. The number of crabs encountered in the study sites was therefore not affected by the experimental structural modification of the mangrove microhabitat. However, organisms may not necessarily respond to all types of disturbance. The abundance of the ocypodid crab, Heleocius cordiformis, was not affected by the manipulation of epiphytic algae, pneumatophore or root density in the sediment, but was affected by softer sediments in which to burrow (Kelaher et al. 1998b).

The manipulation of the microhabitat showed no measurable effect on the activity of the crabs as no difference in specific crab activities was recorded between the treatments, including the control and disturbance control plots. However, it must be remembered that the observations were only conducted on a short-term basis i.e. two and four days after the experimental manipulation of the microhabitat, compared to 30 days in the study involving H. cordiformis (Kelaher et al. 1998b). Therefore, the initial disturbance may promote certain activities (such as feeding in a newly exposed area), but this attraction may not be sustainable in the long-term. The accumulation of detritus and organic leaf matter may provide an enhanced source of food for fauna in mangroves, including molluscs and crabs (Daniel & Robertson, 1990). Furthermore, the availability of food has been reported to be an important factor in the determination of ocypodid crab abundance and distribution on a small-scale (Muraiet al.,1982; Genoni, 1991, Klaasen&Ens, 1993). Any microhabitat manipulation therefore needs to be investigated on a larger time-scale where the actual structural manipulation may override the potential effects of the initial disturbance.

The choice of sampling methods used to estimate the size of animal populations is often affected by the behaviour of the species (Hockett&Kritzler, 1972) and the habitat in which it lives (Skov et al., 2002). The comparison of the methods used between the sites showed that although the burrow and visual counts were the same, the number of crabs caught in the pitfall traps differed significantly from site 1 and 2. The tuxedo crab, A. tridentata, which was seen during visual counts at both site 1 and 2 (although only the activity was recorded as A. tridentata females and early juveniles are not brightly marked as the males), this species was only captured in pitfall traps at site 2. It is possible that some difference in structural microhabitat between the two sites which was not investigated, allowed the species to avoid the pitfall traps or that the difference in crab community composition between the two sites resulted in species-specific interaction with the resultant pitfall trap effects. Australian fiddler crabs of the genus Uca are also, however, rarely caught in pitfall traps and exhibit some behavioural mechanism for avoiding capture using this method (Nobbs & McGuinness, 1999). Much is known about fiddler crab behaviour, which is rather complex. They are deposit feeders, requiring water to sort the sediment for food particles. During neap tides when the sediment may

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be too dry for feeding, a number of burrow openings may be plugged, and this may also affect the accuracy of both burrow and visual counts (Macia et al., 2001, Skov & Hartnoll, 2001).

While direct quantification of crabs is most often not possible, the alternative indirect methods are not without their disadvantages. Pitfall trapping and visual counts with binoculars are entirely dependent on the degree of surface activity and catchability of the crab species investigated (Skov & Hartnoll, 2001), and are likely to be influenced by the surrounding habitat. Visual counts may underestimate juvenile counts as they may remain underground for longer periods to avoid predation or they may easily be overlooked due to their size (Skov & Hartnoll, 2001), while burrow counts may overestimate the population due to a proportion of unoccupied burrows or burrows having more than one opening (Skov & Hartnoll, 2002). Pitfall trapping, which has been found to be selective by species, sex and crab size (Skov et al., 2002), but may be more reliable than visual counts in mangrove habitats when investigating grapsid crab assemblages (Salgado-Kent & McGuinness, 2006).

Data from this study are inconclusive as behavioural activity of the crabs may be species-specific and vary with time of day, lunar phase and individual life stage of the crabs. Further comparative studies are required to spatially and temporally determine the magnitude and direction of potential bias in pitfall trapping due to habitat structure. These studies also need to be conducted on a longer term basis than was employed in this study so as to minimize the initial disturbance effects of the structural manipulation. Researchers need to rigorously test estimation methods for different crab species in a variety of habitats with different physical characteristics and not merely assume that the biases or artifacts will hold true for all species in different habitats (Peterson & Black, 1994). Until then, the true ecological impacts of crabs may be vastly underestimated if reliable methods of abundance and distribution are not employed (Salgado-Kent & McGuiness, 2006).

SUMMARY

- Manipulation of the mangrove microhabitat did not have any measured effect on the behavioural activity or overall abundance of the crabs in the experimental treatments.
- Species-specific behaviour which can result in pitfall trap avoidance and differences in the mangrove forest on a microhabitat scale may lead to biases in crab abundance estimates in certain habitats irrespective of temperature.
- Resource partitioning in a highly productive microhabitat enables two closely related crab species to occupy this niche, providing the crabs not only with food sources but also with a potential means of refuge.
- The Ayiramthengu area is a highly productive system with a number of potential primary producers. The crabs inhabiting here show a marked diversity in resource utilization allowing a number of closely related species to occupy different trophic levels with tolerable temperature.
- Mangrove production in this coastal area is very important and contributes to most of the carbon in the underlying sediments in the mangrove forest. Microphytobenthic algae, however, also supports a number of crab in terms of abiotic parameters, marine phytoplankton appears to contribute little to the creek's productivity.
- The larval distribution of brachyuran crabs on the east coast of Kollam was found to be dominated by species variation between spring, summer and winter.
- No difference in abundance was found between the geographical locations. Frequent wind reversals encountered close inshore in this region may supply the more southern locations with larvae from the more northern region.

REFERENCES

1. Bertness, M. D. & Miller, T. (1984) Thedistibution and dynamics of Ucapugnaz (Smith) burrows in a New England salt marsh. Journal of Experimental Marine Biology and Ecology, 83, 211-237
2. Bogggon, T. &Skilleter, G. A. (2002) Effect of disturbance on the habitat structure of mangrove forests and associated crab assemblages. Unpublished.
3. Daniel, P. A. & Robertson, A. I. (1990) Epibenthos of mangrove waterways and open embayments: community structure and the relationship between exported mangrove detritus and epifaunal standing stocks. Estuarine, Coastal and Shelf Science, 31, 599-619.
4. Dahdough-Guebas, F., Verneirt, M, Tack, J. F., VanSpeybroeck, , D. &Koedam, N. (1997) Food preferences in Neosesarmatiummeinerti de Man (Decapoda: Sesarminae) and its possible effect on the regeneration of mnagroves. Hydrobiologia, 347, 83-89.
5. Frusher, S. D., Giddins, R. L. & Smith, F. J. (1994) Distribution and abundance of grapsid crabs (Grapsidae) in a mangrove estuary: effects of sediment characteristics, salinity tolerances and osmoregulatory ability. Estuaries, 17, 647-654.
6. Genoni, G. P. (1991) Increased burrowing by fiddler crabs in response to low food supply. Journal of Experimental Marine Biology and Ecology, 147, 267-285.

ISBN 978-81-925489-0-6

7. Golley, F., Odum, H. T. & Wilson, R. F. (1962) The structure and metabolism of a Puerto Rican red mangrove forest in May. Ecology, 43, 9-19.
8. Hockett, J. C. &Kritzler, H. (1972) Capture-recapture methods with Uca. Biol Bull (Woods Hole), 142, 49-56.
9. Kelaher, B. P., Chapman, M. G. & Underwood, A. J. (1998a) Changes in benthic assemblages near boardwalks in temperate urban mangrove forests. Journal of Experimental Marine Biology and Ecology, 228, 291-307.
10. Kelaher, B. P., Underwood, A. J. & Chapman, M. G. (1998b) Effects of boardwalks on the semaphore crab Heloclusscordiformis in temperate urban mangrove forests. Journal of Experimental Marine Biology and Ecology, 227, 281-300.
11. Klassen, M. &Ens, B. J. (1993) Habitat selection and energetics of the fiddler crab (Ucatangeri). Netherlands Journal of Sea Research, 31, 495-502.
12. Lee, S. Y. (1998) Ecological role of grapsid crabs in mangrove ecosystems: a review. Marine and Freshwater Research, 49, 335-343.
13. Lee, S. Y. (2008) Mangrove macrobenthos: assemblages, services, and linkages. Journal of Sea Research, 59, 16-29.
14. Macia, A., Quincardete, I. & Paula, J. (2001) A comparison of alternative methods for estimating population density of the fiddler crab Ucaannulipes at Saco mangrove, Inhaca Island (Mozambique). Hydrobiologia, 449, 213-219.
15. Mouton, E. C. & Felder, D. L. (1996) Burrow distributions and population estimates for the fiddler crabs Ucaspinicarpa and Ucalongisignalis in a Gulf of Mexico salt marsh. Estuaries, 19, 51-61.
16. Murai, M., Goshima, S. & Nakasone, Y. (1982) Somebehaviouralcharacteristics related to food supply and soil texture of burrowing habitats. Marine Biology, 66, 191-197.
17. Nobbs, M. & McGuiness, K. A. (1999) Developing methods for quantifying the apparent abundance of fiddler crabs (Ocypodidae: Uca) in mangrove habitats. Ecology, 24, 43-49.
18. Olaffson, E. &Narso, S. G. M. (1997) Impact of the mangrove crabs Ucaannulipes and Dotillafenestrata on meiobenthos. Marine Ecology Progress Series, 158, 225-231.
19. Salgado--Kent, C. P. & McGuiness, K. A. (2006) A comparison of methods for estimating relative abundance of grapsid crabs. Wetlands Ecology and Management, 14, 1-9.
20. Skilleter, G. A. (1996) Validation of rapid assessment of damage in urban mangrove forests and relationships with molluscan assemblages. JMBA (UK), 76, 701-716.
21. Skov, M. W., Vannini, M., Shunula, J. P., Hartnoll, R. G. &Cannicci, S. (2002) Quantifying the density of mnagrove crabs: Ocypodidae and Grapsidae. Marine Biology, 141, 725-732.
22. Skov, M. W. &Hartnoll R. G. (2001) Comparative suitability of binocular observation, burrow counting and excavation for the quantification of the mangrove fiddler crab Ucaannulipes (H. Milne Edwards). Hydrobiologia, 449, 212-
23. Smith, T. J. III, Boto, K. G, Frusher, S. D. &Giddins, R. L. (1991) Keystone species and mangrove forest dynamics: the influence of burrowing crabs on soil nutrient status and forest productivity. Estuarine, Coastal and Shelf Science, 33, 419-432.
24. Saenger, P., Hegerl, E.J. and Davie, J.D.S. (Eds.), 1983 Global Status of Mangrove
25. Ecosystems. The Environmentalist 3 (Supplement):1-88.
26. Peterson, C. H. & Black, R. (1994) An experimentalist's challenge: when artefacts of intervention interact with treatments. Marine Ecology Progress Series, 111, 289-297.
27. Wada, K. &Wowor, D. (1989) Foraging on pneumatophores by ocypodid crabs. Journal of Experimental Marine Biology and Ecology, 134, 89-100.
28. Warren, J. H & Underwood, A. J. (1986) Effects of burrowing crabs on the topography of mangrove swamps in New South Wales. Journal of Experimental Marine Biology and Ecology, 102, 223-235
29. Wilson, K. A. (1989) Ecology of mangrove crabs: predation, physical factors and refuges. Bulletin of Marine Science, 44, 263-273.
30. Zann, L. P. (1995) Our sea, our future. Major findings of the state of the environment report for Australia. Ocean Rescue 2000 Program. Department of the Environment, Sport and Territories., Canberra, Australia.

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STUDY OF AEROMYCOFLORA OVER THE MANGROVE VEGETATION IN THANE

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ABSTRACT
Aerobiology is an applied scientific discipline mainly focused on the transport of micro-organisms and biologically significant materials present in the atmosphere. It also explains the dispersion of insect parts, fungal spores, bacteria, viruses, protozoan cysts, pollen and algal components by the atmosphere that can cause respiratory allergic diseases like allergic rhinitis and bronchial asthma. The present study on aero mycology is aimed to assess the qualitative and quantitative aspects of fungal spores over the mangrove vegetation in the city of Thane, to identify the fungal spores, if any which are released from the infected plant parts, conidiophores, morphology of spores and sporulation. In the present study, of one year, the air spora analysis revealed 20 fungal spore types. Tilak Air sampler was used for the collection of fungal spores. RBS media was used for culturing fungal colonies. Deuteromycetes dominated the air spora followed by Phycomycetes & Basidiomycetes respectively. Ascomycetes were poorly represented.

Keywords:-Aero mycology, fungal spores, mangroves, allergy

INTRODUCTION

Mangroves are the characteristics littoral plant formation of sheltered low lying tropical and subtropical coasts. The present status of mangrove vegetation in Thane has been studied and analysed for prevalence of fungal spores over the mangrove vegetation for one year from Jan 2000 to Dec 2000. The fungal spores were also analysed for their allerginicity.The aims and objectives of study were as follows.

1. To assess the qualitative and quantitative aspects of air borne fungal spores over the mangrove vegetation in the city of Thane.
2. To find out the short term, monthly, seasonal and annual variation in the concentration of fungal spore types in the atmosphere over the mangrove vegetation, its identification, quantification and recording of data from different sites.
3. To evaluate the qualitative and quantitative prevalence of fungal spores with special reference to aero allergenic types trapped from the study sites.

MATERIALS AND METHODS

Present study focused mainly at Ghodbunder area of Thane region with a rich flora of Mangroves

A) **Volumetric sampling using Tilak Air sampler**
Monthly Collection of air samples using Tilak air sampler was done. Micro studies with glycerin jelly smeared in the form of thin film were used. The prepared slides were examined for quantitative analysis.

B) **Petri plate Culture Method**
Petri plates containing Rose Bengal Streptomycin (RBS) Agar medium were exposed once a month for 10 minutes at a height of 2 meters from ground level. Exposures /trappings by petri plate culture method were done in a day at 8.00 hrs, 12.00 hrs and 16.00 hrs.

C) **Gravity Slide sampling**
Glycerine jelly coated micro slides were exposed at a height of 2 meters daily, for duration of 7 consecutive days a month.

RESULTS & DISCUSSION

Months	Jan 2000	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Average colonies developed	59	58	57	47	57	68	86	90	89	65	78	66

Table 1:-Month wise average total fungal colonies developed on Petri plates

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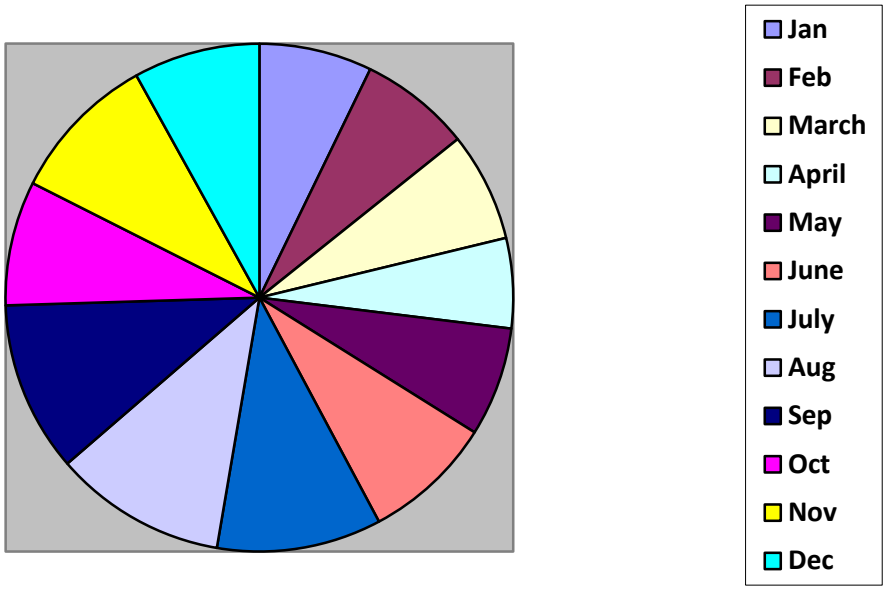

Figure: 1 Month wise average total fungal colonies developed on Petri plates

No	Spore group	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
1	Phyco-mycetes	6.830	5.610	4.723	5.08	7.085	9.176	20.0	23.19	17.469	10.401	7.551	8.161
2	Asco-mycetes	0.247	0.481	0.523	0.214	-	2.638	2.296	3.076	3.276	-	0.137	0.312
3	Basidio-mycetes	2.553	2.847	2.982	2.301	1.951	1.958	1.604	2.377	1.990	2.374	1.393	1.696
4	Deutero-mycetes	45.347	38.014	34.705	35.604	30.153	37.165	32.383	31.10	26.054	37.358	36.395	34.854
5	Aspergillus type	5.762	6.804	7.051	6.082	9.637	15.10	21.884	18.96	17.228	4.247	7.183	9.861
6	Candida type	1.151	1.082	1.004	0.819	0.231	2.661	3.568	2.417	1.10	1.078	1.330	1.276

Table 2:- Month wise average % contribution of fungal spores

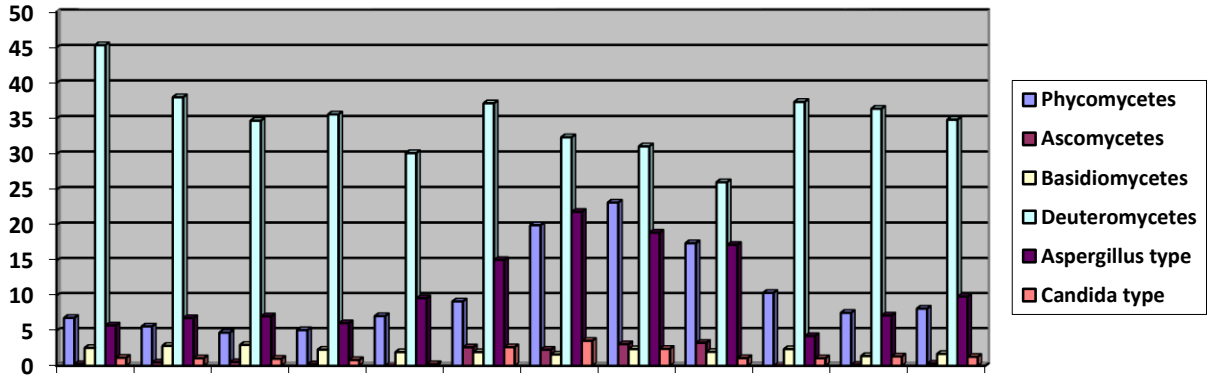

Figure: 2 Month wise average % contribution of fungal spores

No	Fungal spores	Jan 2000	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
1	*Alternaria*	1.398	2.284	25.411	9.852	14.54	13.57	13.46	13.00	10.88	11.47	4.536	4.09

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2	*Aspergillus type*	20.04	18.02	17.09	21.18	18.18	11.66	12.39	12.76	20.80	20.00	23.71	20.45
3	*Basidiospores*	1.631	0.761	1.298	1.97	2.077	4.78	1.709	1.654	-	-	-	1.818
4	*Bispora*	1.398	0.507	1.082	1.477	1.818	0.956	1.282	1.654	1.12	1.475	1.237	0.681
5	*Cercospora*	1.864	-	-	-	0.519	1.338	1.495	1.182	0.96	1.147	1.855	1.59
6	*Chaetomium*	2.797	2.284	3.246	1.724	1.818	3.059	2.564	1.654	-	-	1.03	2.5
7	*Cladosporium*	16.08	6.345	11.03	14.53	9.601	4.971	9.401	8.747	13.28	15.08	8.865	13.63
8	*Curvularia*	3.03	2.03	1.515	1.231	1.038	1.338	1.709	1.418	6.4	3.606	1.443	2.272
9	*Claviceps*	1.864	1.522	1.731	2.216	2.337	1.912	1.282	1.182	0.64	0.491	1.2317	1.59
10	*Didynosphaeria*	0.932	1.269	0.432	0.985	0.519	0.956	1.068	1.182	0.32	0.327	0.618	0.909
11	*Fusarium*	1.398	-	-	-	-	-	0.854	0.472	0.8	1.147	1.649	1.59
12	*Helminthosporium*	3.962	5.583	4.112	3.448	3.896	2.294	1.495	5.347	5.28	4.262	2.268	2.045
13	*Hypoxylon*	0.699	-	-	-	-	-	0.641	0.472	0.32	0.491	-	0.227
14	*Nigrospora*	-	-	-	-	-	3.059	1.709	1.654	4.8	2.786	2.474	-
15	*Periconia*	2.331	0.507	1.515	1.97	1.818	1.338	-	-	0.64	1.311	2.061	0.727
16	*Pithomyces*	2.097	0.507	1.731	1.724	1.558	0.573	4.914	2.836	2.88	3.278	1.443	1.363
17	*Pleospora*	0.932	0.507	0.865	0.492	1.558	0.954	0.427	0.709	0.64	2.95	1.232	0.454
18	*Rusts*	1.864	1.776	1.298	-	-	-	1.068	0.945	0.48	1.311	2.061	1.818
19	*Smuts*	2.797	20.284	1.731	-	-	-	-	0.472	0.64	1.147	12.37	7.272
20	*Unidentified(types)*	3.03	2.284	2.813	3.201	1.818	2.294	2.136	1.654	2.08	11.8	1.649	2.272

Table 3:-Monthly % contribution of fungal spores trapped by using Tilak Air Sampler

CONCLUSION

The airspora analysis revealed 20 fungal spores type. Deuteromycetes dominated the airspora followed by Phycomycetes and Basidiomycetes respectively.Ascomycetes were poorly represented .*Aspergillus type, Cladosporium and Curvularia* predominated the aeromycospora.Rust and Smut spores were not recorded from April to June. *Nigrospora* was not recorded during the period from Jan to May 2000.

Aspergillus type included occurrence of *Aspergillus and Penicillium*.The incidence of *Aspergillus* was six times higher than that of *Penicillium.*

Aero allergenic fungal spores present were mainly *Alternaria, Chaetomium and Curvularia.*

REFERENCES

- Barnett, H.L. and Hunter, B.B.,1972.Illustrated genera of imperfect fungi.Burgesis Publishing Co.Minneappolis, Minnesota
- Dosi, D.K. and Kulkarni, A.R.,1981.Preliminary survey of aerobiology of Bombay, Proc.Nat Conf.Env.Biol.Aurangabad, 97-104
- Gregory, P.H.1961.The Microbiology of the Atmosphere.Interscience Publisher. New York.
- Mishra, R.R. and Kamal.S.,1968. Aeromycology of Gorakhpur-II .Spore content over a paddy field.Mycopath.Mycol.Appl.44:283-288
- Agarwal M.K.., Mukherjee, K.G. and Shivpuri D.N., 1969. Studies on the allergic fungal spores of Delhi. Indian Metropolitan Area-Botanical aspects, J.Allergy.44:193-203.
- Agashe, S.N. and Manunath, K., 1985. Atmospheric biopollution in Urban and Suburban area.3rd National Conference on Aerobiology.
- Blatter, S.J., 1905.The mangroves of Bombay Presidency and its Biology.J.Bombay Nat History .Soc.644-656.
- Deshmukh Sanjay *et al,*.2000.Conservation of the Coastal Biodiversity of the Island city of Mumbai,
- Environmental problems of Coastal areas in India (Ed) Vinod.K.Sharma, Brook well, Delhi pp.71-80
- D'Silva .A.M. and Freitas, Y.M. 1981.The role of aerial mycoflora of Bombay in respiratory allergies.Proc.Nat .Conf.Biol.Aurangabad. pp. 63-70
- Emberlin, J., 1998.Aerobiology and Recent environmental changes. Proc. 6th Int.Conf. on Aerobiology.Perugia:14-17.
- Kunhiraman., 2000. Aerobiology studies in the slum areas of Mumbai.Ph.D.Thesis.Univ.of Mumbai.
- JanakiBai, A. and Subba Reddy, C., 1983. Atmospheric pollen grains of Visakhapatnam .Indian.J.Bot.6 (2):173-175.
- Mishra, R.R. and Shrivastaav, B.B., 1972. Aeromycology of Gorakhpur-V.Air spora over wheat and Barley fields.Ibid.47.
- Mehta, K.C., 1952.Further studies on cereal rusts of India. Part-II Scientific Monograph 18.Indian Con.Agri.Res.new Delhi: 1-368.
- Patil, G.V., 1981.Atmospheric Biopollution at Nagpur.Proc.Nat.Conf.Env.Biol.Auragabad.
- Subrahmanyam, M.N., 1985.Aerobiological studies of the western suburbs of Mumbai.

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MICROBIAL DIVERSITY OF SALT TOLERANT ORGANISMS FROM MANGROVE ECOSYSTEM

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ABSTRACT

Mangrove ecosystem provides a unique ecological niche to different microbes which play various roles in nutrient recycling as well as various environmental activities. Different groups of microorganisms encountered in the mangrove areas perform complex interactions for nutrient and ecological balances. The present study has been designed and formulated to identify microbial diverse groups of organisms from mangroves ecosystem based on depth and salinity of the mangrove zone. Rhizosphere soil and root scrapings from the mangrove of Thane creek were processed on Nutrient agar and MacConkey agar for isolation of bacteria, Sabourauds agar for fungi, and Alkaline Czapek's agar for Actinomycetes. Isolates from the Mangrove soil were identified as *Bacillus subtilis, Micrococcus lylae, Bacillus macerans, Micrococcus varians, Nocardia brevicatena, Micrococcus sedentarius, Actinomyces viscosus, Bacillus pantothenticus, Kluvyera ascorbata, Yersinia kristenseni* and isolates from root scrapings were identified as *Micrococcus halobius, Micrococcus varians, Micrococcus luteus* and *Micrococcus nishinomiyaensis.* The research work was extended to study the microbial diversity of salt tolerant organisms of mangrove ecosystem. Moderate halophiles tolerated 10% of NaCl whereas extreme halophiles like *Actinomyces viscosus* and *Micrococcus lylae* required up to 15% of NaCl. The present study also revealed that both bacteria and fungi exhibited greater ability to tolerate heavy metals like Copper, Zinc and Cadmium. Hence they can act as Biosorbents. Both bacteria and fungi have shown greater ability to accumulate heavy metals and thus they can be used for bioremediation of metal contaminated soils.
(Keywords: Mangrove , diversity, microorganisms, heavy metals).

INTRODUCTION

Mangroves are unique inter-tidal ecosystems of the tropics, which support genetically diverse groups of aquatic and terrestrial organisms. This ecosystem is situated at the inter-phase between the terrestrial and marine environment. [01] True mangrove species are those, that occur extensively in saline wetland environment, with adaptation such as aerial roots, halophytic strategies, vivipary and water conservation. These adaptations distinguish mangrove trees as specialized minority within their families. Their roots have extensions called pneumatophores or breathing roots, that project out of the mud to absorb oxygen. [03] Mangroves are the only forests situated at the sea-level interface in tropical and subtropical latitudes. They are often called as marine tidal forests 'coastal woodlands' or oceanic rainforests. The mangrove forest ecosystem supports biologically diverse group of organisms, this is due to diversified habitats such as core forests, litter forests, mud flats, adjacent coral reefs and sea grass ecosystems as well as the contiguous water bodies that consists of river bags, intertidal creeks, channels and back water.[02]Mangroves possess unique characteristics. The mangroves are live sea walls more effective than concrete wall structures to keep away the sea water. [05]

FUNCTIONING AND ADAPTATION

The mangroves have several functions and adaptations to a life in an intertidal ecosystem. The mangrove trees are fresh water riverine trees. They grow in an environment whose salinity ranges between that of freshwater and seawater. For this reason they have to take up water against osmotic pressure, to overcome the negative osmotic pressure they generate a negative hydrostatic pressure by transpiration process. [04] Several mangrove spp. deposit NaCl in the bark, stem and roots. Other species deposit salt in senescent leaves, which later fall off the tree [04]. Mangroves are trees and shrubs of the genera *Rhizophora, Brugiera, Sonneratia* and *Avicennia* or, more generally, communities dominated by these genera. More than 50 species are present in Asia, thriving along intertidal coastlines on soft saline sediments that are often anaerobic and sometimes acidic. Mangroves possess a range of features which make them uniquely adaptable to their stressful environment (e.g., they are halophytic or salt tolerant, have aerial roots for gathering oxygen, and seeds that geminate on the tree). [01] The present study was carried out to isolate and characterize various micro-organisms like fungi, bacteria and actinomycetes from mangrove soils in Mumbai to capture the biodiversity existing in mangroves with respect to tolerance towards sodium chloride and heavy metal salts.

Aims and Objectives: The aim of the project is to study the microbial diversity of salt tolerant organisms from mangrove soil.

Materials and Method:

Phase 1: Sample Collection:-

Sample was collected in sterile petri plate from the mangrove of Thane creek. Rhizosphere soil and Root scrapping were used. One gram of soil sample and root scrapping from roots were serially diluted using saline.

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1. Dilutions from soil and root scrapping were selected for spread plate technique.
2. The media used were: Nutrient agar, MacConkey agar, Sabourauds agar, Alkaline Czapek's medium.
3. Results were observed after24 hours in MacConkey agar plates, 48 hours in NA plates, up to 1 week in Sabourauds and Alkaline Czapek's agar and.

Phase 2: Identification of the isolates:-

The identification of the isolates was done by using: Morphological, Cultural and Biochemical characteristics. Morphological characteristics of the isolates involved the microscopic examination. Cultural characteristics involved determination of growth pattern on Nutrient agar plates, Sabourauds agar plate and Alkaline Czapek's agar. Biochemical characteristics were studied using various biochemical media. The identification was done using Bergeys manual of systematic bacteriology.

Phase 3: Slide culture technique:-

Slide culture technique was set up for observing the fungal morphology, for observation of development of aerial mycelium/ substrate hyphae and development of conidiospores.

Phase 4: Determination of Salt-tolerance:-

All the isolated organisms were selected for determining their salt tolerant capacity using Sodium chloride (NaCl), Copper sulphate ($CuSO_4.5H_2O$), Cadmium chloride ($CdCl_2$), Zinc sulphate ($ZnSO_4.5H_2O$), Potassium di-chromate ($K_2Cr_2O_7$). The salts were incorporated in Nutrient broth in respective concentration. The salts which were not dissolving in media were dissolved using 0.1 N HCl. All isolates were adjusted to 0.05 O.D. at 530 nm and 0.1 ml of each culture was inoculated in St. Nutrient broth and St. Sabourauds broth with respective salt concentrations for bacteria and fungi. The results were observed after 48 hours of incubation in case of Nutrient broth and 48-72 hrs. in case of Sabourauds broth.

Results: Identification of isolates:

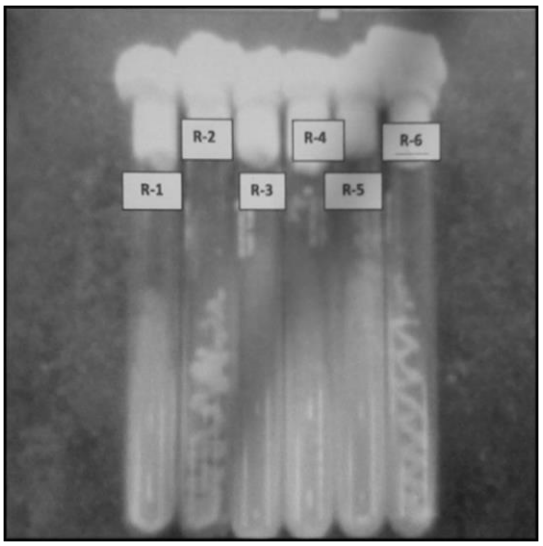

Figure 1: - Isolates obtained from Root Scrapings.

R-1 = Micrococcus halobius
R-2 = Micrococcus varians
R-3 = Micrococcus luteus
R-4 = Micrococcus lylae
R-5 = Micrococcus nishinomiyaensis
R-6 = Micrococcus Luteus.

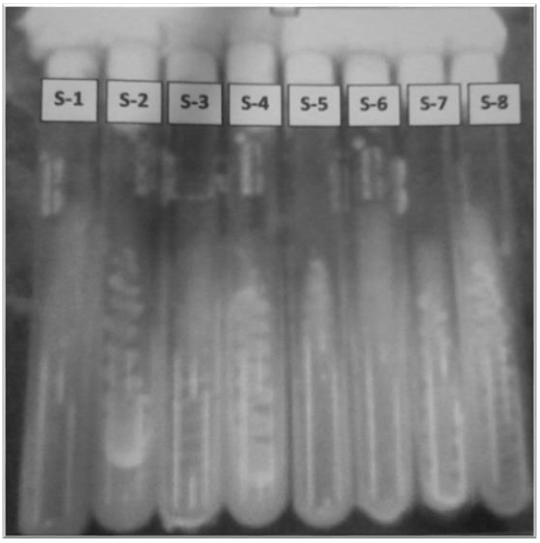

Figure 2: - Isolates obtained from soil.

S-1 = Bacillus subtilis
S-2 = Micrococcus lylae
S-3 = Bacillus macerans
S-4 = Micrococcus varians
S-5 = Nocardia brevicatena
S-6 = Micrococcus sedentarius
S-7 = Actinomyces viscous
S-8 = Bacillus pantothenticus

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Identification of the Fungal isolates :

Isolate	Microscopic Characters		Identified As
	Vegetative hyphae	Conidia	
A1	Creeping, septate and branching	Globose and in chains, conidiophores erect, smooth and arising from mycelia	Penicillium
A2	Creeping, septate and branching	Globose and in chains, conidiophores erect, smooth and arising from mycelia	Penicillium
B1	Non-septate/septate	Conidia elliptical to globose, conidiophores flexous	Aspergillus
C1	Creeping, septate and branching	Globose and in chains, conidiophores erect, smooth and arising from mycelia	Penicillium
C2	Creeping, septate and branching	Globose and in chains, conidiophores erect, smooth and arising from mycelia	Penicillium

Percentage of organism tolerating different concentrations of NaCl

Sodium Chloride	Bacteria		Fungi
	Gram Positive	Gram Negative	
15%	21	-	50
10%	28	50	100
8%	50	100	100
6%	85	100	100
3%	100	100	100

- *Penicillium spp.* tolerated 15% NaCl while *Aspergillus* tolerated 10% NaCl.
- *Nocardia brevicatena, Micrococcus lylae, Micrococcus varians, micrococcus sedentarius, Actinomyces viscous, Bacillus pantothenticus, Kluvyera ascorbata, Yersinia kristenseni, Micrococcus halobius, Micrococcus luteus, Micrococcus nishinomiyaensis* tolerated 3% and 6% NaCl therefore they were grouped as Moderate Halophiles.

Percentage of organisms tolerating heavy metal salts

Metal salts (150ppm)	Bacteria		Fungi
	Gram Positive	Gram Negative	
$CdCl_2$	21	100	100
$CuSO_4$ $5H_2O$	14	100	100
$ZnSO_4$ $5H_2O$	14	100	100

- All isolates got inhibited by very low concentration of $K_2Cr_2O_7$ (20ppm). The most heavy metal tolerant organisms were identified to be *Actinomyces viscous, B.pantothenticus, M.varians, Kluyvera ascorbata, Yersinia kristenseni.* Micro-organisms in these areas have higher tolerance to salts. Both bacteria and fungi have shown greater ability to accumulate heavy metals. Thus they act as Biosorbents.

Discussion

Biodiversity is occupying a center stage in environment policy because it is fast becoming the raw material of the emerging agro and biotechnology industries. The unique and diverse flora, fauna and micro-organisms of the planet have been a source of immense practical value to mankind and must be held in trust for future generations. The present work is centered on the study of microbial diversity of salt tolerant organisms of mangrove soil. In the present study the number of Gram positive bacteria was more than that of Gram negative bacteria; this could be due to the small sample size of the colonies. Slide culture technique and wet mount was done for observation of fungal

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morphology like development of aerial mycelium / Substrate mycelium and therefore its identification. Among the fungal isolates 4 belonged to genus Penicillium and the other one belonged to Aspergillus spp. More organisms both Gram positive and Gram negative tolerated up to higher concentration of Cadmium chloride. Mucoid colonies tolerated higher concentration of Sodium chloride than the non-mucoid. The heavy metal tolerance of fungi can be attributed to adsorption onto fungal cell walls. Thus fungi and bacteria tolerating various concentrations NaCl and salts of heavy metals can be used for bioremediation of metal contaminated soil.

References:

1. A.D. Agate. (1991). Mangrove Microbiology. Proceedings of the symposium.
2. Ail man (2009). Survey of bacterial pathogen on leaves and seeds of red mangroves (Rhizophora mangle). African journal of Environmental Sciences and Technology, 3.p: 116-119.
3. Baker A.J.M. (1994). The possibility of insitu heavy metal decontamination of polluted soils using crops of metal accumulating plants. Resource conservation, 11.pp.41-49.
4. Chan k, Leung OC. (1999). Influence of temperature on ionic sparic effect and cell association cations in the moderate halophile *Micrococcus varians var Halophilus*, Microbiology, 24, pp.81-84.

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STATUS OF PLANKTON AND BENTHOS IN THE PANVEL CREEK

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Abstract
Panvel creek is currently under a heavy anthropogenic stress which is likely to increase in the years to come. The proposed International airport, which is projected to go in operation by 2015, is in close proximity of this creek and the construction as well as operation is sure to result in expansion of the citty. In lieu of it the construction of housing and commercial complexes has already begun.
In view of this a pilot survey of the planktonic and benthic life has been carried out in the year 2011. At 21 collection sites along the Panvel Creek analysed between Panvel Retibundar and Belapur, 6±1.94 species of phytoplankton, 4±1.22 species of zooplanktoan and 3±0.87 species of benthic organisms were noticed. The primary production was 1.326±0.21 mg of glucose/ l/ hr at ambient temperature. The dry organic weight of the zooplankton was 5.086 ± 4.44 g/ m^3. The organic content of sediments was 2.447± 0.89 g%.
It is intended to monitor the changes during the construction of the airport and after it starts functioning to ascertain the effect of the same on biodiversity.

Introduction
Navi Mumbai was developed to decentralize the commercial activities of Mumbai, in an attempt to curtail the ill effects of growing population and urbanization in old Mumbai. Consequently, the otherwise semi-urban area around Panvel is getting thickly populated. This has resulted in a mounting anthropogenic stress on the Panvel creek. The proposed site of the new international airport is in the vicinity of the creek. The site location has coordinates of 18.984677°N 73.079113°E. The proposed Navi Mumbai International Airport is a new international airport, which is to come up at Kopra-Panvel area, is being built through public-private partnership (PPP) — with private sector partner getting 74% equity while Airports Authority of India (AAI) and Govt of Maharashtra (through City and Industrial Development Corporation or CIDCO) holding 13% each. The airport is expected to become operational in 2016. During the construction and after the airport becomes operative, the pollution load is likely to increase still further. Bearing this in mind, the current study was undertaken.
The sea - shore land required is about 11.4 km² for the core airport activity and will have two parallel runways each 3700 metres long. It is to be located on highway NH 4B near Panvel, about 35 km from the existing Chhatrapati Shivaji International Airport in Mumbai. The International Civil Aviation Organisation (ICAO) has already given clearance to the Navi Mumbai airport on technical parameters. The Airport construction is at global tendering stage. Objections were raised by the Union Ministry of Environment and Forests on the current proposed location of the Navi Mumba International airport near Kopra Panvel area, apparently because the construction of the airport would involve reclamation of low-lying areas in an ecologically fragile zone as well as destruction of several hectares of Mangroves. There are serious environmental issues. Its construction would damage mangrove cultivation in the 2,000 hectares, besides the diversion of Gadhi and Ulwe rivers (that form part of Panvel creek), which according to the Union Environment and Forests Ministry is a very serious issue considering the destruction Mumbai faced during the 26th July 2005 floods. In the view of this, it was decided to monitor the biodiversity of Panvel creek.
The study of plankton and benthos as the indicators of the health of coastal waters has been reported by many workers in past (Govindan *et al.,* 1980; Mathew and Govindan, 1995; Swamy *et al.,* 2000; Asha *et al.,* 2002; Ansari *et al.,* 2007; Matondkar, 2007 and Kulkarni *et al.,* 2011). Accordingly in the present work, plankton and benthos was analysed along with certain physic-chemical parameters of water and sediments.

Materials and Methods
The satellite images of the area, available at IIT Powai, were used to identify and determine the more sensitive areas along the Panvel creek for the study. These collection sites along Panvel Creek were assessed in powered fishing boats.
The creek was explored only at high tide since the depth does not permit navigation as well as operation of plankton net at low tide. The surface water was collected for assessing the primary productivity and for analyzing phytoplankton following the treatment with Lugol's iodine. Zooplankton was collected by towing the standard plankton net, at a known speed, from the boat, for certain time periods between the collection sites. The collection and analysis of phytoplankton and zooplankton was done as per the procedures described by Banse, 1994 and Paulinose *et al.,* 1998. The identification of members of zooplankton was done referring to NIO manual and the manual by Altaff (2003). The sediment sampling and the analysis was done following the recommendations of Holme, 1980. The organic content of the sediments was analyzed by the rapid titration method of Walkley and Black (1934).

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Results and Discussion

The result of the analyses has been recorded in tables numbered 1 to 6. The phytoplanktonic species found in the water samples collected from all 21 stations are recorded in table number1.

A total of 24 species were encountered in the pre-monsoon season, of which a maximum 9 were found at two stations, 8 were found at 2 stations, 7 species were encountered at 2 stations, 6 at 2 stations, 5 at 7 stations, 4 at 2 stations and 3 at 2 stations. *Rhizosolenia* species were the commonest being encountered at 20 out of 21 stations, *Skeletonema* species were next being found at 19 out of 21 stations. *Pleurosigma* species could be seen at 14 out of 21 stations. *Chaetoceros* species, *Ditilum breghturelli, Guinardia flacida* and *Volvox* species was each encountered at only one station while the unidentified box like centric diatoms and *Coccosphere* species were also noticed at one station each.

Table1 : Phytoplankton species encountered at all collection stations from Panvel Creek

		w1	w2	w3	w4	w5	w6	w7	w8	w9	w10	w11	w12
1	Rhizosolenia sps.	√		√	√	√	√	√	√	√	√	√	√
2	Skeletonema sps.		√	√		√	√	√		√		√	√
3	Pleurosigma sps.	√		√	√		√			√	√		
4	Pinnate diatom		√	√			√		√	√			
5	Fragillaria sps.	√				√							
6	Ceratulina pelagica											√	
7	Paralia sulcata		√	√								√	
8	Nitzschia closterium		√						√				
9	Biddulphia sps.					√	√						
10	Cosinodiscus radiatus								√				
11	Coscinodiscus excentricus			√					√	√	√	√	
12	Phaeocystis sps		√						√	√			
13	Leptocylindricus danicus				√					√	√		
14	Haplosphaera viridis				√	√			√				
15	Bacillaria paradoxa							√	√				
16	Thalassionema nitzschioides									√			√
17	Chaetoceros sps.	√											
18	Ditilum brighturelli												
19	Guinardia flacida				√								
20	Volvox species			√									
21	Astrionella japonica												
22	Licmophora sps.												
23	Coccosphere												
24	Box like centric diatom												

Table 1 continued

		w13	w14	w15	w16	w17	w18	w19	w20	w21
1	Rhizosolenia sps.	√	√	√	√	√	√	√	√	√
2	Skeletonema sps.	√	√	√	√	√	√	√	√	√
3	Pleurosigma sps.	√	√	√	√	√		√	√	√
4	Pinnate diatom	√	√	√	√	√				√
5	Fragillaria sps.		√		√			√		√
6	Ceratulina pelagica		√							√
7	Paralia sulcata	√		√						√
8	Nitzschia closterium				√					√
9	Biddulphia sps.									√
10	Cosinodiscus radiatus									
11	Coscinodiscus excentricus	√						√		
12	Phaeocystis			√						
13	Leptocylindricus danicus	√								
14	Haplosphaera viridis	√								
15	Bacillaria paradoxa									
16	Thalassionema nitzschioides									
17	Chaetoceros sps.									
18	Ditilum brighturelli	√								

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19	Guinardia flacida									
20	Volvox species									
21	Astrionella japonica						√			
22	Licmophora sps.								√	
23	Coccosphere				√					
24	Box like centric diatom								√	

These observations were not too different from those reported by Matondkar (2007) from Zoari estuary and Zingde and Govindan (2000) from coastal waters of Mumbai and around.

The primary production of the water samples collected from various collection sites along Panvel Creek has been recorded in table number 2

Table 2: Primary production of water collected from different stations along Panvel Creek

Station Number	Pri.Production (mg Glucose/L/Hr)
W1	0.98
W2	1.03
W3	1.36
W4	1.23
W5	1.14
W6	1.04
W7	1.28
W8	1.40
W9	1.52
W10	1.57
W11	1.42
W12	1.48
W13	1.61
W14	1.32
W15	1.54
W16	0.98
W17	1.29
W18	1.04
W19	1.61
W20	1.44
W21	1.56

The primary production ranged from 0.98 to 1.54 mg of Glucose per litre of water per hour at ambient temperature. The average primary productivity of the waters in pre-monsoon was found to be 1.326 $\pm$ 0.218 mg of Glucose per liter of water per hour at the ambient temperature.

Similar values of primary productivity have been reported by Swamy *et al.,*(2000) from stations along Mumbai harbor, except that the primary production at several of the stations along Panvel creek have been a little lower than the average. Godhantaraman (2009) has ascribed the lowering of primary production in tropical coastal waters to the variability and change in global climate due to global warming resulting from green house effect.

The zooplankton collected from different stations located in Panvel Creek showed a total number of 22 types of organisms (table number 3). At any given station, however, the types of organisms found did not go beyond 7. The number is apparently lower than what has been reported by Robin *et al.,* (2009) from southern part of India and Paulinose *et al.,* (1998) from waters of Gulf of Kutchchh, Gujrat. This might be due to the mounting anthropogenic stresses as has also been suggested by Grant *et al.,* (1989) and Ingole and Kadam (2003).

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Table 3: The species composition of zooplankton from various stations in Panvel Creek

s.n.	Species	w1-2	w2-3	w3-4	w4-5	w5-6	w6-7	w7-8	w8-9	w9-10	w10-11	w11-12	w12-13
1	Calanus sps.	√	√	√	√	√	√	√	√	√	√	√	√
2	Pseudocalanus elongatus				√								
3	Ebalia sps.			√	√	√		√					
4	Phialidium		√	√	√	√		√	√	√	√		√
5	Candacia sps												
6	Cosmetira pilosella	√	√		√		√			√			
7	Comb jelly						√		√		√	√	
8	Hemimysis										√	√	√
9	Shrimps										√	√	√
10	Sirella sps.			√		√							√
11	Jaxea sps.			√				√					
12	Acanthephyra			√									
13	Eucheilota maculata						√						
14	Meliceratum						√						
15	Nereis sps		√										
16	Oithiona sps.												
17	Sagitta								√				
18	Zoea larva												
19	Gastropod larvae												
20	Unidentified medusae	√											
21	unidentified larval forms			√									

Table 3: continued

sr.no.	species	w14-15	w15-16	w16-17	w17-18	W18-19	W19-20	W20-W21
1	Calanus sps.	√	√	√	√		√	√
2	Pseudocalanus elongatus							√
3	Ebalia sps.	√	√	√		√	√	
4	Phialidium							√
5	Candacia sps	√		√	√			
6	Cosmetira pilosella							
7	Comb jelly							
8	Hemimysis							
9	Shrimps							
10	Sirella sps.							
11	Jaxea sps.							
12	Acanthephyra							
13	Eucheilota maculata							
14	Meliceratum							
15	Nereis sps							
16	Oithiona sps.	√						
17	Sagitta							
18	Zoea larva				√			
19	Gastropod larvae			√	√	√		√
20	Uidentified medusae							
21	unidentified larval forms							

The dry organic weight of the zooplankton collected from Panvel Creek is presented in Table number 4. As seen from it, the minimum standing crop biomass in the form of dry organic weight of zooplankton has been 0.107 g/m^3 of water while the maximum biomass was 15.86 g/m^3 of water. The mean biomass of all these water bodies was 4.899 $\pm$ 4.41 g/m^3. While studying the effect of habitat degradation and pollution along Thailand, Cheevaporn and Menasveta

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(2003) have reported the quantitative lowering of plankton at large and zooplankton in specific. The dry organic weight of zooplankton from Panvel creek, however, indicates that there isn't an extreme quantitative reduction in plankton. It however needs to be monitored over the years to learn the trend.

As expected, a distinct correlation was found between abundance of phytoplankton, primary production, and abundance as well as dry organic weight of zooplankton collected from various collection sites along Panvel creek. The stations along Ulwe River showed poorer diversity and quantity of phytoplankton (and primary production) and variety as well as dry organic weight of zooplankton, as compared to the stations along Gadhi River and Panvel Creek.

Table 4; Dry organic weight of the zooplankton collected from various stations along Panvel Creek

Station No.	Dry Organic Weight of Zooplankton (g /m^3 of Water)
W1-W2	8.795
W2-W3	11.65
W3-W4	5.685
W4-W5	11.29
W5-W6	4.933
W6-W7	3.84
W7-W8	1.376
W8-W9	1.227
W9-W10	1.892

Station No.	Dry Organic Weight of Zooplankton (g /m^3 of Water)
W10-W11	9.077
W11-W12	15.86
W12-W13	6.898
W13-W14	4.342
W15-W16	3.361
W16-W17	0.107
W17-W18	2.78
W18-W19	0.272
W19-W20	3.189
W20-W21	0.267

The result of analysis of the sediments collected from various stations along Panvel Creek is displayed in Table no. 5. A total of eight varieties of sedimentary organisms could be found and at a given station not more than 5 of them were found. The minimum number of forms was just one. As was noticed earlier with phytoplankton and zooplankton, the diversity of benthic organisms was poorer in Ulve River, as compared to that of Gadhi River and Panvel Creek.

Table 5: The benthic organisms from the sediment samples collected from various stations along Panvel Creek

Benthic forms	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15	W16	W17	W18	W19	W20	W21
Texularia	√	√		√		√			√	√	√	√		√	√	√				√	
Cyclamina		√	√		√				√		√		√		√	√	√	√	√	√	√
Microgromia	√	√		√				√		√	√	√		√	√	√	√		√		
Vernullina	√	√			√	√	√					√			√					√	
Saccamina			√					√	√	√			√	√					√	√	
Rhizonubeula				√	√		√	√		√	√	√									√
Bathysiphon			√			√			√												√
Turrispirillina	√				√	√	√	√	√			√	√			√	√				
Total Types	4	4	3	3	4	4	3	4	5	4	4	5	3	3	4	4	3	1	3	4	3

The organic matter in the sediments expressed as grams per 100 grams of dry sediments can be seen in table number 6. The Sediments from various collection sites had average organic contents of 1.716 $\pm$ 0.89 g%.

A distinct positive correlation was noticed between the diversity of benthos and organic contents of the sediments collected from all the stations along Panvel creek. The general poverty in diversity of benthos and relatively less organic contents can be ascribed to the sand dredging activity that is being carried out at a pace much higher than is legally permitted and ecologically justified. Grant *et al.,* (1989), Gray *et al.,* (1990), Ansari *et al.,* (2003), Prijilal (2003), Desai *et al.,* (2006), Rejomon *et al.,* (2008) and Kulkarni *et al.,* (2011) have revealed effect of pollution of various kinds on the diversity and density of benthos.

Table 6: The organic matter content of sediments collected from various stations along Panvel Creek.

Station	Organic matter contents (g%)
W1	1.613
W2	2.108
W3	1.374
W4	1.725
W5	1.955
W6	1.437
W7	2.037
W8	1.142
W9	0.995
W10	1.840
W11	2.311
W12	4.119
W13	2.871
W14	3.438
W15	0.929
W16	1.445
W17	0.774
W18	1.393
W19	0.671
W20	1.084
W21	0.774

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Anthropogenic stresses are taking their toll on the diversity as well as density of phytoplankton and consequently the zooplankton. These include civil constructions close to waterfront. This is further complemented by the use of Panvel creek as water way for transport, commercial fishing and sand dredging. The sand dredging is by methods beyond what are permitted and the amounts dredged are also considerably over that permitted. There is also a prawn farming activity and blasting activity in the adjacent hills. All these activities are distinctly related to the pressure of urbanization and development activities related to the construction of the International Airport coming up in the vicinity.

Residential complexes close to the banks

Transport facilities along the water ways.

Sand dredging along the creek

Pump dredging of sand.

Prawn farming along the bank of creek.

Blasting of hills at quarries along the creek.

In conclusion it can be said that Panvel creek has already started showing the signs of extreme anthropogenic stresses in response to which the quantitative and qualitative aspects of plankton as well as benthos are showing distinct signs of deterioration. The trend will be clear only if and when a monitoring is done during construction as well as commissioning of Navi Mumbai Airport. There is an earnest need to conserve the habitat and prevent further anthropogenic damage.

ReferaNces

1. Altaf, K (2003) A manual of Zooplankton. Department of Zoology, The New College, Chennai

2. Ansari, ZA; Ingole, BS and Furtado, R (2003) Response of benthic fauna to different pollutants: some case studies and relevance of benthos to Environment Impact Assessment. In Hiramath KG (Ed) Recent Advances in Environmental Science, Oxford Press, India.

3. Ansari, ZA;Sivadas, S and Ingole, BS (2007) Benthic macrofauna, in S R Shetye (ed) Mandovi Zuari Estuaries, NIO, Goa, India pp 91-98.

ISBN 978-81-925489-0-6

4. Asha, RS; Sathish kumar, CS and Ouseph PP (2002) Plankton characteristics in the marine environment of Cochin. Proc. of the 14th Kerala Science Congress pp 435-438.
5. Banse, K (1994) Grazing and zooplankton production as key controls of phytoplankton production. Oceanograph **7(1):** 13-20.
6. Cheevaporn, V and Menasveta, P (2003) Water pollution and habitat degradation in the gulf of Thialand. Marine Pollution Bulletin **43(1-6):** 43-51
7. Desai, SR; Verlekar, XN; Nagarajappa, S and Goswami, U (2006) Genotoxicity of cadmium in marine diatom Chaetoceros tenuissimus, the alkaline commet assay. Ecotoxicology **15(4):** 359-363.
8. Gallardo WG and Buen SMA (2003) Evaluation of mucus, Navicula and mixed diatoms as level settlement inducers for the tropical abalone Haliotis asinine, Aquaculture **24(1-4):** 357-364.
9. Godhantaraman, N (2009) Impact of climate variability and change on marine plankton communities in tropical coastal ecosystems, South India. Earth and Environmental Science **6:** 35-39.
10. Govindan K; Kasinath, R and Desai BN (1980) Quantitative studies of the macrobenthic fauna in the polluted Thana creek and Bombay harbour. J. Indian Fish Ass. **6:** 127-139
11. Grant, A; Hateley, JG and Jones NV (1989) Mapping the ecological impact of heavy metals on the estuarine polychaete Nereis diversicolor using inherited metal tolerance. Mar. Pollut. Bul. **20:** 235-238.
12. Gray, JS; Clarke KR; Warnik RM and Hobbs, G (1990) Detection of initial effect of pollution on marine benthos: An example from the Ekofisk and Eldfisk oilfields, North Sea. Marine Ecology Progress Series **66:** 285-299.
13. Ingole SA and Kadam AN (2003) Pollution of some recreation beaches of Mumbai, Maharashtra. Journal of IAEM **30:** 172- 175.
14. Jagtap TG; Bhosale, SH and Nagle VL (2003) Ecological observations of major Salicornia beds from highly saline coastal wetlands of India. Wetlands **22(3):** 443-450.
15. Jenederdjian, K; Hakobyan, S and Jenderedjian, A (2007) Use of benthic invertebrates as indicators of pollution origin in aquaculture and urban areas. In A. Ebel and T. Divitaeshvili (eds) Air, Water and Soil quality modelling for risk and impact assessment, NATO Security Through Science Series: Environmental Security. Pp 217-220.
16. Kulkarni VA,;Naidu, VS and Jagtap TG (2011) Marine ecological habitat: A case study on projected thermal power plant along Dharamtar Creek, India. J. Environ. Biol. **32:** 213-219.
Matondkar, SG (2007) Phytoplankton. In SR Shetye (ed) Mandovi Zuari Estuaries, NIO, Goa, India pp 67-81.
17. Mattew, A and Govindan, K (1995) Macrobenthos in the nearshore coastal system of Bombay. Proc. Nat. Acad. Sci. India **65(B) IV** 1995.
18. Paulinose, VT, Ramaiah N, Lalithambika CB, Nair VR and Gajbhiye (1998) Zooplankton standing stock and diversity in Gulf of Kutchchh with special reference to larvae of decapoda and pisces. *Indian J. of Marine Sciences* **27:** 340-345.
19. Phatarpekar, PV and Ansari, ZA (2000) Comparative toxicity of water soluble fractions of four oils on the growth of a microalga. Botanica Marina **43:** 367-375.
20. Prinjilal, KG (2003) Impact Assessment of marine pollution in Veli coast, Thiruvananthapuram district, Kerala. M. Phil. Dissertation, Univ. Of Kerala.
21. Rajomon, G; Balachandran, KK; Nair, M and Joseph, T (2008) Trace metal concentrations in marine zooplankton from the western bay of Bengal. Appl. Eco. And Env. Res. **6:** 107-116.
22. Robin, RS; Sriniwasan, M and Chandrasekar, K (2009) Distribution of zooplankton from Arabian Sea, along Southern Kerala (Southwest Coast of India) during the cruise. Curr. Res. J. Biol. Sci. **1(1):** 155-159.
Swamy, BS; Suryavanshi, Vg and Karande, AA (2000) Water quality status of Mumbai Harbour, an update. Indian J. Mar. Sci. **29:** 111-115.
23. Walkley, A and Black, JA (1934), Soil Science, 37:29-38, In CS Piper (ed) Soil and Plant Analysis,
24. Zingde, MD and Govindan, K (2000) Health status of coastal waters of Mumbai and regions around. In V.K.Sharma (ed) Environmental problems of coastal areas in India, Bookwell Publ. New Delhi

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STUDY OF THE EFFECT OF SAND DREDGING ON MACROBENTHOS OF THANE CREEK

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Abstract
The present investigation deals with the assessment of dredging on Thane creek. Creeks and estuaries being the ecotones, as it represent stressed habitats. Additionally they are used as dumps of a variety of wastes all over the world subjecting them to greater stress. Thane creek has been subjected to a lot of pollution from the Asia's biggest Thane—Belapur Industrial Complex located at the south of Mumbai harbor along the west coast of India. The present work involves ecological studies of a portion of Thane creek specifically to establish the effect of sand dredging on the benthic macrofauna.
In the present investigation, chemical parameters like pH, salinity, dissolve oxygen and nutrient contents of water as well as sediments were analysed from predetermined stations for comparing the dredged and undredged areas. The sediment samples were analyzed for their texture, moisture content, organic carbon, nutrients and also for benthic macrofauna. An attempt has been done to correlate the findings with the effect of dredging.

Keywords: macro-benthos, sand dredging.

Introduction

Mumbai metropolis has extended far into the jurisdiction of Thane Muncipal Corporation, Kalyan Dombivali Muncipal Corporation and Ulhasnagar Muncipal Corporation. MMRDA (Mumbai Metropolitan Regional Development Authority) is looking after the infrastructural facilities and other fundamental requirements for human existence. Increased development and changes in land use patterns in the coastal zone has resulted in increased sedimentation and eutrophication, which have led to extensive degradation and loss of biodiversity.
Since the housing costs are within reach of middle and low income groups of the society in MMRDA jurisdiction there a frenzy of construction activities. Moreover the capital gains in the investment in real estate have attracted a number of investors in the business. Sand is a commodity essential and limiting these activities and sand mafias have emerged in the localities.
Sand mining, far in excess of what is permissible and through the practices beyond legislative ones are routinely followed along the stretches of the creek flowing through Kalyan, Bhiwandi, Ulhas Nagar, Diwa, Mumbra, Kalwa and Thane. There are environmental issues related to sand dredging that have been already addressed. However as the demand for sand increases in the industry and construction business, the rivers and creeks are experiencing out of ordinary stress. The sand production by pumping the sediments is against legislation. It grossly disturbs the micro habitat of benthic region.
Analysis of sediments in the region recently exploited by sand mafia by pumping out sediments and comparing it with sediments in the same system where such sand removal has not occurred in the recent past that can provide data that may bring out the ill effects of this method of harvesting sand. The study site was selected along Retibundar, close to the newly formed Kopar Railway Station,
The area is threatened by soil erosion and sedimentation. Sedimentation is one of the contributors to pollution. The accelerated accumulation of sediments in aquatic ecosystems leads to a decline in surface water quality and biodiversity. (Ghose, 1989; Saviour, 2012). Adequate data addressing the effects of sedimentation and particularly sand dredging by pumping out the sediments on aquatic biodiversity in the study area is not available. In this paper we have attempted to establish the direct and indirect impact of sand mining on the creek environment in the region of study.

Study Area

The study was carried out in a creek near Thane City, which is one of the most heavily populated and industrialized cities of India. The creek, known as "Thane Creek" separates the Island City of Mumbai in the west from the mainland in the east and houses industrial areas at a distance of about 25 Km north-east of Mumbai city. Thane Creek lies in the southern part of the Deccan belt of India between latitude 18° 53' to 19° 04' N longitude 73° 48' to 72° 53'E. It is a triangular mass of brackish water which widens out and opens to the Arabian Sea in the South. The creek is narrow at the Northern end, were it is fed partially by river Ulhas. The geographical location of the creek where the study was conducted is seen in **Figure 1**. Three collection stations, two recently dredged (station 2) and silted (station 1) and one not subjected to dredging or dumping of residues (station 3) were chosen.

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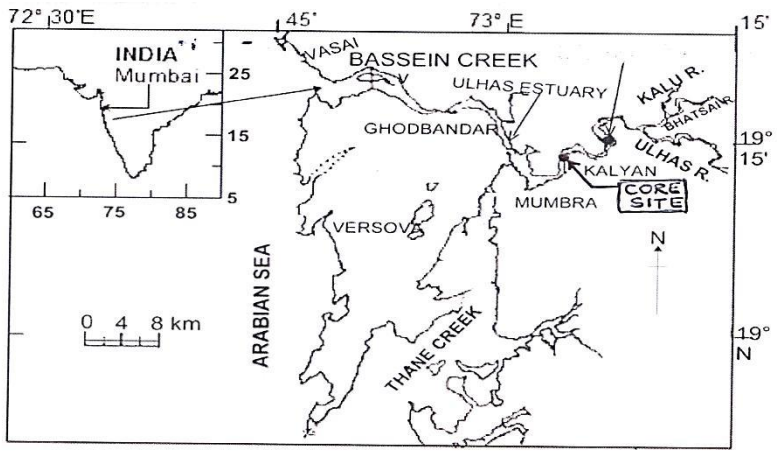
Figure 1-Sampling location at Thane Creek-Kopar

Materials and Methods



For studying the impact of dredging for sand on water, surface water samples were collected from Station 1, 2 and 3. These samples were analysed for pH, dissolved oxygen, salinity and nutrient contents (PO_4-P and NO_x-N). Sediment samples from the top layer (0-20 cm) were sampled simultaneously. The sediment samples were collected by hand-pushing plastic core tubes (10 cm diameter) about 20 cm into the sediments. The core samples retrieved in the field were immediately divided into four parts, from which two parts were stained using Rose Bengal and formalin, (Teitjen, 1969) for study of macro-benthos, one part was air dried in the laboratory for texture as well as nutrient contents and the remaining was analysed for moisture content (APHA,1981). The organic carbon contents were analyzed from the oven dried samples (at 70^0C) using Walkley and Black rapid titration method (Trivedi *et al.*, 1987).

Results and Discussion

The results of analysis of overlying water and sediments from the three predetermined collection stations have been displayed in tables 1 and 2.

Table1: Physico-chemical characters of overlying water from collection stations.

Parameters	Station 1	Station 2	Station 3
pH	7.23±0.04	7.24±0.06	7.21± 0.03
DO (ml/lit)	4.51 ± 0.82	5.68± 1.02	6.16± 1.18
Salinity (ppt)	1.67±0.041	2.05±0.038	3.84±0.053
PO_4-P (µgm/lit)	55.56± 3.11	33.33± 2,57	66.67± 4.29
NO_x-N (µgm/lit)	103.71± 7.66	161.80± 11.2	189.85± 14.32

Table2: Physico-chemical characters of sediment samples from collection stations.

Parameters	Station 1	Station 2	Station 3
pH	7.04±0.06	7.08±0.02	7.11± 0.07
Moisture (gm %)	40± 04	25± 08	40± 11
PO_4-P (µgm/lit)	222.22± 34.05	255.55± 18.9	322.2± 20.66
NOxN (µgm/lit)	138.31± 21.08	143.92± 16.5	155.14± 14.33
Organic C (g %)	6.06± 0.34	9.54± 0.62	8.1± 0.73

Understanding the impact of sand mining operations in a complex environment requires a combined observational and modeling approach (Muhammad *et al.,* 2011). Here, we use field measurements collected after mining operations. Based on the results obtained it was found that the pH values at all the three stations were nearly same with the value 7.2 which is same found earlier (Nikam *et al.,* 2008) The moisture content of Station 1and 3 was 40 gm% owing to the high proportion of clay (80%) and less silt (2-5%). The moisture content of Station 2 was 25% and the proportion of clay (55%) and silt (25%) showed great difference compared to Station 1 and 3.

From the above observations it is noticed that the proportion of silt is more in Station 2 indicating impact of anthropogenic activities like excessive excavation and channelization of the bed. Similar observations were recorded by (Quadros *et al.,* 2009). The Organic carbon at Station 1, 2 and 3 was respectively as 6.06 gm%, 9.54 gm% and 8.16

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gm%. The values signify that due to sand mining the benthic community is disturbed resulting in reduced degradation of the organic matter leading to higher values of organic carbon at Station 2. Further it is observed that the organic carbon content at Station 3 is nearly equal to Station 2 and is contributed by the mangrove ecosystem. Similar observation on the levels of organic carbon due to natural and anthropogenic sources in Thane creek were recorded. (Sheetal Chaudhari , Madhuri Pejaver,. 2010)

The values showed increasing trend for PO_4-P in the order Station 3> Station1>Station2 for both water and sediment with higher proportion in the sediment due to the bound phosphate compounds. The NO_2 and NO_3 values also showed similar trend as of PO_4-P. Sediment values were higher owing to the fact of natural accumulation and human commercial activities.

The earlier data of benthos in Thane creek reveals high standing stock (NIO ,Technical report,2007)where as the area of siltation (Stn 2) showed Low benthic productivity and diversity which may be associated to destruction of benthic organisms by the activity of siltation.

The pollution induced high primary production was not adequately supported by secondary grazing cycle but partially supported by pollutant tolerant benthic organisms especially in the creek. Such trends were common in the organic polluted coastal system along Maharashtra. The estuary sustained high primary productivity associated with organic loading.

Conclusions

The moisture content of sediments at station 1 and 3 was observed to be same supported by high clay content. Benthos estimation showed that station 1 and station 2 has less diversity than station 3 which has rich mangrove ecosystem. The impact of sand mining has resulted in reduction of water quality and destabilization of the stream bed. Mining has also disrupted sediment supply and channel form, which has resulted in deepening of the channel (incision) as well as siltation of habitats, channel instability and sedimentation from in-stream mining can also damage public infrastructure in future.

Acknowledgement

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References

- APHA AWWA and WPCF, 1981.American Public Health Association, American Water Works Association and Water Pollution Control Federation for International Standard Methods for the examination of water and waste water 18th edition, Washington D.C., 874 pp.
- Boyd, S.E., Limpenny, D.S., Rees, H.L. and Cooper, K.M., 2005.The effects of marine sand and gravel extraction on the macrobenthos at a commercial dredging site ICES Journal of Marine Science62(2)145-162.
- Chaudhari, S., Pejaver, M,, 2010. Conservation of Mangroves With respect to their Potentiality of Organic Carbon accumulation in sediment of Thane Creek, Maharashtra, India, Proceedings of “Lake 2010” -Wetlands, Biodiversity and Climate Change p 1-12.
- Ghimire, G.P.S. and Uprety, B.K., 1990. Causes and effects of siltation on the environment of Nepal**.** The Environmentalist 10, 55-65.
- Ghose, M.K. 1989. Land reclamation and protection of environment from the effect of coal mining operation. Mine- tech **10 (5)**, 35- 39.
- Muhammad, A. A., Maah, M. J., Yusoff, I. , Wajid. A. and Mahmood, K. ,2011.Sand mining effects, causes and concerns: A case study from Bestari Jaya, Selangor, Peninsular Malaysia., Scientific Research and Essays. 6(6), pp. 1216-1231.
- NIO, 2008. Monitoring of coastal Marine and estuarine ecology of Maharashtra, Sponsored Project by MPCB, Mumbai Mumbai,IndiaNational institute of Oceanography Mumbai p.12.
- Quadros, G., Sukumaran, S. and Athalye, R.P., 2009.Impact of the changing ecology on intertidal polychaetes in an anthropogenically stressed tropical creek. Aquatic Ecology 43(4)pp 977-985.
- Saviour, N., 2012. Environmental Impact of Soil and Sand Mining a review. International Journal of Science, Environment and Technology 1 (3),125-134.
- Singare,P.U., Lokhande, R.S.,. Pathak, P.P., 2010.Soil Pollution along Kalwa Bridge at Thane Creek of Maharashtra, India1 (2): pp.121-128
- Tietjen, J.H., 1969.The ecology of shallow water meiofauna in two New England estuaries Oceologia, 2: 201-291
- Trivedi, R.K., Goel, P.K.,1986. Chemical and biological methods for water pollution studies, Environment Publ., Karad, India- p 122.
- Trivedi,R.K., Goel,P.K.,1984.Chemical and biological Methods for water pollution studies. Environmental Publications, Karad (India), 340 pp.

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BIOSORPTION BY IMMOBILISED *ASPERGILLUS NIGER* : A PROMISING BIOREMEDIATION STRATEGY FOR MARINE ECOSYSTEM

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Abstract
Fungal strain- *Aspergillus niger* was isolated from effluent of chemical and pharmaceutical industry using SDA agar. The MIC of the strain was carried out for lead and chromium which are widely encountered heavy metal pollutants of urban lakes. Pretreatment of the biomass obtained was carried out and the dried powdered form was used for biosorption of heavy metals. This dried biomass was immobilized in Ca-alginate beads. Ability of lead biosorption with immobilized *Aspergillus niger* biomass was premeditated in the present study. Effect of Initial metal ion concentration, concentration of adsorbent and contact time doses on Lead (Pb) removal was determined. The concentration of Lead in the filtrate was then analyzed by Atomic Absorption Spectrophotometer. The biosorption mechanism was studied using suitable techniques of FTIR, SEM & SPR (SURFACE PLASMON RESONANCE). Suitable conditions for *Aspergillus niger* to take up Pb were shown to be at 50ppm lead as initial metal ion concentration using 2.4 grams of fungal beads as the adsorbent. The optimum contact time was found to be 150 minutes. Based on optimization results, Biosorption and Desorption processes were carried out. Biosorption experiment revealed that *Aspergillus niger* showed 74.61% Pb removal. Desorption using EDTA retrieved 77.78% Pb from the beads. The culture was identified using r-RNA sequencing analysis. This could definitely be a promising mechanism for bioremediation of urban lakes polluted by heavy metals.
Keywords: *Aspergillus niger*, Atomic absorption spectrophotometer, Biosorption, Lead Desorption,Sequencing analysis.

Introduction

The oceans are in jeopardy. At no time in the span of human civilization have we faced such extreme and global threats to our marine ecosystems. Pollution levels in coastal habitats are reaching alarming levels. Heavy metal contamination is yielding some commercial fish stocks unsafe, and many species are exploited to the brink of collapse. Estuaries, the nurseries of the oceans, are being destroyed on a daily basis. Wetlands are filled and mangroves are bulldozed for urban development. The 20th century alone saw the destruction of 50% of the world's mangrove forests. The very chemistry of the ocean itself is threatened with acidification as the release of green house gases explodes and carbon dioxide levels skyrocket. Coral reefs, critical centers of biodiversity that provide habitat for one quarter of all marine life, are in serious decline worldwide. Of the 109 countries around the world that have significant coral reef ecosystems, 93 are exhibiting significant damageBoth agricultural and urban runoff increases the nutrient load on reefs and embayments causing eutrophication, which in turn affects marine pathogen growth and spread[11]. Poor land use practices dramatically increase the rate of erosion which increases sedimentation on the reef, killing coral colonies outright or reducing their resistance to disease. Local governments can halt these assaults on marine ecosystems with better land use laws and improved urban infrastructure and public education. Cities, with their large areas of impermeable surfaces[12], generate enormous volumes of storm-water runoff. This urban run off carries with it a wide variety of contaminants and sediment onto coral reefs and into coastal wetlands. Large volumes of hydrocarbons, household hazardous wastes, and a wide array of other toxic agents are poured down catch-basins each day in urban areas, flushing out into estuaries and reef ecosystems at the first rain. The agricultural hinterlands surrounding urban areas further burden the marine environment with the runoff of topsoil, herbicides and insecticides. The aim of this study was to investigate the lead (Pb) biosorption efficiency with immobilized *Aspergillus niger* biomass. And also to check the effect of different doses of initial metal ion concentration, amount of absorbent and contact time. The desorption activity of EDTA, NH_4Cl, and HCl was tested. The culture was identified using the traditional DNA sequencing analysis. The biosorption mechanism which takes place in the dry biomass as well as immobilized biomass has been assessed using the instrument, SEM .The parameters for the biosorption of the metal has been optimized accordingly.

Materials and Methods

- Identification of strain
- Screening and Selection of Heavy metal resistant fungi
- Determination of Minimum Inhibitory Concentration
- Biomass Harvestation and Pretreatment of Live Biomass

Fungal strain- *Aspergillus niger* was isolated from effluent of chemical and pharmaceutical industry using SDA agar. Spores of 6-7 days old culture grown in Sabouraud's agar plate was inoculated in SAB broth. Culture was grown on shaker to form spherical pellets. After 3-4 days the harvested broth was washed with deionised water. Live harvested

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mycelial biomass was treated with 0.5N NaOH for 30 mins. It was followed by washing with adequate amount of distilled water until the pH reached to neutral range (pH 6.8-7.0).It was then autoclaved at 15 lb/inch^2 for 20 min. The pretreated biomass was dried at 60^{o}C for 24 hr in hot air oven and converted into powder form by grinding in mortar or pestle.

Immobilization of cells

The powdered biomass was immobilized by entrapment in polymer matrix of Na-alginate. 2% (w/v) slurry of Na-alginate was prepared in D/W. After cooling, 5% (w/v) of biomass was added. Add the alginate biomass slurry into 0.1M $CaCl_2.2H_2O$ for polymerization and bead formation using pipette. Resultant beads were 4mm in diameter. The fungus entrapped beads were cured in 0.1M$CaCl_2$. $2H_2O$ for 1 hr. Washed twice with 200ml St. D/W and stored at 4^{o}C in 5mM of $CaCl_2$ solution until use.

Study of biosorption mechanism in dried biomass and immobilized cells

The study of bisorption mechanism was studied and accordingly by FTIR &SEM methods. By viewing the state of the biomass & the immobilized cells before and after biosorption .Thus by viewing the state of this biomass various improvements can be implemented to improvise the biosorption by optimization.

Optimization of Various Parameters for Biosorption

0.4 grams of beads were inoculated into 100 ml metal solution containing (10, 25, 50, 100, 150, 200 pm) lead nitrate in deionised water. The flasks were kept on rotary shaker for 10 mins at 30^{o}C. Solution was analyzed after proper digestion and dilution by Atomic Absorption Spectrophotometer. The experiments were repeated by using various adsorbent concentrations. (0.4, 0.8, 1.2, 1.6, 2.0, 2.4 gms) and contact time. (10, 30, 60, 90, 120, 150 mins).

Biosorption experiment

Based on the optimized results, biosorption experiment was performed in triplicate. Solution analysed using Atomic Absorption Spectrophotometer.

Desorption experiment

Beads from the biosorption experiment were subjected to desorption using:
NH_4Cl- 0.01M/100 ml
HCl- 0.05M/100 ml
EDTA- 0.002M/100ml
Solution analysed using Atomic Absorption Spectrophotometer.

Results and discussion

Identification of strain

The given strain was successfully identified with the maximum number of matches as *Aspergillus niger* strain.The closest match had the E value 0 for certain strains like **GU951769.1, JN227027.1 , JQ675305.1.**

Selection of heavy metal resistant fungi and Minimum inhibitory concentration

All four isolates showed tolerance to lead nitrate, zinc sulfate, cupric sulfate at 1mM concentration on Sabouraud's Dextrose agar.

Heavy tolerance as showed by *Aspergillus flavus* isolated from waste water effluent of chemical industry and *Aspergillus niger* isolated from soil and waste water of chemical industry

Maximum inhibition was shown by *Aspergillus niger* species with lead nitrate and thus was used for further analysis.

The isolates of *Aspergillus niger* on Sabouraud's dextrose agar.

Aspergillus niger on SDA

Large amount of biomass of *Aspergillus niger* was harvested from Sabouraud's broth. Pretreatment of the cells by alkali treatment using NaOH and autoclaving yielded dead and dried biomass. This dead biomass was used for the further processes in carrying out optimization.

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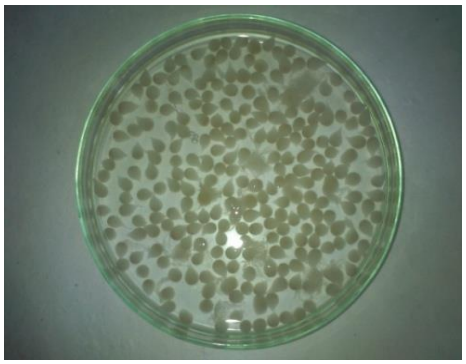
Powdered biomass



IMMOBILIZATION OF CELLS

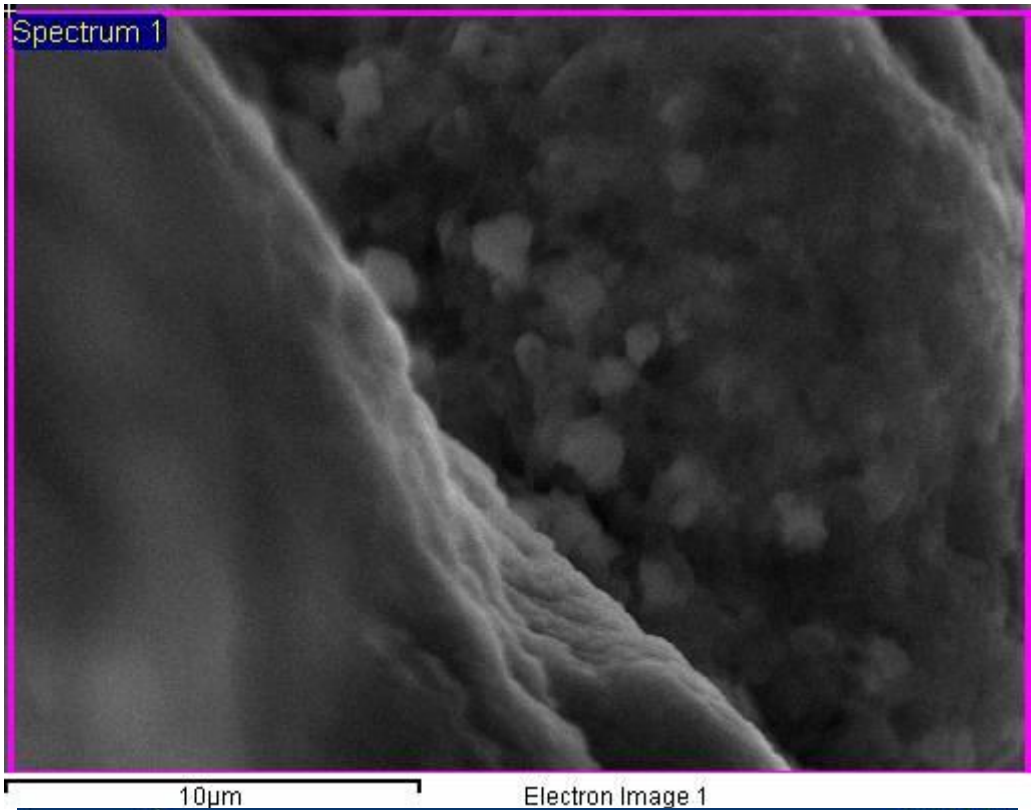
Fungal beads

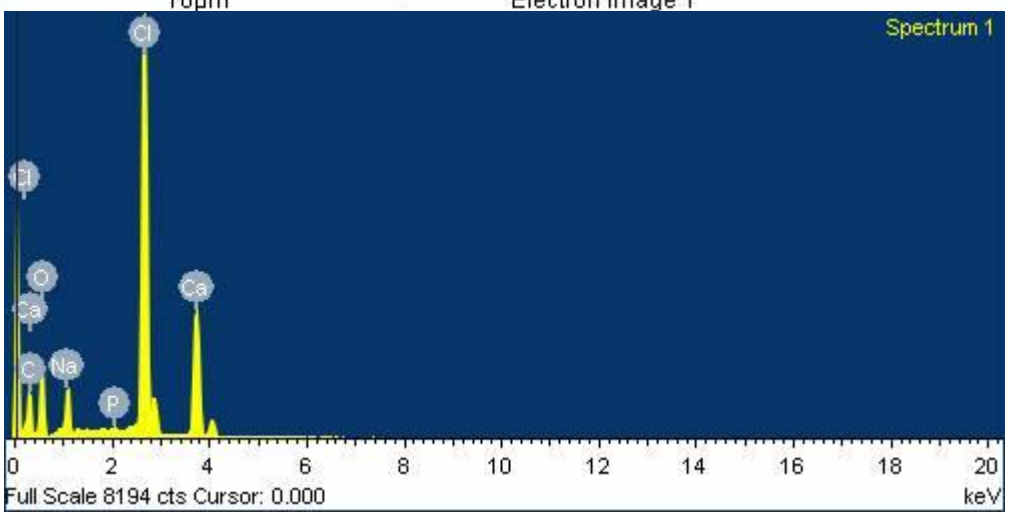
These beads were used in optimization and biosorption experiments.

RESULTS FOR STUDY OF BIOSORPTION MECHANISM

SCANNING ELECTRON MICROSCOPE ANALYSIS

Normal beads





Biosorption mechanism was studied using SEM analysis by which the elements responsible for the biosoprtion were studied.

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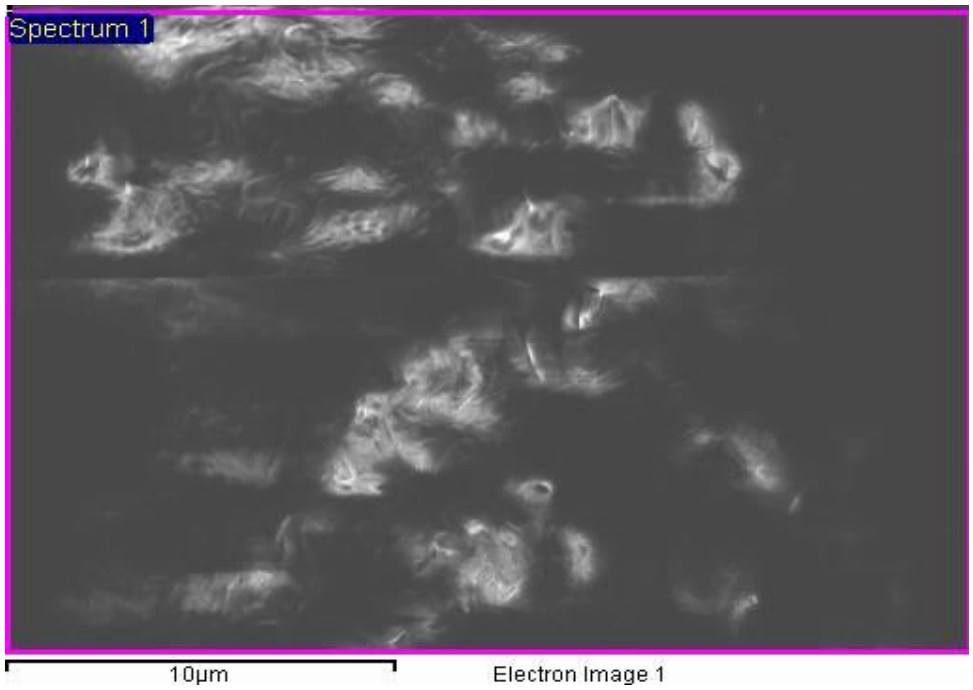
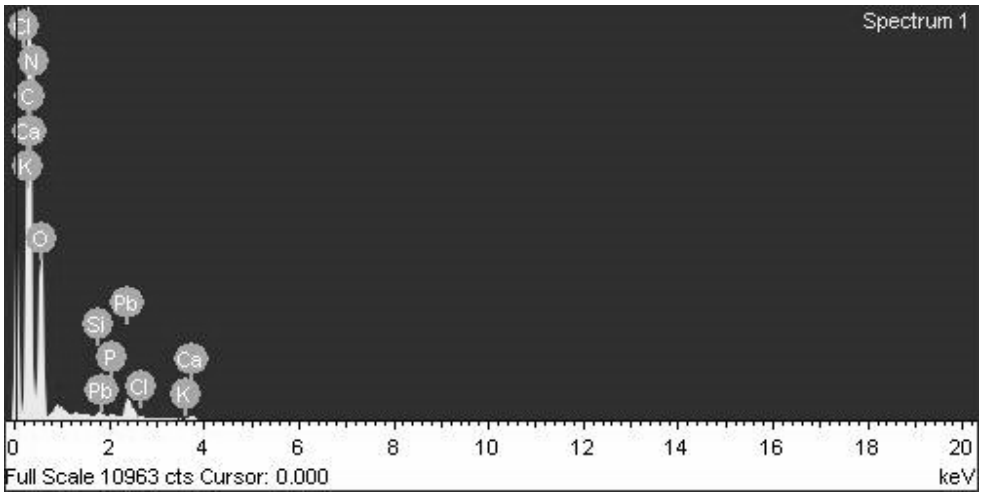
Biosorbed beads





A similar procedure was carried out for the immobilized beads as well .The non biosorbed beads showed presence of calcium , carbon, oxygen, sodium, phosphorus in their respective amounts as shown in the table but the detection with biosorbed beads showed an increase in the carbon content with a decrease in the calcium and phosphorus content thus detecting its presence in the biosorption mechanism.

Optimization of various parameters

Beads concentration		
GRAMS	**LEAD ABSORBED(ppm)**	**% REMOVAL**
0.4	**8**	**17.77**
0.8	**12**	**26.67**
1.2	**17**	**37.78**
Initial metal ion concentration		
CONC. (ppm)	**LEAD ABSORBED(ppm)**	**% REMOVAL**
50	**17**	**37.78**
100	**30.78**	**30.78**
150	**40.58**	**27.05**
200	**48.86**	**30.01**
Contact time		
MINUTES	**LEAD ABSORBED(ppm)**	**% REMOVAL**
30	**27**	**60**
60	**28**	**62.22**
90	**31**	**68.89**

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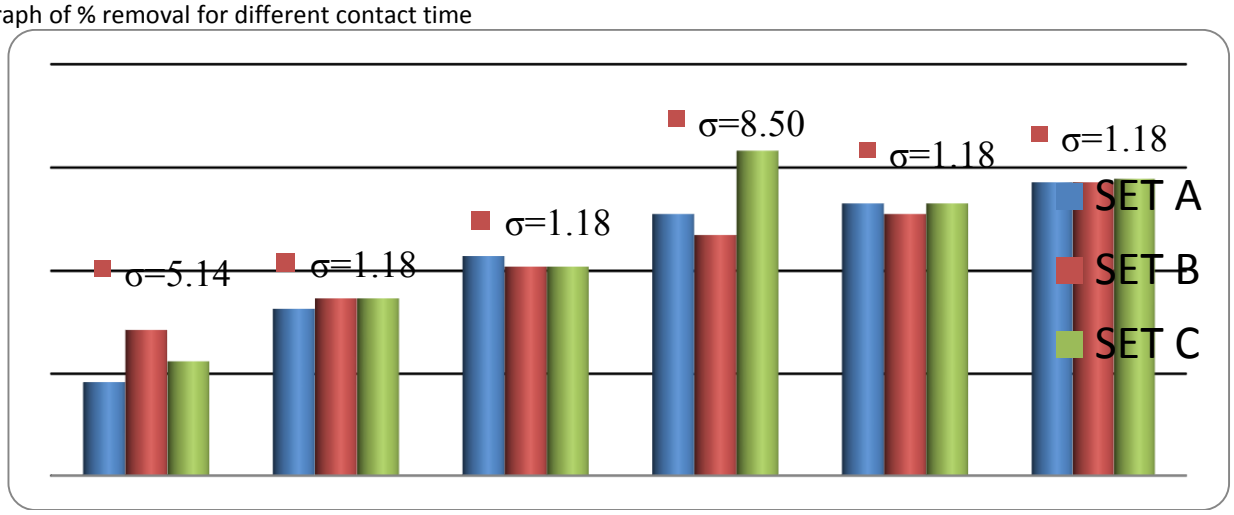
Based on these observations, the optimization was repeated with increasing the parameters gradient. Also all the parameters were done in triplicates to get a statistical result

CONTACT TIME

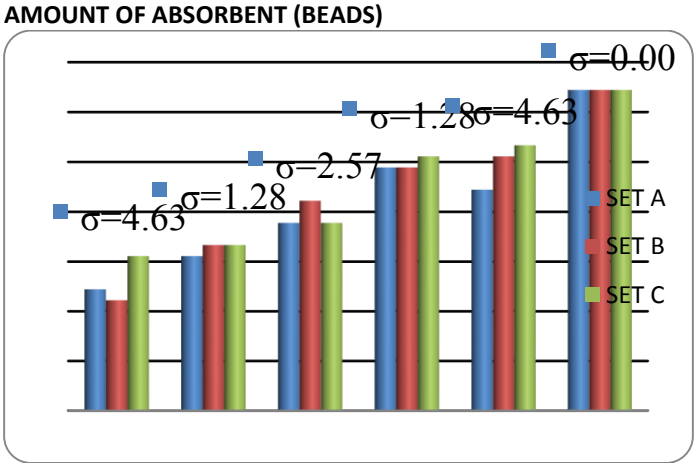
Initial lead detected- 49ppm

Graph of % removal for different contact time



For the same metal different time intervals showed different removal rates. The adsorption of metal ions was greatest at 150 minutes at the specific pH and room temperature by a specific amount of powdered biomass in 100ml of metal solution with a continuous agitation at 120 rpm. This experiment showed that the removal rate is increasing graduallu and then attaining stability at 120 and 150 minutes.

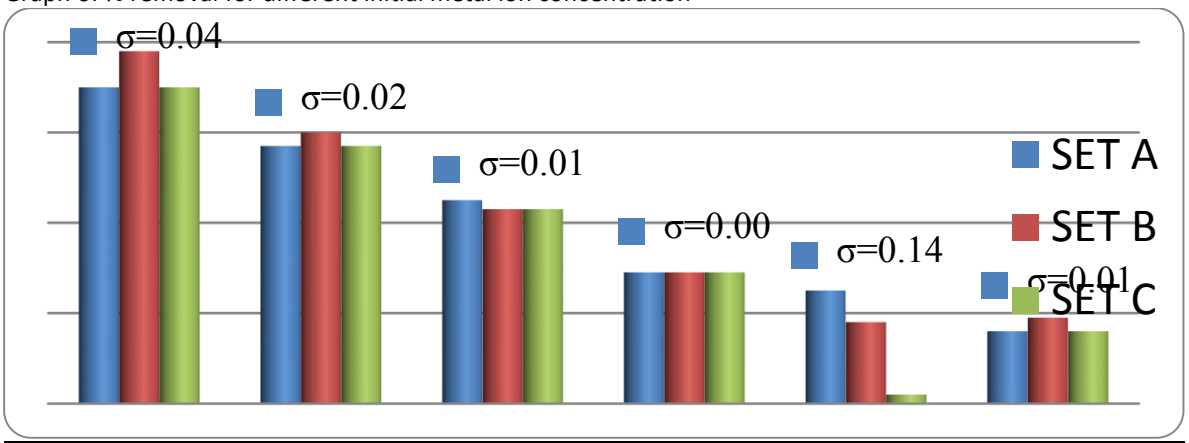
AMOUNT OF ABSORBENT (BEADS)



The experiment on metal uptake reveals that the metal uptake increases when biomass concentration rises. Therefore it is useful to increase the biomass as according to the amount of metal solution to be treated.

INITIAL METAL ION CONC.

Graph of % removal for different initial metal ion concentration



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The biosorption of Pb(II) ions by A. niger decreased with increasing initial concentration of metal ions. This indicates that the beads have a certain limit of metal absorption. Initial metal concentration plays an important role in determining the biosorptive capacity of the absorbent. The initial metal ion concentration used was 50 ppm.

BIOSORPTION EXPERIMENT:

Based on the optimized results, the biosorption experiment was performed in triplicate using:
Beads concentration- 2.4 grams. Initial metal ion concentration- 50 mg/l. Contact time- 150 minutes.

Sample	0 hr	Lead detected	Lead absorbed	% removal
BE1	50	12	38	76
BE2	62	12	40	64.5
BE3	54	9	45	83.33
Average				74.61

From the results obtained, it is clear that by increasing the parameter gradient, the biosorption capacity of lead was increased from 40.7% to 74.61%.
Desorption experiment

Sample	Chemical used	0 hr	Lead detected	% removal
DE1	NH_4Cl	38	2	5
DE2	HCl	40	28	70
DE3	EDTA	45	35	77.78

Beads from the biosorption experiment were subjected to:
NH4Cl, HCl, EDTA for 1 hour on Shaker conditions.
It was found that EDTA gave maximum desorption followed by HCl.
NH4Cl gave as little as 5% removal.

APPLICATION:

	0 hr	Lead detected	Lead absorbed	% removal
TEST	10	3	7	70

Lead contaminated water sample from Valkeshwar was subjected to biosorption. 70% removal of lead from the water sample showed that the technique- IMMOBILIZATION is effective for biosorption of heavy metal- lead. The present study thus focuses on ability of pre-treated and dead biomass of fungi to bind to metal like lead which was analyzed using atomic absorption spectrophotometer. Thus we can conclude that dead cells can be preferred over live cells as it has advantages with regards to no toxicity, nutrient requirements and other maintenance conditions. Biosorption appears to be suitable as secondary or polishing applications for metal removal from dilute waste streams, which would be competitive with ion-exchange resin based on final cost-effective analysis.Thus if by certain additions to the dead biomass the increase in the following elements can be borught about then it would enhance the biosorption process thus giving a comapritively better results.

References

- Saleh M. Al-Garni*, K.Ghanem and A.Bahobail, 2009, Biosorption characteristics of Aspergillus fumigatus in removal of cadmium from an aqueous solution, African Journal of Biotechnology Vol. 8 (17), pp. 4163-4172.
- Jianlong Wang, Can Chen.2009 Biosorption for Heavy metals removal and their future. Biotechnology Advances,Vol. 27 p 195-226.
- Narsi R Bishnoi and Garima. 2005. Fungus- An alternative of heavy metal containing wastewater: A review. Journal of Scientific & Industrial Research, Vol.64, pp: 93-100.
- K. Vijayaraghavan, Y.S. Yun, 2008, Bacterial biosrbents and biosorption, Biotechnology Advances 26 p 266–291.
- Mustafa L, N. Şahin, Z. temoçin, 2005, Adsorption of Fe2+ ions with Saccharomyces cerevisiae immobilized pumice stone, G.U. Journal of Science 18(3):365-373.
- N. Bishnoi, R. Kumar & K. Bishnoi, 2007, Biosorption of Cr (VI) with Trichoderma viride immobilized fungal biomass and cell free Ca-alginate beads, Indian Journal of Experimental Biology-Vol. 45, pp. 657-664.
- D. Park, Y.Yun, and J.Park, 2010, The Past, Present, and Future Trends of Biosorption, Biotechnology and Bioprocess Engineering, 15: 86-102.
- H. Alluri, S.Ronda, V.Settalluri, J. Singh, Bondili, Suryanarayana. V and Venkateshwar, 2007 P. Review-Biosorption: An eco friendly alternative for heavy metal removal. African Journal of Biotechnology, Vol. 6 (25), pp. 2924-2931.

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DIVERSITY OF DECAPODAN FAUNA ALONG THE ESTUARINE AREA OF BHAYANDER AND NAIGAON, THANE, MAHARASHTRA, INDIA

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ABSTRACT
As a part of investigation leading to bio prospecting the diversity of the decapodans, along the Mangrove ecosystem of the estuarine waters of Bhayander and Naigaon of Thane district, Maharashtra state was surveyed. During the study 6 crab species namely *Scylla serrata, Portunus sanguinolentus, Portunus pelagicus, Uca vocans etc. w*ere identified. Among Prawns, 10 different species like *Palaemon tenuipes, Penaeus monodon, Metapenaeus monoceros, Metapenaeus dobsoni, Acetes indicus etc.* were recorded. Lobsters were completely absent in the estuarine waters. The Mangrove ecosystem serves as a nursery ground for decapodans. Due to anthropogenic activity, overfishing and other human activities at different nearby areas are found to have considerable impact on the distribution of the decapodans and the survival of their habitats. Study reveals that some constructive steps must be taken to preserve the mangrove ecosystem, reduce the estuarine pollution and in return foster the increment in abundance of decapodan species. This will preserve the livelihood of the fishermen dependent on the decapodan fishery and also maintain the ecological balance.

Keywords: Prawn, Crab, Crustacean, Decapoda, Bhayander, Naigaon.

INTRODUCTION

India is endowed with an extensive coastline of 7516 km and an Exclusive Economic Zone of 2.04 X 10^6 km^2. (K. Venkataraman *et. al*., 2005) Estuaries are an integral part of the coastal environment. According to Pitchard, "An estuary is a semi-enclosed coastal body of water which has a free connection with the open sea and within which the sea water is measurably diluted with the fresh water derived from land drainage. The mangrove ecosystem of estuaries in India act as nursery ground for a variety of shrimps, crabs and finfishes. (T. Balasubramanian *et. al*., 2002).

The mangrove waters mainly serve as an essential nursery ground for juveniles of many species of decapods. The order Decapoda comprises of commercially important species of prawns, crabs and lobsters. In India as many as 26 species of lobsters, 162 species of hermit crabs, 705 species of brachyuran crabs and 84 species of prawns have been recorded so far. (K. Venkataram *et. al*., 2005; Pawar, 2012)

The Thane district alone shares about 23.6% of the total fish landings from Maharashtra. The contribution of crab and prawn fishery is much higher along the Vasai creek of Thane district. (Nair, 1990) Geographically the estuarine area of Bhayander and Naigaon falls nearer to the Vasai creek. But till date no in-depth study and analysis has been done towards the decapodan diversity along this estuarine area. Also the mangrove ecosystem along this estuarine area is affected because of illicit cutting, reclamation, dumping of waste, dredging and various other anthropogenic activities. The loss to the mangrove ecosystem directly leads to the loss of the decapodan diversity. Exploration of coastal areas for studying marine life is very common in India. Present work deals mainly with diversity of Decapodans along the estuarine area of Bhayander and Naigaon coast.

Study Area:

Station No. 1 Bhayander: a small town in the Thane District of the Maharashtra state. Bhayander is geographically surrounded by sea from the west , by the estuary from the north and by open and occupied land from the south and east . The estuarine water is mainly from the buffering of Ulhas River with the Arabian sea which empties its water in the Thane creek and Vasai creek. The Station No. 1- Bhayander, is located 19^0 19' N and 72^0 51' E. (Google Earth, 2008)

Station No. 2- Panju Bunder/Naigaon jetty, situated in Naigaon, is also a small town in the Thane District of the Maharashtra. Around the area, fishing activity is carried out in the estuarine water and also there are many saltpans in and around the area which are utilizing the estuarine water for production of salt, but this activity mainly goes on during the month of March to May while the rest of the year the saltpans are non-operational. The second station is located 19^0 20' N and 72^0 51' E.

MATERIALS AND METHODS

The decapodan diversity of estuarine area along Bhayander and Naigaon was studied for a year i.e. from June 2008 to May 2009. Visits were planned by considering the tidal activity. This made the visits quite fruitful. Crabs were studied from the intertidal and subtidal region of both the stations. The burrowing crabs were collected by digging inside the burrows. Prawns were collected directly from the net and other types of gears used for fishing

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along the estuarine area of Bhayander and Naigaon. Additional data regarding the decapodan diversity along the estuarine area was also collected and studied through the information provided by the local fisherman as well as periodic visits to the fish landing centers in Bhayander and Naigaon. The collected specimens were carried to the laboratory in icebox and preserved in 5% seawater buffered formalin. For correct identification of the collected decapodans upto the species level standard keys of Bal (1984), Bhargava (2004), Chhapgar (1957), Chan (1998), Fischer W. *et. al.* FAO (1974), Kathiresan (2000) and Srivastava (1999) were followed. The abundance of various decapodans has been displayed by assigning + sign. Significance of the sign is Abundant +++, Common ++ and Rare +.

Table 1: Diversity and density of Crab species at Bhayander and Naigaon estuary.

Phylum	Class	Family	Species Scientific Name	Common Name	Density at Bhayander	Density at Naigaon
Arthropoda	Crustacea	Portunidae	**1) *Scylla serrata***	Mud Crab	+++	+++
			2) *Portunus sanguinolentus*	Blood – Spotted Swimming Crab	++	+++
			3) *Portunus pelagicus*	Flower Crab	++	+++
		Ocypodidae	**4) *Uca vocans***	Fiddler Crab	++	+++
			5) *Uca rosea*	Fiddler Crab	++	+++
		Grapsidae	**6) *Varuna litterata***	Swimming Crab	+	++

Table 2: Diversity and density of prawn species at Bhayander and Naigaon estuary.

Phylum	Class	Family	Species Scientific Name	Common Name	Density at Bhayander	Density at Naigaon
Arthropoda	Crustacea	Palaemonidae	***1) Macrobrachium rosenbergii***	Giant River Prawn	+	++
			2) Palaemon tenuipes	Spider prawn	++	++
		Penaeidae	***3) Penaeus monodon***	Giant tiger prawn	+	++
			4) Metapenaeus monoceros	Speckled shrimp	+	+++
			5) Metapenaeus affinis	Jinga shrimp	++	++
			6) Metapenaeus dobsoni	Kadal shrimp	++	+++
			7) Metapenaeus brevicornis	Yellow shrimp	++	++
			8) Parapenaeopsis stylifera	Kiddi shrimp	++	++
		Sergestidae	***9) Acetes indicus***	Jawala paste shrimp	++	++
			10) Acetes erythraeus	Tsivakihini paste shrimp	+	++

+++ Abundant, ++ Common and + Rare.

RESULTS AND DISCUSSION

The table 1. reveals the diversity and density of crab species at Bhayander and Naigaon estuary. About 6 crab species belonging to 3 families were identified in the estuarine waters of Bhayander and Naigaon. Among the crab species *Scylla serrata, Portunus sanguinolentus, Portunus pelagicus and fiddler crab Uca vocans and Uca rosea* were observed to be abundant. At Naigaon station where as at Bhayander station mud crab *Scylla serrata was observed to be dominant and Portunus sanguinolentus, Portunus pelagicus, Uca vocans and Uca rosea* were observed to be common and *Varuna litterata* was found to be rare. The table 2. reveals the diversity and density of prawn species. At Station 1. Bhayander and Station 2. Naigaon about 10 species of prawn belonging to 3 families were recorded. Among non – penaeid prawns *Macrobrachium rosenbergii, Palaemon tenuipes, Acetes indicus* and *Acetes erythraeus* were found to be common at Station 2. Naigaon; whereas *Metapenaeus monoceros, Metapenaeus dobsoni* were abundant. At Station 1. Bhayander, no species of prawns were abundant whereas non – penaeid prawns *Palaemon tenuipes* and

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Acetes indicus were common and among penaeid prawns *Metapenaeus affinis, Metapenaeus dobsoni, Metapenaeus brevicornis* and *Parapenaeopsis stylifera* were common and *Macrobrachium rosenbergii, Penaeus monodon, Metapenaeus monoceros* and *Acetes erythraeus* were rare. None of the lobster species were recorded from both the stations. Absence of lobster species may be due to unsupportive ecological conditions at both the stations and also because of presence of deleterious water in the estuaries.

Pawar (2012) has recorded about 13 species of crabs and 11 species of prawns in the mangrove ecosystem of Uran creek of Raigad district. A. Verma *et. al.* (2004) have notified about 5 crabs and 3 prawns species in the Mahul creek of Mumbai. Bandekar *et. al.*, (2011) reported 15 species of crabs in Karwar mangrove environment and have shown that population of commercially important mangrove crabs are declining day by day due to indiscriminate fishing during their breeding season and also fishing of undersized crabs.

From the present study it is revealed that the diversity of the decapodans from both the estuarine area of Bhayander and Naigaon is slightly declining. The decline in decapodan diversity can be attributed to stress generated in estuarine water because of dumping of religious refuge, construction waste, release of nearby industrial effluents and untreated domestic sewage water from the residential area. The mangrove ecosystem along the estuarine area of Bhayander and Naigaon is also getting destructed due to illicit cutting of mangroves and land reclamation, affecting the breeding grounds of the decapodans.

According to Rajendran (1992) the prawns and crab fishery in the mangroves provide direct employment to many fisherfolks. The destruction of mangroves leads to the loss of the prawn and crab diversity leading to the unemployment of these fisherfolks. Thus, inorder to sustain the diversity of decapods along the estaurine area of Bhayander and Naigaon, there is need to take urgent steps to control the factors affecting it.

- **REFERENCES**

- Verma, S., Balachandran, Chaturvedi, N. and Patil, V., 2004. A Preliminary report on the biodiversity of Mahul Creek, Mumbai, India with special reference to avifauna. Zoo Outreach Organisation, Pg. No. 1599 – 1605.
- Bal, D. V. and Rao, K. V., 1984. Marine Fisheries; Tata McGraw – Hill Publishing Company Limited.
- Bandekar, P. D., Neelkantan, K. and Kakati, V. S., 2011. Biodiversity of crabs in Karwar Mangalore Environment West coast of India. Recent Research in Sci. and Tech., 3 (4): 1 – 5.
- Bhargava, A. K. *et. al*., 2004. Field guide for identification of marine fishery resources, Fishery survey of India, 1 – 71.
- Chan, T.Y., 1998. Shrimps and Prawns. In: FAO identification guide for fishery purposes. The Living Marine Resources of the Western Central Pacific, Cephalopods, Crustaceans, Holothurians and Sharks, Vol 2. Edited by K. E. Carpenter and V. H. Neem: 827 – 1155.
- Fischer, W. and Whitehead, P. J. P. (ed.), 1974. FAO Species Identification Sheets for Fishery Purposes, Vol. I – IV. Food and Agriculture Organization of the United Nations, Rome.
- Google Earth, 2008. www.earth.google.com. 10 – 2 – 2008 and 9 – 2 – 2009.
- Venkataraman, K. and Wafar, M., 2005. Coastal and Marine Biodiversity of India. Indian Journal of Marine sciences, Vol. 34 (1),57 – 75.
- Kathiresan, K., 2000. Flora and Fauna in Mangrove Ecosystems: A Manual for Identification. All India coordinated project on coastal and marine biodiversity, training and capacity building on coastal biodiversity (east coast), Ministry of Environment and Forests, CAS in Marine Biology, Parangipettai.
- Nair, V. and Jyothi, A, 1990.Fishery Potential of the Thana – Bassein Creek System. Journal of the Indian Fisheries Association, 20, 1990, 7 – 10.
- Pawar, P. R., 2012. Diversity of Decapod fauna from mangrove ecosystem of Uran (Raigad), Navi Mumbai, Maharashtra, West Coast of India. Indian J. Sci. Res. 3 (1): 87 – 90.
- Rajendran, N., Kannupandi, T. and Soundarapandian, P., 2002. CAS in Marine Biology, Annamalai University, 308 – 320.
- Srivastava, C. B. L., 1999. A textbook of Fishery Science and Indian Fisheries., Kitab Mahal, .43 – 59.
- Balasubramanian, T., Khan, S. A., Rajendran, N., *et. al*., 2002. Estuaries of India: State of the Art Report, Environmental Information System Centre, Centre of Advanced Study in Marine Biology, Annamalai University, 1 – 2, 138 – 145.

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THREATS TO MARINE BIODIVERSITY IN COASTAL ZONE OF MITHBAV, SINDHUDURG DISTRICT, MAHARASHTRA, INDIA

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Abstract
The sustainability of coastal zone is a growing concern worldwide. There is drastic ongoing destruction of many of the marine and coastal resources essential to human beings. The present investigation is carried out in Mithbav coastal zone ($16^0$20'N 73^0 25'E) of south Konkan. Ancient time onward, the same zone was thickly populated by varieties of organisms. Now a days, the biodiversity is under the threats because of siltation. The siltation from agriculture, waste discharge from local natives, heavy residue from the adjacent hills are dumped in mansoon. These are the most important causes of coastal resources degradation. What required is integrated coastal zone management and projects to address all the factors which have impacts on coastal zones. The species like *Gerres filamentous, Sillago Spp, Plytycephalus Spp, Lates calcarifer, Meretrix casta, Soletellina violacea, Thalassina Spp* etc are under great threats. The Government has not yet concentrated towards the shallowness zone due to siltation. Therefore an important biodiversity has the threats soon.
Key words – Mithbav, threats, biodiversity

Introduction

A major need for biodiversity maintenance, is protection of special, littoral habitats including mangrove forest, sea grass meadows, shallow water bodies like shallow water lagoons, beaches and removal of silt to make the benthic floor suit for the fauna. The stability of fauna is depend upon the type of benthic floor on which they feed and hides. The burrowing species are very sensitive about the habitat. (Patole 2010, Dekate 2012). The species like *Gerres spp, Sillago Spp, Plytycephalus spp* are the dominant resource fauna migrate in the creeks, estuaries, lagoons for breeding during monsoon period. (Yeragi 2004). If the suitable floor is not available then straight way they return to the sea. The fishery is greatly affected. Fishery Ministery should focus their attention toward shallow water bodies for sustenable development. Last ten years, the fishery potentiality of this coastal zone is gradually decreasing along with the biodiversity. The coastal natives are shouting against this situation to solve their problem of bread and butter. They have maintained this zone clean but removal of silt is beyond their limitation.

Man made changes have the effect of reducing the number of species inhabiting the area, for example, eutrophication leading lowered oxygen concentration in the water and sediments limits the number species to those few to tolerate those conditions. (Thakur 2012). In general, most adverse impacts on coastal ecosystems are characterized by decreasing species diversity. Monitoring of species diversity is therefore a useful technique for assessing damage to the system and maintenance of good species diversity is a positive management objective. The areas rich in productivity, spawning grounds, nursery grounds, migrations are to be protected and proper care should be taken (Patole 2010). Mithbav creek has high productivity since ancient time onward. Many coastal living families have the main income source during mansoon time. Today, the whole scenario is drastically changed due to siltation. The entire coastal zone is under the threats of siltation, which affects the biodiversity. Large numbers of species of fish, Molluscs, crustaceans are under the threats today.

The marine ecosystem as a varying profile. The coastline encompasses almost all type of intertidal habitat from hypo to hyper saline and brackish water lagoons, estuaries and coastal marsh as well as mudflats to sandy and rocky regions. The sub-tidal habitat are equally diverse among the coastal wetlands, estuaries, mangroves and coastal lagoons are biodiversity rich area.

Materials & Methods

Author has made the observations for the period of four decades in the coastal zone. The data is collected from the native for proper analysis.

Results & Discussion

The biodiversity has the threats in most of the creeks, estuaries and lagoons due to negligence of fishery ministry. The creeks are fully loaded by siltation which is an unfavorable condition for the flora and fauna. The coastal natives are fully dependent on such water bodies for the fishery point of view. Mithbav creek was deep formarally but now-a-days it is saturated by silt. This creek having many deep areas but today they are shallow where the fauna does not live for longer time. The biodiversity is very much affected by this condition. May-June is the proper time for the fauna to migrate in the creek for breeding. The fish like *Gerres filamentous, Sillago*

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sihama, Mugil Spp, Scatophagus Spp, Platycephalus Spp were migrating for spawning. After entering, they used to go to the deeper region for laying the eggs.

The following resource organisms are under great threats.

Meretrix spp.

The species like *M. casta and M. meretrix* were available in large number. The fishery was conducted by coastal people in the month of January to June till the mansoon begins. The population density was high. The rate of collection was three specimen per minute. New a-days due to heavy siltation both the species are vanished. During the month of May when the salinity reached to peak 29-30 $\%^0$ with high ttemperature 28-29^{0}C that time they used to spawn. The spat needs, smooth and soft habitat for settlement (Hegiste 2006). The spat does not settle on the silt hence during the selectivity of floor ultimately whole spats enter in the sea. Thereafter, it affects the Molluscan fishery heavily. Now-a-days the coastal natives are unable to collects there clams. In future if the silt is not removed then they would be under endangered condition. This is the important species for sustainable development. They have wide range of tolerance. *M. meretrix* population density 2-3 m-2 and size 2-3 cm. *M.casta* - density 4-5 m^2 and size 1-2 cm.

***Soletellina violacea* :-** It is newly recorded joint mussel (Yeragi 1979). It's population density was high. They always live in smooth, sandy-muddy floor. They live in shallow areas. This specimen spawns in the month of May in presence of high salinity and temperature. The spat is very sensitive in selectivity of habitat. The spat does not settle in siltation areas. Because of such reason, recently this species is under the threats. At present population density is 1-2 m^2, size 4-5 inchs.

Perna viridis (Green Mussel):

It is commonly known as 'Sinnane' due to their green colour of peridium. This species was available in plenty but today they are totally disappeared from this coastal zone. It is easy to culture. The spats are sensitive for settlement and if the smooth sandy ground is not available then transferred to sea.

Placuna placenta

It is called 'Windowpane' Oyster' found only in muddy ground in vertical position. The shells were brittle, smooth, silvery with smooth layers. The spat only settles in muddy ground for protection from predators. If the suitable ground is not available there or it is polluted then spats straight way go to sea. Due to siltation spat is unable to settle in Mithbav coastal zone. At Present their density is too low but tomorrow this will be away from the biodiversity. The organic silt is not suit for any type of young ones. The population density at present is 0-1m^{-2} and size 4-6 inches.

Cardium Spp.

It is commonly called 'Rangana Mula' or blood clam. The percentage of availability was high in this coastal zone but during last decade due to heavy siltation their density is too low. It is under the threat. There are three species found in Mithbav coastal zone. These species were plenty in this creek. Their shells are thick hence coastal people used to make edible lime as well as lime used for fishery point of view. Recently they are disappeared from the biodiversity**.**

Katelysia Spp :-

This is commonly known of Tisarya *Katelysia opima* was very popular species in this zone with density 5-7 m^{-2} and size 2-3 cm. This specimen needs the habitat less sandy and more muddy but never stay in silt lying floor. Due to siltation, now-a-days, their availability is too low. It is endemic in this creek. The population density is 1-2m^{-2} and size 2-3 cm.

Natica picta :-

It is commonly called 'Ghubar'. It is edible and population density 2-3 m^{-2} size 2-4 cm. Now-a-days this intertidal specimen is not found because of unfavourable habitat. They are rare in this coastal zone.

Crassostrea cattuckensis :-

It is joint oyster commonly known as 'sad'. The oyster beds are located interior in subtidal region of creek side area on submerged rocks about 3-5 m deep from high water mark. The population density was 7-12 m^{-2} and size 5-11 cm. At percent due to heavy siltation, their density is reached to 3-4 m^{-2} and size reduced to 4-6 cm. This specimen is also under the threats.

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Lates calcarifer :-

It is commonly called Giant perch or Bhekti or pongi or Jithade. It is migrated from sea to creek in the month of June for spawning. It always prefers muddy ground lined by oyster bed. It lives in the caves or the gap between the stones in deep water ponds and lagoons. *It is also entered in paddy field heavily*. It has wide range of tolerance to any hydrological parameters except oxygen. Now-a-days whole scenario of this creek is changed therefore they do not migrate in this creek. The population density is too low about 0.1 % only. The lagoons as well as paddy fields are devoid of this species. It is really a rare member in the biodiversity of this coastal zone.

Gerres Spp :

Total five species of this genus are available in this coastal zone. This genus is an important brackish water commercially available fish in creeks, estuaries, lagoons throughout the year. It is well suited for aquaculture. Among all, *Gerres filamentous* is most important species because of its length 20-25 cm. and weight about 0.5 kg. They migrate from sea to creek in monsoon for breeding. It is burrowing, schooling and sensitive fish need always sandy-muddy floor. Due to siltation, recently they do not prefer to stay for longer period in this creek. During high tide they migrate in the coastal zone but in low tide instead of staying there they return to sea. This happens because of there are no deep ponds, and unfavourable habitat. They do not prefer silt for burrowing. The population density is too low. The percentage composition of fishery is reached to 1% against 60 %. They always prefer deep ponds for spawning. The juvenile of 3-4 inches size used to recruit in fishing zone of creek in the month of October. Now-a-days, their *life cycle* is not complited in this creek. This species is under the threats.

Indian Whiting Fish (Sillago sihama):

It is commonly known as layd's fish because of beautification, simplicity and attractive golden yellow colour. It is very very sensitive fish only live in soft sandy regions, but not in siltation habitat. It is burrowing fish. They migrate in this creek during the month of May-June. They spawn in deep area and their youngones recruit in fishing zone in the month of October – November. The percentage composition at present is 02% against 55-60% of previous. This species is in decline state. Their population density is tremendously declining every year only because of unfavourable habitat.

Plytycephalus Spp :

There are three species available in the biodiversity of this creek. Amongst *P. punctatus* is dominant. They migrate in late May in this coastal zone. It is an indicator of monsoon. Their presence in the creek indicates the monsoon is going to start soon. They are burrowing hence prefer sandy-muddy ground. They spawn in deep region. The percentage composition in catch is about 0.5% against 20% of previous. This species does not prefer silt coating ground for burrowing as well as for feeding. Due to lack of facilities their juveniles return to sea. This is also disappeared from the coastal biodiversity.

The survey clearly indicates that many more species are disappeared from the coastal biodiversity only because of negligency of Government coastal management. The creeks, estuaries, lagoons are an important water bodies for biodiversity. These are the favourable habitat for fish fauna, molluscan, crustacean for breeding, spawning as well as for nursery. If these habitats are under the threat then tomorrow the recruitments is going to affect heavily.

Crustacean and molluscs are the major edible resource organisms. Most of them can fulfill the demand of substitute nutrient to mankind. They play an important role in food chain and food web. All the groups are ecologically and economically important as food and also their shells have been used in various industries like sugar, paint, textile, medicinal agriculture and fertilizers. Mariculture of edible molluscs is now recognized as an effective way for enhancing food production. (Yeragi 2004). Large number of seed of oysters, mussels, and clams are available along the different parts of Indian coast. Hatchery techniques for seed and farming methods are also available. The population density of *Thalassina anomala* is continuously decreasing due to unavailability of proper habitat. They form the colony in mangrove mudflat and amongst the sea grass at highest level of high tide. Formerly their density was 2-3 m^{-2} but at present 0-1m^{-2}. This is only because of stony bandhara and andropogenic activities.

Crabs :-

Good market demand and lack of abundant supply has led many Asian counties to attempt artificial propagation and commercial farming of the crabs. This coastal zone support more than 10 species of crabs at different habitant. Amongst *Scylla serrata, Portunus pelagicus* are still dominant. Due to heavy siltation and shallowness of the floor, the population density for last ten years is decreased to 1-2m^{-2} in mudflat region against 5-6 m^{-2} formerly. This crab prefer muddy habitat but not silt coated floor. In the silt loaded ground their stay is rare because of inability to construct the deep hole. *Portuous pelagicus* is not available in monsoon. It is dominant in post monsoon season. Their population is also affected drastically in this creek. At present their population density is 2-4m^{-2} of size 3-4 inches. This crab prefer marine algal zone for hiding but due to presence of silt the

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density of marine algae as well as grasses are very much low. The coastal natives are unable to catch required of these crabs for market sale. *Matuta lunaris* is totally disappeard from this coastal zone.

Prawns :-

Amongst edible crustaceans prawns occupy first rank with high export potential prawns like Penaeus indicus, *P. monodon, Metapenaeus dobsoni,* and *Macrobrachium rosenbergii* are the main resource organisms. They migrate in Aagar, Kharland ponds, lagoons etc in large scale. *P indicus* migrates from sea to estuaries and *M. rosenbergii* from river to estuaries and then creek.

Their juvenile shrimp were dominant in muddy floor of coastal zone. They do not prefer siltation for feeding as well as for burrow. Now-a-days their density is very much low and reach to 1-2 kg/ 2 hrs. of filtration with yendi (filter net) against 5 kg/2hrs.

***Suggestions* for the conservation of biodiversity in coastal zone.**

1) To maintain the cleanliness of the coastal zone.
2) To stop dumping of agricultural, domestic, and industrial wastes.
3) The fishery ministry has to make surface of the creek siltfree at least once in ten year.
4) To make the provision in budget for removal of silt load.
5) To avoid the catching of fauna specially fish during high tide at the mouth of the coastal zone.
6) To stop the over exploitation of oysters & crustacean.
7) Allow the fauna to enter in coastal zone for breeding and spawning for such awareness is required among the natives.
8) To stop fishing the juveniles till they attend maturity.
9) Coastal regulation zone – 1, where no development is allowed.
10) Debris disposal, killing mangroves and destroy the biodiversity habitat hence restrict such activities by law.
11) Advised to stop indiscriminate harvesting of molluscs from the coastal zone estuary as conservation resource.
12) Do not cut the mangrove plants from coastal zone for maintaining hydrostatic pressure which prevent erosion of adjacent bandhara.

Conclusion

Environmental changes, over exploitation and habitat loss are among the major causes of species loss that, according to certain estimates is of the order of a species per day. Equally important as knowledge of what lives in the marine environment is a prediction of what would live there in the future. This is especially true of regions where rapid loss of habitats and decline in water quality could be altering drastically the species diversity.

REFERANCES

- Dekate, Hiren (2012) Ecology and Biodiversity of Mangroves in Mumbri creek of south konke Deogad Taluka, Maharashtra, Ph.D. Thesis, university of Mumbai.
- Hegiste, U.M. (2006) Ecology and Biodiversity of Mangroves in Deogad estuary of south Konkan, Maharashtra Ph.D. Thesis, University of Mumbai.
- Patole, V.M. (2006). Ecology and Biodiversity of Mangroves in Mochemad estuary of Vengurla south Konkan, Maharashtra, Ph.D- Thesis, University of Mumbai.
- Thakur, S.A. (2012). Ecology and Biodiversiyt of Mangroves of Akshi creek of Nagao, Raigad distriest, Maharashtra Ph.D. Thesis, University of Mumbai.
- Yeragi, S.G. (1979) Studies on ecology of some molluscs of Bombay. Ph.D. Thesis University of Mumbai.
- Yeragi S.G. (2004) - Need of an aquaculture prospects of marine edible resources in Kharland lagoons of Sindhudurg distric. Maharashtra, India J. aqua Biol. Vol. 19 (2) / 169-174.

List of some threats species in coastal zone of Mithbav.

Pisces –

1. *Lates calcarifer*
2. *Gerres filamentous.*
3. *Plytycephalus unctatus*
4. *Sillago sihama*
5. *Scatophagus Spp*
6. *Megalops Spp*
7. *Heniochus acuminatus*
8. *Monodactylus rgenteus*

Molluscs.

1. *Meretrix meretrix*
2. *Meretrix casta*
3. *perna viridis*
4. *Soletellina violacea*
5. *Cardium spp.*
6. *Placuna placenta*
7. *Katelysia opima*
8. *Crassostrea attuckensis*
9. *Natica picta.*
10. *Solen spp*

Crustacean

1. *Charybdis lucifera*
2. *Portunus pelagicus*
3. *Dotilla spp.*
4. *Thalassina anomala.*
5. *Matuta lunaris*

Echinodermata

1. *Asterias rubens*
2. *salmacis bicolor*

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ENVIRONMENTAL CONSERVATION OF MANGROVE ECOSYSTEM OF MUMBRI CREEK OF DEOGAD TALUKA, SINDHUDURG DIST., MAHARASHTRA

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Abstract
The oysters, prawns and annelids of Mumbri creek (Lat. 16º 21' N, Long. 73º 25' E) of South Konkan are very important from the conservation of the environment. The study was done from June 2010 - July 2011. The oysters, prawns and annelids provide bread and butter to the poor coastal people throughout the seasons. It is noticed that the juveniles of prawns namely *Penaeus indicus, P. monodon, Metapenaeus dobsoni, M. monoceros* and *Macrobrachium rosenbergii* were abundant in the creek. The maximum catch per unit area, per unit time is only because of presence of lagoons with thick mangroves. The mangroves protect the juvenile prawns and provide food. The oyster farming has been considered as a traditional practice. It fulfils the demand for animal protein in the developing countries. The fresh meat provides muscular buildup for heavy work. The meat gives proteins, lipids, minerals, vitamins, glycogen, etc. hence, the people harvest on large scale. This creek is very popular for oyster collection throughout the year. Mangrove is the well protected and safe environment for luxurious and healthy growth of polychaete annelids. Coastal people for their numerous natural products have exploited mangroves. Apart from the many products that are taken directly from the ecosystem, mangroves also provide various amenities like protection against coastal riverbank erosion, flood and waste assimilation, educational, tourism and recreational opportunities.
Key words: Oyster, Prawns, Polychaete annelids, Mumbri creek, Mangrove.

Introduction

The mangrove is the silent and undisturbed ecosystem always in favour of juvenile prawns. The mangroves mud-flat zone provides excellent feeding, breeding and growth monitoring grounds. The population density is always high due to less predation and least anthropogenic activities. Today as the climate change is taking place the mangrove are set to be destroyed and with the destruction of the mangroves the prawn cultivation is bound to suffer. Prawns are important in commercial fishery leading to losses, if climate change takes place.

The juveniles are always buried in soft mud ground for protection. If such environment is properly utilized for the farming of prawns, it would provide maximum yield within a short span of time. The harvesting of prawn differs from region to region, but is always low at open places. It is also noticed that the growth of prawns in mangrove habitat is faster and free from diseases than that of the other areas because of easy availability of nutritious food and more stability in feeding. In the study carried out at the creek, it was observed that it was rich in juveniles of five prawn species *Penaeus indicus, P. monodon, Metapenaeus dobsoni, M. monoceros* and *Macrobrachium rosenbergii*.

The oysters identified were *Saccostrea cuculata*, *Crassostrea cuttackensis*, *Crassostrea madrasensis, Crassostrea gryphoids* and *Saxostrea cuculata*. Oyster meat is the main attraction for the tourist coming to Deogad Taluka. Mumbri creek is very clean and smooth, hence tourists are attracted throughout the year in large numbers. The oysters provide delicious meat to the natives living in coastal areas. It is bread and butter for day to day life of poor natives. The oyster farming has been considered as a traditional practice. It fulfills the demand for animal protein in the developing world. The oyster meat provides proteins, minerals, lipids, vitamins, glycogen, etc. hence oysters are harvested in large numbers. The live meat is tonic for hard workers. The Mumbri creek is very popular for oyster fishery throughout the year. The oysters are fast growing and are tastier. It is the best known commercial important resource organism. Now-a-days it is widely cultivated species all over the world. Mumbri creek and their mangrove belts are the treasure house of oysters. The natives collect the oysters at home and take out the meat on large scale to fulfill the demand of tourists as well as hotels. The coastal natives collect the oysters during low tide.

The polychaete annelids comprising one of the most prominent components of marine biodiversity are virtually unexploited and have a potential as a source of bioactive sources. Mangrove mudflats are the treasure house of polychaetes hence commercially important resource organisms are associated with this ecosystem. Polychaete worms obtain food easily from the mudflats. The polychaetes play an important role in the food chain and food web of mangrove ecosystem. *Mugil spp.* abundantly found in this ecosystem is present throughout the year because of the availability of polychaetes. The *Salmonella spp.* only infects the grey mullet, sometimes heavily. *Therapon spp., Scylla serrata, Gerres spp.* feed on polychaetes; their gut content also reveals presence of polychaetes. *Anguilla spp.* feed voraciously during high tide on mud containing polychaetes. *Trygon spp*., Sole fish also feed on polychaetes.

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Materials and Methods

Weekly sample collection was done from June 2010 - July 2011 at M_1, M_2 & M_3 regions representing three hydrologically different habitats. Preferred and methodical sampling was conducted from each of the collection region. Using the filter net prawn juveniles were analyzed to study their distribution and relative abundance. Live specimens of edible oysters were collected for the study purposes from the different regions of the creek.
Qualitative samples of polychaete annelids were collected on the intertidal mudflats by digging while others from the stones, rotten wooden logs and posts were cut open by chisel and hammer when they were exposed to low tides. The specimens were also collected from rotten husk of coconuts and empty shells of gastropods, oysters. The coconut husk is an excellent habitat for many worms in this creek. Keys of the following characters were taken into account for exact identification- body segments, prostomium, proboscis, parapodia and their bristles, eyes, tentacles, cirri, setae, etc.

Result

Analysis of weekly collection was done for the distribution and relative abundance of juveniles belonging to different species. Five species of prawns i.e. *Penaeus indicus, Metapenaeus dobsoni, Metapenaeus monocerous, Macrobrachium rosenbergii* and *Penaeus monodon* were indentified. The study reveals that the juvenile of three species although found in all the collection sites, the *Penaeus indicus* numerically dominated at all sites to be followed by *M. dobsoni, M. monocerous*. Larval development was observed much faster in somewhat saline water, monsoon season was observed as the best season for the lavish growth of these species. The juvenile of this species was always found in freshwater association of stilt roots of mangrove. The density count was high in mangrove roots. *M. rosenbergii* is very sensitive to oxygen and salinity. Growth of these is very slow in high salinity.

It was displayed by the frequency polygon curve that all the five species were present throughout the study phase. The frequency of *P. indicus* was larger from May to September and then turned down. The highest frequency was observed in September and lowest in February. The frequency of *M. dobsoni* hit the highest point in the month of October and low in June. In case of *M. monoceros*, the frequency was observed lowest in August and highest in January. The frequency of *Penaeus monodon* was high in January and reduces in May and June. The freshwater species *Macrobrachium rosenbergii* showed high density as well as the growth. Growth is directly correlated with the oxygen content.

Five species of edible oysters identified were *Saccostrea cuculata*, *Crassostrea cuttackensis*, *Crassostrea madrasensis, Crassostrea gryphoids* and *Saxostrea cucullata*. *Saccostrea cucullata* is also called as rock oyster. The percentage composition of this oyster shows 54% (highest) density in post-monsoon period as compared to 50% pre monsoon and 49 % monsoon periods. *Crassostrea cuttackensis* (Newton and Smith) shows resemblance to *Crassostrea madrasensis,* (Rao,1958), *Crassostrea gryphoids* (Durve & Bal,1965).

Crassostrea cuttackensis, a euryhaline oyster found long west coast of India, is found in all the creeks and backwaters. It is found maximum during monsoon i.e. 41% and lowest post monsoon i.e. 33%. *Saxostrea cucullata* (Awati and Rai, 1931) was also found in the Mumbri creek, but the availability was lowest with the maximum 13% post monsoon and lowest 10% in the monsoon.

Annelids belonging to different families were identified in the study period, these were Family Nereidae, Family Lumbrineridae, Family Eunicidae, Family Capitellidae and Family Sabellaridae. Family Nereidae with five species was present maximum in monsoon - 55%, while Family Lumbrineridae with two species was maximum 15% in pre-monsoon, Family Eunicidae with two species is maximum 14% in pre-monsoon, Family Capitellidae with one species is maximum 13% in post-monsoon and Family Sabellaridae includes one species is maximum 12% in post-monsoon.

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Fig.1: Graph of Month wise Percentage of Juvenile prawns in mumbri creek.

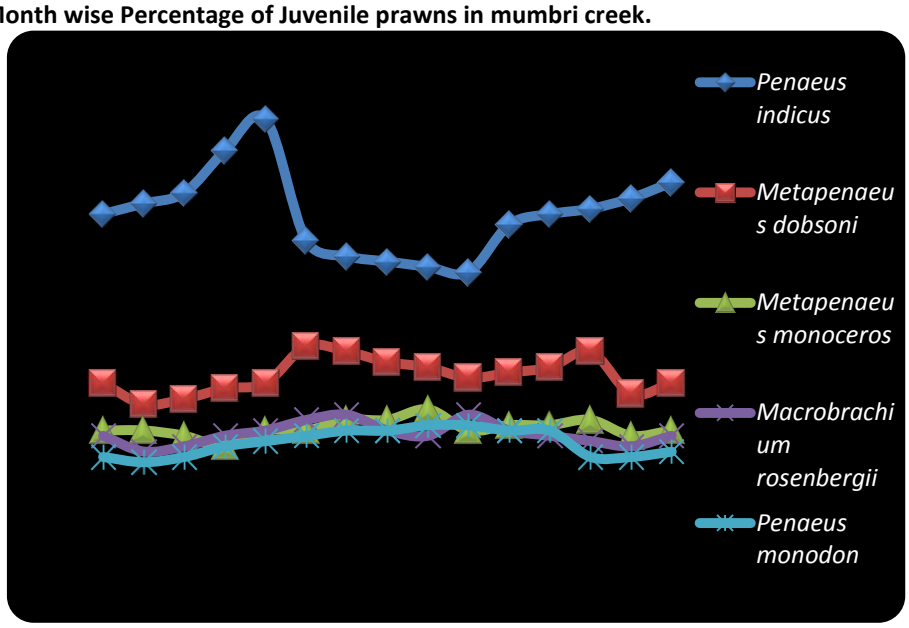


Fig. 2: Graphical representation of percentage composition of edible oysters at mumbri creek.

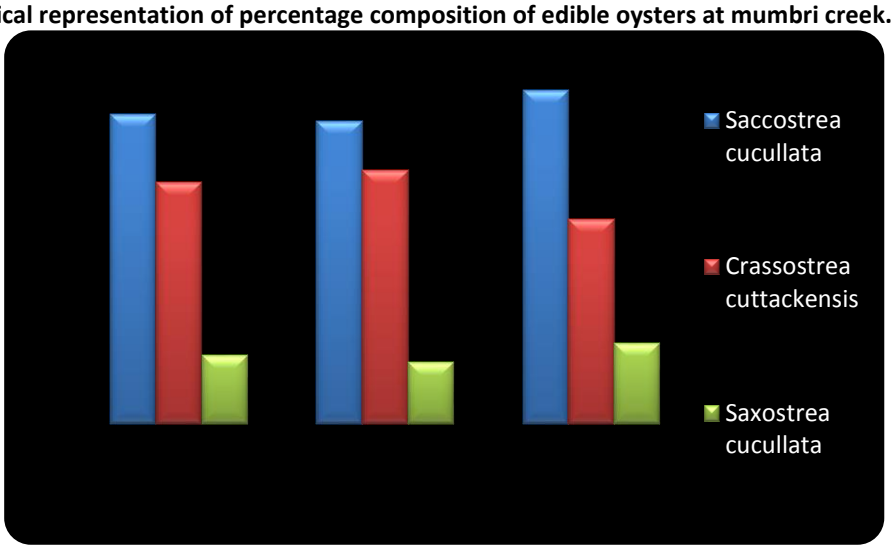
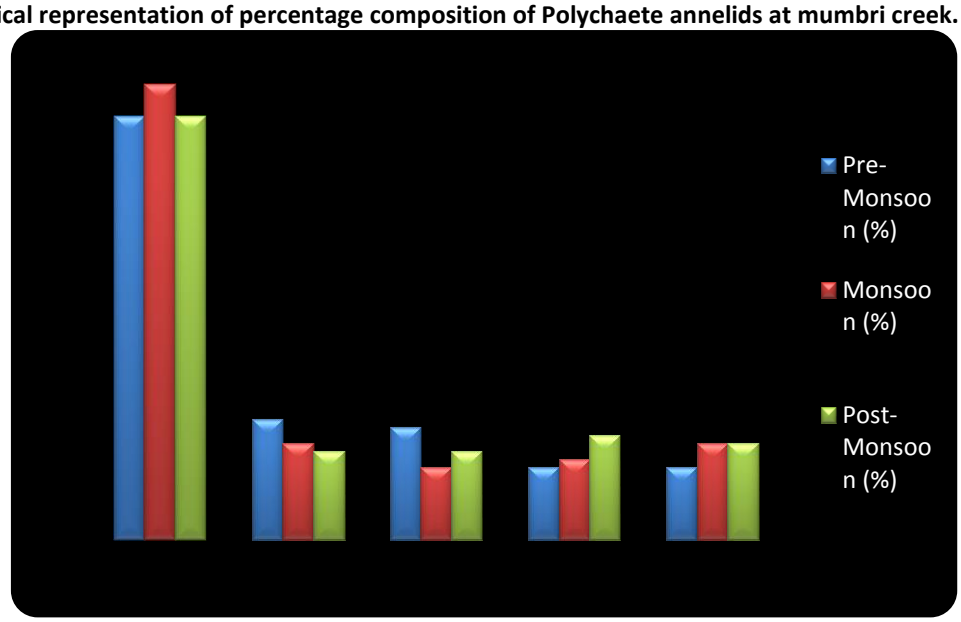


Fig. 3: Graphical representation of percentage composition of Polychaete annelids at mumbri creek.



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Discussion

Ecological and biological characteristics of mangrove ecosystem have received maximum consideration recently Balasco (1977), Untawale et al (1973). Inspite of all the pains, there are several gaps in our knowledge regarding the energetic of varied group organisms in the mangrove food web. Microbial organisms play a major role particularly in the biodegradation process resulting in the formation of protein rich detritus which is chief food for many organisms.

The richness of any ecosystem will depend on the total number of species present in that ecosystem. Whereas the number of individuals of a species in relation to the total number of individuals of all the species will indicate the dominance of that species. Both of them are the important aspects of the ecosystem structure.

If the mangrove environment was properly utilized for the cultivation of prawns, it would provide maximum yield within a short span of time. The catch of juveniles of mangrove areas constantly diverge both qualitatively and quantitatively. Because of the availability of organic debris and stability the growth of prawns in the mangrove areas are faster than the open. It is evident that significant quantities of mangrove, carbon are being associated through secondary sources Yeragi (1997). Though most of the hectares of mangrove area have been rehabilitated for fish farming, agriculture, urbanization, salt pans and other uses, no actual information is available on such issues. Taking into deliberation their contradictory interests and the multiple use practices of mangrove areas a tentative 'National Mangrove Plan' is proposed which point out different guidelines for conservation and exploitation of various mangrove would positively reinstate the coastal ecological equilibrium and get a better environment and also the economy of the coastal population.

The meat of the oyster provides protein, lipid, minerals, vitamins, glycogen, etc. therefore there is great demand for the meat. Yeragi S.G. (2004). The meat is consumed after cooking in curry as well as other delicious dishes. It fulfills demand for animal protein. The survey of commercially important species of oysters in mumbri creek and mangrove belts noticed that *S. cuculata* are available in large scale. *C. cuttackensis* also occurred plenty but need more effort for collection from deep water because of its demand. Their shells are abundantly available in mangrove belts throughout the year, so that the coastal native uses these commercially easily available resources on large scale for solving the problem of bread and butter.

Among all the marine benthos, polychaetes constitute the most important compound of macro invertebrates. The extensive use of polychaete annelids as indicators of various degrees of marine pollution. Patole (2009), Yeragi ,et al (2009). The local fishermen collect them to use as bait for hand line and long line fishery. The polychaete worms are better than earthworm as bait for the fishing of large size mullets, catfish, *Platycephalus spp*. and *Caranx spp*. Analysis of the benthic macro fauna is important in marine and estuarine monitoring programmes because most of them are sedentary and respond immediately to organic stress.

References

- Newton, R.B. and Smith, E.A. (1912). On the survival of Miocene oyster in recent seas. Rec. Geol. Surv. India; 42, 1-15.
- Awati, P.R. and Rai, H.S. (1931). The Indian Zoological memoirs on Indian animal types. 3. *Ostrea cuculata* (The Mumbai Oyster) 1-104.
- Rao, V.K. (1958). Molluscan Fisheries. In fisheries of west coast of India. Ed. Jones, S. pp. 55-59.
- Durve, V.S. & Bal, D.V. (1965). Studies on the chemical composition of the oyster, *Crassostrea gryphoids* (Schothein) J. Mar. Boil. Ass. Indfia. 13: 70-77.
- Untawale et al (1973). Ecology of mangrove in Mandovi-zuari estuaries and interconnecting Cumbarja Canal of Goa, *Indian J. Mar. Sci.*, 2:47-53.
- Balasco F: (1975). Mangroves of India. Inst. Fr. Pondicherry. Trans. Sect. sc.: Tech. 15:175 pp.
- Yeragi S.S. (1997). Species composition and distribution of prawn juveniles in Mangroves. J. Aqua. Bio. Vol. 12(182):16-17.
- Yeragi, S.G. (2004). Scenario of edible clams of Mithbav creek of South Konkan in Maharashtra. Nature Env. Poll. Tech. Vol. 3(3):405-408.
- Yeragi, S.G., Yeragi, S.S. and Veena Srivastava, (2009). Study of Ecobiology of Polychaete Annelids from the Mangrove swamps of Mithbav creek of South Konkan in Maharashtra. J. Aqu. Bio. 24(2) 46-49.
- Patole, V.M. (2009). Biodiversity and ecology of mangroves in Mochemad Creek, Vengurla, Maharashtra. Ph.D Thesis. University of Mumbai.

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BIODIVERSITY OF KHARDANDA BEACH, MUMBAI, INDIA

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Abstract
Ecosystems are increasingly productive and efficient when there is sufficient biodiversity. Each form of life works together with the surrounding environment to help recycle waste, maintain ecosystem and provide services that others use and benefit from. Biodiversity is fundamentally the diversity of gene sequences in ecosystem. Most recent publication of International Union for Conservation of Nature (IUCN, 2009) record of threatened species has reported 39% of listed species as threatened with extinction (*www.iucnredlist.org*). Conservation of global biodiversity is an important priority. It is necessary to have long term monitoring program at selected sites to provide information on how biodiversity changes with space and time and whether changes are brought about by natural means or by anthropogenic impact. The most critical contributors to changes in marine biodiversity are now recognised to be fishing, pollution and eutrophication, physical alterations of coastal habitat, invasion of exotic species and global climate change. Biodiversity of the seas and oceans includes pelagic and benthic life forms. Intertidal diversity of benthic macro-fauna includes crustaceans, coelenterates, cephalopods, fish, reptiles, birds and mammals.
West coast of Mumbai city show many beaches with a variation in substratum and habitats. Khardanda beach (Lat. 19^{o} 4'N and Long.72^{o} 49'E) has rocky substratum with few scattered patches of shallow sand and a small patch of mangroves. The study was conducted throughout the seasonal cycle. The biodiversity observed and recorded on Khardanda beach included ten species of macro-algae, three species of mangroves, eight species of crabs, sixty eight species of molluscs, fifteen species of fish and fourteen species of birds. Impact of anthropogenic activities was noted.

Keywords: Khardanda, Biodiversity, Molluscs, Mangroves.

Introduction

Ecosystems are increasingly productive and efficient when there is sufficient biodiversity. Each form of life works together with the surrounding environment to help recycle waste, maintain ecosystem and provide services that others use and benefit from. Ocean ecosystem can take sewage and recycle it into nutrients and produce food for many species thus, in losing species we lose the productivity and stability of entire ecosystem. Biodiversity is fundamentally the diversity of gene sequences in ecosystem and conservation of global biodiversity is an important priority. It is necessary to have long term monitoring program at selected sites to provide information on how biodiversity changes with space and time and whether changes are brought about by natural means or by anthropogenic impact.
The stress to marine environment has adversely affected and may deteriorate life from the intertidal zone to deep sea. A major need for marine biodiversity maintenance is protection of special or critical littoral habitats including mangrove forests, coral reefs, sea grass meadows, shallow water lagoons, and beaches. The coastline encompasses almost all types of interstitial habitats from hypersaline and brackish water lagoons, estuaries, coastal marshlands and mud flats to sandy and rocky shore. Marine fauna demonstrates gradient of change throughout Indian coast. Venkatraman and Wafar (2005) made an attempt to summarise the coastal and marine Biodiversity of Indian seas and their various ecosystems from the literature available, museum records and other sources of information. Poor as it is, our knowledge of the biodiversity on land and their importance for mankind far exceeds our knowledge of marine biodiversity and its links to the livelihood and quality of life of people, especially coastal communities (Gray, 1997). Accelerated loss of coastal and marine biodiversity components over the last few decades has been of great concern. Environmental changes, over-exploitation and habitat loss are among the major causes of species loss.
Biodiversity of marine waters has been extensively studied by large number of researchers which includes diversity of marine algae, mangroves, crustaceans, molluscs, fish, reptiles, birds and mammals. Untawale *et. al.* (1983) published a list of marine algae from India. Khadilkar (1986), studied Marine algae of Bombay coast. Oza and Zaidi (2000), gave revised checklist of Indian marine Algae. Kathiresan and Rajendran (2005), studied the mangrove ecosystems of Indian Ocean region, while Terdalkar *et. al.* (2005), studied mangrove biodiversity and economics of Ratnagiri coast with special reference to Bhatye estuary. Ajmal Khan *et. al.* (2005), studied the Brachyuran crab diversity in natural and artificially developed mangroves. Subbarao (1991, 1998) gave an account of Mollusca in 'Animal resources of India'. Intertidal biodiversity with reference to Mollusca in and around Mumbai was studied by Jaiswar (1999).

Materials and Methods

Biological diversity of Khardanda beach was studied by field observations, photography, collection and observation of the fauna and flora. Specimens were also procured from local fisher folk. The entire specimens of algae were collected

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from Khardanda beach and preserved in the form of herbarium. The twigs of mangroves were also collected and identified.
Specimens were identified with relevant literature, online resources were also used.

Results and Discussion
The biodiversity of Khardanda can be categorised into attached macro-algae, mangroves and associated flora, and Macro-benthic organisms like cnidarians, arthropods including crabs and barnacles, molluscs mainly gastropods and pelecypods, fish, reptiles and birds.

Algae
The algae on Khardanda beach were represented by attached macro-algae. The algal distribution was patchy and mostly concentrated in a relatively small area of tidal pool, on the seaward side of the patch of mangrove. The algae at Khardanda included five species each of Chlorophyta and Rhodophyta.
Kingdom: PLANTAE
Phylum: CHLOROPHYTA
Order: SIPHONOCLADALES
Family: VALONIACEAE
Valonia ventricosa J. Agardh, 1887
CLASS: ULVOPHYCEAE

Order: ULVALES.
Family: ULVACEAE.
Ulva lactuca Linnaeus, 1753
Ulva intestinalis Linnaeus, 1753
Ulva compressa Linnaeus, 1753

Order: CLADOPHORALES
Family: CLADOPHORACEAE.
Cladophora bombayensis BØrgesen, 1935

Phylum: RHODOPHYTA
Class: FLORIDEOPHYCEAE
Order: BONNEMAISONIALS
Family: BONNEMAISONIACEAE
Asparagopsis armata Harvey, 1855

Order: CERAMIALES
Family: CERAMIACEAE
Centroceras clavulatum (C. Agardh) Montagne, 1846

Order: GRACILARIALES
Family: GRACILARIACEAE.
Gracilaria corticata (J. Agardh) J. Agardh, 1852

Order: GIGARTINALES
Family: HYPNEACEAE.
Hypnea valentiae (Turner) Montagne, 1841
Family: CAULACANTHACEAE
Caulacanthus ustulatus (Mertens ex Turner) Kutzing, 1843

Mangroves and associated flora
The rocky beach of Khardanda showed a patch of mangroves about 500 meters in length along the Carter road promenade. The most abundant species were *Avicennia marina, Bruguiera gymnorrhiza and Rhizophora mucronata.* Certain other trees like *Casuarina* were also observed on the beach, probably introduced from gardens.

Division: MAGNOLIOPHYTA.
Class: EQUISETOPSIDA.
Order: LAMIALES.
Family: ACANTHACEAE.
Avicennia marina (Forssk.) Vierh.

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Order: MALPIGHIALES.
Family: RHIZOPHORACEAE.
Bruguiera gymnorhliza (L.) Lamk.
Rhizophora mucronata Lamk.

Division: TRACHEOPHYTA
Family: CASUARINACEAE
Casuarina

Benthic Macro-fauna
Cnidarians
Only one species of Sea anemones (Banded sea anemone) was found in the rock crevices and tidal pools in small or large aggregations.
Phylum: CNIDARIA
Class: ANTHOZOA
Order: ACTINIARIA
Family: ACTINIIDAE
Anthopleura
Arthropods
Crabs and barnacles represented Phylum Arthropoda on Khardanda beach. Following are the species of crabs found on Khardanda beach.
Phylum: ARTHROPODA
Sub-Phylum: CRUSTACEA
Class: MALACOSTRACA
Order: DECAPODA
Family: GRAPSIDAE
Grapsus albolineatus Latreille, in Milbert, 1812
Metopograpsus messor Forskål, 1775
Family: OCIPODIDAE
Sub- Family: UCINAE
Uca (Gelasimus) vocans Linnaeus, 1758
Family: PORTUNIDAE
Sub-Family: PORTUNINAE
Scylla serrata Forskål, 1775
Sub-Family: THALAMITINAE
Charybdis (Charybdis) lucifera Fabricius.1798
Thalamita crenata Rüppell, 1830
Thalamita prymna Herbst, 1803
Family: XANTHIDAE
Sub-Family: ZOSIMINAE
Atergatis integerrimus Lamarck, 1818

Barnacle, of only one species was observed on Khardanda beach.
Phylum: ARTHROPODA
Class: MAXILLOPODA
Order: SESSILIA
Family: BALANIDAE
Amphibalanus amphitrite Darwin, 1854

Mollusca
The rocky substratum of Khardanda beach formed ideal habitat for gastropods. Hence gastropods were the dominant group. 52 species of gastropods belonging to 24 families were noted on the beach. The class Pelecypoda was represented by 16 species of 11 families. Large aggregations of oysters (3 species) were observed on the rocks in the northern part of the beach. Chiton and Onchidium were the rare findings on the Khardanda beach.

Phylum: MOLLUSCA
Class: GASTROPODA

Family: BABYLONIDAE
Babylonia spirata Linnaeus, 1758

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Family: BUCCINIDAE
Cantharus spiralis Gray, 1839
Family: BURSIDAE
Bufonaria echinata Link,1807
Bursa tuberculata Brodrip
Family: CANCELLARIIDAE
Trigonostoma costiferum G.B. Sowerby I, 1832
Family: CERITHIIDAE
Clypeomorus bifasciatus G.B. Sowerby II, 1855
Cerithium echinatum Lamarck, 1822
Family: COLUMBELLIDAE
Pyrene atrara Gould.
Pyrene terpsichore Sowb.
Family: CONIDAE
Conus biliosus RÖding, 1798
Conus cumingii Reeve, 1848
Conus figulinus Linnaeus, 1758
Conus hyaena Hwass in Bruguière, 1792
Conus praecellens A.Adams, 1855
Family: CYPRAEDAE
Erronea onyx Linnaeus, 1758
Palmadusta lentiginosa J.E. Gray, 1825
Family: DRILLIIDAE
Clavus crassa Smith
Clavus preclara Mel.
Family: ELLOBIDAE
Cassidula nucleus Gmelin, 1791
Family: FISSURILIDAE
Diodora bombayana Sowerby, 1862
Diodora lima G.B. Sowerby II, 1862
Family: MELONGENIDAE
Hemifusus pigulinus Born, 1778
Family: MITRIDAE
Neocancilla circula Kinner, 1838
Family: MURICIDAE
Drupa contracta Melvill1920
Drupa subnodulosa Mel.
Morula (Morula) granulata Duclos, 1832
Ocenebra bombayana Mel.
Thais echinulata Lamarck, 1822
Thaisella blanfordi Melvill,1893
Thaisella lacera Born, 1778
Thaisella tissoti Petit de la Saussaye,1852
Family: NACELLIDAE
Cellana radiata radiata Born, 1778
Family: NASSARIDAE
Nassarius oneratus Deshayes, 1863
Nassarius nodifer Powys, 1835
Family: NATICIDAE
Natica picta Récluz, 1844
Natica vitellus Linnaeus, 1758
Family: NERITIDAE
Nerita albicillia Linnaeus, 1758
Nerita crepidularia Lam.
Nerita (Argonerita) oryzyrum Récluz, 1841
Nerita (Linnerita) pollita Linnaeus, 1758
Family: ONCHIDIIDAE
Onchidium
Family: PLANAXIDAE
Planaxis sulcatus Born, 1778

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Family: POTAMIDIDAE
Potamides conicus Blainville, 1829
Telescopium telescopium Linnaeus, 1758
Family: ROSRELLARIIDAE
Tibia curta G.B. Sowerby II, 1842
Family: TROCHIDAE
Euchelus asper var. tricarinatus Lamarck
Trochus radiatus Gmelin, 1791
Trochus stellatus Gmelin
Family: TURBINIDAE
Astrea stellata Gmelin
Turbo brunneus RÖding, 1798
Family: TURRIDAE
Turricula javana Lamarck, 1816
Class - PELECYPODA
Family: ANOMIDAE
Anomia achaea Gray, 1850
Family: ARCIDAE
Tegillarca granosa Linnaeus, 1758
Family: CARDIIDAE
Papyridea lata Born, 1778
Family: DONACIDAE
Donax faba Gmelin.
Family: NOETIIDAE
Striarca symmetrica Reeve, 1844
Family: OSTREIDAE
Crassostrea tulipa Lamarck, 1819
Dendrostrea sandvichensis G.B.Sowerby II, 1871
Ostrea cristagalli Linnaeus, 1758
Family: SEMELIDAE
Semele cordiformis Holten, 1802
Family: TELLINIDAE
Gastrana polygona Hanley
Family: TRAPEZIIDAE
Trapezium vellicatum Reeve.
Family: VENERIDAE
Pelecyora nana Reeve, 1850
Katelysia opima Gml
Gafrarium divaricatum Gmelin, 1791
Piter erycina Linne.

Fish

Due to the rocky substratum, the beach at Khardanda had a number of permanent enclosures, constructed by the local fisher folk, using available rocks. These supported a small scale shore based fishery. Large gill nets were also used for fishing as a cooperative effort during the spring tides. These nets yielded a great variety and number of fish to facilitate commercial fishery on the shore itself. Following fish were identified from Khardanda.

Super-Class: PISCES
Class: ELASMOBRANCHII
Order: CARCHARHINIFORMES
Family: CARCHARHINIDAE
Scoliodon laticaudus (Müller and Henle, 1838)

Class: ACTINOPTERYGII
Order: ANGUILLIFORMES
Family: MURAENIDAE
Muraena tessellata
Order: BELONIFORMES
Family: BELONIDAE
Strongylura Strongylura (Van Hasselt, 1823)

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Rhynchorhamphus georgii (Valenciennes, 1847)
Order: CLUPEIFORMES
Family: PRISTIGASTERIDAE
*Ilisha elongata (*Anonymus [Bennet], 1830)
Order: MUGILIFORMES
Family: MUGILIDAE
Mugil cephalus (Linnaeus,1758)
Liza macrolepis (Smith,1846)
Order: PERCIFORMES
Family: GOBIIDAE
Gobiopsis macrostoma (Steindachner,1861)
Family: LABRIDAE
Halichoeres bicolor (Bloch and Schneider, 1801)
Family: LATIDAE
Lates calcarifer (Bloch, 1790).
Family: SCATOPHAGIDAE
Scatophagus argus (Linnaeus, 1766)
Family: SERRANIDAE
Epinephelus malabaricus (Bloch and Schneider, 1801)
Family: TERAPONTIDAE
Terapon jarbua (Forsskål, 1775)
Family: TRICHIURIDAE
Lepturacanthus savala (Cuvier, 1829)
Order: SILURIFORMES
Family: ARIIDAE
Nemapteryx caelata (Valenciennes, 1840)

Reptiles

During one of the field visits a dead sea-turtle was found on the beach. Similar Dead turtles of various sizes had also been noticed on the beach by local fisher folk.
Class: REPTILIA
Order: TESTUDINES
Sub-Order: CRYPTODIRA
Family: CHELONIIDAE
Lepidochelys olivacea (Eschscholtz, 1829) - Olive Ridley Turtle

Birds

Following birds were observed on the Khardanda beach.
Class: AVES
Order: APODIFORMES
Family: APODIDAE
Palm swift *Cypsiurus parvus* Lichtenstein, 1823
Order: CICONIIFORMES
Family: - ARDEIDAE
Little egret *Egretta garzetta* Linnaeus, 1766
Indian pond heron *Ardeola grayi* Sykes, 1832
Light and Dark form of Western reef egret *Egretta gularis* Bosc, 1792
Great egret *Ardea alba* Linnaeus, 1758
Order: CHARADRIIFORMES
Family: LARIDAE
Gull billed tern *Gelochelidon nilotica* Gmelin, JF, 1789
Order: FALCONIFORMES
Family: ACCIPITRIDAE
Black Kite / Pariah kite *Milvus migrans* Boddaert, 1783
Family: - SCOLOPACIDAE
Little stint *Calidris minuta* Leisler, 1812
Common red shank *Tringa tetanus* Linnaeus, 1758
Order: - CORACIIFORMES
Family: - ALCEDINIDAE
Common kingfisher *Alcedo atthis* Linnaeus, 1758

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Order: - PASSERIFORMES
Family: - CORVIDAE
House crow *Corvus spendens* Vieillot, 1817
Large billed crow *Corvus macrohynchos* Wagler, 1827
Family: - MASCICAPIDAE
Oriental magpie robin *Copsychus saularis* Linnaeus, 1758
Order: PELECANIFORMES
Family: - PHALACROCORACIDAE
Indian cormorant *Phalacrocorax fuscicollis* Stephens, 1826

Different types of anthropogenic activities on the beach have impacted the diversity of life on the beach. Due to unavailability of records of diversity exclusively on that of Khardanda, it was difficult to establish the link between the anthropogenic activities and their impact on diversity of life at Khardanda. However, comparison with the records of diversity of life forms of west coast or Mumbai coast revealed that the coastal features and Biodiversity at Khardanda are adversely impacted due to various anthropogenic activities like automobile activity, waste water discharge, construction of promenade, construction of road in intertidal zone etc.

References

- Ali, S.,1996. The Book of Indian Birds (12th Ed). BNHS & OXFORD Univ. press, 1996.
- Ajmalkhan, S., Raffi, S.M. and Lyla, P.S., 2005. Brachyuran crab diversity in natural (Pitchavaram) and artificially developed mangroves (Velar estuary). Curr. Sci. India, 88 (8): 1316-1324.
- Almeida, M. and Chaturvedi, N., 2006. The Trees of Mumbai. BNHS and OXFORD publication, 2006.
- Apte, D., 1993. Marine gastropoda of Bombay- A recent survey. J. Bombay Nat. Hist. Soc., 90 (3): 537- 539.
- Apte, D., 1998. The Book of Indian Shells. BNHS and OXFORD university publication, 1998.
- Chhapgar, B. F., 1957. On the Marine crabs of Bombay State. Part I. J. Bombay Nat. Hist. Soc., .54 (2): 399-439.
- Chhapgar, B. F., 1957. On the Marine crabs of Bombay State. Part II. J. Bombay Nat. Hist. Soc.,54 (3): 503-549.
- Chhapgar, B. F., 1958. Additions to the crab fauna of Bombay State. J. Bombay Nat. Hist. Soc., 55 (3): 582-585.
- Chhapgar, B. F., 1968. More additions to the crab fauna of Bombay State. J. Bombay Nat. Hist. Soc., 65 (3): 608-617.
- Cooke, Theodor, 2006.The Flora of the presidency of Bombay Volume I & II. Taylor and Francis London, 1908, Reprinted By – Bishen Singh Mahendra Pal Singh, Dehradun, 2006.
- Daniel, J.C., 2002. The Book of Indian reptiles and Amphibians. BNHS and OXFORD University press, 2002.
- Day, F.T., 1989. The fauna of British India including Ceylon and Burma Fishes, Vol. I & II. 19th Edition, Taylor and Francis Ltd. London.
- Gray, J.S., 1997. Marine Biodiversity: Pattern, threats and Conservation Needs.
- Biodiversity and Conservation Vol. 6 Number 1 / Jan 1997, pp 153- 157.
- Grimmett, R., Inskipp, C. and Inskipp, T., 2007. Pocket Guide to the Birds of Indian Subcontinent. OXFORD University Press, 2007.
- Jaiswar, A.K., 1999. Intertidal biodiversity with respect to Mollusca in and around Mumbai. Ph.D. Thesis, Univ. of Mumbai.
- Kathiresan, K. and Rajendran, N., 2005. Mangrove ecosystems on Indian Ocean region. Indian J. Mar. Sci.,34 (1):104-113.
- Khadilkar, S.G., 1986. Marine algae of the Bombay coast. Ph. D. Thesis, Univ. of Bombay. pp 1-89.
- Kundu, H.L., 1965.On Marine fauna of Gulf of Kutch Part III–Pelecypods. J. Bombay Nat. Hist. Soc., 62(1): 84-103. Plates I - XV.
- Kundu, H.L., 1965. On Marine fauna of Gulf of Kutch Part III – Pelecypods Contd. J. Bombay Nat. Hist. Soc., 62 (2): 211-236. Plates XVI – XXVII.
- Monga, S., 2003. Birds of Mumbai. India Book House Pvt. Ltd., 2003.
- Oza, R.M. and Zaidi, S.H., 2000. A revised checklist of Indian Marine Algae, Central Salt and Marine Chemicals Research Institute, Bhavanagar, India, pp 296.
- Subbarao, N. V., 1991. Mollusca in faunal diversity in India. Zool. Sur. India, Calcutta, (1991) : 125 -147.
- Subbarao, N. V., 1998. Mollusca in faunal diversity in India. Zool. Sur. India, Calcutta, (1998) :104 -117.
- Subrahmanyam, T.V., Karandikar, K.R., Murthi, N.N., 1949. The Marine Pelecypoda of Bombay. J. Univ. of Bombay (1948-49) 17(5):50-81
- Subrahmanyam,T.V., Karandikar,K.R.,Murthi,N.N.,1952-53. Marine Gastropoda of Bombay. Part-I J. Univ. of Bombay.1951, 20 (I): 21- 34.
- Subrahmanyam,T.V.,Karandikar,K.R.,Murthi,N.N.,1952-53. Marine Gastropoda of Bombay. Part-II. J. Univ. of Bombay.1952, 21(III):26- 73.
- Terdalkar, S.S., Apte, S.A. and. Kulkarni, A.S., 2005. Mangrove biodiversity and economics of Ratnagiri coast with special reference to Bhatye estuary. Nat Environ Pollut Tech 4(2): 265 – 268.
- Untawale, A.G., Dhargalkar, V.K. and Agadi, V.V., 1983. List of Marine algae from India. Technical report National Institute of Oceanography, Goa, India.
- Venkatraman, K. and Wafar, M.,2005. Coastal and Marine Biodiversity of India. Indian J. Mar. Sci., 34 (1): 57- 75.
- http://www.algaebase.org/ http://www.avibase.org/ http://www.biosearch.in/
- http://www.fao.org/ http://www.iucnredlist.org/ http://www.sealifebase.org/

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STUDY OF MANGROVE DIVERSITY OF SHIRODA MITHAGAR AREA IN SINDHUDURG DISTRICT

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Abstract
Mangrove forests along the coastlines are among the world's most productive ecosystems. These are often called as tidal forests, coastal woodlands or oceanic rainforests. Mangroves are an ecosystem in itself. They provide refuge as well as serve as breeding and nursing grounds for many species of animals.
Mangrove forests act as a natural barrier. They disseminate the energy of cyclones, tidal incursions, wind and storm. They also prevent soil erosion and entry of sea water in to the terrestrial water sources, thus protecting the underground freshwater system of the coastal region. Mangroves found in Shiroda, Mithagar area in Sindhudurg district are ***Rhizophora mrucronata, Excoecaria agallocha, Avicennia marina, Sonneratia alba*** and ***Ceriops tagal.***
Mangrove allied plant in the area are ***Salvadora persica*** and ***Acanthus ilisifolius.*** Mangrove forests serve the breeding areas of fish like ***Diodon liturosus***, Fiddler crab, Prawns, Mud skipper and many molluscs by furnishing nutrients, food and hiding places. It ensures the conservation of the diversity of fishes, crustaceans, molluscs, reptiles and mammals in this ecosystem.
Keywords: Mangrove forests,coastal region, ***Rhizophora mucronata, Excoecaria agallocha, Avicennia marina, Sonneratia alba, Ceriops tagal,*** fishes, crustaceans, molluscs, reptiles and mammals.

INTRODUCTION

Mangrove ecosystems support genetically diverse groups of aquatic and terrestrial organisms. They include diversified habitats. Mangroves support communities of phytoplankton, zooplankton and fishes. Mangroves play a special role as nursing grounds for juveniles of fishes. Saline marshes along the sea coasts and estuarine flanges at Aronda Redi and Shiroda, consist of *Acanthus ilicifolius* Linn., *Aegiceras corniculatus* (Linn.) Blanco, *Avicennia marina* (Forsk.) Vierh., *Avicennia marina* (Forsk.) Vierh. var. *acutissima* Stapf ex Moldenke, *Avicennia officinalis* Linn., *Caesalpinia crista* Linn., *Ceriops tagal* (Pior.) Roxb., *Clerodendrum inerme*(Linn.) Gaertn., *Colubrina asiatica* Brongn., *Cyperus deformis* Linn., *Cyperus polystachyus* Rottb., *Cyperus rotundus* Linn., *Derris trifoliata* Linn., *Enicostemma hyssopifolium* (Willd.) Verdoon, *Excoecaria agallocha* Linn. *Fimbristylis miliacea* Linn., *Fimbristylis schoenoides* (Retz.) Vahl, *Kandelia candel* (Linn.) Druce, *Lumnitzera racemosa* Willd., *Peplidium maritimum* (Linn. f.) Wettest, *Premna integrifolia* Linn., *Rhizophora mucronata* Poir, *Salvadora persica* Linn., *Scirpus littoralis* Schrader., *Sesuvium portulacastrum* Linn., *Sphenoclea zeylanica* Gaertn., *Sonneratia apetala* Buch. – Ham., *Sonneratia caseolaris* (Linn.) Engl., *Spinifex littoreus* (Burm.f.) Merr., *Suaeda maritima* (Linn.) Dumort., *Zoysia matrella* (Linn.) Merill.

In India 4482 sq.km and in Maharashtra 118sq.km area is filled with mangrove vegetation (forest Research Institute, 2001). In Shiroda Mithagar area of Vengurla tahasil have ***Rhizophora mrucronata, Excoecaria agallocha, Avicennia marina, Sonneratia alba, Ceriops tagal*** and mangrove associate plants are ***Salvadora persica*** and ***Acanthus ilisifolius***. Due to developmental activities mangroves are destroyed by the people and there is threat to the diversity of various fishes, Crustaceans, Molluscs, reptiles and mammals. It is a natural barrier between fresh water and marine water. It can save us from the tsunami and other disastrous wind , storms and cyclones.

MATERIAL AND METHODS

Study was conducted in the mangrove forest area .Frequent visit to shiroda mithagar (Vengurla) mangrove forest study area in three month from June 2012 to August 2012. It involved observations of various species of mangroves and allied plants as well as collection of seedlings Observation of crustaceans, reptiles, birds and insects in the study area.
Observations were made by direct visual methods .For much specifications digital camera Canon S5 IS is used.
Nine mangrove species Marine and Freshwater Research 49(5): 369-372.
Chaudhari,A.B and Chaudhary ,A. 1994 Mangroves of Sundarbans. India1:24 pp

1) ***Rhizophora mrucronata***

Common name: Red Mangrove
Local name: Kandal
Well develop aerial stilt root sallow easy recognition of this species in the field; small white flowers are pollinated by wind or insect. The seeds of this mangrove are viviparous, i.e they germinate when still attached to the parent plant. Propagules (seedlings) are cylindrical, narrow at the apex and grow 65 cm long.

2) ***Excoecaria agallocha***

Common name: Milky mangroves
Local Name: Hurha

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Root system without prominent roots , may laterally spreading superficial and snake like It can tolerate high salinity near estuaries and also fresh water conditions, make inflorescence like a cat tail

3) ***Avicennia marina***

Common name: White mangrove

Local name: Tivar

The root system is characterised by upright pencil like pneumatophores that originate from an underground cable root. Numerous spongy pneumatophores spread out from the base of the tree. The length of these pneumatophores appears to depend on the inundation time. Short aerial roots originating directly on the stem, usually very close to the ground, but often just hanging from the stem without anchoring into the ground, are uncommon.

Avicennia marina has developed cryptoviviparity, i.e. the embryo grows out the seed coat, but does not emerge from the fruit. The seed have a velvet capsule

This is one of the most dominant mangrove species common along the influence of highly saline water, extremely tolerant to various stresses of salinity and pollution This species is associated with ***Avicennia alba, Bruguiera sp. and Sonneratia sp.***

4)***Sonneratia alba***

Common name: Mangrove apple

Local name: Chipi

Sonneratia albahas thick cone shaped pneumatophores. It uses ultra-filtration at the root levelto exclude salt .It is a front mangrove, i.e.mangroves that are the nearest to the sea as they prefer open area. Trees grow as tall as 30 m. Flower are larger than that of ***Sonneratia apetala*** Flowers bloom at night and are pollinated by bats.

5) Ceriops tagal

Common name: Yellow mangrove

Local name: Choti chipi, sonchipi

Buttress roots and knee roots. Pale green buds , flowers are small with orange petals . The species is found on better drained soil on the inner and outer fringes of the intertidal zone. Often occurring as short, stunted trees, especially in very saline environment , It grows to 5m tall in areas with freshwater influence

6)***Salvadora persica***

Common name: Toothbrush plant

Local name: Meswak

Salvadora persicais not a true mangrove species as it does not have special adaptation like in true mangroves. It does not grow well in areas with great tidal influence, but it can survive just beyond the line of high tide. The leaves are thick and waxy, with an eye catching green colour. There are two varieties of based on colour of the fruit, white and dark red.

1) ***Rhizophora*** mrucronata

2) ***Excoecaria agallocha***

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3) ***Avicennia marina***

4) ***Sonneratia alba***

5) ***Ceriops tagal***

6) ***Salvadora persica***

7) ***Acanthus ilisifolius***

Mud Skipper

Crab

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Result and Discussion

The mangrove ecosystem is necessary for the conservation of diversity of Fishes,molluscs, reptiles, insects and mammals. The study area Shiroda mithagar is a prime location between Shiroda and Redi. Mining in the Redi village is increasing the pollution in this area, disturbing the diversity of animals as well as plants. There is an urgent need to conserve this mangrove ecosystem in the area. This is time to protect Mangrove ecosystem because the tsunami of Indonesia in 2005 has taught us a lesson of the importance of it.

References

- Ananda Rao T. Mclur S.Walkar S.1995Report on the workshop on “Conservation and Assessment and management plan for Mangroves of India. Pp.106.
- K.Karthiresan and S.Z.Qasim Biodiversity of Mangrove ecosystems Hindusthan Publishing Corporation.
- Aksornkoae, S.1993 Ecology and management of mangrove IUCN .The world conservation Union Bangkok, Thailand. Pp.176.
- Baba, S.2000 What can we do for Mangroves. Proceding of Asia pacific Co operationson Research for conservationof Mangroves Okinawa, Japan.pp.39-62.
- Baruah, A.D.2004 Muchupet Mangroves and canal banks planting techniques. Tamil Nadu Forest Department Publication ,Nagapattinam. Pp. 61.

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INTERACTIONS BETWEEN SCLERACTINIANS AND ZOANTHIDS IN THE ROCKY INTERTIDAL AREA OF SAURASHTRA COAST, GUJARAT, INDIA

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ABSTRACT

Zoanthids like *Palythoa* spp. are known to have interaction with the organisms in their surroundings. They are thought to be competitive with other intertidal organisms. In the present study, we made a visual observation of the invasion of *Palythoa* onto the hard coral *Porites* sp. We found that *Palythoa* is competing with *Porites* for space. As both are found to be utilizing sediments for their skeleton, competition is obvious. *Palythoa* is usually found in areas with good sediment deposition as they utilize it for the skeletal formation. The hydrodynamics of Sutrapada inter tidal area is such that the effluent released from GHCL flows towards the shore area due to the water current and thus load of sediment is brought to shore. This facilitates the spread of *Palythoa*. The current study thus shows the interaction being competitive between the scleractinian coral and Zoanthid.

INTRODUCTION

The present work represents the survey of the study done on the coast of Saurashtra, Gujarat showing the presence of the competition between the community structures of an intertidal area. The purpose of the study was to bring in limelight the threat of biotic factors other than abiotic factors to the scleractinian corals. The paper represents the zoanthid, *Palythoa* being capable of overgrowing the scleractinian coral *Porites spp.* Various factors affecting the observed conclusion may be due to environmental stress (Loya, 1976). Saurashtra coast is a part of the coastline of Gujarat. A diverse habitat is found in the entire coastal area, characterized by rocky, muddy and sandy shores. The hydrodynamics of any aquatic regime is found to affect the sediment settlement and geomorphology of the nearest shore. These conditions arising out of wave transforming over a coastal area generate wave set up and long shore currents resulting in movement and transport of sediments already present in that zone. Such environmental conditions are favorable for the establishment of Zoanthid communities. Along with this, the rising sea levels are also a major concern for the organisms of this intertidal coastal area.

Community structure of any ecosystem depends on the competition between the organisms inhabiting that zone. This is an ever changing process as the conditions favorable for different organisms change with the change in variety of factors in that particular zone. The presence of zoanthids in this area has not been documented; however, they are not unknown also. Due to the faster dispersal of such zoanthids in this area, it is a big concern as they overlap the existing intertidal community. Corals of various types are principally found in the Gulf of Kachchh and their presence in the coastal zone of Gujarat is also reported (Dave, 2011; Raghunathan et. al., 2004). The anthozoans have been studied with special reference to Scleractinians only in the Gujarat Coast and very less attention has been paid to the diversity and distribution of other group of anthozoans like zoanthids.

The colonial zoanthids are characterized by the incorporation of sediments in the tissue of the body-walls. The zoanthid, *Palythoa* spp. is a well known sediment trapper and fast growing too in such sediment deposition zone (Bhattji et al., 2010; Haywick and Muller, 1997). They are found to set up in a new surrounding competing with organisms for food and space. Over growth is a well known phenomenon of this species (Suchanek and Green, 1981). A massive carpet in the intertidal area is formed by the colonies of these organisms (Soares et. al., 2006).

A wide variety of researchers are now interested in researching on the making up of long-range predictions about intertidal community structure. Competition between corals and algae is a well known fact and the competition between *Palythoa* spp. and organisms surrounding it is a known observation (Buss and Jackson, 1979, Suchanek and Green, 1981). Therefore, a need rose to work on the competition between these two organisms in this particular area as to whether this competition is beneficial, harmful or is there a mutualism. Usually in any temperate sub tidal rock-wall communities appear to be having an unpredictable settlement and overgrowth pattern of encrusting invertebrates' are most likely dependent on both the accessibility of propagules at any point in time and the pace of lateral growth by each colony (Suchanek and Green, 1981).

MATERIALS AND METHOD

1. Study site:

The station site was Sutrapada. Uniqueness in this location is that the area is near to the GHCL factory which provides the perfect substratum for the growth of these organisms. Geo-location of observation site is at the latitude of 20˚85̇ and the longitude of 70˚45̇.

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2. Sampling procedure:

Competitive interactions of *Palythoa* spp. and *Porites* spp. was examined through field observations. A visual identification method was used to determine the presence of scleractinian genus *Porites* and zoanthid *Palythoa* using identification keys (Reimer, 2010 and Venkatraman and Wafar, 2005). An entire area of approximately 2km was surveyed at Sutrapada during the low tide exposures.

RESULTS AND DISCUSSION

There is an abundance of *Palythoa* in the entire intertidal area of Sutrapada. The over growth may be by the means of the favorable factors for *Palythoa*. The changing oceanic conditions and constructions around the coastal areas provide a good substratum for some specific kind of benthic organisms. These benthic organisms use the sediments by trapping them and utilize them for skeleton formation. One such example of this is the genus *Palythoa* (Fig.1) (Costa et.al., 2011).

Suchanek and Green have worked on the competition between *Palythoa* and its associated fauna and have found various kinds of over growth of *Palythoa* like, Lateral Aggression (with and without physical contact), Overtopping and Point Settlement in 1981. In our study, *Palythoa* was seen over growing the *Porites* spp. following the process of lateral aggression (Fig.2) and point settlement (Fig.3). Interaction by lateral aggression has been found relatively common with scleractinian corals in the study area. This interaction has one peculiarity that sediment often accumulates in the marginal area and the top area (Fig.3). Other Zoanthid species were also found to fill the gap between an advancing *Palythoa* colony and living tissue of adjacent scleractinian coral (Fig.4).

Interaction as point settlement was also common but not as common as lateral aggression. Here we found that all the gaps between the Scleractinians were filled by *Palythoa* species itself. Part of the gap was covered by the zoanthids of different genus *Zoanthus* spp.

Due to the effluents of GHCL, the sediment load on the intertidal area may have increased in the past few years. The average abundance of *Palythoa* in this area than other benthic and intertidal organisms reaches to around 60% of the total area. However even with the average expected growth rate of 5mm/day, *Palythoa* will cover up this entire area probably, leaving no space for other species to grow (Suchanek and Green, 1981).

Reports say that only two other species are known to have the ability to overgrow *Palythoa* i.e. encrusting gorgonian *Erythropodium caribaeorum* (Duchassaing and Michelotti) reported by Karlson (1980) in Jamaica and an encrusting colonial tunicate *Tridemnum solidum* by Birkeland *et. al.* (1981).

Factors that do affect the spread of *Palythoa* are present in the environment and probably that is why it has been in at least 1% of control. The genus *Palythoa* is characterized by having encrustations in the body wall discouraging predation, also the presence of palytoxin may act (Ciereszko and Karns 1973) same way but may also be involved in the acquisition of space. So even though having a morphology and biochemistry of such kind *Palythoa* is prone to predation.

Further studies are in progress on the spread of *Palythoa* in other different intertidal areas of the coast of Gujarat.

Figure 1: Area covered with *Palythoa* and small colony of Scleractinian coral

Figure 2: Spread of *Porites* and sedimentation Lateral aggression of P*alythoa* on *Porites*

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Figure 3: *Palythoa* affecting the *Porites* spp. - Point settlement for space

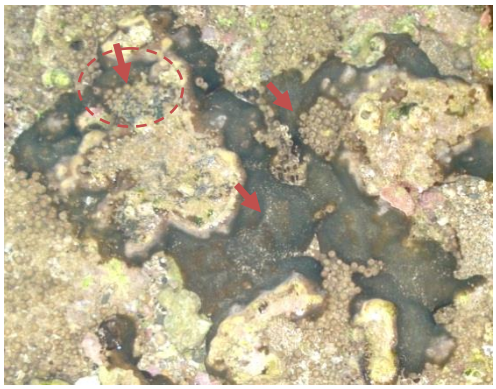

Figure 4: *Palythoa, Porites and Zoanthus* together in an area showing competition

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REFERENCES

- Buss, LW and Jackson JBC; 1979. Competitive net-works: non-transitive competitive relationships in cryptic coral reef environments. Am. Nat. 113: 223-234.
- Bhattji NS., Shah DG., Desai ND. and Mankodi PC.; 2010. New record of a Zoanthid Genus *Palythoa* from the Gulf of Kachchh, Gujarat; Seshaiyana, 18(3).
- Carpenter, RC. and Glatfelter EH.; 1979. Growth and competitive dynamics of the sessile benthic com-munity. In Environmental Studies of Buck Island National Monument, St. Croix, USVI, II. USNPS Report.
- Costa DL, Gomes PB, Santos AM, Valença NS, Vieira NA, Pérez CD.; 2011. Morphological plasticity in the reef zoanthid Palythoa caribaeorum as an adaptive strategy. *Ann*. *Zool. Fennici.* 48:349–358.
- Ciereszko, L.S. and Karns T.K.B. 1973. Comparative biochemistry of coral reef coelenterates. In O.A. Jones and R. Endean (eds.) Biology and Geology of Coral Reefs. Vol. II, Biology 1: 183-203.
- Connell, J.H., 1976. Competitive interactions and the species diversity of corals. In G.O. Mackie (ed.). Coelenterate Ecology and Behavior: 51-58. Plenum Press.
- Dave, C. S.; 2011. Ecological assessment of Narara reef with special reference to coral community; PhD. Thesis.
- Dayton, PK., 1971. Competition, disturbance and community organization: the provision and subsequent utilization of space in a rocky intertidal community. Ecol. Monogr. 41: 351-389.
- Haywick, D.J. and E.M. Mueller, 1997. Sediment retention in encrusting *Palythoa* sp.— a biological twist to a geological process. *Coral Reefs*, 16: 39–46.
- Buss, LW. and Jackson J.B.C. 1979. Competitive net-works: non-transitive competitive relationships in cryptic coral reef environments. Amer. Nat., 113: 223-234.
- Jackson, J.B.C.,1977a. Competition on marine hard substrata: the adaptive significance of solitary and colonial strategies. Amer. Nat., 111: 743-768.
- Jackson, J.B.C., 1977. Habitat area, colonization, and development of epibenthic community structure, in: Keegan, B.F.et al. (Ed.). Biology of Benthic Organisms: 11th European Symposium on Marine Biology, Galway, pp. 349-358.
- Loya,Y., 1976. Effects of water turbidity and sedimentation on the community structure of puerto rican corals; Bulletin of Marine Science, 26(4): 450-466.
- Paine, RT.; 1974. Intertidal community structure: experimental studies on the relationship between a dominant competitor and its principle predator. Oecologia 15: 93-120.
- Porter, JW.,1972. Patterns of species diversity in Caribbean reef corals. Ecology 53: 745-748.
- Raghunathan C., Sen Gupta R., Wangikar U., Lakhmapurkar J., 2004. A record of live corals along the Saurashtra coast of Gujarat, Arabian Sea. Current Science, 87(8): 1131-1138.
- Reimer JD., 2010. Key to field identification of shallow water brachycnemic zoanthids (Order Zoantharia : Suborder Brachycnemina) present in Okinawa;; Galaxea, Journal of Coral Reef Studies; 12:23–9.
- Soares CLS., Pérez1 CD., Maia MBS., Silva RS., Melo LFA., 2006. Evaluation of the anti-inflammatory and analgesic activity of the crude hydroalcoholic extract of the zoanthid *Palythoa* caribaeorum (Duchassaing & Michelotti, 1860. Brazilian Journal of Pharmacognosy; 16 (4): 463-468.
- Suchanek T. H. and Green, D. J., 1981. Interspecific competition between *Palythoa caribaeorum* and other sessile invertebrates on St. Croix reefs, U.S. Virgin islands; Proceedings of the Fourth International Coral Reef Symposium, Manila, vol 2.
- Venkataraman K. and Wafar M., 2005. Coastal and Marine Biodiversity of India. Indian Journal of Marine Sciences; 34(1): 57-75.

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DIVERSITY OF ETHNOMEDICINALLY IMPORTANT COASTAL PLANTS OF MAHARASHTRA WITH SPECIAL REFERENCE FAMILY FABACEAE

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ABSTRACT
The paper deals with coastal plants belonging to Family Fabaceae with respect to their importance in traditional medicine and conservation of ecosystem. Such plants commonly called as coastal sand dune legumes, enrich the sand dunes by fixing atmospheric nitrogen. However due to urbanization and natural calamities there is a threat of loss and imbalance of coastal ecosystem. The need for stability, conservation and management of coastal ecosystem and the ethnomedicinal uses of coastal sand dune legumes of Maharashtra coast are highlighted in this paper.
Key words: Ethnomedicinal, coastal, sand dunes, legumes, ecosystem, conservation.

INTRODUCTION

Maharashtra is blessed with a beautiful diversified long coast which extends from Mumbai to Vengurla. The plants growing along the coast are called as sand dune plants. These plants play an important role in the conservation of coastal ecosystem. There are a few plants belonging to Family Fabaceae growing in this habitat. Most of them fix atmospheric nitrogen and add organic matter to the dunes, play a role in restoration of biogeochemical cycles and are used in tribal medicine. However such ethnomedicinal coastal flora is endangered due to urbanization, tourism and natural calamities like windblow, erosion, tsunamis etc.The need for stability, conservation and management of coastal ecosystem and the ethnomedicinal uses of some coastal sand dune legumes of Maharashtra are described in this paper.

Area under study- The coast line of Maharashtra is spread over 720 km comprising of six districts viz. Thane, GreaterMumbai, Mumbai, Raigad, Ratnagiri , Sindhudurg. The coastal zone of Maharashtra extends from 15°43'N and 73°30'E. The temperature varies from 25°C to 35°C.The climate is warm and humid throughout the year with average rainfall 2286 mm-2540 mm and average humidity is 60-90%.The koli tribals dwell in these regions.
The present paper highlights eighteen plants frequently used by these tribals to cure common diseases.

Materials and Methods

The area under study was visited frequently and information regarding ecosystem, habitats and local medicinal uses was recorded with the help of elderly folk and local coastal dwellers. A critical systematic documentation was done thereafter.

Observations

The list of plants with their common names, botanical names, family and uses is tabulated in table - 1 given below:-

List of Ethnomedicinal Plants

No.	Common Name	Botanical Name & Sub-Family	Medicinal Uses
1	Gunj	*Abrus precatorius* Linn (Paplionaceae)	Leaf juice –given in treatment of sore throat, cough,fever.
2	Khair	*Acacia catechu* Wild (Mimoseae)	Powder of bark-applied over deep cuts and wounds. Decoction of bark- painful menses, abdominal pain
3	Kanchan	*Bauhinia purpurea* Linn (Caesalpineae)	Decoction of Root –one cup once a day-Leucoderma.
4	Palas	*Butea monosperma* Kuntza (Papilionaceae)	Paste of fresh bark is crushed –applied Locally on fracture of bones.
5	Sankasur	*Caesalpinea pulcherima* Swarz (Caesalpineae)	Powder of seeds-stomachache, intestinal worms.

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6	Bahava	*Cassia fistula* Linn (Caesalpinae)	Paste of leaves and pods-intestinal worms.
7	Takala	*Cassia tora* Linn (Caesalpinae)	Juice of leaves-in diarrhoea, loose motions.
8	Harbara	*Cicer arietinum* Linn (Paplionaceae)	Decoction of young leaves-stomachache.
9	Gokarna	*Clitoria ternata* Linn (Paplionaceae)	Decoction of roots-constipation, used as diuretic,demulsant.
10	Pangara	*Erythrina variegata* L (Papilionaceae)	Powder of bark in water-intestinal worms.
11	Lajalu	*Mimosa pudica* Linn (Mimosae)	Juice of roots-locally applied on boils, scabies etc.
12	Kuhilu	*Mucuna pruriens* (Linn.) DC. (Papilionaceae)	Paste of leaves applied on ulcers. Decoction of bark applied on-swelling due to watery fluid.
13	Karanj	*Pongamia pinnata* Linn (Paplionaceae)	Decoction of roots-given in dogbite, Seed oil applied-scabies, leprosy, psoriasis.
14	Bavachi	Psoralea corylifolia Linn (Paplionaceae)	Powder of dried leaves –scabies,leprosy,sorasis etc.
15	Chinch	*Tamarindus indica* Linn (Caesalpineae)	Poultice of leaves applied once a day-all parasitic skin diseases till cured. Seed rubbed on stone-scorpion bite.
16	Unhali	*Tephrosia purpurea*(Linn).Pers (Paplionaceae)	Decoction of plant-one cup-4 days-chronic skin diseases.
17	Pithvan	*Uraria picta* Desv (Paplionaceae)	Pinch of root powder + water –given orally for-Snake bite (Cobra). Juice of leaves to cure - Pus in the ears
18	Mirchikand	*Vigna trilobata*(L)Verdc (Paplionaceae)	Powder of roots + Water given orally for- Snake Bite (Saw scaled viper – phonsom), Cobra

Conclusion

The rapid intrusion of modern civilization into coastal areas due to urbanization and tourism is leading to removal of organic debris, deforestation, loss and imbalance of coastal ecosystem. Thus the importance of traditional medicinal knowledge is valued and it indirectly helps in conservation and restoration of coastal ecosystem.

Therefore special efforts should be made to collect record and store the valuable data on ethnomedicine before its extinction.

References

- Chopra, R. N. Nayar, S. L. and Chopra, I. C. (1956) Glossary of the Indian Medicinal Plants, CSIR Publication, New Delhi
- Jain,S.K., Sinha, B.K. and Arvind Saklani 'Some interesting medicinal plants known among several tribal societies of India' Ethnobotany 1: 89-10
- V.D. Vartak and Madhav Gadgil-'Studies in Ethnobotany- A New Vista in Botanical Sciences.Vartak, V.D; Kumbhujkar, M.S and Nipunage, D. S.-Sacared grooves of tribal areas along the Western Ghats (1987).

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HERPETOFAUNA OF BASSEIN FORT AND SURROUNDING REGION, THANE, MAHARASHTRA

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ABSTRACT
The diversity study of Reptiles and amphibians in and around Bassein Fort, Dist. Thane Maharashtra was carried out during February 2010 to March 2012. Total 34 visits were made alternately in day and night in 26 month. In the study area various habitats such as marshes, mangroves, tidal flood plains, rocky fort allures have rich biodiversity. A total 40 species of Reptiles were recorded during 2 years study. Brahminy Skink (*Mabuya carinata*), Indian toad (*Duttaphrynus melanostictus*), Rat snake (*Ptyas mucosa*) and Russell viper (*Daboia russelii*) were most commonly found species in the study area. Endangered species like Indian rock python, Olive green turtle and Monitor lizard were also recorded, overall 25% rare species were spotted during study period which itself indicates the healthy environment in the study area.
Keywords: Diversity, Reptiles, Rare

Introduction

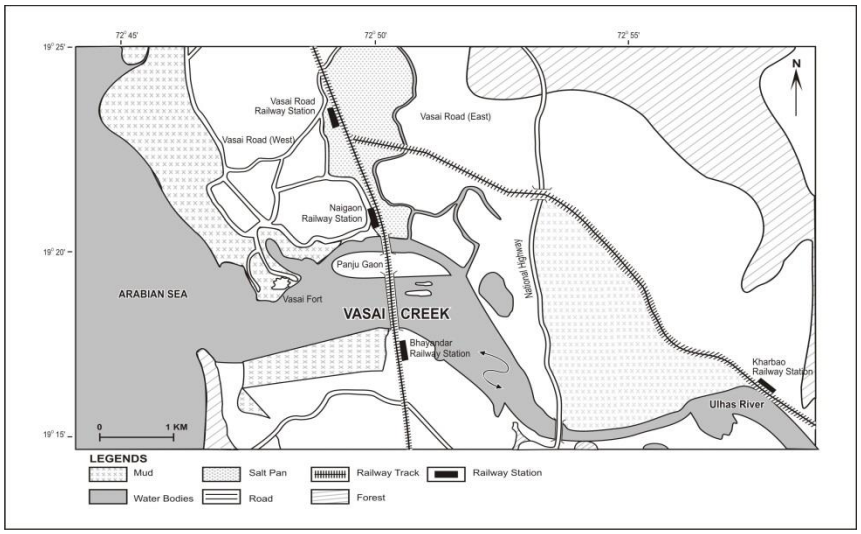
It was found that very less work has been published on Herpetofauna**, i**n 1997 a list was made of Indian reptiles with special reference on endangered species (Anon, 1997), Vyas R. made list in 2000 and 2001 for Reptiles from Gir forest, Gujarat state Biodiversity of Mahul Creek was studied by Verma *et al*. in 2004. Nande and Deshmukh have listed out the snakes from Amravati district in Maharashtra. Perhaps very less research work was done to find out the species in fort and mangrove area related to reptiles. Hence the work carried out to find out the diversity in such habitats.

The Bassein Fort is situated in Mumbai suburb, on west coast of India in Thane district (19°19'49"N 72°48'54"E) having an area of 35 sq. miles (Figure 1). The near shore fort with adjacent wetland has a splendid biodiversity. The wetland provides great biodiversity value to such type of habitats. The Fort is a historical monument with rocky structure which is an ideal habitat for most of the reptile and amphibian species. Surrounding area shows diversity of Mangroves, with most dominant species of *Avicennia marina*, with some other common species viz. *A. alba, A. officinalis and Salvadora persica*. The fort also shows characteristic vegetation of trees, Climbers, herbs and shrubs viz. Baobab (*Adansonia digitata*), Acacia coral (*Adenanthera pavonina*), Banyan tree (*Ficus bengalensis*), Pipal tree (*Ficus religiosa*), Rock pipal (*Ficus arnottiana*), Mahogany (*Swietenia mahogany*), Indian wild date (*Phoenix sylvestris*), African fan palm (*Borassus flabellifer*), Indian jalap (*Operculina turpenthum*), Banana (*Musa paradisiaca*), Nirgundi (*Vitex negundo*), Peanut butter shrub (*Clerodendron trichotomum*), Bilimbi (*Averrhoa bilimbi*), Rui (*Calotropis gigantia*) and Jamun (*Syzygium cumini*).

Figure 1: Map showing Vasai fort and surround area

Materials and Methods

Reptilian fauna was recorded by direct sighting; extensive search was done for different types of reptilian habitats viz. rocky area for terrestrial habitat, trees for arboreal habitat, mud and water for aquatic habitats. The reptiles were identified referring, the book of Indian reptiles (Daniel, 2002). A guide to Snakes of Maharashtra, Goa and Karnataka (Khaire, 2006) and Snakes of India: The field Guide (Whitaker, 2006). Sea snakes were identified with the help of Smith, (1926), Murthy (1977, 1992), and Warel, (1994). The observed fauna was categorized as Common(C) and Uncommon (UN) and Rare (R).



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Observation and Results

The reptilian diversity was studied in and around Bassein fort, in different months for the period of 7 years. A checklist 40 reptiles and amphibians are presented in Table 1.

The rocky fort area having healthy vegetative conditions, adjacent creek and marshy area supports a great reptilian diversity. Total number of 40 species was recorded in this area for the study period of 7 years. The reptilian diversity includes 21 Snakes species, 3 Skinks species, 5 Gecko species and 3 Lizards species and 1 terrapin and 1 Turtle species. Amphibian includes 5 frog and 1 toad species.

Amphibians- Presence of amphibians were restricted to fort area only Indian toad was spotted 2-3 times at the dry intertidal area near the mangroves. Skippering frog was commonly sighted in the pond which is situated inside the fort. During study period once Bull frog was observed feeding on Common toad. After 7 minutes Indian Bull Frog was able to Engulfed Common Indian toad totally (Fig 2.7)

Reptiles- Garden lizard was observed throughout the year and was seen in breeding plumage in mid of April and may. Monitor lizard were rarely spotted in all habitats viz. intertidal area, Mangroves and rock crevices of fort area. Among the geckos *H. brooki* and *H. flaviviridis* were commonly observed and bark gecko was rarely spotted. Three species of *Scincidae* were spotted in fort area, out of which 2 species belongs to same genus *Mabuya* and were commonly spotted, third one was *L. punctatus* which was occasionally spotted.

Among serpents, *Colubridae* family members were dominating and most of them were terrestrial. Dog face snake and Glossy marsh snake were spotted in the intertidal area. Checkered keel back snake was seen occasionally in water region (mostly fresh water). Indian rock python was spotted in all the habitats in the study area (according to Wildlife Protection Act the Indian rock python is declared as **Schedule A** species). Rat snakes were commonly spotted in the study area throughout the study period, sometime also spotted on the mangrove tree. Common wolf snake was seen throughout the year, most of the times on the walls of fort. Buff stripe keel back, Racer, Kukri and Worm snake were mostly observed during monsoon season, out of which Worm snake was most commonly spotted. Except Saw scale viper all other type of major venomous snakes in India were recorded from the area viz. Russell's viper, Indian spectacle cobra and Common krait. The Russell's viper were commonly spotted at fort area through the year and were seen abundantly in September mid week. Common krait and Indian cobra were occasionally spotted. Among the arboreal snakes common vine snake was seen on the trees near the periphery on fort and sometime was recorded even on the mangroves. Common trinket was seen only three times on the shrubs and sometime on trees.

On March 20, 2010, at 18.45 hr. White bellied sea eagle was spotted feeding on Hook nosed sea snake. Among marine snakes Hook nosed sea snake was most commonly seen entangled in the fishing net. Bombay sea snake was rarely spotted from the study area. Dog faced snake was commonly spotted in the wet intertidal area after 18.00 hr. On September 25, 2011, it was spotted in intertidal area and were trying to feed on mudskippers. File snake (Fam-*Acrocordidae*) are spotted commonly at exposed intertidal area, occasionally it was spotted near the mangroves.

Terrapin was seen in well situated in fort area and they were 5 in number. Olive green turtle was rarely spotted in the study area, it was spotted twice in the fishing net (on October 25, 2010 at 1300 hr it was rescued from the fishing net).

Table 1: List of Hepetofauna found in and around Bassein Fort during 2010-2012

No.	Common Name	Scientific name	Order	Category	Habitat
Family: Agamidae					
1	Garden Lizard	*Calotes versicolor*	Iguania	C	Ab,Ld,Rc
2	Forest Lizard	*Calotes rouxii*	Iguania	C	Ab,Ld,Rc
Family: Varanidae					
3	Monitor Lizard	*Varanus bengalensis*	Lacertilia	R	Ab,Ld,MAq
Family: Gekonidae					
4	Broke's Gecko	*Hemidactylus brookii*	Sauria	C	Rc
5	Rock Gecko	*Hemidactylus maculatus*	Sauria	C	Rc
6	Bark Gecko	*Hemidactylus leschenaultii*	Sauria	UN	Ab,Rc
7	Yellow green House Gecko	*Hemidactylus flaviviridis*	Sauria	C	Rc
8	Asian House Gecko	*Hemidactylus frenatus*	Sauria	C	Rc
Family: Scincidae					
9	Brahminy Skink	*Mabuya carinata*	Sauria	C	Ld
10	Snake Skink	*Lygosoma punctatus*	Sauria	UN	Ld
11	Forest Skink	*Mabuya macularia*	Sauria	C	Ld
Family: Colubridiae					

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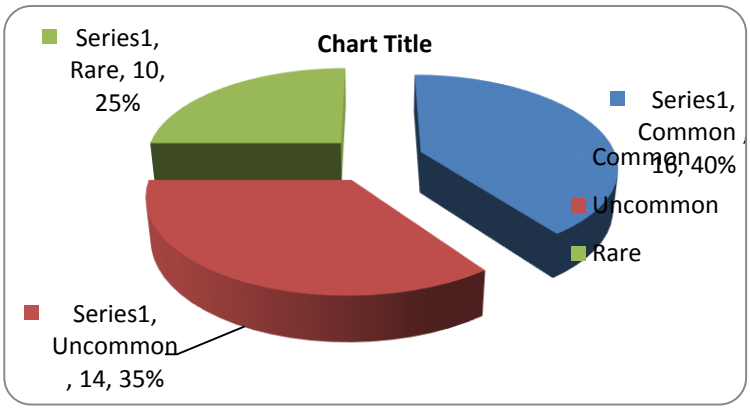
12	Rat Snake	*Ptyas mucosa*	Serpentes	C	Ld,Rc
13	Checkered Keelback	*Xenochrophis piscator*	Serpentes	C	FAq, MAq
14	Buffstriped Keelback	*Amphiesma stolata*	Serpentes	C	Ld,Rc
15	Common Trinket Snake	*Coelognathus helena helena*	Serpentes	UN	Ab
16	Banded Racer	*Argyrogena fasciolata*	Serpentes	UN	Ld,Rc
17	Banded Kukri	*Oligodon arnensis*	Serpentes	UN	Rc,Ld
18	Wolf Sanke	*Lycodon aulicus*	Serpentes	C	Rc
19	Vine Snake	*Ahaetulla nasuta*	Serpentes	UN	Ab
20	Dog Faced Snake	*Cerberus rynchops*	Serpentes	C	MAq
21	Glossy Marsh Snake	*Gerarda prevostiana*	Serpentes	R	MAq
Family: Elapidae					
22	Indian Spectacle Cobra	*Naja naja*	Serpentes	UN	Ld
23	Common Krait	*Bungarus caeruleus*	Serpentes	R	Ld
24	Annulated Sea Snake	*Hydrophis cyanocinctus*	Serpentes	UN	MAq
Family: Viprideae					
25	Russel's Viper	*Daboia russelii*	Serpentes	C	Ld,Rc
26	Saw scaled viper	*Echis carinatus*	Serpentes	UN	Ld,Rc
Family: Boidae					
27	Sand Boa	*Gongylophis conicus*	Serpentes	UN	Fs,Ld
Family: Pythonidae					
28	Indian Rock Python	*Phython molurus molurus*	Serpentes	R	Ab,MAq,Ld
Family: Thilophidae					
29	Brahminy Worm snake	*Ramphotyphlops braminus*	Serpentes	C	Ld,Fs
Family: Acrochordidae					
30	File Snake	*Acrochordus granulatus*	Serpentes	C	MAq
Family: Hydrophiidae					
31	Hook Nosed Sea Snake	*Enhydrina schistosa*	Serpentes	C	MAq
32	Many Toothed Sea Snake	*Hydrophis clarias*	Serpentes	UN	MAq
33	Bombay Sea Snake	*Hydrphis mamillaris*	Serpentes	R	MAq
Family: Ranidae					
34	Common Bull Frog	*Hoplobatrachus trgerinus*	Anura	C	FAq, Ld
35	Skipper Frog	*Euphlyctis cyanophlyctis*	Anura	C	FAq
36	Fungoid Frog	*Hylarana malabarica*	Anura	UN	FAq, Ld
37	Cricket Frog	*Fejervarya limnochoris*	Anura	UN	FAq, Ld
Family: Bufonidae					
38	Indian toad	*Duttaphrynus melanostictus*	Anura	C	Ld,Fs,
Family:Rhacophoridae					
39	Common Tree Frog	*Polypedates maculatus*	Anura	UN	Ab
Family: Trionychidae					
40	Flap Shell Terrapin	*Lissemys punctata*	Testudines	C	FAq
Family: Cheloniidae					
41	Olive Green Turtle	*Lepidochely olivacea*	Testudines	R	MAq

Habitat: Arboreal- Ab, Fresh water Aquatic-FAq, Marine water Aquatic- MAq, Land dwellers- Ld, Forsorial- Fs, Rock crevices- Rc

Figure 2: Status chart for Hepetofauna of Bassein fort and surrounding area



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Conclusion

Of the total number of 40 reptile and amphibian species record, 40% were common, 35% were uncommon and 25% were rare (Figure 2) which includes globally threatened species *Lepidochely oilivacea* and Indian threatened species like *Python molurus molurus* and *Varanus bengalensis.* Their presence indicates healthy condition in the study area. According to present study good reptilian and amphibian diversity was recorded from in the study area indicating that the habitat was ideal for reptiles and the food is available abundantly. Presence of rare species of reptiles recorded in the study area suggest that the area is not very much influenced by anthropogenic activities, as well it should be conserved on high priority by considering reptilian biodiversity which plays the important role in maintaining the ecological balance.

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References

- Current Ecological Status and Identification of potential ecologically sensitive areas in the Northern Western Ghats: October 2010. Institute of environmental education and research; Bharati vidyapeeth deemed university Pune, Maharastra.
- Daniel J.C., 2002.The Book of Indian Reptiles and Amphibians. Bombay Natural History Society, Oxford University Press, Mumbai.
- Das I. & Dutta S. K., 1998. Checklist of amphibians of Indian with English and common names. Hamadryad. 23:63-68.
- Das, L., 1997a.Checklist of the reptilies of India with English common names. Hamadryad 22(1):32-45
- Das, L., 1996b. Handbook : Indian Lizards Herpetological review 27: 44-46
- Inger, R. F., H. B. Shaffer, M. Koshy and R. Bakde,1984. A report on a collection of amphibians and reptiles from the Ponmudi, Kerala, South India. Journal of the Bombay Natural History Society, 81(2): 406–427 & 551-570.
- Khaire, N., 2006. A Guide to Snakes of Maharastra, Goa and Karnataka. Indian Herpetological society. 'USANT', Maharastra, India, 104-114pp.
- Kumar, A., R. Chellam, B. Choudary, D. Mudappa, K.Vasudevan, N. M. Ishwar and B. R. Noon, 2001. Impact of rainforest fragmentation on small mammals and herpetofauna in the Western Ghats, South India.Report of Wildlife Institute of India, Sálim Ali Centre for Ornithology and Natural History and U.S. Fish and Wildlife Service: 28.
- Mangrooves- A coastal belt in the suburbs of Mumbai.Life Science leaflets (LSIC 2011) 59-65, 2012**.**
- Padhye A. D. & Ghate H. V., 2002. An overview of Amphibian fauna of Maharashtra State. *Zoos' Print Journal* 17(3): 735-740.
- Chauhan, R., 2012.Preliminary survey of Herpetofauna of Borivali.
- Chandramouli S.R. and Ganesh, S.R Herpetofauna of Southern Western ghats, India-Reinvestigated after decades. Taprobanica Oct,2010, Vol.02, No.02. pp. 72-85. 4 pls
- Sharma, R. C., 2003. *Handbook – Indian Snakes*.Director– Zoological Survey of India, Kolkata: 292.
- Smith, M. A., 1935. *Fauna of British India includingCeylon and Burma.Vol – II Sauria*. Taylor & Francis, London: 440.
- Smith, M. A., 1943. *Fauna of British India including Ceylon and Burma. Vol – III Serpentes.* Taylor & Francis, London: 583.
- Vijay Awasare. (2011)The Book of Reptiles and Amphibians of Maharastra Nature Park Society.
- Wall, F., 1919. Notes on a collection of snakes made in the Nilgiri Hills and the adjacent Wynaad. *Journal of the Bombay Natural History Society*, 26: 552-584.
- Wall, F., 1920. Notes on a collection of snakes from Shenbaganur, Palni Hills. *Journal of the Bombay Natural History Society*, 29: 388-398.
- Whitaker, R. and A. Captain. 2004. *Snakes of India –The field guide*. Draco Books, Chengelpet, South India: 481.
- ZSI (Zoological Survey of India) e-News, Volume-3: No. March 2011
- A.Verma *et al*(2004), A preliminary report on the Bio-diversity of Mahul creek, Mumbai, India with special refrence to Avifaunna, Zoo's print journal 19(9):1599-1605.

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A REVIEW OF DISCODORID OPISTHOBRANCH MOLLUSCS ALONG INDIAN COASTS

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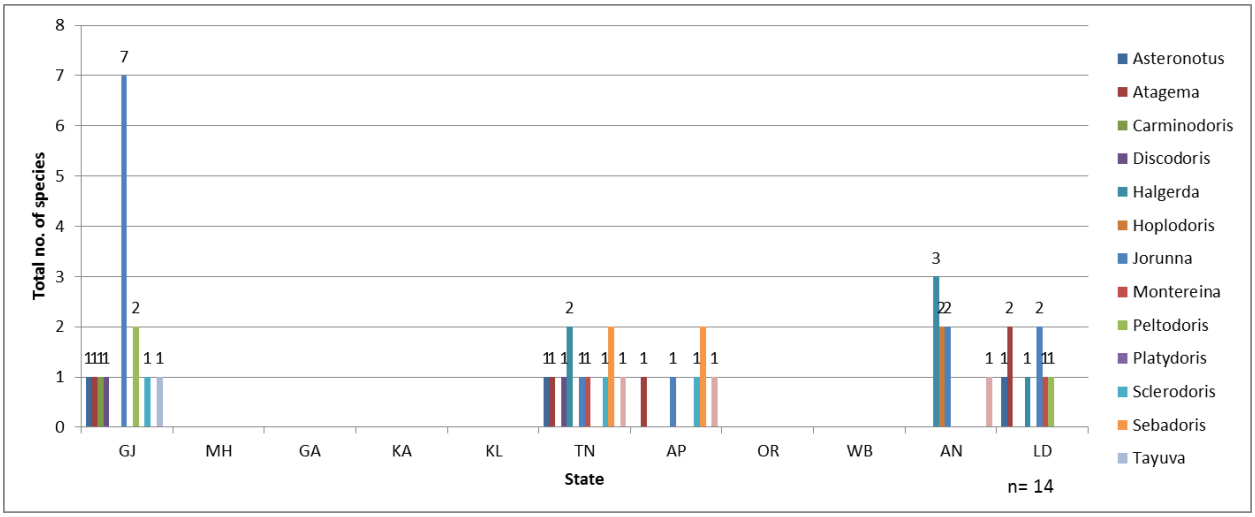
Abstract
India is having large coastline along both east and west coast, even though the opisthobranch fauna is still amongst poorly reported taxa. Discodorididae is a family of disc shaped sea slugs which are distributed worldwide. Several species were described and few were recorded from India. Most of the studies however, were confined to the sites such as Gulf of Mannar, Gulf of Kutch and Waltair coast.
Present study deals with a literature review of Discodorid (Family: Discodorididae) sea slugs from India which will help to understand the current status of Indian Discodorid fauna and identify gaps in our knowledge of Indian Discodorids.

Keywords: Opisthobranch, Discodorididae, Arabian Sea

Introduction

Family Discodorididae has 27 genera distributed worldwide (Bouchet, 2012). There are total 33 Discodorid opisthobranch species recorded from India belonging to 14 genera of which 9 were newly described species. New descriptions were mostly from the south west coast of India. Out of 11 coastal states, Discodrids were studied along 3 coastal states and 2 Union Territories namely Gujarat, Tamilnadu, Andhra Pradesh, Andaman & Nicobar Islands and Lakshdweep Alder and Hancock (1864), Narayanan (1968 to 1971), Satyamurthi (1952), Ramakrisna *et al.* (2010), Apte *et al.* (2010), and Sreeraj (2010).



Statewise species diversity

Besides patchy distribution of Discodorididae, Genus *Platydoris, Halgerda,* and *Atagema* were found to be abundant and best represented with species diversity. Rest of the genera was represented by either 1 or 2 species along the Indian coast.

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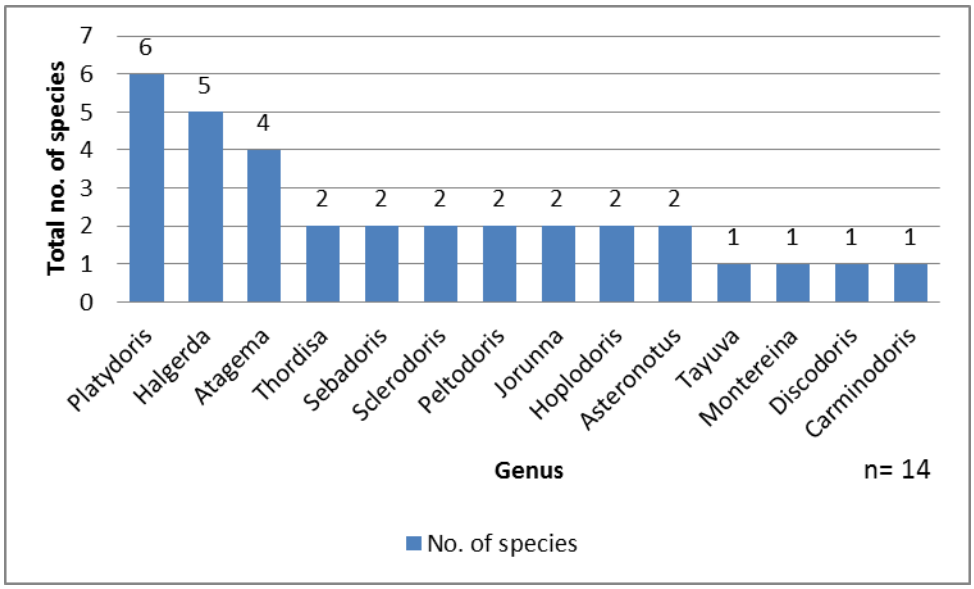
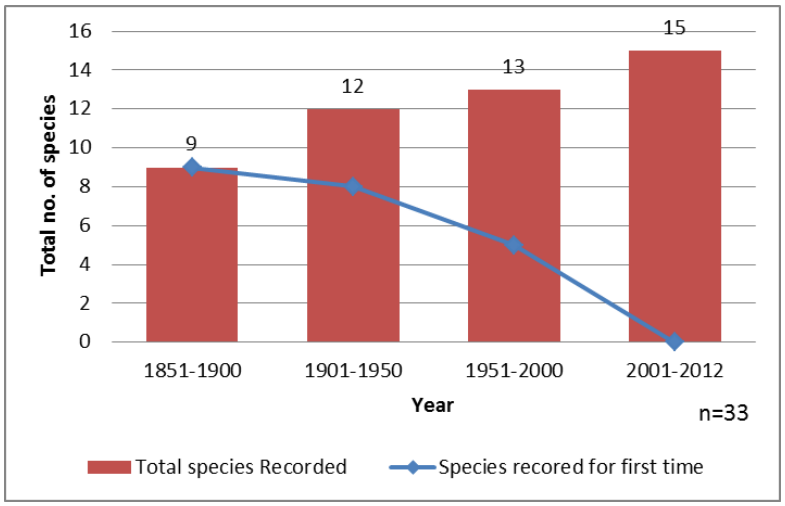


Genus wise species number

History



Year wise species number

Worldwide distribution of Family *Discodorididae* includes 27 genera (Bouchet, 2012). Discodorid sea slugs are well represented along the Indian coast in most of the marine habitats specifically from rocky intertidal pools to coral reefs. As work done on discodorid opisthobranchs is patchy & focused only in certain areas, it was not possible to get generalized idea about its wider distribution and occurrence.

Great amount of knowledge about discodorid slugs generated in India in mid of 19th century from the collection of Mr. Walter Elliot made during the years 1853 to 1854 from Waltair, Vishakhapatanam. Besides preserving the specimens, the description was also supported with good quality drawings for all specimens (Alder and Hancock, 1864). This collection was analyzed by the British researchers Joshua Alder and Albany Hancock in 1864 which has descriptions of 9 discodorid species of which 7 were newly described species and still considered valid species.
In first half of 20th century, Farran in 1905 presented a report on the opisthobranchiate mollusca collected by Prof. Herdman from the Gulf of Mannar which mentions a record of a discodorid species.

Later the species of Alder and Hancock (1864) and Kelaart (1858) collected from southern India and Ceylon were re-evaluated by Sir Eliot (1906a, b), where total 5 Discodorids were recorded. Sir Eliot in 1910 provided a report on Nudibranchs collected by Mr. Stanley Gardiner from the Indian Ocean in which total 2 discodorids were recorded from which 1 was new species. Gravely F. H. (1927) presented a complete checklist of shells and other animals found on Madras beach which were having record of 2 discodorid species.

Further O'donoghue, C.H. (1932) published notes on nudibranchs from southern India where, notes were based upon a collection of nudibranch mollusca made by Dr. F. H. Gravely in the Gulf of Mannar, and in possession of the Madras Government Museum. There were 4 discodorid species records with detailed morphological and radular descriptions.

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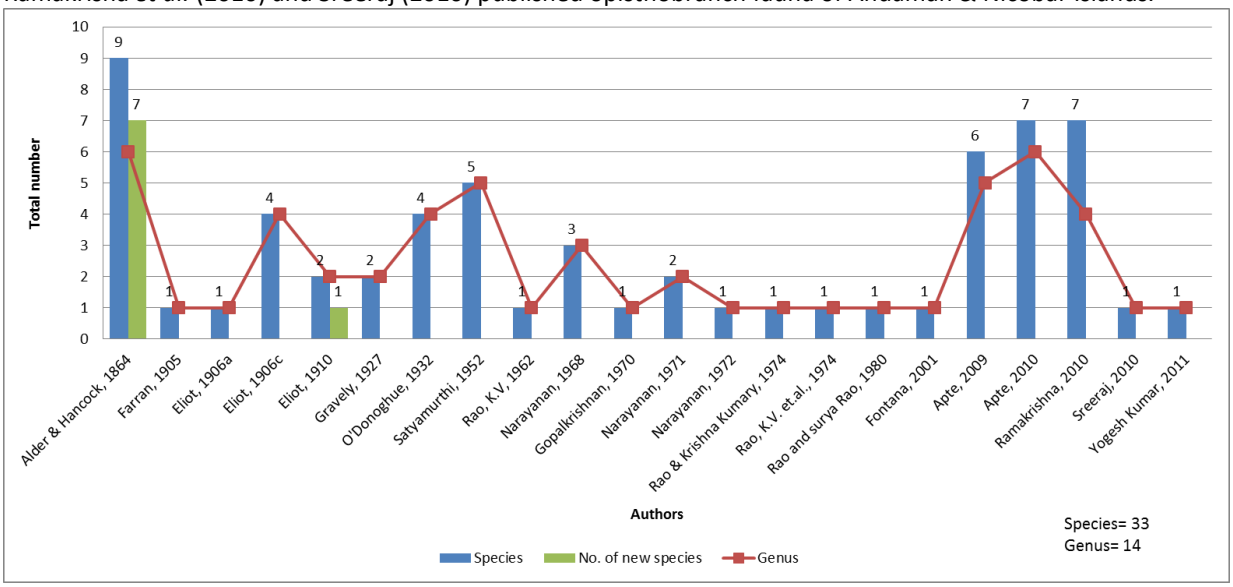
In the mid of 20th century, Satyamurthi in 1952 studied mollusca of Krusadai Island in which 5 discodorid species were recorded along with their respective radular morphologies.

Rao (1962), Rao & Krishna Kumary (1974), Rao & Rao (1980) gave an account of some new records, taxonomy and studies on early development in some of the discodorid species. Rao (1974) published a paper listing new record of a Discodorid species from Lakshadweep Islands. Next major work on the Indian Discodorid Opisthobranchs was by Narayanan (1968 to 1971) with total 6 records from Gulf of Kutch. This was the first extensive study for that area. Fontana *et al.* (2001) studied marine Opisthobranchs for their chemo-ecology.

The most recent work however was by Apte (2009) who gave an account on total 6 discodorid from Lakshadweep and Apte *et al.* (2010) listed 7 discodorid species from the Gulf of Kutch. Apte (2012) listed 12 discodorids from west coast of India.

Yogesh Kumar (2011) recorded single discodorid species from Gulf of Mannar.

Ramakrisna *et al.* (2010) and Sreeraj (2010) published opisthobranch fauna of Andaman & Nicobar Islands.



Author wise species records

MATERIALS AND MethodS

Present study deals with the review of Indian Discodorid fauna based on the available literature. References were collected from various institute libraries and also web based literature. Old literature was obtained from Biodiversity Heritage Libraries and open access journals. Year wise distributional records were listed and represented graphically.

Discussion

Number of Discodorididae underwent taxonomic revision by many foreign authors, e.g Monograph of basal discodorids (Dayrat, 2010), phylogeny of genus *Rostanga* (Garovoy *et al.*, 2001), systematics and phylogeny of Caryophyllidia bearing dorids by (Valdes *et al.*, 2001), and systematic revision of *Jorunna* by (Camacho Garcia *et al.*, 2008) (Table 1).

Table 1: Revised names of some of the Discodorids

Sr. no.	Old Nomenclature	Rescent valid name of species
1	*Doris apiculata* by Alder & Hancock, 1864 and *Halgerda apiculata* by O'donoghue, 1932	*Sclerodoris apiculata* (Alder & Hancock, 1864)
2	*Doris tristis* by Alder & Hancock, 1864; *Trippa tristis* by Eliot, 1906; Gravely, 1927 and Satyamurthi, 1952	*Atagema tristis* (Alder & Hancock, 1864)
3	*Doris fragilis* Alder & Hancock, 1864; Eliot, 1906a; *Discodoris fragilis* by Gravely, 1927 and Rao & Krishna Kumary, 1974	*Sebadoris fragilis* (Alder & Hancock, 1864)
4	*Doris villosa* by Alder & Hancock, 1864; *Thordisa villosa* by Satyamurthi, 1952	*Thordisa villosa* (Alder & Hancock, 1864)
5	*Doris areolata* by Alder & Hancock, 1864	*Atagema spongiosa* (Kelaart, 1859)

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6	*Doris concinna* by Alder & Hancock, 1864; Eliot, 1906c	*Montereina concinna* (Alder & Hancock, 1864)
7	*Argus indicus* by O'Donoghue, 1932; *Thordisa crosslandi* by Satyamurthi, 1952	*Sebadoris nubilosa* (Pease, 1871)
8	*Doris (Staurodoris) pustulata* by Eliot, 1910	*Hoplodoris nodulosa* (Angas, 1864)
9	*Asteronotus madrasensis* by O'Donoghue, 1932	*Asteronotus cespitosus* van Hasselt, 1824
10	*Hoplodoris desmoparypha* Bergh, 1880 by Narayanan, 1968	*Asteronotus raripilosa* (Abraham, 1877)

Species Diversity

Majority of the studies on Indian opisthobranch were confined to the intertidal habitats. Majority of the surveys in Gujarat, Lakshadweep and Andaman & Nicobar were mainly in coral reef areas. Although these areas showed high diversity in Discodorid species; one need to look at rest of the marine intertidal habitats such as rocky shores.

Species Abundance

Within all the records of Discodorids, *Jorunna funebris* is wide spread species found along most of the coastal states. Besides that *Sebadoris fragilis* and *Asteronotus cespitosus* were found to be moderately abundant along the coral reef habitats.

Final considerations

Without a doubt, knowledge regarding opisthobranchs of India had a notable increase in last few years especially for family Discodoridae. Indian Discodorid fauna is represened by 14 genera out of 27 known worldwide (Bouchet, 2012). Nevertheless genera like *Rostanga*, *Diaulula*, *Paradoris* are commonly distributed worldwide but not yet recorded from India. Therefore, intensive studies are necessary to improve the Opisthobranch knowledge of the area.

Table 2: Species Checklist: Discodorididae

Sr. No	**Scientific name**	**GJ**	**MH**	**GA**	**KA**	**KL**	**TN**	**AP**	**OR**	**WB**	**AN**	**LD**
1	*Asteronotus cespitosus* van Hasselt, 1824						+					+
2	*Asteronotus raripilosa* (Abraham, 1877)	+										
3	*Atagema ornata* (Ehrenberg, 1831)											+
4	*Atagema rugosa* Pruvot-Fol, 1951	+										
5	*Atagema spongiosa* (Kelaart, 1858)							+				+
6	*Atagema tristis* Alder & Hancock, 1864						+					
7	*Carminodoris* cf. *grandiflora* (Pease, 1860)	+										
8	*Discodoris boholiensis* Bergh, 1877	+					+					
9	*Halgerda bacalusia* Fahey & Gosliner, 1999										+	
10	*Halgerda formosa* Bergh, 1880						+					
11	*Halgerda punctata* Farran, 1902						+					
12	*Halgerda stricklandi* Fahey & Gosliner, 1999										+	
13	*Halgerda tessellata* (Bergh, 1880)										+	+
14	*Hoplodoris armata* (Baba, 1993)										+	
15	*Hoplodoris nodulosa* (Angas, 1864)										+	
16	*Jorunna funebris* (Kelaart, 1859)	+					+	+			+	+
17	*Jorunna rubescens* (Bergh, 1876)										+	+
18	*Montereina concinna* (Alder & Hancock, 1864)						+					+
19	*Peltodoris murrea* (Abraham, 1877)	+										+
20	*Peltodoris rubescens* Bergh, 1905	+										
21	*Platydoris cruenta* (Quoy & Gaimard,											+

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	1832)											
22	*Platydoris ellioti* (Alder & Hancock, 1864)							+				
23	*Platydoris formosa* (Alder & Hancock, 1864)							+				
24	*Platydoris pulchra* Eliot, 1904	+										
25	*Platydoris scabra* (Cuvier, 1804)					+						+
26	*Platydoris striata* (Kelaart, 1858)							+				
27	*Sclerodoris apiculata* Alder & Hancock, 1864						+	+				
28	*Sclerodoris tuberculata* Eliot, 1904	+										
29	*Sebadoris fragilis* (Alder & Hancock, 1864)						+	+				
30	*Sebadoris nubilosa* (Pease, 1871)						+	+				
31	*Tayuva lilacina* (Gould, 1852)	+										
32	*Thordisa annulata* Eliot, 1910										+	
33	*Thordisa villosa* (Alder & Hancock, 1864)						+	+				

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Bibliography:

- Alder, J. & A. Hancock, 1864. Notice on the collection of Nudibranchiate mollusca made in India by Walter Eliot Esq. with descriptions of several new genera and species. Transactions of Zoological Society of London 5: 117-147.
- Apte, D.A., 2009. Opisthobranch fauna of Lakshadweep Islands, India with 52 new records to Lakshadweep and 40 new records to India. Journal of the Bombay Natural History Society 106 (2): 162-175.
- Apte, D.A., 2010. An annotated and illustrated checklist of the opisthobranch fauna of Gulf of Kutch, Gujarat, India with 21 new records for gujarat and 13 new records for India: part 1. Journal of the Bombay Natural History Society 107 (1): 14-23.
- Apte, D.A., 2012. Field Guide to the Marine Life of India. Published by Animesh Apte, pp 502. ISBN 978-93-5067-144-3.
- Bouchet, P., 2012. Discodorididae. Accessed through: World Register of Marine Species at http://www.marinespecies.org/aphia.php?p=taxdetails&id=1761
- Camacho Garcia, Y.E. & T.M. Gosliner, 2008. Systematic revision of Jorunna Bergh, 1876 (Nudibranchia: Discodorididae) with a morphological phylogenetic analysis. Journal of Molluscan Studies 74:143-181.
- Dayrat, B., 2010. A Monographic Revision of Basal Discodorid Sea Slugs (Mollusca: Gastropoda). California Academy of Sciences pp. 403.
- Eliot, C.N.E., 1906a. On the nudibranchs of southern India and Ceylon, with special reference to the drawings by Kelaart and the collections belonging to Alder and Hancock preserved in the Hancock Museum at Newcastle-on-Tyne. Proceedings of the Zoological Society of London pp. 636-691, pls.42-47.
- Eliot, C.N.E., 1906b. On the nudibranchs of southern India and Ceylon, with special reference to the drawings by Kelaart and the collections belonging to Alder and Hancock preserved in the Hancock Museum at Newcastle-on-Tyne. No. 2. Proceedings of the Zoological Society of London pp. 999-1008.
- Eliot, C.N.E.,1906c. Nudibranchiata, with some remarks on the families and genera and description of a new genus, Doridomorpha. pp. 540-573, pls. 32. *In*: Stanley Gardiner, J. (Ed.): The fauna and geography of the Maldive and Laccadive Archipelagoes, being the account of the work carried on and of the collections made by an expedition during the years 1899 and 1900, vol. 2.
- Eliot, C.N.E., 1909a Report on the nudibranchs collected by Mr. James Hornell at Okhamandal in Kattiawar in 1905-6. Report to the government of Baroda on the marine zoology of Okhamandal 1: 137- 145.
- Eliot, C.N.E.,1910a. Nudibranchs collected by Mr. Stanley Gardiner from the Indian Ocean in H.M.S. Sealark. *In*: Reports of the Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of Mr. J. Stanley Gardiner, M.A. Transactions of the Linnaean Society, Zoology series 2, 13(2): 411-439, pls. 25.
- Eliot, C.N.E., 1910b. Notes on nudibranchs from the Indian museum. Records of the Indian Museum 5(4): 247-252, pls. 19.

ISBN 978-81-925489-0-6

- Eliot, C.N.E., 1916. Mollusca Nudibranchiata. In: Fauna of the Chilka Lake. Memoirs of the Indian Museum 5: 375-380.
- Farran, G.P., 1905. Report on the opistobranchiate Mollusca collected by Professor Herdman, at Ceylon, in 1902. Report to the Government of Ceylon on the pearl oyster fisheries of the Gulf Of Manaar, Supplementary Report No. 21: 329-364. Pls. 1-6.
- Fontana, A., M. L. Ciavatta, L. D'souza, E. Mollo, C. G. Naik, P. S. Parameswaran, S. Wahidulla & G. Cimino, 2001. Selected chemo-ecological studies of marine opisthobranchs from Indian coasts. Journal of the Indian Institute of Science 81(4): 403-415.
- Gravely, F. H., 1927.Shells and other animal remains found on the Madras beach. II. Snails, etc. (Mollusca Gastropoda). Bulletin of the Madras Government Museum, New Series, Natural History Section 5(2):1-110.
- Gopalkrishnan, P.,1970. Some observations on the shore ecology of the okha coast. Journal of Marine Biological Association of India 12 (1 & 2): 15-34.
- Narayanan, K.R., 1968. On three opisthobranchs from the south-west coast of India. Journal of Marine Biological Association of India 10 (2): 377-380; figs. 1-2.
- Narayanan, K.R., 1969. On the opisthobranchiate fauna of the Gulf of Kutch. Proceedings of the Symposium on Mollusca held at Cochin from January 12 to 16, 1968, Journal of Marine Biological Association of India, Mandapam Camp, India. Symposium Series 3 pp. 189–213, pls. 1, figs. 1–20.
- Narayanan, K.R., 1971. On two doridacean nudibranchs (Mollusca: Gastropoda), from the Gulf of Kutch, new to the Indian coast. Journal of the Bombay Natural History Society 68(1): 280-281.
- Rao, K.V., 1962. On two opisthobranchiate molluscs, *Placobranchus ocellatus* Hasselt and *Discodoris boholiensis* Bergh, from Indian waters not hitherto been recorded. Journal of the Marine Biological Association of India 3(1, 2):253-256.
- Rao, K. V., P. Sivadas & L. K. Kumary, 1974. On three rare doridiform nudibranch molluscs from Kavaratti Lagoon, Laccadive Islands. Journal of the Marine Biological Association of India 16(1): 113-125.
- Rao, K. V., & L. K. Kumari, 1974. On some aspects of taxonomy, structure and early development of the nudibranchiate gastropod, *Discodoris fragilis* (Alder & Hancock). Journal of the Marine Biological Association of India 16(3):689-699.
- Rao, N.V. & K.V. Surya Rao, 1980. On a rare nudibranch, *Thordisa crosslandi* Eliot (Mollusca: Doridiidae) from the west coast of India. Bulletin Zoological Survey of India 2(2-3): 219, pls. IV.
- Ramakrishna, C.R. Sreeraj, C. Raghunathan, C. Sivaperuman, J.S. Yogesh Kumar, R. Raghuraman, Titus Immanuel & P.T. Rajan,2010. Guide to Opisthobranchs of Andaman and Nicobar Islands. Zoological Survey of India 196 p, 96 colour figs, ISBN : 8181712615.
- Satyamurthi, S.T., 1952. The mollusca of Krusadai Island. 1. Amphineura and Gastropoda. Bulletin of the Madras Government Museum (Natural History) 1(2): 216-251.
- Sreeraj, C.R., P.T. Rajan., R. Raghuraman., C. Raghunathan., R. Rajkumar, Titus Immanuel & Ramakrishna, 2010. On some new records of sea slugs (Class: Gastropoda, Subclass: Opisthobranchia) from Andaman and Nicobar Islands, pp. 289–298. In: Recent Trends in Biodiversity of Andaman and Nicobar Islands, Zoological Survey of India, Kolkata.
- Valdés, Á. & T.M Gosliner, 2001. Systematics and phylogeny of the caryophyllidia-bearing dorids (Mollusca, Nudibranchia), with the description of a new genus and four new species from Indo-Pacific deep waters. Zoological Journal of the Linnean Society 133(2): 103-198.
- Yogesh Kumar, J.S., C. R. Sreeraj & R. Sornaraj, 2011. Opisthobranchs of the Gulf of Mannar, Biosphere Reserve, Tamilnadu, India. Indian Journal of Fisheries vol.58, (4), 105-114.

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BIODIVERSITY OF MARINE SHORE BIRDS

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Abstract
Marine birds face enormous challenges on a daily basis; the conservation status of shore birds is deteriorating faster than that of any other bird group. The seabirds index shows that the status of seabird population remains poor, 44% of known population are decreasing and only 17% are increasing (State of World's waterbird 2010). Families with relatively high proportions of decreasing population include Stork, most families of Waders, Grebs, and Jacanas. Seabirds, particularly Albatrosses, are becoming increasingly threatened and at a faster rate globally than all other species-groups of birds; they face a wide variety of threats.

Many declines are closely linked to the expansion of commercial logline fisheries in shore bird feeding areas, combined with the impacts of invasive alien species at nesting colonies.

The world's oceans are open and dynamic systems that pose few physical barriers to the dispersal and migration of many seabirds: seas are not separated as are the continents. Shore bird conservation issues need therefore to be addressed globally.
Keywords : invasive alien species, marine birds.

Introduction

India has one of the longest shorelines in the world and many marine species of birds are found in the Indian seas and on the coastal areas. Shore bird**s** (also known as **marine birds**) are birds that have adapted to life within the marine environment. While seabirds vary greatly in lifestyle, behavior and physiology, they often exhibit striking convergent evolution, as the same environmental problems and feeding niches have resulted in similar adaptations. The first shore birds evolved in the Cretaceous period, and modern shore bird families emerged in the Paleogene.

There exists no single definition of which groups, families, and species are shore birds, and most definitions are in some way arbitrary. In the words of two shore bird scientists, "The one common characteristic that all shore birds share is that they feed in saltwater; but, as seems to be true with any statement in biology, some do not." However, by convention all of the Sphenisciformes and Procellariiformes, all of the Pelecaniformes except the darters, and some of Charadriiformes (the skuas, gulls, terns, auks and skimmers) are classified as shorebirds. The phalaropes are usually included as well, since although they are waders ("shorebirds"), two of the three species are oceanic for nine months of the year, crossing the equator to feed pelagically.

Loons and grebes, which nest on lakes but winter at sea, are usually categorized as water birds, not seabirds. Although there are a number of sea ducks in the family Anatidae which are truly marine in the winter, by convention they are usually excluded from the seabird grouping. Many waders (or shorebirds) and herons are also highly marine, living on the sea's edge (coast), but are also not treated as seabirds.
In general, seabirds live longer, breed later and have fewer young ones than other birds do, but they invest a great deal of time in their young. Most species nest in colonies, which can vary in size from a few dozen birds to millions. Many species are famous for undertaking long annual migrations, crossing the equator or circumnavigating the Earth in some cases. They feed both at the ocean's surface and below it, and even feed on each other. Seabirds can be highly pelagic, coastal, or in some cases spend a part of the year away from the sea entirely (Boca Raton).

Objectives

- To address shore bird conservation issues at a global level.
- To facilitate existing, and promote new, initiatives to reduce the incidental mortality of seabirds by fisheries, particularly in respect of longline.
- To establish and support a network to influence global and regional policies affecting seabirds.
- Protecting marine biodiversity.

Data

Seabirds are a taxonomically varied group of nearly 350 bird species (around 3.5% of all birds) that depend on the marine environment for atleast part of their life cycle. They are typically apex-predators within the oceanic food chain and consequently, key indicators of wider marine health. Over recent decades, the status of the

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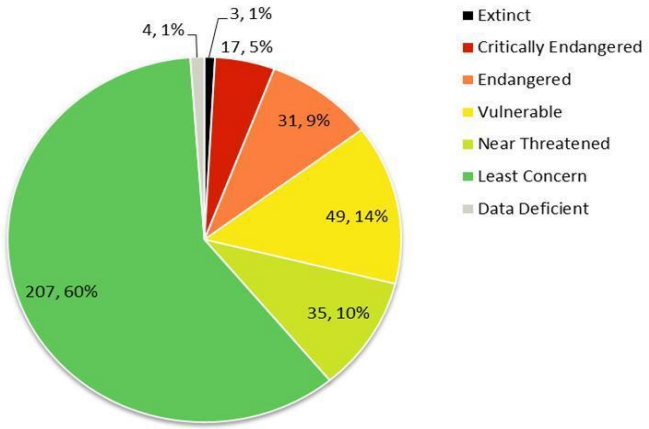
world's seabirds has deteriorated, with several species slipping close to extinction. Human activities lay behind these declines—the introduction of invasive species has had a catastrophic impact on many breeding colonies, while overfishing has degraded the marine environment and caused the accidental deaths of innumerable seabirds.

Marine environments cover more than 70% of the Earth's surface and are vital to sustaining life. The oceans govern global climate and weather patterns and, through the activities of microscopic photosynthesizing organisms, help create and maintain the planet's atmosphere. Despite the pivotal significance of marine ecosystems, our knowledge of them remains poor. Seabirds are a conspicuous part of the marine realm and compared to other major groups of marine organism are exceptionally well-studied. Consequently, seabirds provide a crucial window onto the condition of the oceans and are excellent indicators of its health.



Proportion of seabird species in each IUCN Red List category **(State Of World's Birds 2010)**

The IUCN Red List Index (RLI) for birds tracks the movement of species through categories of extinction risk. It reveals that although there has been a steady deterioration in the status of birds in all regions of the world, species associated with the marine environment especially the open ocean have fared particularly badly. Of the 346 seabird species, 97 (28%) are globally threatened, 17 (5%) in the highest category of Critically Endangered, and a further 10% are Near Threatened (Figure 1). Nearly half (47%; 52% of those with known trends) of seabird species are known or suspected to be experiencing population declines (Figure 2).

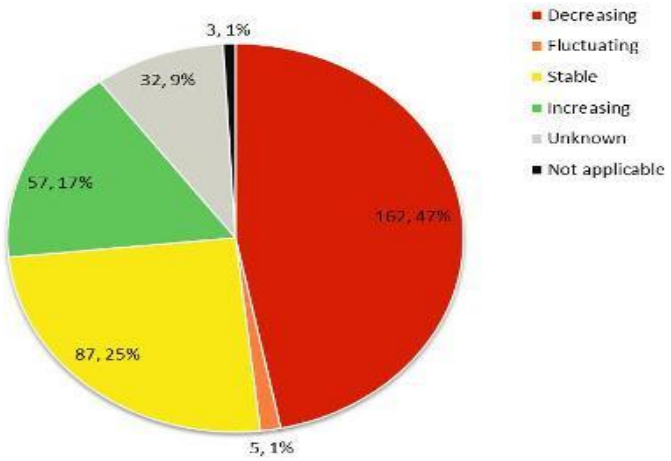


Figure-2. Current direction of trend for all seabird species **(State Of World's Birds 2010)**

Seabirds are thus more threatened than all other groups of birds with similar numbers of species: 26% of parrots (Psittacidae; 374 species), 19% of pigeons/doves (Columbidae; 318 species), and 18% of raptors (Accipitridae; 238 species) are threatened. The most threatened seabirds groups are the Sphenisciformes (penguins) and Procellariiformes (albatrosses and petrels). The albatross family (Diomedeidae) is especially imperiled—for long-lived, slow-breeding species, even quite small increases in mortality can lead to significant population declines (figure 3).

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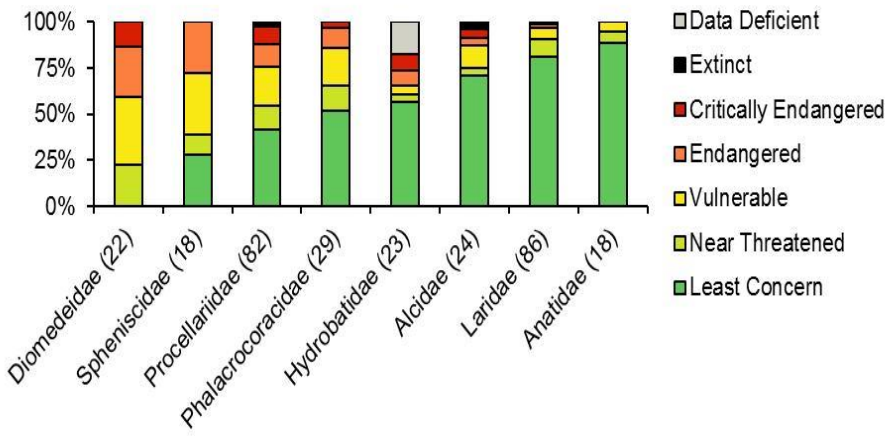
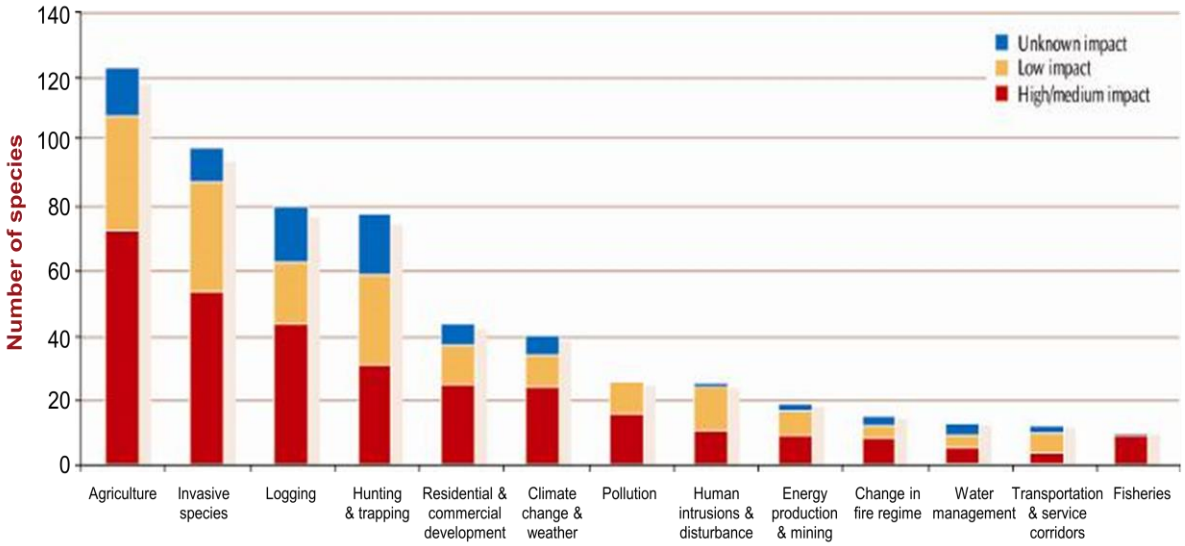


Figure - 3. Percentage of species in each IUCN Red List category for the major seabird families. Number of species per family in brackets **(State Of World's Birds 2010).**



Threats

Habitat loss and degradation driven by infrastructure development, water regulation, agricultural intensification and human disturbance are among the most frequent threats to key wetland and their seabird populations.

The major threats contributing to bird extinctions (Rory Mccann)

- Human actions are putting pressure on bird species, sites and habitats - Both inland & coastal wetlands often act as a magnet for human visitors because they are scenically attractive & they provide opportunities for many recreational activities. Sustainably manage tourism generates essential revenues for local communities & thus often makes a substantial contribution to the maintenance of wetlands. However, poorly manage tourism can cause severe over use of water resource, pollution & habitats loss through construction tourism facilities & infrastructure. Tourism developments & wetlands loss is a particular high threat to shore birds.
- Invasive alien species, including disease, are spreading - The introduction of non- native species is common cause of imbalance in ecosystem which can lead to population declines & even cause extinction. Interactions between a non- native species & its new environment are often complex & unexpected & are usually detrimental.
- Fish species often introduced for sport & as as essential source of food & the impact can be catastrophic for e.g. The Alaotra Grebe in Madagascar was declared extinct in 2010, an important cause of which was identified as competition with species of introduced carnivorous fish.
- Land claim – On going & recent costal reclamation as well as constructions that formerly brought slit to sustain & replenish the intertidal habitats, are resulting in major habitat loss in many regions of country.
- Water Regulation & Agriculture Intensification- Beside stimulating & land reclamation, agriculture intensification is also responsible for degradation of wetland habitats through increase abstraction of water for irrigation, & through polluting wetland with nutrients, leading to eutrophication & deposition of toxic chemicals. Agriculture intensification is driven not only by human population growth but also by increasing demand for industrial crops, including bio- fuel. Loss of wetlands due to this is significant contributor to the drastic decline in shore bird numbers in large part of country.

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- Overexploitation threatens many bird species
- Commercial fisheries seriously threaten seabirds
- Human-induced climate change may pose the greatest challenge - Water birds are expected to be particularly affected by climate change, which is predicated to be the cause of habitats change including loss of open tundra through forest enchroachment, loss of tidal flats to sea level rise & loss of other wetlands due to melting of glaciers, changing rain fall patterns & increased evaporation due to higher temperature.
- The build-up of toxins and pollutants in seabirds is also a concern - Seabirds, being apex predators, suffered from the ravages of DDT until it was banned; among other effects, DDT was implicated in embryo development problems and the skewed sex ratio of Western Gulls. Oil spills are also a threat to seabird species, as both a toxin and because the feathers of the birds become saturated by the oil, causing them to lose their waterproofing. Oil pollution threatens species with restricted ranges or already depressed populations (Threatened birds of Asia – The Birdlife International Red Data Book).

Conservation

Water birds provide many benefits to people the spectacular conclusion in which some species occur, the amazing journey they undertake & the way these change with the seasons, have all evoked human fascination & wonder through the ages. The spiritual value of water birds in many many cultural traditions is also high, with for example cranes being consider scared in many parts of country & Mandarin Ducks & wild Geese being considered symbol of fidelity & loyalty.

In many parts of country, water birds represent one of the most accessible sources of proteins. Shore birds represent recreational services for sport hunting & bird watching, both multi-billion dollars industry. Because of the wealth of knowledge about water birds & their relationship with the environment, they are also substantial education resource shore birds, especially the migratory species, are essentially shared resources connecting habitats & people situated thousands of kilometers apart. Destruction or deterioration of water birds habitats or over exploitation or persecution of migratory water birds population in one part can strongly influence water birds numbers elsewhere along it. Such activities may deprive people thousands of kilometers away of the aesthetic, consumptive, recreational & educational values provided by these birds. Similarly, investments in to conservation management of population at some critical sites may have a multiplying effect elsewere.

Threfore, the conservation of migratory water birds can also be effective if the share responsibility for maintaining water bird population in a favorable conservation status through implementation of actions to manage the species & there habitats at local, national & global level.

Recommendation

- Identify all key sites for seabird populations, provide adequate protection to their habitats and biodiversity and ensure their sustainable use in co-operation with local communities & other stakeholders.
- Halt & reverse the loss of wetlands & other key habitats outside protected areas in collaboration with governments, local communities & other user groups including hunters & industry groups.
- Co-ordinate management of shorebird hunting to eliminate the risk of over harvesting populations.
- Improve the frequency, consistency & quality of monitoring waterbird populations, so as a critical under pinning of the planning & implementation of their wise use & conservation as a contribution to the shorebird index
- Protecting the 10,000 Important Bird Areas identified to date would make an enormous contribution towards maintaining not just birds but much other biodiversity. While formal protection often remains the preferred option, there are many other, often innovative, approaches that can also be highly effective. These include ensuring effective application of safeguard policies and environmental assessments for development projects. In all cases, maximizing the involvement of local communities and stakeholders, and a commitment to long-term engagement, are keys to success (Brooke *et al.).*

REFERENCES

- Ali.S. 2002 The Book of INDIAN BIRDS
- Ali.S. & Futehally.L. About INDIAN BIRDS
- Rory MccannBirdLife International (2004) State of the world's birds 2004: indicators for our changing world. Cambridge, UK
- BirdLife International (BLI) (2008). IUCN Red List of Threatened Species
- Brooke *et al.* (2008) Conservation Biology
- Gooders.J. 2004 BIRDS A PRACTICAL GUIDE. A fascinating exploration of ornithology, revealing the diverse world of birds.
- NJ Collar, AV Andreev, S Chan, MJ Crosby, S Subramanya and JA Tobias Threatened birds of Asia – The Birdlife International Red Data Book
- Schreiber, Elizabeth A. & Burger, Joanne.(2001.) *Biology of Marine Birds*, Boca Raton: CRC Press
- Taej Mundkur Status of waterbirds in Asia – Results of the Asian Waterbird Census : 1987- 2007
- Zuo David et al Status of waterbirds in Asia-Results of the Asian waterbirds census – 1987-2007 Natural History Book service

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A REVIEW OF HYDROZOA FROM MAHARASHTRA

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Abstract
An effort is made to review class Hydrozoa from coastal Maharashtra. Total 78 species from 32 families and 50 genera were recorded along Maharashtra coast historically. Though India has few previous records for hydrozoa; the studies remained confined to mostly south east coast of India. The paper presents the review of hydrozoan studies from Maharashtra coast over last few decades.

Keywords: Hydromedusae, benthic hydrozoans, coastal waters, estuaries, planktonic form, fouling fauna, Maharashtra

Introduction

Maharashtra has around 720 km of coastal area with 5 coastal districts. The Arabian Sea is adjoining to the state and is a rich source to study hydrozoans. Though Maharashtra have much diverse habitats for hydrozoans such as creeks, bays, rocky beaches and coral reefs; Hydrozoa from Maharashtra were studied and recorded by barely few scientists. The brief history of hydrozoan research from Maharashtra is given as below.

Brief Account

Lele and Gae (1935) was the first to record hydromedusae from Bombay harbour with six new records. Bal and Pradhan (1952) reported same species which were previously recorded by Lele and Gae in 1935. Thomas and Chhapger (1975, 1977) recorded new species to Maharashtra and for India as well. They added a new species to science *Aglauropsis vannuccii* in 1975. Santhakumari (1996, 1997) and Tiwari and Nair (2002) gave important contribution in studying hydromedusae from Arabian Sea, estuaries and coastal waters of Mumbai coast. Rengarajan (1975) reported siphonophorans for the first time from this state. All the species reported were medusa form of hydrozoans and were collected from deep sea and from estuarine zones of Maharashtra. Intertidal or benthic hydroid species were less studied than planktonic hydrozoans. Venugopalan and Wagh (1986, 1990) were first to report hydroids as fouling fauna from offshore waters of Bombay. Sawant *et. al.* (2010) reported only 4 species of hydroid from Mumbai harbor as fouling fauna; of which one species is taxonomically incorrect.

Class Hydrozoa is distributed among two subclasses namely Hydroidolina, Trachylinae and seven different orders such as Actinulidae, Narcomedusae, Trachymedusae, Anthothecata, Leptothecata, Limnomedusae and Siphonophorae. Order Actinulidae is still not recorded from the region. Among these, Leptothecata have highest number of species reported following Anthothecata. Least recorded groups are Limnomedusae and Narcomedusae (Figure 1).

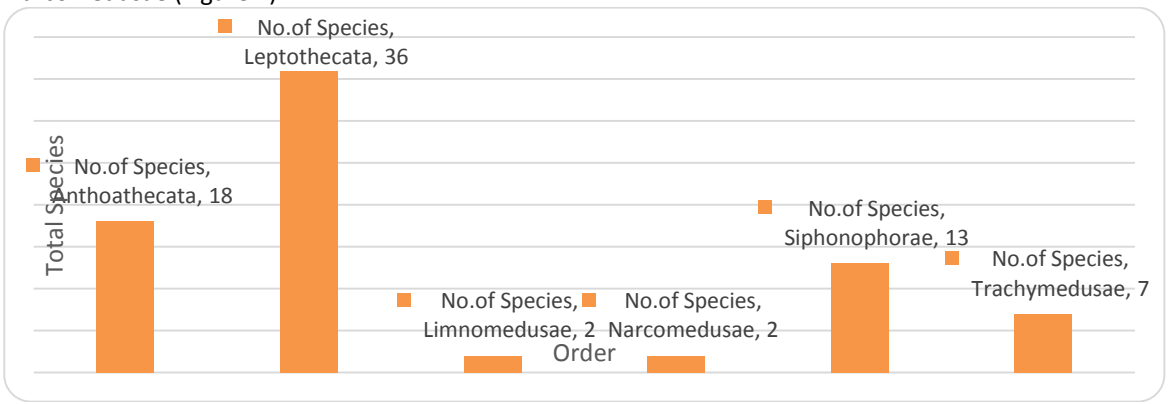

Figure 5: Total no. of species from different orders.

Overall 50 genera have been recorded throughout the region. Only 12 genera have more than one species (Figure 2) and 38 genera have single species recorded. The most commonly found species over all the districts are *Aglaura hemistoma*, *Diphyes chamissonis* and *Solmundella bitentaculata*. Thomas and Chhapgar (1975) recorded one new species to science from India *Aglaoropsis vannuccii* which is collected from Bombay harbour. The authors also reported four new records in 1977 for Indian waters such as *Aequorea australis*, *Podocoryne ocellata* (now *Hydractinia ocellata*), *Eutonina indicans* and *Phialidium malayense*. Venugopalan and Wagh (1986) recorded four new species of hydroids to the Indian Ocean namely *Obelia dichotoma, Cuspidella humilis,*

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Sertularia inflata and Aglaophenia pluma, whereas six species as range extension to Maharashtra such as *Obelia bidentata, Dynamena crisioides, Sertularia turbinata, Clytia gracilis, Diphasia digitalis* and *Halopteris diaphana.*

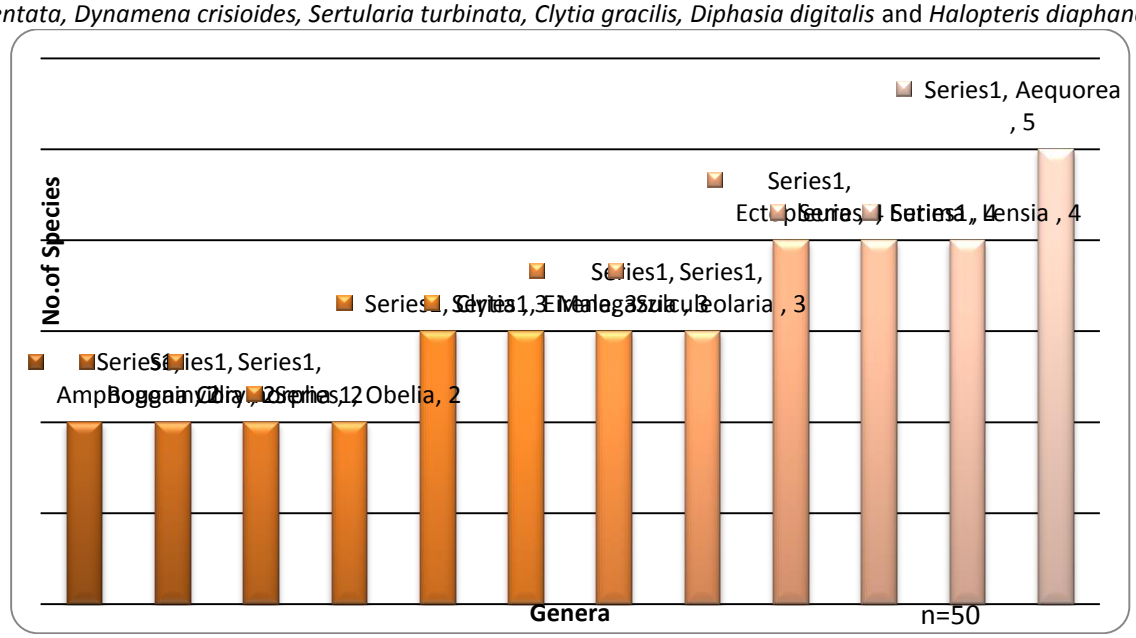

Figure 6: Total species from Maharashtra.

Out of five coastal districts only four have records for hydromedusae (Figure 3). Mumbai have 30 records out of 78 species recorded species which contains 9 hydroids while others are medusae. Thane district have 36 species with highest record for species in Maharashtra. Specific records for Sindhudurga could not be found in literature but in few articles area of the district was marked as sampling point for hydromedusae (Santhakumari, 1996; Rengarajan, 1975). Ratnagiri have records of 17 hydromedusae. All the districts have diverse type of marine habitats still the records are sporadic and only Mumbai and Thane coast has been studied more intensively than other districts. Hence the records of hydromedusae are scattered over the districts. However, the records for hydroids are still restricted to Mumbai district with total 9 hydroid species.

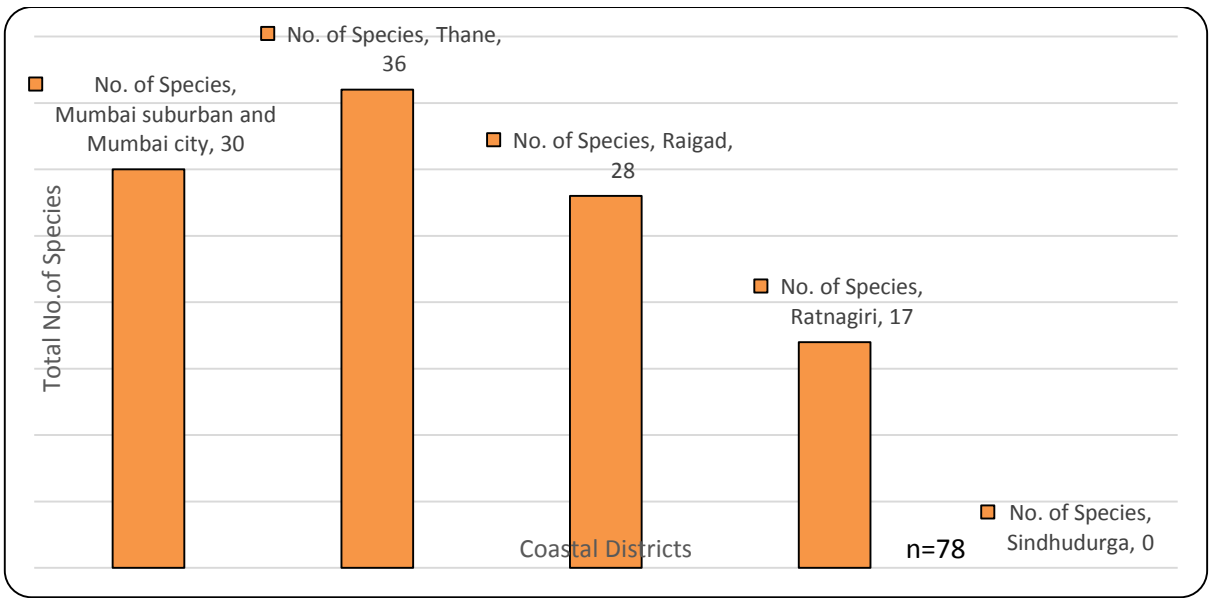

Figure 7: District wise records of species.

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Species Name	Life cycle stage	Mumbai suburban and Mumbai city	Thane	Raigad	Ratnagiri	Sindhudurga
Aequorea australis	M	*				
Aequorea conica	M	*	*	*		
Aequorea forskalea	M		*			
Aequorea pensilis	M			*		
Aequorea tenuis	M		*	*		
Agalma okeni	M	*				
Aglantha elata	M				*	
Aglaophenia pluma	H		*			
Aglaura hemistoma	M	*	*	*	*	
Aglauropsis vannuccii	M		*			
Amphinema rugosum	M			*		
Amphogona apicata	M				*	
Amphogona apsteini	M	*				
Blackfordia virginica	M		*	*		
Bougainvillia fulva	M			*		
Bougainvillia muscus	M		*			
Clytia globosa	M			*		
Clytia hemisphaerica	M		*	*		
Clytia simplex	M		*	*		
Cnidocodon leopoldi	M				*	
Corymorpha bigelowi	M	*	*	*		
Corymorpha nutans	H					
Cunina duplicata	M		*			
Cytaeis tetrastyla	M				*	
Diphyes chamissonis	M	*	*	*	*	
Ectopleura crocea	M		*			
Ectopleura dumortierii	M		*			
Ectopleura larynx	M		*			
Ectopleura sacculifera	M		*			
Eirene ceylonensis	M	*	*			
Eirene hexanemalis	M	*				
Eirene menoni	M	*				
Enneagonum hyalinum	M	*				
Eucheilota menoni	M		*	*		
Eudoxoides spiralis	M				*	
Euphysa aurata	M	*	*			
Eutima commensalis	M		*	*		
Eutima gracilis	M		*			
Eutima mira	M		*	*		
Eutima orientalis	M	*				
Eutonina indicans	M	*				
Geryonia proboscidalis	M			*		
Gossea	M		*			
Helgicirrha malayensis	M		*	*		
Hybocodon unicus	M		*	*		
Hydractinia ocellata	M	*				
Lensia cossack	M			*	*	

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Lensia fowleri	M				*	
Lensia multilobata	M				*	
Lensia subtilis	M				*	
Liriope tetraphylla	M	*	*	*	*	
Malagazzia carolinae	M	*				
Malagazzia condensum	M		*	*		
Malagazzia multitentaculatum	M		*			
Merga tergestina	M	*				
Moerisia inkermanica	M		*	*		
Muggiaea delsmani	M				*	
Obelia	M		*	*		
Obelia dichotoma	H	*	*			
Octophialucium indicum	M	*	*	*		
Pennaria disticha	H					
Phialella fragilis	M			*		
Rhopalonema velatum	M				*	
Solmundella bitentaculata	M	*	*	*	*	
Sulculeolaria monoica	M				*	
Sulculeolaria turgida	M			*		
Tiaropsidium japonicum	M		*			
Vogtia pentacantha	M				*	
Zanclea costata	M		*			
Obelia bidentata	H	*				
Clytia gracilis	H	*				
Cuspidella humilis	H	*				
Sertularia marginata	H	*				
Sertularia turbinata	H	*				
Dynamena crisioides	H	*				
Diphasia digitalis	H	*				
Halopteris diaphana	H	*				

M=Medusa, H=Hydroid

Discussion

Work on hydrozoa was not observed from past few years in Maharashtra. After 1935, collection and records of hydromedusae reduced to almost nil till 1975. Later the studies increased further, leading to total records of 78 species from Maharashtra. Still the records are meagre and inconsistent. Many creeks, estuaries and coastal waters from Maharashtra are still undivulged for hydrozoa. Lele and Gae (1935), Thomas and Chhapgar (1975, 1977), Rengarajan (1975), Santhakumari (1996, 1997) and Venugopalan and Wagh (1986, 1990) established the valuable data for hydromedusae and hydroids from Mumbai. Further work should be carried out to enhance the knowledge for hydrozoa from the region.

Most noticeable fact is that hydrozoan study remained focused to planktonic forms. More attention needs to be provided for benthic forms of hydrozoa. To study sessile benthic hydrozoans, rocky shores from Maharashtra one should unveil. Thus we have great scope to study and investigate the distribution of hydrozoans from coast of Maharashtra.

Acknowledgement

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ISBN 978-81-925489-0-6

Reference

1. Bal, D.V. and Pradhan, L.B., 1952. Records of zooplankton in Bombay waters during 1944-1947. Journal of the University of Bombay, (8.) 20B: 75-80.
2. Gaonkar, C.A., Sawant, S. S., Arga, C. A., Krishnamurthy, V and Harkantra, S.N., 2010. Changes in the occurrance of hard substratum fauna: A case study from Mumbai harbour, India. Indian Journal of Marine Sciences, 39(1): 74-84.
3. Rengarajan, K. 1975. Distribution of Siphonophores along the west coast of India and the Laccadive Sea. Journal of Marine Biological Association of India, 17(1): 56-72.
4. Lele, S.H. and Gae , P.B.,1935. Some common hydromedusae from Bombay harbor. Journal of the University of Bombay 3(5) 90-101, 3 pls., 1 text- fig.
5. Tiwari, L.R. and Nair, V.R., 2002. Plankton biodiversity of Dharamtar creek adjoining Mumbai harbour. Proceedings of National Seminar on Creeks, Estuaries and Mangroves-Pollution and conservation, 96-102.
6. Gajbhiye, S.N. and Abidi, S.A.H.,1993. Zooplankton distribution in the polluted environment around Bombay. Environmental impact on Aquatic and Terrestrial Habitat, 127-142.
7. Thoma,s J. and Chhapgar , B.H., 1975. A new medusa (Coelenterata: Hydrozoa) of the genus Aglauropsis from Bombay seas. Journal of Bombay Natural History Society. 72: 809-812.
8. Thomas, J. and Chhapgar, B.F., 1977. Hydrozoa from the coastal waters of Maharashtra. Journal of Bombay Natural History Society.74, (supp. Issue).
9. Venugopalan, V. P.and Wagh, A.B., 1986. A note on the fouling hydroids from the offshaore waters of Bombay. Mahasagar- Bulletin of National Institute of Oceanography. 19(4): 275-277.
10. Venugopalan, V. P.and Wagh, A.B., 1990. Biofouling of an offshore oil platform: Faunal composition and biomass. Indian Journal of Marine Sciences. 19:53-56.
11. Santhakumari, V., 1996. Medusae from the sea Laccadive group of islands (7^0-18^0N/69^0-76^0E). Proceedings of the Second Workshop on Scientific Results of FORV Sagar Sampada, pp 249-255.
12. Santhakumari, V., Neelam, R. and Nair, V.R., 1997. Ecology of hydromedusae from Bombay Harbour-Thana and Bassein Creek estuarine complex. Indian Journal of Marine Sciences, 26: 162-168.

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PROTECTION OF WHALES

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ABSTRACT
Several whale species are listed on the International Union for Conservation of Nature's Red List of Threatened Species as 'vulnerable', 'endangered' or 'critically endangered'. These include the sei, blue, fin, sperm, northern right whales and some sub-populations of humpback whales - notably the Oceania population that includes Eastern Australian humpback whales. Whales with a ranking of 'vulnerable', 'endangered' or 'critically endangered' indicates that the number of individuals of that species is low or it is at risk of extinction.
Whales have a very slow reproductive rate with adult females giving birth to one calf every few years. With an increasing number of threats to cetaceans, it can be difficult to determine whether whale populations are increasing or if they are remaining stable or even declining.

KEYWORDS: Vulnerable, Cetaceans, Endangered,Threatened.

INTRODUCTION

Marine mammals are major consumers of production at most trophic levels from primary production (i.e.sirenians) to predatory fish and even to other marine mammals, as in the case of killer whales Orcinus orca,some pinnipeds, and the polar bear Ursus maritimus.Because of their large body size and abundance, theyare thought to have amajorinfluence on the structureand function of some marine communities (Estes 1979, Ray1981, Laws 1984, Katona & Whitehead 1988). Thelong-standing debate surrounding ecological interactionsbetween marine mammals and fisheries is rootedin the belief that marine mammals can have significanteffects on prey populations that are of commercialinterest to humans (e.g. Gulland, 1987, Anon, 1992, Butterworth, 1992, Punt & Butterworth, 1995) and that fisheries may impact marine mammals (e.g. NRC, 1996). Some species are listed as 'data deficient' which means that insufficient is known about these species to assess the level of threat, opening the possibility that there are more species that may need protection. Recovery of whale populations from historic overexploitation has been patchy and incomplete. While some populations and species show encouraging signs of recovery, others show almost no signs of improvement despite a complete ban (e.g. 'the moratorium') on commercial whaling having been in place for almost 25 years. Since industrial whaling emerged in the 17th century, over a million whales have been killed globally. This scale of whaling has severely impacted most whale populations and significantly changed their ecological role within the broader marine environment. Whales are key species within an ecosystem, playing an important role in nutrient cycling and are often viewed as an indicator of ecosystem health. It is not yet possible to accurately determine the nature and extent of impact that climate change and other environmental impacts will have on cetacean populations in coming years. Recent reports indicate that, due to their large size and life spans reaching up to more than 80 years, whales may serve as a source of carbon storage in the oceans suggesting that not only may they be impacted by climate change, but that they may, in turn, have an impact on climate change. Protection of whales has delivered significant economic benefits, especially from non-consumptive activities such as whale-watching. Whale-watching is a growing industry and, world-wide, is estimated to have generated nearly three billion dollars in 2008, deriving profits far in excess of those obtained from hunting whales. Responsible whale-watching is the most sustainable, environmentally-friendly and economically-beneficial use of whales in the 21st century - demonstrating that whales are worth much more alive than dead.

Killilng of whales.

- There were 493,242 deaths registered in England and Wales in 2010, a rise of 0.4 per cent compared There with 2009
- The 2010 age-standardised mortality rates for both males and females were the lowest ever recorded in England and Wales
- The 2010 infant mortality rate is the lowest ever recorded in England and Wales (4.3 deaths per 1,000 live births)

Today there are estimated to be less than 3500 Blue Whales worldwide. That is not much more than 10% of the number of Blue Whales that were **killed in a single year** in 1931, when 29,650 Blue Whales were slaughtered back in the bad old days of commercial whaling.
In 1966 the Blue Whale was finally given protected status internationally which afforded a welcome start on a very long road to recovery. However, to give some perspective to the destruction that has already and 1969 of whaling kills (see chart below). During this period over 2 million whales were slaughtered. been wrought to these magnificent creatures.

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Statistics of Whaling Kills by species between 1910 and 1969. (Compiled from detailed yearly whaling statistics from http://luna.pos.to/whale/sta.html)							
	Blue	**Fin**	**Humpback**	**Sei**	**Sperm**	**Others**	**Total For Period**
1910 - 1919	26819	42410	52113	7160	6112	37246	171860
1920 - 1929	69330	78473	16320	13628	11881	10226	199858
1930 - 1939	170855	141988	34632	7724	29031	8164	392394
1940 - 1949	46199	110860	9267	8715	54071	1969	231081
1950 - 1959	29618	263121	32618	29180	147172	1483	503192
1960 - 1969	7434	170180	12449	143313	248801	2436	584613
Total Whales Killed 1910 - 1969	**350255**	**807032**	**157399**	**209720**	**497068**	**61524**	**2082998**

Below is a Chart of the total whales killed between 1986 (when the moratorium supposedly came into force) and 2001.

YEAR	Japan	Russia	Denmark	Iceland	Norway	USA	Other	TOTALS FOR YEAR
1986	2769	3197	156	116	379	30	71	6718
1987	2762	3186	99	100	375	31	2	6555
1988	273	150	128	78	29	29	0	687
1989	241	179	87	68	17	26	0	618
1990	330	162	114	0	5	44	0	655
1991	327	169	117	0	1	46	1	661
1992	288	0	137	0	95	50	2	572
1993	330	0	129	0	226	52	2	739
1994	351	42	132	0	280	46	0	851
1995	430	85	175	0	218	57	0	965
1996	517	43	195	0	388	44	0	1187
1997	540	79	175	0	503	66	2	1365
1998	539	126	187	0	625	54	2	1533
1999	489	124	194	0	591	48	2	1448
2000	527	116	162	0	487	47	5	1344
2001	599	113	166	0	552	75	3	1508
Whale kills 1986 -87	5531	6383	255	216	754	61	73	13273
Whale Kills 1988 - 2001	5781	1388	2098	146	4017	684	19	14133
TOTALS	**11312**	**7771**	**2353**	**362**	**4771**	**745**	**92**	**27406**

Australia's whale conservation policies

Australians have long recognised the importance of whales, dolphins and porpoises to our unique marine ecosystems, and believe that it is essential to ensure the survival of these mammals. The Australian Government has made whale, dolphin and porpoise conservation a priority and is a world leader in the protection and conservation of these species both in Australia and on an international scale.

Under national environment law (the Environment Protection and Biodiversity Conservation Act 1999), all cetaceans are protected in Australian waters. Protection measures include:

• the Australian Whale Sanctuary that includes all Commonwealth waters from the three nautical mile state waters limit, out to the boundary of the Exclusive Economic Zone (i.e. out to 200 nautical miles and further in some places), and

• within the Sanctuary it is an offence to kill, injure or interfere with a cetacean with severe penalties applying to anyone convicted of such offences.

Which whales need the most protection?

Within Australian waters, the following five whale species are currently listed under national environment law as nationally threatened:

• blue whale (endangered)

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- southern right whale (endangered)
- sei whale (vulnerable)
- fin whale (vulnerable), and
- humpback whale (vulnerable).

The International Whaling Commission and whale protection

The International Whaling Commission (IWC) is the primary international body with the responsibility to conserve and manage the world's cetaceans. Australia is working with others in the IWC to develop conservation management plans as a modern, flexible, and adaptive tool for the conservation management of cetaceans as they face a wide range of established and emerging threats. The development of conservation management priorities will reflect those species, regions and threats with the most pressing need, and the greatest likelihood of success.

Through the IWC Scientific Committee and its sub-committees, a range of mechanisms are used to review the global status of cetaceans, evaluate key threats in a regional manner, and thus develop a strategic evaluation of where to target conservation management plans. Australia is supporting and encouraging other nations to develop plans for critically endangered species such as the Western Pacific gray whale.

CONCLUSION: We have much to learn about the ecological roles ofmarine mammals, but there is evidence that the abundancedistribution of marine mammals can haveimportant effects on the structure and function of someecosystems. However, despite the suggestive analysesof the ecosystem responses to large-scale changes inmanne mammal abundance, we have little understandingof the role of marine mammal predation in theopen ocean. Developing a better understanding of therole of marine mammals in marine ecosystems is one ofthe greatest challenges facing those interested in marine mammal ecology. Depleting whale can be a threat to the marine ecosystem as the depletion of the whales can lead to the disturbance of the marine eco system and food chain.

BIBLIOGRAPHY:

- Anon. (1992) Marine mammal/fishery interactions analysis of cull proposals. Report of the meeting of the Scientific Advisory Committee of the Marine Mammal Action Plan. Liege, Belgium. United Nations Environmental Program (OCA)/MM.SAC.3/1
- AUSTRALIAN GOVERNMENT, Department of the Environment, Water, Heritage & the Arts.
- Butterworth DS (1992) Will more seals result in reduced fishing quotas? S Afr J Sci 88:414-416
- Estes JA (1979) Exploitation of marine mammals: r-selection of K-strategists? J Fish Res Bd Can 36:1009-1017.
- Gulland JA (1987) Seals and fisheries: a case for predator control? Trends Ecol Evol 2:102-103
- Katona S. Whitehead H (1988) Are Cetacea ecologically important? Oceanography Mar Biol Annu Rev 26:553-568.
- Laws RM (1984) Seals. In: Laws RM (ed) Antarctic ecology.Academic Press, London, p 621-716.
- NRC (1996) The Bering Sea ecosystem. National Research Council, Washington, DC
- Punt AE. Butterworth DS (1995) The effects of future consumption by the Cape fur seal on catched and catch rates of the Cape hakes. 4. Modelling the biological interaction between Cape fur seals *Arctocephalus pusillus pusillus* and the Cape hakes *Merluccius capensis* and *M. paradoxus* S Afr J Mar Sci 16:255-285
- Ray GC (1981) The role of large organisms. In: Longhurst AR (ed) Analysis of marine ecosystems. Academic Press, London, pg 397-413
- Bowen W.D. 1997. Role of mammals in aquatic ecosystems marine Mar Ecol Prog Ser 158: 267-274, Maine Fish Division, Bedford Institute of Oceanography. Department of Fisheries and Oceans, Dartmouth, Nova Scotia.

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"JELLYFISH BLOOM"- A THREAT TO MARINE LIFE

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ABSTRACT
"Jelly fish" a group that includes Scyphmedusae, Hydromedusae, Siphonophores and Ctenophores are important zooplankton predators throughout the world's estuaries and Oceans. These beautiful creatures have come to public attention when there is a sudden bloom in aquatic environment, nevertheless, Jellyfish are generally considered to be nuisances because they interfere with human activities by stinging swimmers, clogging power plant's intakes and nets of fishermen and fish farms, competing with fish and eating fish eggs and larvae.
There is concern that environmental changes such as global warming, eutrophication and overfishing may result in increased Jellyfish population. Last year alone Nuclear power plants in Scotland, Japan ,Israel and Florida and also a desalination plant in Israel, were forced to shut down because Jellyfish were clogging the waters inlets.
Keywords- Scyphmedusae, Hydromedusae, Siphonophores, Ctenophores, Global warming, Biodiversity, Pollution, Eutrophication.

Introduction
From Europe to North America and from Australia to Japan and Hawaii, Jellyfish are becoming more numerous and widespread and they are showing up in places where they have rarely been seen before. They are sitting swimmers and forcing the closure of recreational beaches. In 2007 more than 30.000 people in Australia were treated for Jellyfish stings and twice the number treated in 2009. In recent years Jellyfish swarms have forced the closing of beaches of Waikiki in Hawaii, Australia. They are also clinging to and clogging fishing nets, causing a decrease in fishery catches. The problem is especially bad in Mediterranean Sea. In fact, some fishermen in Mediterranean are finding more Jellyfish in their nets than fish.

By the pulsed nature of their life cycles, gelatinous zooplankton come and go seasonally giving rise in even the most undistributed circumstances to summer blooms. Even holoplanktonic food is available in greater abundance. Beyond that basic life cycle - driven seasonal change in number, several other kinds of events appear to be increasing the number of Jellies present in some ecosystems. Over recent decades, men's expanding influence on the ocean has begun to cause real change and there is reason to think that in some regions, new blooms of Jellyfish are occurring in response to some of the cumulative effects of these impacts, the issue is not simple and in most cases there are few data to support our perception. Some blooms appear to be long term increase in native Jellyfish Population. A different phenomenon is demonstrated by Jellyfish whose populations regularly fluctuate, apparently with climate causing periodic blooms. Perhaps the most damaging type of Jellyfish increase in recent decades has been caused by population of new, non- indigenous species gradually building up to "bloom" levels in some region. Some Jellyfish will undoubtedly fall subject to ongoing species elimination process that already portent a vast global loss of biodiversity.

As parts of the oceans become increasingly disturbed and overfished, there is some evidence that energy that previously went into production of pelagic Cnidaria. Commercial fishing efforts continue to remove top predator fishes through the world oceans and it seems reasonable to watch increasing trends in jelly fish population, as jellyfish typically feed on the same kinds of prey as do many either adult or larval fishes. Richardson added (2004): **"Jellyfish are great opportunists and take advantage if the conditions at sea are favorable to them. They are the thermometers of the oceans because jellyfish populations are indicators of the health of our seas.**

According to a report issued by the national science foundation, the Population explosion of Jellyfish is the result of many negative factors affecting the ocean. These include overfishing of natural predators; rising sea temperature and pollution that depletes the oxygen in coastal seas. Jellyfish may be maritime survivors since they are able to thrive in damaged in environment. Over fishing of both large and small fishes has left Jellyfish with little competition for plankton and a fewer predators.

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Factors affecting the "Jelly Fish bloom"

Global Warming- The warming of the ocean water caused by global warming contributes to an increase in Jellyfish population since most Jellyfish reproduce faster in warmer water. Global warming has also reduced rainfall in temperate zones allowing the jellyfish to survive better closer to shore. Rain runoff from Land would normally cause a slight decreasing the salinity of coastal waters, creating a natural barrier that keeps Jellyfish away from coast.

Pollution and Sedimentation- Pollution and Sedimentation contributes to a reduction to oxygen levels. This hits hard to other fishes in physiological aspects but jellyfish can cope for better with this condition. Jellyfish are attracted to polluted waters around every coastal city around the world. In the coastal polluted waters the jellyfish feeds on large numbers of dead fish and are increasing in number as they have little or no predators. Combined with climate change and warmer waters it has resulted in a sudden spike in jellyfish numbers, and is causing havoc with the world's fishing industry.

If we do not stop the pollution which flows into, and gets dumped into the sea, then the jellyfish populations in our oceans worldwide will keep on growing exponentially

Eutrophication- Increase in Jellyfish in some other cases has been the result of eutrophication in local environments. Eutrophication is the ecosystem response to the addition of artificial or natural substances such as nitrates and phosphates through fertilizers or sewage to an aquatic bodies. It induces reduction in other specific fish and other animal population but it enhances the Jellyfish population and it negatively affects other species.

Finally there is small amount of evidence suggesting that some Jellyfish blooms may also turn out to be indicators of climate-induced regional regime shifts (Shimomura,1959; Baden et al.,1990) rather than a response to anthropogenic change.
To some extent, what we interpret as a Jellyfish bloom may reflect our expectation about an ecosystem. The life cycles of Jellyfish lead to appearance of "blooms" in nearly all cases.

There seems to be a general agreement that anthropogenic activities are having measurable effects on the oceans in many places and certainly in most coastal habitats. Jellyfish populations (Hydromedusae, Scyphomedusae and Ctenophores) respond to these changes. Local increasing in abundance of Jellyfish seems to be of two sorts. In some cases, species that have always been present suddenly experience severe increases or "**blooms**", often with little evidence of what caused the population increase. In other cases, introduction of non-indigenous species to an ecosystem can lead to their unchecked population growth. Several recent increase of medusa and ctenophore population can be attributed to such circumstances.

The following selected examples illustrate increase of native Jellyfish species and non indigenous species.

1. *Stomolophus nomurai* in the sea of Japan- Shimomura (1959) described a very large bloom of very large rhizostome medusa,*Stomolophus nomurai* in the sea of Japan in 1958. This species seems to be tolerant of a wide temperature range, occurring that year in temperature from 12-28 degerr Celsius and the bloom extended from the Sea of Japan even to waterloo Hakkaido. Fishermen are reported to have caught 20,000-30,000 *S. nomurai* medusae per day in October and November in 1958. Another very large and predicted bloom of *S. nomurai* occurred in the sea of Japan in 1995.

2. *Pelagia noctiluca* in the Mediterranean- *P.noctiluca* blooms in the Mediterranean have especially noteworthy because the medusa sting and the summer blooms are considered highly offensive to summer bathers. A several year bloom in the early 1980 stimulated two "Jelly fish Blooms" meetings in Athens in 1983 and 1991. High temperature and high atmospheric pressure appear to correlate well with *P.noctiluca* blooms. These factors occur during the reproductive period for this species and are likely influencing it.

3. ***Chrysaora,Cyanea* and *Aequorea* population in Bering sea**- Scientists working on Alaskan fisheries for the U.S national oceanic and atmospheric administration (NOAA) realized that there is an unprecedented biomass, especially of large jellyfish in Bering Sea. Biomass, especially of the Scyphomedusae *Chrysaora melanoster* and Hydromedusae *Aequorea aequorea*, has been estimated in NOAA's eastern shelf trawl samples.

4. Siphonophores *Muggiaea* in the German Bight and Apolemia off the coast of Norway- Greeve(1994) described a seemingly unprecedented invasion of the small calycophoran siphonophore *Muggiaea atlantica* into the German Bight, North Sea. Pecuilar winds or ocean currents are certainly capable of causing the appearance of local Jellyfish blooms by adding unusual species into new areas.

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5. Chrysaora and Aequorea population in the Benguela current,Southern Africa and Namibia- Similar increase in population of *Chrysaora hysoscella* and *Aequorea* medusa are implied to have taken place in the Benguela current off the West coast of southern Africa during the 1970s. High number seen in the 1970s have persisted through the 1980s and late 1990s off Namibia where both species are still abundantly present to the point of negatively impacting the fishing indirectly.

Jellyfish eat the tiny plankton at the base of the ocean food chain. Only few animals are able to eat such massive amounts of jellyfish, this may mean a dead-end for food going up the food chain.

What the new research found is that jellyfish release organic matter that dissolves in seawater. In other words, jellyfish "sweat" large amounts of carbon to the water surrounding them. This dissolved carbon is then used by a rare type of marine bacteria that turns it into carbon dioxide. So jellyfish add carbon dioxide to seawater – eventually turning the ocean more acidic.

There are Some Initiatives Taken by the People to Maintain the Balance of Aquatic Species and to Overview the Population Density of Jellyfish

Bioregional Management: Bioregional management is a total ecosystem strategy, which regulates factors affecting aquatic biodiversity by balancing conservation, economic, and social needs within an area. This consists of both small-scale biosphere reserves and larger reserves. Biosphere reserves, generally small in scale, have a strong conservation focus, and consist of one or more protected central habitats and surrounding buffer zones. In these bio conservation units, activities such as fishing, hunting, harvesting, and development activities are strictly limited.

Specialized Programs: Many specialized programs have been instituted to protect biodiversity. The goal of this program is to restore the balance and health of the associated species.

Research: Various organizations and conferences that research biodiversity and associated conservation strategies help to identify areas of future research analyze current trends in aquatic biodiversity, even conduct specialized studies.

Increase Public Awareness: Increasing public awareness is one of the most important ways to conserve aquatic biodiversity. This can be accomplished through educational programs, incentive programs, and volunteer monitoring programs.

With the help of large scale Techniques we can check and control the Jellyfish population size

1. Net Sampling- It is a common traditional method to determine the jellyfish population. It is often adequate for the small abundant Hydromedusae and Siphonophores.

2. **Other animals as Samples**- An indigenous method of determining the large scale distribution of gelatinous species has been by use of their predators as samples.

3. **Satellite and electronic tracking and acoustic sampling**- Use of predators as samplers might allow location of gelatinous organism by satellite. Various attempt have been made to tag Jellyfish with Fish tags, with limited success. Difficulty arises because the tags sink the Jellyfish and migrate out of the gelatinous tissue. Acoustic routinely are used to estimate the Jellyfish

4. Continuous plankton recorder (CPR)- It has been conducted for decades in the North sea and North Atlantic and part of the sample analysis includes counting nematocysts.

5. **Video survey**- Video recording system has been used to quantify Scyphomedusae and Ctenophores relative to environmental condition (depth, temperature, salinity, dissolved oxygen)

6. **Ocean Surface survey**-When in situ sampling is not possible, visual observation from the surface can yield data on large scale distribution of large Jellyfish.

7. Shore based survey- Some of the longest records of Jellyfish occurrence have been from shore based survey.

8. **Aerial survey**- Near surface Jellyfish aggregation and large Jellyfish can be quantified from Aerial survey.

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CONCLUSION

How big an impact will this have on the global ocean? It's difficult to know how much will jellyfish blooms trim ocean food webs or contribute to make the ocean more acidic, because we don't know how frequent and large jellyfish blooms are in the open ocean. However, we do know that jellyfish blooms are becoming more frequent in coastal waters.

What is the solution? Because the cause of the blooms is probably due to a combination of factors (such as organic pollution, climate change, and overfishing), there's no silver bullet that's going to fix the problem from one summer to the next.

REFERENCES

- Baden,S.P.,et.al(1990),Effects of eutrophication on benthic communities including fish: Swedish west coast.-Ambio 19, page no.113-122.
- Colombo G, Ferrari I, Rossi. R, and Ceccherelli, V. (1992), Marine Eutrophication and Popular dynamics 25TH Marine Biology, Olsen Publisher, page no- 360-361.
- Hill, M. (2010) Understanding environmental pollution-A primer, Cambridge university pressU.K, page no-278-279
- Karleskint.G, and Turnes. R (2010), Introduction to marine biology, Yolando Cussio publisher, page no.549
- Pickering, K. and Owen.L, (1997) An introduction to global environmental issues, Routeldge publisher, page no-362-363
- Popular Science, (April 2005) Ocean life in hot water-Global warming is taking a toll and helping Jellyfish of ocean to rule the sea, Page no-42
- Purcell J. C., Graham W. M, and Dumont H. J. (2001), Jellyfish Blooms: Ecological and Societal importance, Kluwer academic publishers, page no-55-58.
- Purcell J, Pitt K, (2008), Jellyfish Blooms: Causes, Consequances and Recent advance, Springer publisher, page no-24-27
- Razvi V. (2008), The Age of Nepotism, page no-32-33.
- Richardson, A.J (2004) Impact of climatic change on marine pelagic phenology and trophic mismatch, Nature, 430, page no-881-884
- Shimomura, T(1959) On the unprecedented flourishing of Stomolophus nomurai in the Tsushima warm current regions in autumn. Pp-85-107.
- http://www.jellywatch.org/blooms
- http://www.cosmosmagazine.com/news/4384/jellyfish-blooms-endanger-foodwebs
- http://www.wired.co.uk/news/archive/2011-01/14/jellyfish-blooms

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USE OF PREPONDERANCE INDEX AS A TOOL FOR COMPARING SPECIES DIVERSITY

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Abstract

Biodiversity assessment uses a number of statistical methods. Each of these has its own advantages and disadvantages as well as limitations. Some methods are used for simple richness studies, Some are for diversity studies while others are used for pollution-related studies. The choice of the method depends upon the purpose to which it is to be applied. The present study describes the use of the preponderance index method for the purpose of measuring species diversity. This method has been extensively used hitherto for gut content analysis, however, its use in diversity studies has not been very frequent. The present study also uses the Spearman's rank correlation method for testing significance of the preponderances in estimating diversity. Two samples from adjacent fish landing centers located on Rajpuri creek of Raigad District, Maharashtra were taken as data for testing the utility of the above-mentioned methods. The methods have also been compared to other similar methods using abundance and biomass.

Key words: Index of Preponderance, Spearman's rank correlation, biodiversity

Introduction

The assessment of biodiversity is a very important feature of ecological studies. Quantification helps in understanding the diversity profile of an area in a way so as to enable its proper management. Leveque and Mounolou (2003) have suggested that changes in the structure of an aquatic community can be used as a means of estimating the degree of environmental disturbance in the ecosystem of that community. Ecologists have been using a number of mathematical and statistical tools for this purpose and each of these methods has its own advantages and disadvantages. Among the number of tools used, there are those based on a direct enumeration of species (richness indices), those which take into account the proportion of species (diversity indices), those that require not only the proportion but also the biomass (abundance-biomass indices) and those that are based on ranking in terms of occurrence.

Materials and Methods

In the present study, diversity samples were collected from the Khamde and Bhalgaon fish landing centres located on the banks of the Rajpuri creek of Raigad district of Maharashtra. The coordinates of the sampling site are: 18° 16' 01.92" N, 73° 02' 34.78" E (Khamde) and 18° 18' 15.11" N, 73° 02' 33.19" E (Bhalgaon). Khamde is a village of the fishing community whose members venture into the neighbouring creek. The main gear used here are barrier nets. The fishing method has been described in detail by Mane and Deshmukh (2007). Fortnightly samples of fish landings of barrier net fishery were collected and identified to species level during April 2003 to March 2004. Their biomasses were measured using monopan balance while the numbers were counted.

The preponderance index technique proposed by Natarajan and Jhingran (1961) for gut content analysis was used in the current study as a tool for measuring species diversity. Further, the study also uses Spearman's rank correlation method for testing statistical significance.

Results and Discussion

For the purpose of describing the method, the data of one sample from each site have been considered. They are presented in Tables 1 and 2 and graphically represented in Figures 1 and 2. The biomass and abundance of each species along with their percentages are calculated in these tables. The preponderance of each species was then calculated based on the product of the biomass and the abundance, by the following formula:

$$I_i = \frac{B_i \times A_i}{\sum(B_i \times A_i)} \times 100$$

where,

B_i is the biomass of i^{th} species A_i is the abundance of i^{th} species.

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Table 1. Biomass, abundance and preponderances of species collected at Khamde

Rank	Species	Biomass (B) kg	%	bundance (A)	%	B x A	preponderance
1	*Arius caelatus*	307.50	22.83%	3844	3.16%	1181953	8.1
2	*Terapon jarbua*	128.25	9.52%	6413	5.28%	822403	5.7
3	*Mugil cephalus*	41.25	3.06%	589	0.48%	24308	0.2
4	*Thryssa mystax*	36.00	2.67%	900	0.74%	32400	0.2
5	*Escumosa thoracata*	94.50	7.02%	31500	25.92%	2976750	20.5
6	*Johnius dussumieri*	122.25	9.08%	1881	1.55%	229924	1.6
7	*Coilia dussumieri*	28.88	2.14%	2888	2.38%	83377	0.6
8	*Penaeus merguiensis*	257.25	19.10%	25725	21.17%	6617756	45.5
9	*Metapenaeus brevicornis*	45.00	3.34%	15000	12.34%	675000	4.6
10	*Metapenaeus monoceros*	9.00	0.67%	4500	3.70%	40500	0.3
11	*Metapenaeus moyebi*	45.75	3.40%	18300	15.06%	837225	5.8
12	*Macrobrachium rosenbergii*	47.25	3.51%	5906	4.86%	279070	1.9
13	*Scylla serrata*	183.75	13.65%	4083	3.36%	750313	5.2
	TOTAL	1346.63	100.00%	121528	100.00 %	14550979	100.0

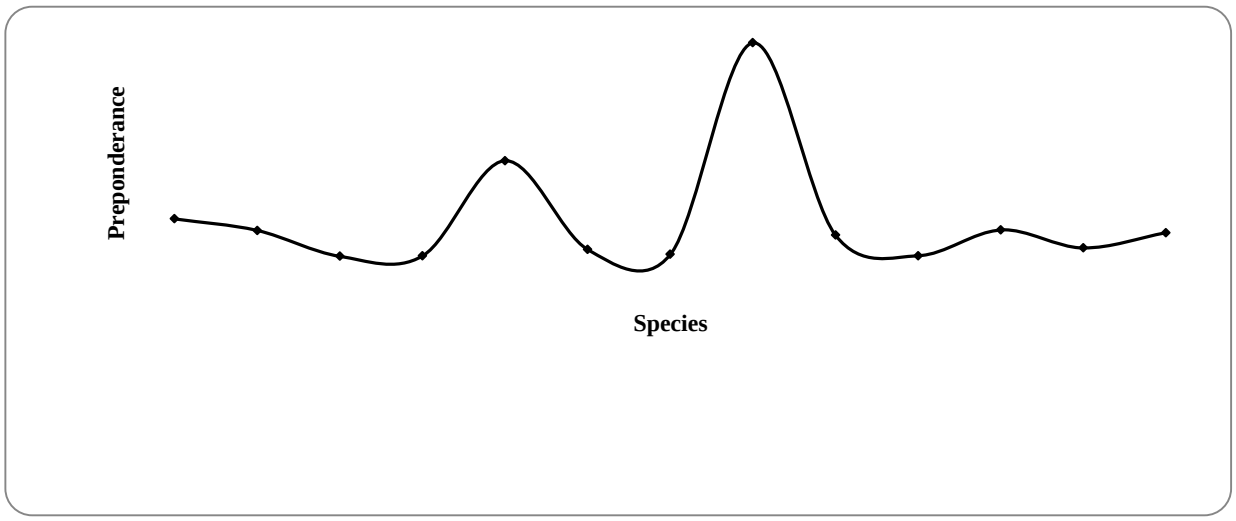

Figure 1. Preponderance indices of species at Khamde

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Table 2. Biomass, abundance and preponderances of species collected at Bhalgaon

Rank	Species	Biomass (B) kg	%	Abundance (A)	%	B x A	preponderance
1	*Arius caelatus*	44.11	4.96%	551	0.49%	24319	0.3
2	*Terapon jarbua*	119.26	13.40%	5963	5.35%	711147	9.4
3	*Mugil cephalus*	39.62	4.45%	566	0.51%	22425	0.3
4	*Thryssa mystax*	18.08	2.03%	452	0.41%	8172	0.1
5	*Escumosa thoracata*	85.26	9.58%	28421	25.51%	2423260	31.9
6	*Johnius dussumieri*	166.60	18.72%	2563	2.30%	426983	5.6
7	*Coilia dussumieri*	7.08	0.80%	708	0.64%	5013	0.1
8	*Penaeus merguiensis*	50.18	5.64%	5018	4.50%	251803	3.3
9	*Metapenaeus brevicornis*	41.54	4.67%	13847	12.43%	575218	7.6
10	*Metapenaeus monoceros*	56.47	6.34%	28233	25.34%	1594205	21.0
11	*Metapenaeus moyebi*	38.97	4.38%	15588	13.99%	607464	8.0
12	*Macrobrachium rosenbergii*	44.42	4.99%	5553	4.98%	246686	3.2
13	*Scylla serrata*	178.47	20.05%	3966	3.56%	707812	9.3
	TOTAL	890.057	100.00%	111429.35	100.00%	7604507.65	100.0

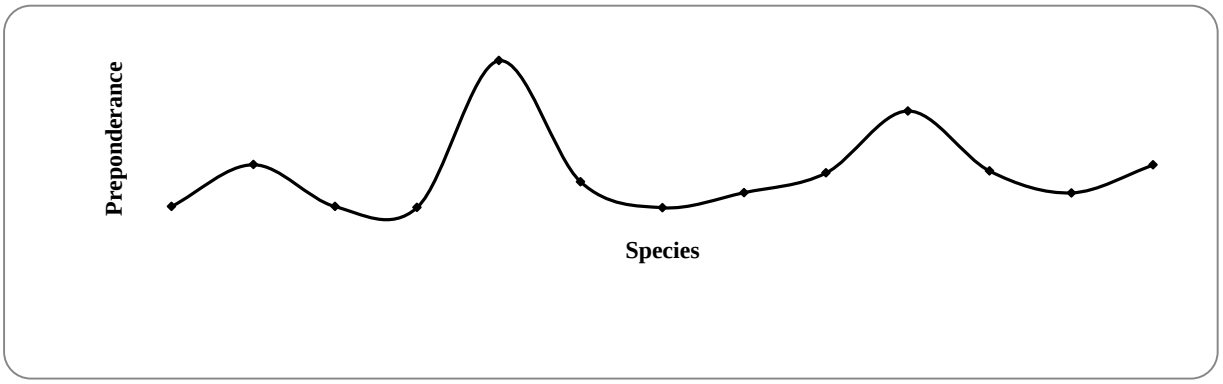

Figure 2. Preponderance indices of species at Bhalgaon

It can be seen from the Tables 1 and 2 that the sum total of the preponderances of all species in each sample is 100. Further, it is apparent from Figure 1 that at Khamde, 2 species are showing predominance, namely *Penaeus merguiensis* and *Escumosa thoracata* whereas from Figure 2 it is apparent that in Bhalgaon, the predominant species were *Metapenaeus monoceros* and *Escumosa thoracata*.

It is also observed that there are subtle differences in the preponderances of the rest of the species. In order to account for these subtle differences, the data were subjected to Spearman's rank coefficient method. In this method, the species preponderances were first ranked in descending order for the Khamde sample. Then, arranging the Khamde sample alongside the Bhalgaon sample, the preponderances of species from the Bhalgaon site were also ranked in a descending order. The difference *d* between the two sets of ranks was calculated for each species. '*d* 'was then squared to get absolute values. Spearman's rank was then calculated using the following formula:

$$\text{Spearman's rank coefficient} = 1 - \frac{6\Sigma d^2}{[n(n^2-1]}$$

where, d^2 is the square of the difference in ranks of each species in the two samples, and
n is the total number of species present in each sample

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Table 3. Calculation table of Spearman's rank correlation

Species	Khamde preponderance	Species rank	Bhalgaon preponderance	Species rank	difference *d*	d^2
Escumosa thoracata	20.5	2	31.9	1	1	1.0
Metapenaeus monoceros	0.3	11	21.0	2	9	81.0
Terapon jarbua	5.7	5	9.4	3	2	4.0
Scylla serrata	5.2	6	9.3	4	2	4.0
Metapenaeus moyebi	5.8	4	8.0	5	-1	1.0
Metapenaeus brevicornis	4.6	7	7.6	6	1	1.0
Johnius dussumieri	1.6	9	5.6	7	2	4.0
Penaeus merguiensis	45.5	1	3.3	8	-7	49.0
Macrobrachium rosenbergii	1.9	8	3.2	9	-1	1.0
Arius caelatus	8.1	3	0.3	10.5	-8	56.3
Mugil cephalus	0.2	13	0.3	10.5	3	6.3
Thryssa mystax	0.2	12	0.1	12.5	-1	0.3
Coilia dussumieri	0.6	10	0.1	12.5	-3	6.3
n= 13					Σd^2	215.0

$$\text{Spearman's rank coefficient} = 1 - \frac{6\Sigma d^2}{[n(n^2-1]} = 0.4$$

The Spearman's rank co-efficient ($p_{(0.05),\ 13}$ = 0.4) indicates that although the species composition in the two sites is exactly similar, the species are significantly different (p<0.05) in terms of their preponderances. Thus, it can be said that in any two given locations even if the species occurrence is similar, there might exist differences in the diversity based on the preponderances of those species. In other words, although the graphical representation shows a similarity in species occurrence, statistically there might be differences in species diversity.

Conclusion

In other methods using abundance as well as biomass, such as the Abundance-Biomass Comparison (ABC) method proposed by Warwick (1986), species were ranked individually based on biomass and abundance irrespective of the species name. When ABC curves were plotted, the species appear in the curves in the form of ranks rather than names. Whereas, in the method used in the current study, although ranking was done similarly in terms of dominance, the actual names of the species appear in the graphs rather than their ranks. Thus, it was easier to recognize the dominating species.

However, the above-mentioned deficiency in the ABC method was not its shortcoming because this method was used for a totally different purpose in pollution-related studies where the objective was to find out the difference between the distribution of the numbers of individuals among species and the distribution of biomass among species (Meire and Dereu, 1990). In the preponderance index method, the objective was to combine the biomass and the abundance into a single entity, which was the preponderance. Further, it was also possible to test the significance of the results by applying the Spearman's rank coefficient method to the preponderances. Thus, the Index of Preponderance along with the Spearman's rank coefficient method becomes an effective and simple tool in assessment of diversity,

References

- Leveque, C. and Mounolou, J – C. (2003). Biodiversity Published by: John Wiley and Sons Ltd., Sussex, UK.
- Mane, Sushant and Deshmukh, V. D. (2007). Biology of Metapenaeus moyebi (Kishinouye, 1896) and barrier net fishery in Maharashtra waters. J. Mar. Biol. Ass, India, 49 (2): 206 – 212.
- Meire, P. and Dereu, J. (1990). Use of Abundance Biomass Comparison method for detecting environmental stress: some considerations based on intertidal macrozoobenthos and bird communities Journal of Applied Ecology, 27, Laboratorium voor Ecologie der Dieren, Zcogeografie en Natuurbehoud, Gent, Belgium. pp 210 – 223.
- Natarajan, A. V. and Jhingran, A. G. (1961) Index of Preponderance – a method of grading the food elements in the stomach analysis of fishes. Ind. J. Fish. 8(1): 54-49.

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HYDROLOGY AND SEDIMENT STUDIES OF COASTAL AREA IN AND AROUND VASAI.

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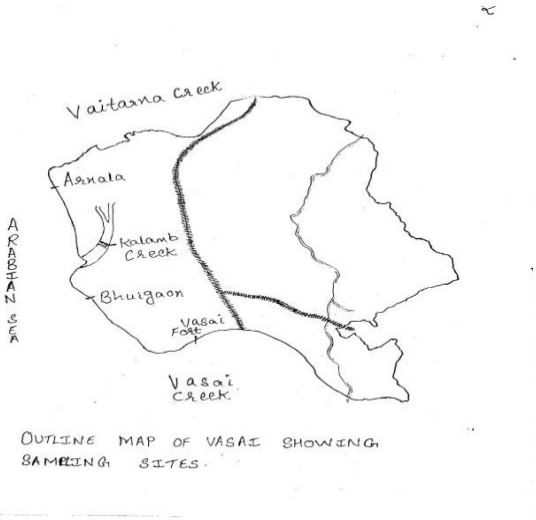
Abstract
Hydrological and sediment studies are indicators of biodiversity. Vasai coastline is situated on the west coast of Indian peninsula on the Arabian sea. For the present studies four sites were selected covering entire Vasai coastline. The areas selected were, Arnala coast on the north side, Vasai fort creek (Killa bunder), on the south, and an area in between Bhuigaon coast (Ran beach) and Kalamb creek. Surface water sampling was done monthly during spring high and spring low tides. Parameters like temperature, pH, CO2, DO, BOD, COD. Nutrients like silicates, phosphates, nitrates, nitrites and salinity, conductivity of water and soil parameters like temperature, pH, conductivity, organic content, moisture content were analysed using standard methods. As direct sewage disposal and heavy industrial effluents are low on the Vasai coastline, physico-chemical characteristic of water and sediments are suitable for the survival and growth of biodiversity. Urbanization is in full swing, which may change the environmental status to a polluted one in the coming few years. Destruction of mangroves (to construct resorts) will slowly destroy the feeding and breeding grounds of many marine and riverine organisms, in turn affecting the already declining fishery catch. The development and planning of this nature gifted heritage rich area should be sensitive towards the environmental aspects. An awareness has to be created regarding the future problems. This will help the implementation of mitigation measures to save the rich biodiversity.
Key words: water, sediment, analysis, coastal area, Vasai, biodiversity, destruction, awareness.

Introduction

The above project was undertaken to study physico-chemical characteristiscs of water and sediment in order to assess its present status of pollution and focus on quality of coastal environment of Vasai. Hydrological and sediment studies are an indicator of biodiversity.Water quality determines the distribution and abundance of resident and visiting flora and fauna of coastal area. The results would provide plans for remedial work, so that the existing biodiversity can be saved.

Vasai coastline is situated on the west coast of Indian peninsula on the Arabian sea. This region is separated from greater Mumbai and Mira-Bhayander by the Vasai creek. For the present studies four sites were selected covering entire Vasai coastline.On the north side Arnala coast, on the south Vasai fort creek (Killa bunder) and in between Bhuigaon coast(Ran beach) and Kalamb creek.

Arnala coast- It is a vast sandy beach on one side, highly influenced by domestic and fishing activities. The other side is covered with casurina plantation a picnic spot along the ruins of Arnala fort. To the northen edge of the coast is vaitarna creek.



OUTLINE MAP OF VASAI SHOWING SAMPLING SITES.

Bhuigaon coast- A vast stretch of sandy and rocky shore.Very rich in biodiversity as it is almost undisturbed away from residential area. Popular for oyster beds, scanty corals and sponges, variety of mollusk, brittlestar, eels, sea anemones, etc. Solid wastes include cremation ashes and agricultural wash-off.

Kalambcreek- From the north of bhuigaon coast starts the creek heavily bounded on both the sides by thick mangroves.It takes a turn passes through the main road of kalamb gaon and terminates at Wagholi(nirmalgaon).Rich biodiversy like crabs, mudskippers and telescopium.Also supporting a good fishery.receives open sewage waste from locals.

Vasai creek-Fort region (Killa bunder)- Situated just behind the ruins of the histrorical monument Vasai fort bounded on both sides by mangroves.This creek which starts from Arabian sea of pachu bunder travels towards the east passing through the bhayander railway bridge and meets Thane creek and Ulhas river.Since the fort region comes under restricted area this region also shows rich biodiversity of uca crabs, mudskippers, mollusks etc.

Methodology

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After a brief survey of the vasai coastal area four sites were selected.Two open sea and two creeks. Study was conducted for a period of six months.

Surface water sampling was done monthly during spring high and spring low tides.During high tide sampling was done about 15m away from the high tide mart at a depth of 1.25m. During low tide sampling was done 5m away from low tide mark at a depth of 1.25m. Parameters like temperature, pH, CO2, were immediately measured on the site; samples were fixed for DO and BOD and then brought to the laboratory for analysis. Hydrological and sediment samples were analysed for different parameters using standard methods. (APHA, AWWA, WPCF 1981, Trivedi and Goel, 1984).

The surface sediments were collected during low tide from three levels of the shore low, mid, and high water level marks using a metal scoop. Random sampling was done at each level and mixed to treat as one sample. Samples were oven dried at 70˚ C. Organic content was analysed by walkley and black method.

Results and discussions

Water temperature: It ranged from 24˚ C to 31˚ C at Arnala, 21.5˚ C to 31.7˚ C at Bhuigaon 25.3˚ C to 31.8˚ C at Fort and 20˚ C to 32˚ C at Kalamb creek. The creeks are slightly warmer as compared to open sea in summer probably due to their shallow nature and less water mass. Peak values were recorded in summer as in the case of Thane creek. (Quadros et al. 2001) soil temperature coincides with water temperatures within the small range of 2˚ C.

pH: ranged between 7.9 to 8.2 at Arnala, 7.65 to 8.25 at Bhuigaon, 7.45 to 8.2 at Fort and 7.3 to 8.2 at Kalamb creek the soils are alkaline and favourable to the lives of many organisms. This is probably due to saline water inflow in the shore soil.

Dissolved Oxygen : The values ranged between 6.6 to 9.9 mg/L at Arnala, 7 to 9.9 mg/L at Bhuigaon, 6.6 to 9.6 mg/L at Fort and 6.2 to 9.6 mg/L at Kalamb. The sewage disposal is confined to septic tanks in Vasai hence influx of sewage and industrial waste is probably less. DO shows a gradual decline as the temperature increases in all the regions as expected (Jaiswar 1999) Bhuigaon shows high level of DO probably due to absence of anthropogenic activities

BOD & COD:

BOD fluctuated between 4.2 to 8.7 mg/L at Arnala, 4.1 to 8.5 mg/L at Bhuigaon, 4.2 to 8.5 mg/L at Fort and 3.3 to 8.5 mg/L at Kalamb creek. In winter the lack of water circulation due to thermal stratification may be one of the reasons for slightly high BOD values. COD values are lower in the open sea as compared to creeks which may be ascribed to influx of industrial inorganic waste.

Nutrients: Silicate values ranged between 12 to 30 µg/L, Phosphates between 20 to 50 µg atoms/L which are higher in the summer probably because of upwelling and effect of currents. Nitrates vary between 130 to 300 µg atoms /L, with higest values at Kalamb creek. While Nitrites vary from 150 to 400 µg/L with highest value at Fort creek.

Salinity: Kalamb being a creek water shows maximum salinity at 43 ppt, especially in the summer months. There is no influx of fresh water and the width is narrow which may explain it. In others areas such as Fort they are exposed to more sea water due to large expense and hence the values are slightly lower. Ther is a proportional corelation between salinity and conductivity which varies between 35 to 45 mS/cm.

Soil Parameters: Creek soils show higher conductivity as compared to the shores soils of open area. This may be due to close proximity to highly saline waters. The organic content of Arnala and Bhuigaon show low levels as compared to fort and Kalamb creek. This is due to the nature of soil in open shores and creek. Also Kalamb creek shows higher values about 3.17 gm% as it receives sewage and domestic wash off during high tide from the mangrove grounds. Bhuigaon open shore levels are higher to Arnala as Bhuigaon receives cremation ashes and agricultural wash off. Moisture content is high in the creek soil due to clay depositions in comparision to sandy shores. The capillary water capacity is between 10 to 20 g% which ensures life of burrowing worms and other benthos.

Conclusions

From the above results it can be concluded that as direct sewage disposal and heavy industrial effluents are low on the Vasai coastline, physico-chemical characteristic of water and sediments are suitable for the survival and growth of bio-diversity. But with the increase in population and transport facilities human interference has increased on the coastline. Urbanization is in full swing, hence it is not wrong to predict that in the coming few years, the unpolluted environmental status will be changed to a polluted one.

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Studies done on Mumbai coastline (Jaiswar, 1999) and at Gorai beach (Reza, 2001) focus on the deteriorating marine habitats of this area. Studies done at Thane creek, which is connected to Vasai creek, show high levels of pollution and degradation of mangroves. (Quadros *et al.,* 2001; Athalye and Quadros , 2002).

During the survey it was found that mangroves near Kalamb creek have been destroyed for reclamation. In the very midst of the creek and mangrove swamps is constructed a resort named Andaman. Such activities will slowly destroy the feeding and breeding grounds of many marine and riverine organisms in turn affecting the already declining fishery catch. Also the City and Industrial development Corporation (CIDCO) plans to discharge sewage into the creeks after treatment in sewage plants, as septic tanks (that are common in Vasai gaonthan) may be harmful to health in the near future. Tourism will be promoted at suitable locations like Pachubunder, Arnala, Vaitrana etc. (Draft development plan of Vasai-Virar sub region report, 1995)

The development and planning of this nature gifted heritage rich area should be sensitive towards the environmental aspects. An awareness has to be created regarding the future problems for the common public and the authorities. Non government organization like “Harit Vasai Sangarsh Samiti has played a better role towards awareness and conservation. In order to save the existing environmental status and rich bio- diversity it is necessary to implement mitigation measures on war footing.

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Reference

- Trivedi R.K.and Goel Pk (1984).Chemical and biological methods for water pollution studies. Enviromental Publication P 35-96.
- APHA – AWWA – WPCF (1989) 17th edition standard methods: for examination of water and waste water. American Public health association and water pollution control federation.
- Patil SM and Hande RS (2002). Assessment of water quality and aspects of pollution in Patelganga Creek and Arabian sea aof Raigad district of Maharashtra. Proceedings of national seminar on creeks. estuaries, mangroves – pollution and conversation, Nov – 2002. Thane.
- Ramesh R. and Anbu m. (1996). Chemical methods of environmental analysis (water and sediment) macmillan press,Madras.
- Zingde M.D. and Govidan K. (1997). Health status of the coastal water of Mumbai and regions around, proceedings of seminar on coastal series in India. Responding to environmental and socioeconomical issues concerned. July 16th 1997, organized by Indira Gandhi Institute of development research, Mumbai – 65, India.
- Goldin Quadros 1995. Study of hydrological parameters of Thane creek M.Sc. Thesis University of Mumbai 204 pp.
- Quadros Goldin, Vidya Mishra, Vidya Ullal, K. S. Gokhale and R.P. Athalye . 2001 status of water quality of Thane creek (India) Ecology, Environment and conservation. 7 (3): 17-22.
- Draft development plan of Vasai-Virar sub region report, 1995.
- Walkey A.,1947 .A Critical examination of a rapid method for determining organic carbon in soil. Soil Science, 63; 251 – 263PP.
- Swami, B.S. Suryawanshi, V.G. and Karande, A.A., 2000. Water quality status of Mumbai harbor – an update, Indian journal marine sciences 29: 111 – 115.

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MYCORRHIZAL BIODIVERSITY IN THE COASTAL AREA OF MUMBAI REGION AND ITS USE AS A BIO-FERTILIZER

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ABSTRACT
Mumbai has an expansive coastline, generally sandy and rocky. Soil cover in the suburbs is largely alluvial and loamy. A survey was conducted on ten locations of Mumbai and its suburbs, to investigate the presence of Arbuscular Mycorrhizal Fungal association in the wild plants. *Physalis minima* Linn, *Eclipta alba* Linn, *Mimosa pudica* Linn., *Coriandrum sativum* Linn., *Clitoria ternatea* Linn. *Gossypium* sps.Linn. *Sida acuta* Burmf.and *Spinacia oleracea* Linn.are few plants to mention as the wild plants. Seventy three percent of the wild plants showed symbiotic association with mycorrhizae. Roots and rhizosphere soil was subjected to the study. Spores were isolated, quantified and identified using the standard techniques. Nine species of arbuscular mycorrhizal fungi were recorded. They include *Acaulospora laevis*, *Acaulospora scrobiculata*, *Gigaspora margarita*, *Glomus aggregatum, Glomus fasciculatum, Glomus macrocarpum, Glomus microcarpum,Glomus mosseae*, and *Glomus muticaule*. Mycorrhizal inoculum was prepared and introduced into a fruit bearing plant, *Solanum melongena* (Brinjal) to assess the reduced dormancy period, enhanced phenotype, early anthesis, fruit setting and the quality of the fruit. The observations were impressive, as the growth pattern showed genuine changes without changing the basic constitution, a boon in the present agricultural scenario. Arbuscular mycorrhizal fungal diversity in these coastal areas can be used to introduce these novel fungi to other common vegetables also, which has manifold bio-fertilizer effect that can ensure nutrition to the mankind, in a natural way.

Key words: Arbuscular Mycorrhizal Fungi, Rhizosphere, Dormancy, Anthesis, Bio-fertilizer

INTRODUCTION

As Mumbai, an island city, is known to have saline soil, cultivation in this area is remote. Coastal area is enriched with mangroves, an exclusive flora known to be growing in sandy soil. The curiosity to explore the means of cultivation in the said region gave fuel to the idea to introduce the gift of Mother Nature, the mycorrhiza, as a natural bio-fertilizer. Mycorrhiza is a symbiotic association of fungus and the roots of higher plants[1]. As every stretch of land shows this unique association, it is imperative to evaluate the existence of these fungi in the coastal area of Mumbai and its suburbs and its further use in the growth of required plantation in the specified area. Their natural presence in the wild plants, gave an inspiration to introduce these novel association in the cultivated plants.

MATERIALS AND METHODS

IScreening of root and rhizosphere soil was done. Pretreatment of roots prior to staining[2,3] was carried out. Roots were cut into pieces of approximately 1cm.and microscopic examination was carried out to determine the symbiotic association of arbuscular mycorrhiza and percentage of mycorrhizal association in the root was calculated by using Nicolson's formula[4]. Arbuscular mycorrhizal spores were isolated, quantified and identified using the standard techniques[4, 5]. Arbuscular mycorrhizal inoculum was prepared and it was inoculated in a fruit bearing plant , *Solanum melongena* **–** (Brinjal) and the vegetative and reproductive growth was noted both in the experimental [E1,E2,E3] and control [C1,C2,C3] plants.

RESULTS AND DISCUSSION

Plants along with their roots and rhizosphere soil were collected from ten locations of the coastal area of Mumbai. These plant samples were screened to determine the association of arbuscular mycorrhizal fungi**.** About 73% of the plants from coastal area showed this diverse form of association[6].Genera namely, *Acaulospora, Gigaspora,* and *Glomus* were associated with the plants. *Glomus* species were invariably predominant[7] while *Gigaspora* represented the least. As arbuscular mycorrhizal fungi are biotrophic they cannot be isolated and maintained in axenic culture, hence the inoculum was prepared [8].

Rhizosphere soil showed the abundance of arbuscular mycorrhizal spores of nine species namely, *Acaulospora laevis*, *Acaulospora scrobiculata*, *Gigaspora margarita*, *Glomus aggregatum, Glomus fasciculatum, Glomus macrocarpum, Glomus microcarpum,Glomus mosseae*, and *Glomus muticaule*.

Experimental plants of *Solanum melongena* showed a 50% reduction in the dormancy period of the seeds because of the arbuscular mycorrhizal association compared to the control plants.

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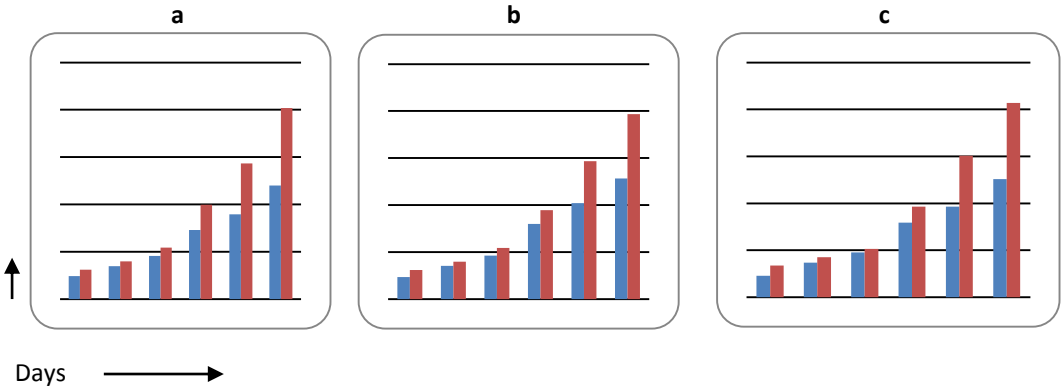
Shoot length in brinjal was studied for ninety days at an interval of fifteen days for both experimental and control plants. All the plants showed a gradual increase in the shoot length, but the experimental plants, where the mycorrhizal association was present, showed a notable growth of the shoot length. Increased shoot length in experimental plants in definite intervals was probably due to the effect of mycorrhiza.

Table :1
Effect of Arbuscular Mycorrhiza on the shoot length of *Solanum melongena*

Treatment	Shoot length (cm) (Post)					
	15 days	30 days	45 days	60 days	75 days	90 days
C1	**9.7**	**14.0**	**18.3**	**29.2**	**35.8**	**48.0**
C2	**9.1**	**14.7**	**19.1**	**31.8**	**38.6**	**50.3**
C3	**9.4**	**14.2**	**18.5**	**32.0**	**40.9**	**51.3**
Average increase in length	**9.4**	**14.2**	**18.5**	**31.0**	**38.4**	**49.8**
E1	**12.4**	**16.0**	**21.8**	**39.9**	**57.4**	**80.8**
E2	**13.5**	**17.0**	**20.6**	**38.6**	**60.2**	**82.8**
E3	**12.4**	**16.0**	**21.8**	**37.8**	**58.7**	**78.7**
Average increase in length	**13.0**	**16.!**		**38.6**	**58.2**	**81.3**

There is a net difference (increase in length) of 31.5 (cm) in experimental group as compared to control group, over a period of ninety days .

Figure No : 1
Effect of Arbuscular Mycorrhiza on growth of Solanum melongena



Legend : shoot length was used as a parameter to evaluate the growth.

a: C1 Control plant No. 1 E1 Experimental plant No. 1
b: C2 Control plant No. 3 E2 Experimental plant No. 2
c: C3 Control plant No. 3 E3 Experimental plant No. 3

Influence of Arbuscular Mycorrhizal Fungi on the Reproductive growth in *Solanum melongena*:

- Anthesis was observed for experimental and control plants. Experimental group showed anthesis 13 days before the control group. Table:2 shows all the experimental plants start flowering before seventy five days completed. Out of the three experimental plants, two plants bloomed in between forty five to sixty days and the other experimental plant flowered in between sixty to seventy five days. All the non-mycorrhizal control plants started flowering after completing seventy five days.

Table : 2
Effect of Arbuscular Mycorrhiza on anthesis in Solanum melongena

Treatment	between 45-60 days	between 60-75 days	between 75-90 days
C1	**Nil**	**Nil**	**78**
C2	**Nil**	**Nil**	**83**
C3	**Nil**	**Nil**	**89**
Average days for anthesis			**83**
E1	**Nil**	**61**	**Nil**
E2	**46**	**Nil**	**Nil**
E3	**Nil**	**75**	**Nil**
Average days for anthesis			**60**

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- Fruit setting was observed for experimental and control plants. Experimental group showed fruit setting 11 days before the control group. All the three experimental plants showed an early fruit setting, very much within sixty to seventy five days and all the control plants set their fruits after 75 days.

Table : 3

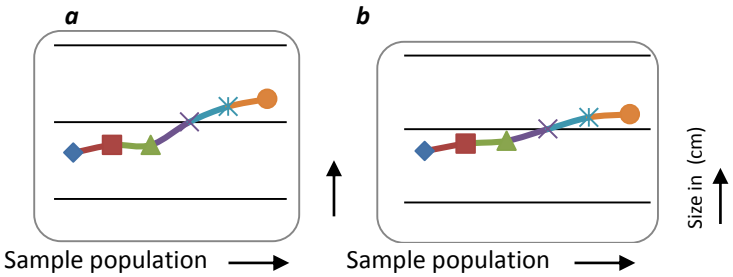
Effect of Arbuscular Mycorrhiza on the size and weight of fruit in *Solanum melongena*

Plants	Size(cm)	Weight (g)
C1	3.5	30
C2	4.0	35
C3	4.2	35
Average size & weight	3.9	33
E1	5.0	50
E2	5.8	60
E3	6.0	55
Average size & weight	5.5	56

There was a net difference (increase in fruit weight) of 23 grams(g) in experimental group[E] when compared to control[C] group. Table :3 shows, all the experimental plants producing large fruits with more weight and control plants with smaller fruits with reduced weight.

Figure : 2

Effect of Mycorrhiza on the size and weight of fruit in *Solanum melongena*



Legend: Weight of the fruit Size of the fruit

Sample population : Control plants (C1,C2 and C3) ,without AM association
Experimental plants(E1,E2 and E3), with AM association

Figure No :2 depicts enlarged size in fruits and increased weight compared to the control plants.

Mycorrhiza is an association of fungi and the roots of higher plants. It had been observed that in this association, the plant root, when associated with symbiotic fungus, became a functionally distinct organ in mineral nutrient uptake from the soil [7].

Experimental plants of *Solanum melongena* inoculated with the AM Spores showed early germination of seeds, increased shoot length, early anthesis, fruit setting, increased size and weight of fruits, etc.

If we are exploiting the constructive sides of this natural fertilizer, several hectares of infertile land can be used for agriculture, which is a boon to this Third world Country.

REFERENCES

- Harley, J., Smith, S. E.,1983.MycorrhizalSymbiosis. Academic Press: London.
- Koske, R. E., 1989. A modified procedure for staining roots to detect vesicular- arbuscular mycorrhiza. Mycol. Res., 92(4): 486-488.
- Grace, C. and D. P., Stribley, 1991.A safer procedure for routine staining of vesicular- arbuscular mycorrhizal fungi. Mycol. Res. 95 (10): 1160-1162.
- Gerdemann, J.W., Nicolson ,T.H., 1963. Spores of mycorrhizal Endogone species extracted from soil by wet sieving and decanting. Trans Br Mycol Soc 46:235–244.
- Schenck, N.C. & Pérez, Y. 1989. Manual for identification of VA mycorrhizal fungi.
- Brundrett, M.,2004. Diversity and classification of Mycorrhizal fungi.Biol. Rev.,79:473-495.
- Vyas, D. and Soni,A .,2004. Diversity and distribution of VAMF in the semi natural grass land. Indian J. of Ecology.
- Gerdemann, J. W., and B. K., Bakshi, 1976. Endogonaceae of India: Two new species. *Trans. Br. Mycol. Soc.* 66:340-343.

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DEPENDENCE OF FISHER WOMEN ON BIO-RESOURCES, IN AND AROUND CREEK OF AKSHI VILLAGE, ALIBAG TALUKA, RAIGAD DISTRICT OF MAHARASHTRA

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Abstract
The present investigation is carried out in the creek of Akshi village, Raigad district, Maharashtra (latitude 17,72'N and longitude 73,64'E)
Akshi creek is rich in organic matter and nutrients, hence supports large biomass of flora and fauna throughout all the seasons. The fishery potentiality in this region is always at its peak in all the seasons therefore the creek along with its mangrove is a productive ecosystem.
Since the livelihood of coastal people, especially women largely depends upon bio-resources in and around the creek, Akshi creek is the lifeline of these people. Life of people is hinged around the availability of the sea food in the region. While sea is the domain of men, creek is the domain of the women. Seafood mainly available in the creek is oyster (*Saccostrea cuculata, Crossostrea cutuckensis*), prawns (*Pinaeus indicus, P.monodon, Metapenaus Dobsoni, Macrobrachium rossenbergi*), Crabs (*Scylla serrata)* and variety of fishes, due to increase in human population and tourists, the demand for sea food is increased. So, women's work is getting harder and more time consuming and further leads to over exploitation of creek, which is a threat to their livelihood.

Key words: Akshi, Livelihood, Fishery potentiality

INTRODUCTION

It has been clearly established that women take active part in almost all activities in the society. In fishery sector, except for the actual off-shore fishing, they play promising role. It may be due to the tradition, need, inherited skills that the women are seen in catching, handling, processing , transporting and marketing of fish and fishery products. Women have demonstrated tremendous potential in making meaningful, long lasting contribution to their communities, their families and most importantly to themselves.

"The degree of participation of women in the fishery sector is an overall reflection of the cultures, the law of the country and the priority given by the state to ensure gender equality". Without full participation of women, economic and social development is impossible.

Organic rich mud-flats of Akshi Creek are the ideal environment for spawning, breeding and feeding activities of organisms. It harbours a variety of organisms including commercially important species such as oysters (*Saccostrea cuculata*, *Crossostrea cutckenies*), and large variety of fishes. All women in Akshi Creek participate directly or indirectly in fishing and fishery related work.

METHODS

The research reported here is based on the following four main components:-

1. Visits and study of onsite activities in all the seasons.
2. Information from direct interviews of fisher-folks.
3. The feedback from the questionnaires.
4. Literature review and analysis.

RESULTS

Women offer an active contribution, extensive involvement and play a pivoted role in all areas of fishery business. Traditionally, they are more involved in fishing activities in shallow waters of the creek. The fisherwomen thus help in preserving traditional knowledge, maintaining biodiversity, ensuring provision for family and nutrition.
Table shows that women spend 15'30"hrs. in fishing and fishery related activities which is about 65% of each day.
Table No. 1:

Activities	Hours
Fishing and collection	5' 30"
Processing and transportation	5' 00"
Marketing and revenue collection	5' 00"
Household chores	5' 00"
Social interaction	1' 30"
Rest and personal hygiene	7' 00"
Total	24' 00"

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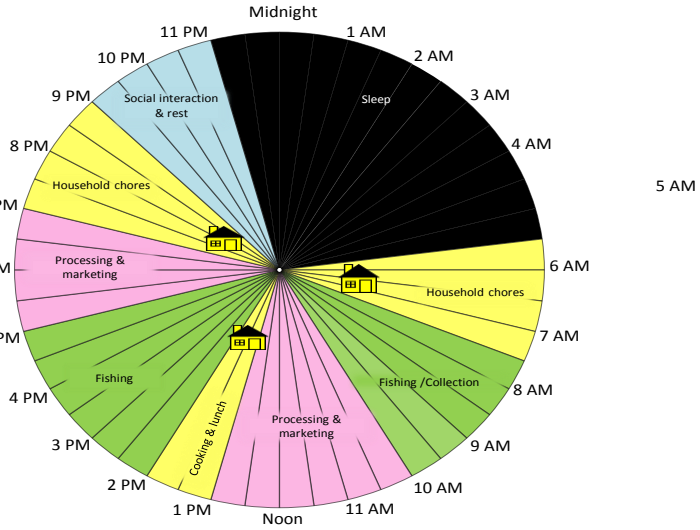
Chart No. 1

Fishing is done with the help of canoes employing traditional nets. Manual collection of molluscs is significant. Oyster catch is the main amongst the molluscs and is characteristic of the area. Oyster and larger prawns are available throughout the year except during monsoon season, while crab and fishes are available throughout the year. Chart no.2 shows availabity of sea food throughtout the year.



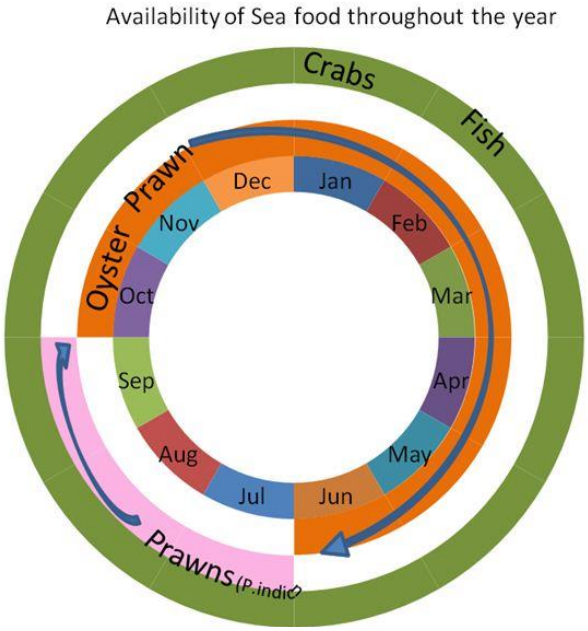


Chart no 2.

As fishing is done by applying traditional or artisanal methods more time is required for daily catch compared to the earning which is shown in the chart no.3. Women reinvest 100% of their income back into their own household ensuring that the benefits of development spread to both local communities and the environment. Chart no.4 shows that men spend more time in fishing compared to women while women are more engaged in collection of oysters in the creek.

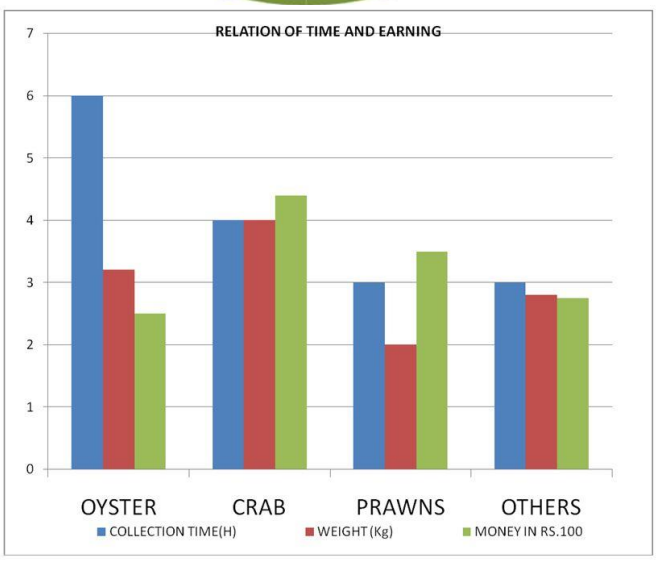


Chart No 3

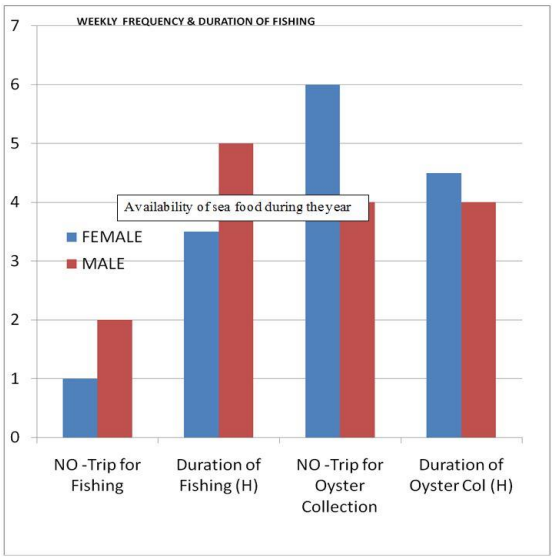


Chart No 4.

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Conclusion

Men and women spend almost equal time in fishing, but women spend more time for collection of oysters, fish processing and marketing which is almost exclusively the domain of women.

Increase in human population and the tourist demand for fish and other fish products has suddenly increased in relatively short time. Women's work is also getting harder and more time consuming due to ecological degradation, over exploitation of creek and changing technologies and practices.

References

- Vijaya Khader, R. Sathiadad and Mohamed Kasim, 2005. Role of women in Fishery in coastal ecosystem of Andhra Pradesh, Kerala, Tamil Nadu. J. res AMGRAS, 3(1) 53-59.
- Mohamed Ali Shah, 2002. Women in fishing communities in Pakistan face marginalization. Pakistan fish-folk forum(PFF).
- Catherine Chando, 2002. Gender role in fishery planning and project master's thesis.
- Stella Williams 1994. Women in fishing communities, Food and Agriculture Organization, Economic project.
- Chang ling Yap, 1986. Women in fisheries department FAO Rome.
- M.Sunderrajan, women in fisheries in Asia.
- Isatou Jouray. Gender issues in the fisheries and effective participation (FAO).
- An assessment of the Role of women in fisheries in YAP, Federated State of Micronatia.

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BIOACTIVES FROM MICROBES OF INDIAN COAST: WITH SPECIAL REFERENCE TO ANTIMICROBIAL ACTIVITY

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ABSTRACT

Marine environment is the last frontier for the humankind to explore. This environment, which forms more than 75% of the planet earth, is extremely diverse with respect to ecology, habits, flora and fauna. Microbes, which are at the base of the food chain, are now being explored to harness their ability to produce a variety of biomolecules that have potential to serve mankind. The bioactive molecules produced by marine microbes have been divided into groups of 1) antimicrobial, 2) anti-inflammatory, 3) anticancer, 4) anti-tumour to name a few. The present paper reviews the role of microbial flora in the production of important novel drugs and molecules.

INTRODUCTION

Marine environment is vast and diverse, contributing to the enormous biodiversity. India is geographically blessed with a coast line of about 7000 km, including Andaman and Nicobar Islands (CIA factbook, August, 2012). The variety of life found in this environment is being explored for new biomolecules which are useful for the mankind in terms of pharmaceuticals. The vast marine flora offers abundant resource for the novel molecules which have better efficacy and specificity to treat human aliments (Haefner, 2003). Marine microbes are a resource for various pharmaceuticals which is still to be explored. There are several microbes which are yet to be identified and characterized.

The marine organisms thrive in extreme conditions of pressure, salinity and temperature by altering their metabolic needs (Hunter-Cevera, 2005). In this process of biochemical adaptation they produce novel metabolites (Kathiresan, 2008). Thus they are a source of new genes which encode for new molecules. These molecules can be explored for their pharmaceutical potential. The bacteria often have a symbiotic relation with other marine organisms and offer structural variety of bioactives which have broad range of biological effects (Penesyan, 2010). Several bioactive compounds, showing efficacy for anti-inflammatory, anticancer, antimicrobial, antibiotic, antiviral and antiprotozoan activities have been identified (Inbaneson, 2012). Marine microbes have yielded novel anti-inflammatory molecules such as E pseudopterosins (Roussis, 1990), topsentins (Tsujii, 1988), scytonemin, isolated from intertidal cyanobacteria (Balskus, 2011) and manoalide (Wheeler *et al*., 1987); and anticancer agents e.g., bryostatins, discodermolide (Gunasekera, 1990) eleutherobin (Long, 1998), and sarcodictyin to name a few. Some molecules identified with anticancer potential are thiocoraline, a novel bioactive depsipeptide isolated from *Micromonospora marina* (Ebra, 1999), scytonemin (Stevenson, 2002), calothrixin A (I) and B (Richards, 1999), curacin-A (Carte, 1996).Okamyi, (1986), found a polysaccharide, named marinactan, from marine *Flauobacterium sp.*, which was effective against Sarcoma-180 solid tumour virus (S-I 80) in mice.

Marine Microbes: Classification and Distribution

The marine microbes constitute almost upto 90% of ocean biomass (http://serc.carleton.edu/ microbelife/marine/about.html)**.** These marine microbes can be roughly classified into Archea, Bacteria, Eukarya and their associated viruses (http://serc.carleton.edu/microbelife/marine/about.html). Microbes are known to thrive in varied environment and their habitats include, open water (pelagic), sediments, mangroves, hydrothermal vents, other marine organisms etc. The marine microbes are freeliving as well as symbiotic with other marine organisms.

Archea are ancient group of microbes which are known to thrive in un-habitable environment (DeLong, 1992). The marine Archea consist of four groups, methanogens, halophiles, sulphur-reducing Archea and extreme thermophiles. In the marine environment, archaeal habitats are generally limited to shallow or deep-sea anaerobic sediments, free-living and endosymbiotic methanogens, hot springs or deep-sea hydrothermal vents, methanogens, sulphate reducers, and extreme thermophiles (Takai,1999; Miroshnichenko, 2004; Brazelton, 2006) and highly saline land-locked seas, halophiles, (DeLong, 1992). Further, Archea can be classified into four major groups: Group I *Crenarchaeota,* Group II*,* III planktonic *Archaea* and pelagic Group IV *Archaea* (DeLong, 2003). Certain Archea are found to be symbiotically associated with marine sponges (Preston, 1996; Lee, 2003).

Marine bacteria are divided into two major groups namely, Gram positive bacteria and Gram negative bacteria. They have been isolated from mangroves (Radhakrishanan, 2011), surface waters and deep sea (González-Párraga, 2011). There is a major group of bacteria found to be symbiotically associated with sponges (Hentschel, 2003), macroalgae

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(Staufenberger, 2008; Tujula, 2010), sea weeds (Sureshkumar, 2002), corals (Ganesh Babu, 2004; Wegley, 2007), bryozoan (Davidson, 1999), mollusks (Morris, 1990) and tunicates (Jang, 2002).

Eukarya is a vast group which includes variety of microscopic organisms including fungi, microalgae, diatoms, dinoflagellates and protozoa (Poulin, 2010). This group includes all the eukaryotic organisms which are not multicellular. These organisms are distributed in surface waters, for example autotrophic dinoflagellates and diatoms and are distributed all over worldwide (Dolan, 2009).

Marine microbes are also found in the mangrove ecosystem. These microbes thrive on the detritus produced in the mangrove forests (Bano, 1997). The diversity of these microbes has contributed to discovery of new pharmaceuticals (Sahoo, 2009).

Microbes play variety of roles in the food chain of the marine ecosystem and as indicated earlier, are found as free living surface microbes, in association with other marine organisms, in sediments of mangroves and deep sea. In the quest for survival in these varied habitats, microbes adopt a variety of diversity in their metabolism and this leads to production of novel molecules which can be used as drugs. The present paper reviews only the antimicrobial activity of the marine microbes obtained from the Indian coast.

Marine Bacteria

The screening of marine organisms as a source of antibacterial compound has started from 18th century. The early reports published by De Giaxa in the year 1889, hinted at antibiotic activity exhibited by marine microbes. Later, in 19th century, significant contribution was made by Dr. C. E. ZoBell and his colleagues (1936; 1944). They carried out the first large-scale systematic study on antibiotic activity of marine organisms against *Bacillus anthracis*. Several workers like, Baslow (1969), Gauthier (1969), Lebedeva & Markianovic (1971), Burkholder (1973) and Ballester *et al.* (1977), have published papers on antimicrobial compounds from marine bacteria in the past decades (Austin, 1989).

A decade ago, Jayanth, K. and co-workers (2002) isolated 162 pigmented bacteria from submerged substrates, sediment, sea-plants and bivalves from Tuticorin coast. The authors reported that 62 bacteria had antibacterial potential against human pathogens.

Kokare *et al.* (2004) islolated and charaterized a halophilic Actinopolyspora species from a marine sediment sample from Alibag, West Coast of Maharashtra. They tested antimicrobial activity of this strain using cylinder plate method. They found that this strain showed good antibacterial activity against *S. aureus* (zone of inhibition 17mm), *S. epidermis* (13.2mm), *Bacillus subtilis* (12.5mm) and antifungal activity against *Aspergillus niger*, *A. fumigatus*, *A. flavus*, *Fusarium oxysporum*, *Penicillium sp.* and *Tricoderma sp.* with a zone of inhibitions 12mm, 5mm, 15.8mm, 16.2mm, 17mm, 13.5m respectively.

Remya and Vijaykumar (2008) isolated 173 actinomycetes from near shore and mangrove ecosystem of Kerala. Twenty-one isolates of these bacteria exhibited antimicrobial activity. It was observed that two species, *Streptomyces sp.* RM17 and *Streptomyces sp.* RM42 showed broad spectrum antimicrobial activity. The isolated compounds were further analysed using HPLC.

Khajure and Rathod (2010) analysed 28 isolates of micro-organisms obtained from the deep sea sediments collected from Karwar region, West Coast of India, for antimicrobial activity. These microbes were tested against Gram positive and Gram negative organisms. The antibacterial compounds were isolated and purified from these microbes and were tested for broad spectrum antimicrobial efficacy. In this study the authors concluded that the broad spectrum activity and large zone of inhibition (Agar well diffusion method) was shown by compounds isolated from *Pseudomonas sp.*

Pabba and his colleagues (2011) isolated 41 strains of marine bacteria from different sampling sites along the coast of Visakhapatnam. The secondary metabolites from these bacteria were screened, partially purified and were testes against pathogenic bacteria (*Escherichia coli*, *Staphylococcus aureus, Enterobacter aerogenes and Bacillus cereus).*

Recently, Savrav, K. and Kannabiran, K. (2012) isolated, purified and characterized, a compound, 5-(2,4-dimethylbenzyl) pyrrolidin-2-one, from marine *Streptomyces VITSVK5 sp.*, obtained from Marakkanam Coast of Bay of Bengal, India. This compound was evaluated for its antibacterial activity against selected strains of bacteria and fungi. They found that this compound showed maximal activity against *Escherichia coli* with a MIC value of 187 µg/ml, followed by *Klebsiella pneumoniae* (MIC of 220 µg/ml and 10.3mm zone of inhibition), *Staphylococcus aureus* (MIC of >1000 µg/ml and 4.4mm zone of inhibition) and *Bacillus subtilis* (MIC of 850 µg/ml and 2.6mm zone of inhibition). During the course of their study these authors observed that, the compound was a potent inhibitor of opportunistic

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fungal pathogens too. It showed a maximum activity against *Aspergillus niger* with a MIC value of 1 µg/ml and 28 mm zone of inhibition.

In another study, conducted by Chandrasekhar and co-workers (2012), 23 isolates of marine bacteria were isolated from sediment samples obtained from different locations of the Vishakhapattamnam coast. Six isolates of marine bacteria exhibited antimicrobial activity against *Escherichia coli MTCC443, Pseudomonas aeruginosa MTCC424, Proteus vulgaris MTCC1771, Bacillus cereus MTCC430, Bacillus subtilis MTCC441 and Staphylococcus aureus MTCC3160.*

Venkat Ratna Ravi and his co-workers (2011), have reported an isolation of 72 samples of actinomycetes from sediment samples collected from Visakhapatnam coast of Bay of Bengal. These isolates were investigated for their antibacterian activity against Gram positive and Gram negative bacteria. This group has been successful in finding a new species of actinomycetes, *Amycolatopsis albavar*. *nov*. DVR D4, after genotypic characterization using 16s rRNA analysis. Further, they have obtained maximum production of a novel antibiotic from this species by optimizing the process parameters.

Marine Fungi

Fungi isolated from the marine environment have yielded around 240 new compounds (Samuel, 2011). It remains as one of the rich source for bioactive compounds. Around five species of marine fungi were isolated from the samples collected from the south east coastal region of Tamilnadu, by Samuel and his collegues (2011). It was observed that the fungi belonged to genus *Geotrichum.* These isolated compounds were found to be effective against 5 different human bacterial pathogens.

Extensive work of Geetha V. and collaborators (2011) has lead to discovery of an antibacterial macrolide. They isolated and characterized this compound which was found to be most effective against Gram positive and Gram negative bacterial strains. This compound was obtained from the 12 fungal strains isolated from Mandabam region of Tamil Nadu Coast. The authors have proposed the chemical structure of the most active component of ethyl acetate extract as elucidated by IR and NMR. This study revealed that the active compound contains a functional group similar to that of a macrolide.

Sethukkarasi and collegues (2012) isolated 53 bacteria from different areas of Cochin backwaters. The primary screening of these bacteria revealed their antibacterial potential. They discovered that a species of Bacillus showed antibacterial activity against all the test organisms. Thus, this organism was further investigated and extracts were obtained which were screened for secondary metabolites and were subjected to FTIR and NMR spectrum analysis. The compound which showed broad spectrum anti bacterial activity probably was a straight chain polyhydroxy polyether compound with a single double bond and possessing complex ring structure.

Similar kind of study was earlier undertaken by Gokulkrishnan and co-workers (2011). They evaluated the antibacterial potency of sediment samples obtained from Mangalore, West coast of India. They found that 21 of the isolated microbes, exhibited antibacterial efficacy against *Bacillus subtilis, Staphylococcus aureus*, *Escherichia coli*, *Proteus vulgaris* and *Salmonella typhi*.

Recently, Bhimba *et al.* (2012) have reported antibacterial activity of a compound isolated from marine fungi *Phoma herbarum.* They have characterised this metabolite using TLC and GCMS spectrum.

Symbiotic Microbes

Extensive study has been conducted on the microbes associated with marine organisms like sponges, corals, molluscs, ascidians etc., and also in association with marine algae and seaweeds (Subramanian, 2008).

Anand *et al.* (2006) had presented the first report on antibiotic producing bacteria associated with a sponge from Indian waters. During their study 75 bacterial strains were isolated from 4 species of sponges namely, *Echinodictyum sp*., *Spongia sp*., *Sigmadocia fibulatus* and *Mycale mannarensis*. This study was carried out from Tuticorin coast, Gulf of Mannar region. A total of 21 strains were found to be antibiotic produces, their phylogenetic analysis was accomplished using comparative analysis of sequenced 16s rRNA. It was reported that most of the active bacterial strains belonged to genera *Vibrio* and *Bacillus*.

Similar kind of study was later conducted by Boobathy (2009), in which he isolated symbiotic bacteria associated with marine sponge, *Callyspondia diffusia*, collected from the coast of Mumbai. Williams and co-workers (2007) successfully isolated 8 species of bacteria associated with benthic sea-anemone, *Stichodactyla haddoni.* These bacterial species were identified as *Alcaligenes sp., Corynebacterium sp.*, *Aeromonas sp.*, *Sporosarcina sp., Renibacterium sp., Carnobacterium sp1*, *Carnobacterium sp2* and Salinococcus *sp*. The extracts from these bacteria

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were tested with promising antimicrobial activity against human bacterial and fungal pathogens. Several researchers, like Kanagasabhapathy and Shinichi Nagata (2008), Selvin (2009), Gnanmbal, E. M, Chellaram and co-workers have worked on bacteria associated with corals from Tuticorin coast and Gulf of Mannar (2005; 2009; 2010), marine algae (Seenivasan, 2010) and seaweeds (Sugathan, 2002), to name a few, and have described antibacterial potential of the some isolates.

CONCLUSIONS

In this mini review an attempt has been made to site work on microbes, of the Indian coast, having antimicrobial potential. The compilation is expected to encourage more researchers to work in the challenging field of discovering pharmaceutically useful biomolecules from marine environment.

REFERENCES

- Austin, B., 1989. Novel pharmaceutical compounds from marine bacteria: A Review. Journal of Applied Bacteriology, 67: 461-470.
- Balskus, E. P., Case, R. J., Walsh, C. T., 2011. The biosynthesis of cyanobacterial sunscreen scytonemin in intertidal microbial mat communities. FEMS Microbiology Ecology: 1–11.
- Bhimba, V. B. *et al*. 2012. Phthalate derivatives from the marine fungi phoma herbarum vb7. International Journal of Biological & Pharmaceutical Research. 3(4): 507-512.
- Brazelton, W. J., Schrenk, M. O., Kelley, D. S., Baross, J. A., 2006. Methane- and sulfur-metabolizing microbial communities dominate the Lost City hydrothermal field ecosystem. Appl. Environ. Microbiol, 72(9):6257-70.
- Carté, B. K., 1996. Biomedical potential of marine natural products. BioScience, 46(4): 271–286.
- Chandra Sekhar, M. D. A. G., E. Radha Krishna, P., Shamsher Kumar and Murali Mohan, C., 2012. Isolation and Screening of Antimicrobial Activity of Marine Sediment Bacteria from Bay of Bengal coast, Visakhapatnam. Journal of Pharmacy Research, 5 (3).
- Chellaram C, Sreenivasan, R. S., Jonesh, S., Prem Anand, T. and Edward, J. K. P., 2009. In vitro Antibiotic bustle of coral reef associated gastropod, *Drupa margariticola* (Broderip, 1832) of Tuticorin coastal waters, Southeastern India. Biotechnology, 8 (4): 456-461.
- Chellaram, C. and Prem Anand, T., 2010. Antitumor assay using artemia toxicity of five *Cyprae sp*. (Mollusca; Gastropoda) from Gulf of Mannar Coastal Waters. Current Scenario in Microbial Biotechnology. Excel Publication, New Delhi, Pp-60-64.
- Church, M. J., DeLong, E. F., Ducklow, H. W., Karner, M. B., Preston, C. M. and Karl, D. M., 2003. Abundance anddistribution of planktonic *Archaea* and *Bacteria* in the Western Antarctic Peninsula. Limnol. Oceanogr. 48:1893–1902.
- CIA fact book, 2012 (https://www.cia.gov/library/publications/the-world-factbook/geos/in.html)
- Davidson, S. K., and M. G. Haygood. 1999. Identification of sibling species of the bryozoan *Bugula neritina* that produce different anticancer bryostatins and harbor distinct strains of the bacterial symbiont "*Candidatus Endobugula sertula*" Biol. Bull. 196:273-280.
- De Giaxa, 1889. Uber das Verhalten einiger pathogener Mikro-organismen in eerwasser. Zentralblattfur Hygiene und Infektionkrankheiten, (6):162-225.
- Delong, E. F., 1992. Archaea in coastal marine environments. Proc. Natl. Acad. Sci. USA, 89(12): 5685–5689.
- Delong, E. F., 2003. Oceans of Archaea. ASM News, 69(10): 503-511.
- Erba, E., Bergamaschi, D., Ronzoni, S. *et al*., 1999. Mode of action at thiocoraline, a natural marine compound with anti-tumour activity. British Journal of Cancer, 80(7): 971–980.
- Ganesh Babu, T., Nithyanand, P., Kannapiran, E., Veera Ravi , A. and Karutha Pandian, S., 2004. Molecular identification of bacteria associated with the coral reef ecosystem of Gulf of Mannar Marine Biosphere Reserve using 16S rRNA sequences. Proceedings of MBR National Seminar on New Frontiers in Marine Bioscience Research, pp 47-53.
- Geetha V., *et al*., 2011. Isolation and Characterization of New Antioxidant and Antibacterial Compoundsfrom Algicolous Marine Fungus Curvularia Tuberculata. International Conference on Bioscience, Biochemistry and Bioinformatics IPCBEE vol.5, IACSIT Press, Singapore.
- Gnanambal, E. M. K., Chellaram, C. and Patterson, J., 2005. Isolation of antagonistic marine bacteria from the surface of the gorgonian corals at Tuticorin, south eat coast of India. I.J.M.S., 34(3):316-319.
- Gokulkrishnan, R. K., Kusuma, S. and Boopalan, K., 2011. Antimicrobial activity of marine bacteria isolated from the Mangalore coast, west coast of India. Recent Research in Science and Technology, 3 (4).
- Gunasekera S. P., Gunasekera, M., Longley, R. E., Schulte, G. K., 1990. Discodermolide: a new bioactive polyhydroxylated lactone from the marine sponge *Discodermia dissolute.* J. Org. Chem., 55 (16): 4912–4915.
- Haefner, B., 2003. Drugs from the deep: marine natural products as drug candidates. Drug Discovery Today, 8(12): 536–544.

ISBN 978-81-925489-0-6

- Hentschel, U., Fieseler, L., Wehrl, M., Gernert, C., Steinert, M., Hacker, J., Horn, M., 2003. Microbial diversity of marine sponges. Prog Mol Subcell Biol., 37:59-88.
- Inbaneson, S. J. and Ravikumar, S., 2012. In vitro antiplasmodial activity of marine sponge Stylissa carteri associated bacteria against Plasmodium falciparum. Asian Pacific Journal of Tropical Disease, 370-374.
- Jang, W. S., Kim, K. N., Lee, Y. S., Nam, M. H., Lee, I. H., 2002. Halocidin: a new antimicrobial peptide from hemocytes of the solitary tunicate *Halocynthia aurantium*. *FEBS Lett*., *521:81*-86.
- Jayanth, K., Jeyasekaran, G., Shakila, R., 2002. Isolation of marine bacteria, antagonistic to human pathogens. Indian Journal of Geo-Marine Sciences, 31(1): 39-44.
- Kathiresan, K., Thiruneelakandan, G., 2008. Prospects of lactic acid bacteria of marine origin. Indian Journal of Biotechnology. 7(2): 170–177.
- Khajure, P. V. and Rathod, J. L., 2010. Antimicrobial activity of Pseudomonas species isolated from marine environment of Karwar, West coast of India. Ecology and Fisheries, 3(1): 9-18.
- Kokare, C. R., Mahadik, K. R., Kadam, S. S. and Chopade, B. A., 2004. Isolation, characterization and antimicrobial activity of marine halophilic *Actinopolyspora* species AH1 from the west coast of India. Curr. Sci., 86: 593–597.
- Lee, E. Y., Lee, H. K., Lee, Y. K., Sim, C. J., Lee, J. H., 2003. Diversity of symbiotic Archaeal communities in marine sponges from Korea, Biomol Eng., 20(4-6):299-304.
- Long, B. H., *et al*., 1998. Eleutherobin, a novel cytotoxic agent that induces tubulin polymerization, is similar to paclitaxel (Taxol). Cancer Res.,58(6):1111-5.
- Manmadhan Kanagasabhapathy and Shinichi Nagata., 2008. Cross-species induction of antibacterial activity produced by epibiotic bacteria isolated from Indian marine sponge *Pseudoceratina purpurea*. World Journal of Microbiology and Biotechnology., 24(5):687-691.
- Miroshnichenko, M. L., 2004. Thermophilic microbial communities of deep-sea hydrothermal environments. Mikrobiologiia., 73(1):5-18.
- Morris, S. A., De Silva, E. D., Anderson, R. J., 1990. Chromodorane diterpenes from the tropical doridnudibranch *Chromocloris cavae*. Can. J. Chem. *69*: 768-771.
- Okamyi, 1986. Marine microorganisms as a source of bioactive agents. Microbial Ecology, (12)6578.
- Pabba, S. K., *et al*., 2011. Isolation and screening of marine bacteria for antimicrobial activity along Vishakapatanam Coast. J. Microbiol. Biotech. Res., 1 (2): 86-89.
- Penesyan, A., Kjelleberg, S. and Egan, S., 2010. Development of Novel Drugs from Marine Surface Associated Microorganisms. Mar. Drugs. (8): 438-459.
- Pilar González-Párraga, P., Cuesta, A., Meseguer, J and Esteban, M. A., 2011. Marine microorganisms: the world also changes. Science against microbial pathogens: communicating current research and technological advances. Fish Innate, 1281-1292.
- Preston, C. M., Wu, K. Y., Molinski, T. F. and DeLong, E. F., 1996. A psychrophilic crenarchaeon inhabits a marine sponge; *Cenarchaeum symbiosum*. Proc. Natl. Acad. Sci. USA, 93:6241–6246.
- Radhakrishnan, M., Saravanan, D., Balagurunathan, R., Vanaja Kumar., 2011. Fungal Bioproespecting from Sundarban Mangrove Forest with special reference to Antibacterial and Antimycobacterial Activity. International Journal of PharmTech Research, 3(2):719-723.
- Remya, M. and Ramasamy, V., 2008. Isolation and characterization of marine antagonistic Actinomycetes from west coast of India. Medicine and Biology, 15(1):13-19.
- Rickards, R.W., Rothschild, J. M., Willis, A.C. *et al*., 1999. Calothrixins A and B, novel pentacyclic metabolites from Calothrix cyanobacteria with potent activity against malaria parasites and human cancer cells. Tetrahedron, 55(47): 13513–13520.
- Roussis, V., Wu, Z., Fenical, W., Strobel, S. A., Van Duyne, G. D., Clardy, J., 1990. New anti-inflammatory pseudopterosins from the marine octocoral *Pseudopterogorgia elisabethae.* J. Org. Chem., 55 (16):4916–4922.
- Sahoo, K. and Dhal, N. K., 2009. Potential microbial diversity in mangrove ecosystem. A review. I.J.M.S., 38(2):249-256.
- Samuel, P., Prince, L and Prabakaran, P., 2011. Antibacterial Activity of Marine derived Fungi Collected from South East Coast of Tamilnadu, India. J. Microbiol. Biotech. Res., 1 (4):86-94.
- Saurav, K., Kannabiran, K., 2012. *In vitro* activity of 5-(2,4-dimethylbenzyl) pyrrolidin-2-one extracted from marine *Streptomyces VITSVK5 spp*. against fungal and bacterial human pathogens. Rev Iberoam Micol. 29(1):29-33.
- Seenivasan, R., Indu. H., Archana, G. and Geetha, S.,2010. The antibacterial activity of some marine algae from south east coast of India. Journal of Pharmacy Research, 3(8).

- Sethukkarasi, M., Asha Devi, N. K., Vasuki, B., Nishanthini, A., Falaq Naz and R. Thirumurugan., 2012. Antagonistic Activity of Marine Bacteria from Cochin Backwater of Arabian Sea. International Journal of Microbiological Research 3 (1): 16-23.

ISBN 978-81-925489-0-6

- Staufenberger, T., Thiel, V., Wiese, J., Imhoff, J. F., 2008. Phylogenetic analysis of bacteria associated with Laminaria saccharina. FEMS Microbiol Ecol., 64(1):65-77.
- Stevenson, C. S., Capper, E. A., Roshak, A. K. *et al*., 2002. The identification and characterization of the marine natural product scytonemin as a novel antiproliferative pharmacophore. Journal of Pharmacology and Experimental Therapeutics, 303(2): 858–866.
- Subramanian, V., Maniramakrishnan S. R., Shanmugasudara, M., Annappan M., 2008. Isolation and screening of marine associated bacteria from Tamil Nadu, Southeast coast of India for potential antibacterial activity. Annals of Microbiology, 58 (4): 605-609.
- Sujatha P, Bapi, R., Ramana, T., 2005. Studies on a new marine streptomycete BT-408 producing polyketide antibiotic SBR-22 effective against methicillin resistant *Staphylococcus aureus.* Microbiol Res 160: 119-126.
- Sureshkumar, S., Christopher J. A., and Ravikumar, S., 2002. Antimicrobial activity of seaweed extracts from south west coast of India. Seaweed Research and Utilization, 24, 111-115.

- Takai, K., Horikoshi, K., 1999. Genetic diversity of Archaea in deep-sea hydrothermal vent environments. Genetics, 152(4): 1285–1297.
- Tsujii, S., Rinehart, K. L , Gunasekera , S. P, Kashman, Y., Cross, S. S., Lui, M. S., Pomponi, S. A., Cristina Diaz, M., 1988. New anti-inflammatory pseudopterosins from the marine octocoral *Pseudopterogorgia elisabethae. J. Org. Chem.*, 53 (23):5446–5453.
- Tujula, N.A., Crocetti, G.R., Burke, C., Thomas, T., Holmström, C., Kjelleberg, S., 2010. Variability and abundance of the epiphytic bacterial community associated with a green marine Ulvacean alga. ISME J. 4(2):301-11.
- Venkata Ratna Ravi Kumar *et al*., 2011. Screening of Antagonistic Marine Actinomycetes: Optimization of Process Parameters for the Production of Novel Antibiotic by Amycolatopsis Albavar. nov. DVR D4J Microbial Biochem Technol., 3:5.
- Wegley, L., Edwards, R., Rodriguez-Brito, B., Liu, H., Rohwer F., 2007. Metagenomic analysis of the microbial community associated with the coral Porites astreoides. Environ Microbiol. 9(11):2707-19.
- Wheeler, L. A., *et al*., 1998. Manoalide, a natural sesterterpenoid that inhibits calcium channels. Cancer Res., (58):1111.
- Williams, P. G., *et al*., 2007. Antimicrobial activity of tissue and associated bacteria from benthic sea anemone Stichodactyla haddoni against microbial pathogens. Journal of Environmental Biology, 28(4):789-793.
- Zobell, C. E. 1936. Bactericidal action of sea water. Proceedings of the Society of Experimental Biology and Medicine, (34): 113-116.
- Zobell, C. E. and Upham, C., 1944. A list of marine bacteria including descriptions of sixty new species. Bulletin of Scripps Institute of Oceanography, University of California 5, 239-292.

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NEW STRATEGIES TO CONSERVE MARINE BIODIVERSITY AND COASTAL ECOSYSTEMS OF INDIA.

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ABSTRACT
India has long coastal line and large marine ecosystems that can be used to harvest several commercial products for human consumptions. Out of these fisheries are of great importance as a source of food and liver oil. Recently it has been realised that marine biodiversity can be a potential pool for the development of novel therapeutic drugs. The coastal and marine biodiversity is severely affected due to habitat loss, urbanization, pollution, invasive alien species and human induced climate changes. Overfishing and other anthropogenic activities put tremendous pressure on these fragile ecosystems. The Ministry of Environment and Forests issued Notifications to protect and conserve the coastal line from time to time. The latest Notification was brought out in 2011 that would help in effective conservation of coastal and marine biodiversity of India.

SPECTRAL CHARACTERISTICS OF MANGROVE VEGETATION IN MUMBAI

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ABSTRACT
Mangroves are woody plants that grow at the interface between land and sea in tropical and sub-tropical latitudes. Mangroves and mangrove ecosystems have been studied extensively but remain poorly understood. With continuing degradation and destruction of mangroves, there is a critical need to understand them better. Remote Sensing an advanced tool to study vegetation spatially can be significant to monitor degradation and destruction of coastal vegetation due to anthropogenic activities. Mumbai a metropolitan city is under tremendous stress as far as space for dwelling is concerned. In addition rising real estate prices also attracts builders to exploit coastal land for construction purpose .Spectral characteristics of Mangrove vegetation can provide data to understand degradation pattern and hence allow to take appropriate action against degrading factors. A healthy green leaf intercepts incident radiant flux directly from the sun or from diffused skylight scattered onto the leaf .This incident electromagnetic energy interacts with the pigments, water and intercellular air spaces within the plant leaf. The amount of radiant flux reflected from the leaf, the amount of radiant flux absorbed by the leaf and the amount of radiant flux transmitted through the leaf can be carefully measured as we apply the energy balance equation and attempt to keep track of what happens to all the incident energy. These principles of spectral; characteristics of vegetation are of immense importance during remote sensing.

Key Words: Mangroves,Degradation,Remote Sensing, Ecosystem

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THREATS TO MARINE BIODIVERSITY

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ABSTRACT
Biodiversity being source of species, on which the human beings depend for food fodder, fuel, fibre, shelter, medicine etc. It is crucial for the survival of an ecosystem. The loss of even one species can be disastrous. It maintains stability of the biosphere, which results in stability of climate and other related factors. Some unexplored species may have medicinal value; some other species may contribute to gene pool. For ever increasing population some such species may supplement the human food. Mumbai being coastal area is potential source of income and sustenance at present and in future also in a sustainable manner, but is subject to many threats.

Key words: Population, overexploitation, Pollution, oil spill, awareness.

THREATS TO COASTAL BIODIVERSITY: A CASE STUDY OF MANGROVE HABITAT IN CARTER ROAD, BANDRA – A POPULAR TOURIST LOCATION

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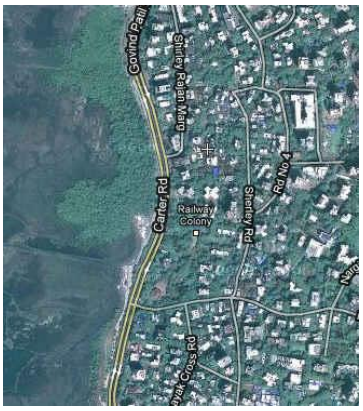
ABSTRACT
The present paper deals with the documentation of mangrove species and its associates at Carter road. It also gives a first hand information of the other plant species growing at the Mangrove belt, the avifauna found therein and other places nearby Carter Road.
This paper also documents the present status of swampy mangrove land which is becoming a solid land due to siltation.
Key words: Mangrove, Carter Road, Siltation

Introduction:
The oceans cover 70% of the planet's surface area. A large part of our marine life is dependent on the coastal environmental conditions. Life in our seas produces one third of the oxygen that we breathe, offers a valuable source of protein and moderates global climatic change.

Some examples of marine and coastal habitats include mangrove forests; coral reefs; sea grass beds; estuaries in coastal areas; hydrothermal vents; and seamounts and soft sediments on the ocean floor a few kilometres below the surface.

The diversity of mangroves, which grow in saline conditions, found in the coastal areas play a major role in preserving and conserving many marine species making them crucially as important as any other marine species is.

India has a coastline of about 7570 kms. out of which 114 Km. is occupied by Mumbai coast. Today the mangroves face a great threat because of human intervention, making them one of the coastal species which needs conservation.
India has a coastline of about 7570 kms. out of which 114 Km. is occupied by Mumbai coast. Today the mangroves face a great threat because of human intervention, making them one of the coastal species which need conservation.



Satellite image of Carter Road Mangrove

Reason for undertaking this project:
In India, a legal protection is afforded to this ecosystem by way of legislation in the form of Coastal Regulation Zone Notification. Recently Mumbai High Court has ordered freeze on destruction of mangrove forests in Maharashtra and

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has banned construction within 50 meters of them. The court has also directed to notify mangrove areas as protected forests. Thus, there is already a mechanism provided for management of this ecosystem. Unfortunately, however many a times the legal provisions are not being enforced to curb the illegal activities.

In such a situation, protection of the mangrove ecosystem is possible only through the participation of the local community and by building up pressure groups for ensuring management of this ecosystem and strict implementation of the legal provisions by the Government. Thereby, integrity of habitats critical for spawning, juveniles and feeding and for biodiversity, apart from ecological sustainability and community-sustainability could be maintained.

In the past few years there has been an increase in the awareness of the people in Mumbai. Residents associations are coming together to spread this awareness. They realize that the rapid destruction of mangroves along the coast of Mumbai will have far-reaching effects on the city. The NGOs in Mumbai are making efforts to highlight the issues like land reclamation, coastal regulation zone notification and illegal destruction of the mangrove areas through the interventions of the local state government and a local bodies.
The average **population** in **Bandra** is 51275 people per square kilometre – **twice the average population** in overall suburbs. This population is increasing **exponentially** day by day. This indeed has an **effect on the green cover of the city**. **Band stand & Carter Road** are two of the most popular tourist locations in Bandra along the shoreline. Thick **vegetation of mangroves** is replaced by **bare rocks** in these areas giving a dull look to these places. More over, these mangrove vegetations used to be **breeding site** for many of the crustacean species & used to act as **barrier for the seawater** to enter the mainlands thereby protecting the lands from **flooding**.
The state of the mangroves at carter road is really bad and is getting worse day by day, due to the increasing encroachments by people for settlements and shops .As we all have studied about mangroves which are very important for us and form a unique part of our marine ecosystem there is great need to maintain and preserve them. The marine life is also been affected by these destructive actions. We couldn't see a very important part of our biodiversity going through such a dreadful situation, so I and my partner took up this project to study these things in detail and look out for ways to overcome this destruction and bring back the past beauty of carter road. This was our emotional motive behind taking this project. Now the scientific reason behind this work is to preserve the biodiversity and the ethnic beauty of the Carter road area as well as create awareness about their exploitation.

Objective / Rationale :

- To **document mangrove diversity** in Bandra
- To study **the effect of the urbanization and pollution on the** mangrove diversity in the city.
- To **spread this information** among the school & college students and citizens of Bandra thereby taking a step towards protecting the green cover of the city.

Methodology:

Phase 1 : (15 Days)

- Literature survey on the relevant issue
- Survey and Identification mangrove and other plant species from carter road, Mangrove stretch

Phase 2 : (10 Days)

- Document the current status of Carter Road Mangrove

Phase 3: (5 Days)

- Compilation of Data and Report writing

The Study Area - Ecology of Carter Road, Bandra : The Present Scenario

Bandra being one of the coastal suburbs is blessed with a huge diversity in its habitat and ecosystems which not only includes the waterfronts but also the land bound mass of the suburb.
On the western side of the suburb is the Arabian Sea which boasts of an immensely rich habitat harbouring a large variety of clams and shells, coastal fish. Thus making it the perfect environment for waders. An array of *Herons, Egrets, Sea-gulls, Cormorants, Kites, Sand pipers, Plovers, Crakes* are found in abundance.
The Mithi river originating from the Sanjay Gandhi National Park resting to the North of Bandra meets the Arabian Sea just towards the South of Bandra, marking the southern boundary of the suburb. This provides a habitat with fresh and brackish water for the *River terns*, which proliferate in these fish-rich waters. However, the ever-increasing urbanization in the name of development has disturbed both the breeding and feeding habitats of the *Painted Storks* and what seems like an ideal coastal habitat for these waders is increasingly becoming a passed dream due to the ever-expanding human encroachment on the coast, which has polluted the river. The Bandra Bandstand and Carter Road, which are great attractions to all, formerly used to be rocky coasts and mangrove patches. However, these are no longer pristine and healthy as they used to be in the past.

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MANGROVES – A home to many species of Birds and other invertebrates

Mangroves are different types of trees up to medium height found in estuarine regions as well as intertidal regions of shallow bays and the creeks. The mangrove ecosystem is a peculiar habitat found at the interface between land and sea.

For years together, the mangroves which serve as buffers between the sea and the coast, have been commonly viewed as filthy, marshy plants growing uselessly along shores. However, the mangroves play a pivotal role, both economically and ecologically. This varies from providing food, shelter, breeding ground marine life, reduction in wave action, stabilizing coastlines, assimilating sewage water wastes and heavy metals from industrial plants, providing livelihood to local population living along the coastline and of course providing shelter to migratory birds during winter.

Apart from housing a variety of insects, molluscs, crustaceans and reptiles, it also harbors a plethora of birds; both aquatic and tree-dwelling. Some of the commonly found birds here are *Kingfishers, Herons, Storks, Sea Eagles, Kites, Sand Pipers, Bitterns, Egrets, Cormorants, Black winged stilts*, etc. This is because many birds depend on the mangroves for their prey (*Sea Eagles, Kites, Pond Herons, Egrets*, etc) while many thrive on the mangroves since it provides a perfect breeding environment (the likes of *Cormorants and Egrets*). There are around **5-6 species of mangroves** and mangrove associates reported from **Carter Road**. The dominant species of mangroves are *Sonneratia apetala*, *Avicennia alba*, *A. marina*, *Rhizophora sp*, *Bruigeria* sp. Etc. They serve as **breeding ground** for many of the crustacean and other species of animals. These organisms are in turn **food** for many of the birds. They need to be protected to save this ecosystem. Moreover, mangrove belt helps in **checking the inlands from flood.**

With **the urbanization**, mangrove land is becoming the **target for the land developers**. It is time to **create awareness about the significance** of mangrove and protect them **to save the life of mankind.**

View of Carter Road Mangrove Stretch

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The following table depicts the habitat wise distribution of birds recorded in Bandra:

Family	Genus	Species	Common Name
Halcyonidae	***Halcyon***	***smyrnensis***	White breasted King-fisher
Alcedinidae	***Alcedo***	***atthis***	Small blue Kingfisher
Phalacrocoracidae	***Phalacrocorax***	***niger***	Little Cormorant
		fuscicollis	Indian Cormorant
Ardeidae	***Bulbulcus***	***ibis***	Cattle Egret
	Egretta	***garzetta***	Little Egret
		gularis	Western Reef Egret
	Ardea	***alba***	Large Egret
		cinerea	Grey Heron
	Ardeola	***grayii***	Pond heron
	Nycticorax	***nycticorax***	Black crowned Night Heron
Laridae	***Larus***	***brunnicephalus***	Brown headed gull
	Larus	***ridibundus***	Black headed gull
	Chlidonias	***hybridus***	Whiskered tern
Rallidae	***Amaurornis***	***phoenicurus***	White breasted Waterhen
Accipitridae	***Accipiter***	***badius***	Shikra
	Haliastur	***indus***	Brahminy kite
	Milvus	***migrans***	Black kite
Tytonidae	***Tyto***	***alba***	Barn owl
Megalaimidae	***Megalaima***	***haemacephala***	Coppersmith barbet
Muscicapidae	***Copsychus***	***saularis***	Oriental magpie Robin
	Prinia	**socialis**	Ashy Prinia
Psittacidae	***Psittacula***	***krameri***	Rose ringed Parakeet
		eupatria	Alexandrian Parakeet
Maropidae	***Merops***	***orientalis***	Small Green bee eater

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Family	Genus	Species	Common Name
Corvidae	*Rhipidura*	*albicollis*	White spotted Fan tail
	Dicrurus	*adsimilis*	Black Drongo
	Corvus	*splendens*	House Crow
		macrorhynchos	Jungle Crow
	Oriolus	*kundoo*	Golden Oriole
Sturnidae	*Acridotheres*	*tristis*	Indian Myna
	Sturnus	*roseus*	Rosy Starling
		contra	Asian Pied Starling
Nectariniidae	*Nectarinia*	*zeylonica*	Purple rumped Sunbird
Columbidae	*Columba*	*livia*	Blue Rock Pigeon
Cuculidae	*Eudynamys*	*scolopacea*	Asian Koel
Alaudidae	*Passer*	*domesticus*	House Sparrow
Centropodidae	*Centropus*	*sinensis*	Crow Pheasant
Pynonotidae	*Pycnonotus*	*cafer*	Red vented Bulbul
		jocosus	Red Whiskered Bulbul
Scolopacidae	*Actitis*	*hypoleucos*	Common Sandpiper
	Tringa	*ochropus*	Common green Sandpiper
		glareola	Wood Sandpiper
		totanus	Common Redshank
Sylviidae	*Orthotomus*	*sutorius*	Common Tailorbird
	Acrocephalus	*stentoreus*	Clamorous Reed Warbler
	Phylloscopus	*trochiloides*	Greenish leaf Warbler
Passeridae	*Lonchura*	*punctulata*	Scaly breasted Munia
Apodidae	*Apus*	*affinis*	House Swift
Hirundinidae	*Hirundo*	*rustica*	Barn swallow
		concolor	Dusky Crag Martin

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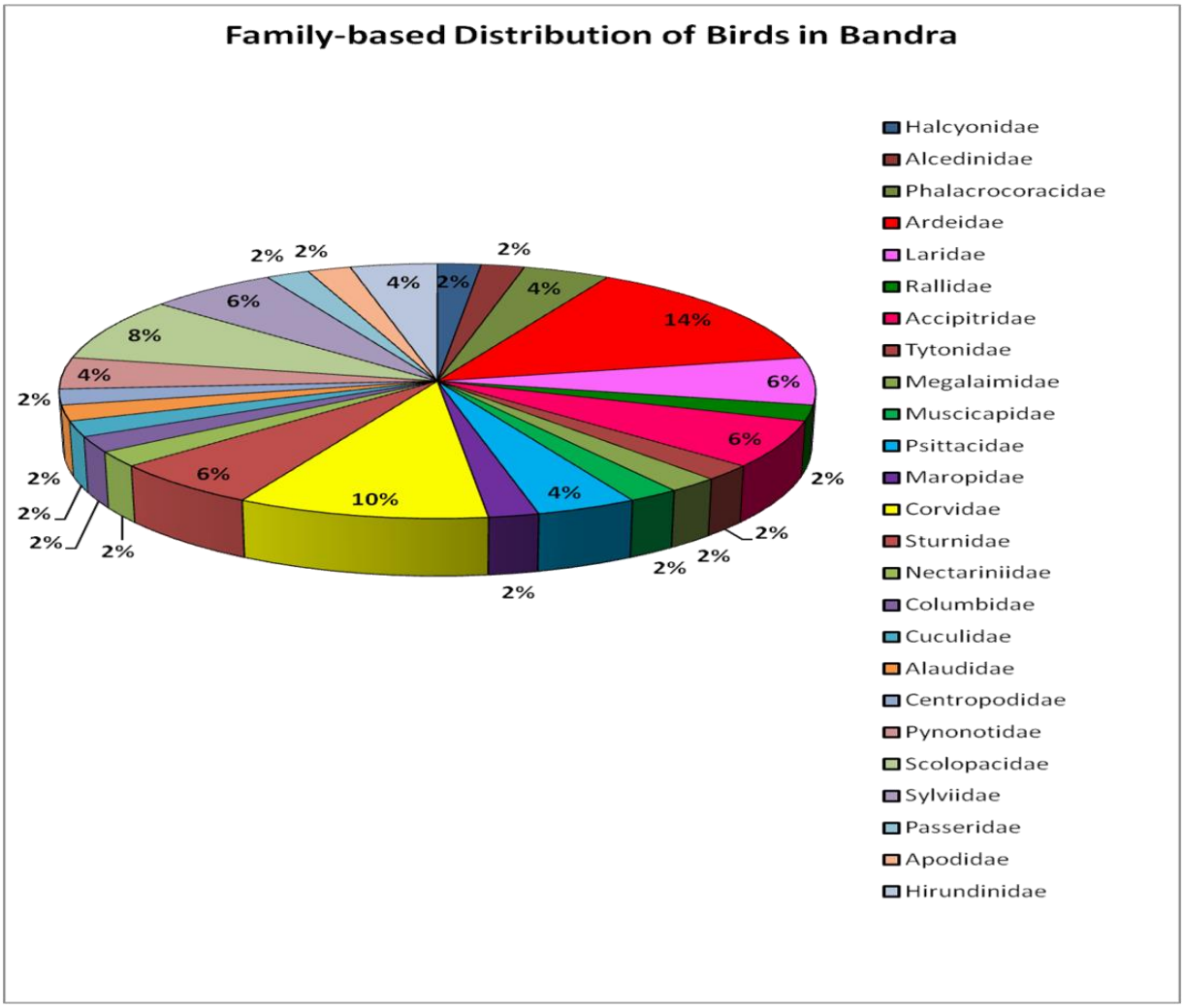

Present scenario of carter road mangroves

Over the years the mangrove population has been steadily diminishing due to a rise in the marine water pollution, over exploitation of shorelines by the local communities and widespread mining of gravel from the sea beds. Sedimentation, coastal erosion and most importantly the housing and industrialization activities have also been cited as the possible reasons for the dwindling numbers of mangroves. Subsequently a sea-level rise may cause stronger wave action, higher tides, and greater probability of surges, all of which may cause coastal erosion and depletion of mangroves, thus aggravating current patterns of physical damage. This poses a serious threat to the mangrove ecosystem, which could be harmful if coupled with reduced silt deposition.

It is estimated that the mangroves with a significant discharge from the land can maintain themselves by accumulating deposited silt with sea level rise as high as 2.5 mm/year. This has put a serious threat on the ecosystem leading to an irreplaceable loss of biodiversity.

During the present survey we have noticed some shocking truth in the mangrove belt at Carter Road. The presence of plants like *Peltophorum pterocarpum, Ficus bengalensis, Ficus religiosa*, etc. reveals that the salinity in this marshy land, which otherwise support the luxuriant growth of mangrove species and its associate is disturbed. This itself is an indicator of the changing ecosystem of this place.

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Garbage thrown in the mangroves

Peltophorum ferruginarum – a terrestrial tall tree growing among Avecinnia sp. At Carter Road

Swampy land becoming solid due to siltation

Some of the noteworthy Mangrove, its Associates and Terrestrial Plant Species on the banks of mangrove land noted by us in Carter Road:

Name of the species	**Family**
Avicennia sp.	- Avicenniaceae
Acanthus ilicifolius	- Acanthaceae
Thespsia populnea	- Malvaceae
Datura metel	- Solanaceae
Vernonia sp.	- Asteraceae
Alternanthera sessilis	- Amaranthaceae
Pongamia pinnata	- Fabaceae
Leucaena leucophloea	- Mimosaceae
Physalis minima	- Solanaceae
Phyllanthus sp.	- Euphorbiaceae
Amaranthus viridis	- Amaranthaceae
Euphorbia hirta	- Euphorbiaceae
Boerhavia diffusa	- Nyctaginaceae
Eclipta prostrata	- Asteraceae
Borreria hispida	- Rubiaceae
Blumea sp.	- Asteraceae
Abutilon indicum	- Malvaceae
Ricinus communia	- Euphorbiaceae
Ficus bengalensis	- Moraceae
Cleome rutidosperma	- Cleomaceae
Portulaca oleracea	- Portulacaceae
Rhizophora sp.	- Rhizophoraceae
Salvadora persica	- Salvadoraceae
Operculina turpethum	- Convolvulaceae
Tinospora cordifolia	- Menispermaceae
Derris scandens	- Fabaceae

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Terminalia catapa	- Combretaceae
Sida acuta	- Malvaceae
Ficus religiosa	- Moraceae
Oxalis corniculata	- Oxalidaceae
Zizyphus mauritiana	- Rhamnaceae
Phoenix sylvestris	- Arecaceae
Sonneretia apetala	- Sonneratiaceae
Syzygium cumini	- Myrtaceae
Abelmoschus sp.	- Malvaceae
Cleome viscosa	- Cleomaceae
Acalypha indica	- Euphorbiaceae
Ipomea biloba	- Convolvulaceae
Crotalaria sp.	- Fabaceae
Brassica juncea	- Brassicaceae
Malachra capitata	- Malvaceae
Achyranthus aspera	- Amaranthaceae
Casuarina equisitifolia	- Casuarinaceae
Coccinia grandis	- Cucurbitaceae
Ludwigia perennis	- Onagraceae
Oldenlandia sp.	- Rubiaceae
Euphorbia sp.	- Euphorbiaceae
Psidium guajava	- Myrtaceae
Celosia argentea	- Amaranthaceae
Avicinnia sp.	- Avicinniaceae
Muntingia calabura	- Muntingiacea

Discussion:

Our observation suggests that there are around 50 species of birds in general, belonging to 25 different families, including 30 species of terrestrial birds, 15 species of waders and 4 species of raptors in Bandra. Most of these birds frequently visit Carter Road and its adjoining areas in Bandra. This indicates that the terrestrial species of birds are more dominant as compared to the waders and raptors, suggesting that the habitats in Bandra are more suitable for the survival of the terrestrial species of birds. **The lesser numbers of waders as compared to the terrestrial species of birds could be attributed to the rising marine water pollution, over exploitation of shorelines by the local communities and widespread mining of gravel from the sea beds in turn destroying the habitats of the waders. But still there's hope.**

"If wetlands are managed properly with help from locals, there is still a possibility that we can revive the population of the feathered friends included in the threatened category. We just have to put in more efforts," said Adesh Shivkar, a city-based naturalist and a bird watcher.

The shocking situation reported by us here is the **siltation in the swamp resulting in the introduction of terrestrial tree species like Pongamia pinnata, Peltophorum ferruginarum, Ficus bengalensis etc.speaks a volume about the health of this significant vegetation. If this is not controlled immediately, a day will come when these terrestrial tree species will replace the mangroves. This will disturb the whole wcosystem.**

Future strategies that can be adopted for protection of Mangroves:

- **Checking** encroachment, destruction and reclamation of mangrove areas.
- **Monitoring** changes in mangrove area, floristic and faunal composition and physiographic.
- **Raising awareness** among the public on the importance of mangroves and the need for their preservation.

Government has declared this zone at Carter Road as **protected area. We as the citizen of this land must be helping the government to conserve them through action oriented programme.**

We at R. D. National College **have started an initiative in the form of a competition entitled "Biodiversity is Life" in which one of the sub topic is - Biodiversity of Mangroves**. This will be the first step just not to create the awareness but, also to **sensitize the students- tomorrow's decision makers regarding the effects of destruction of such habitat** on us.

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Conclusion:

- The present work is an attempt to **create a first hand data about the present scenario of mangrove habitat in Carter Road, Bandra.**
- This will help the concerned authority **to plan and take necessary remedial measures**.

Selected References

- Pocket Guide to Birds of the Indian Subcontinent (Grimmett, Inskipp & Inskipp, 2000)
- Book of Indian Birds (Dr. Salim Ali)
- Environmental protection and the Law – Dr. Vijay Chitnis.
- Google Earth
- Flora of Maharashtra (M. R. Almeida, Vol. 1-5)
- http://www.mangroves.godrej.com/MangrovesinMumbai.htm
- http://articles.timesofindia.indiatimes.com/2012-07-06/mumbai/32564806_1_mangroves-debris-chimbai-beach
- http://envis.maharashtra.gov.in/envis_data/files/Mimportants.html
- http://wikimapia.org/113047/Carter-Road-Mangroves

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The authors would like to thank all the people of Bandra for their help during the survey.
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THREATS TO SEA TURTLE: IT'S THE TIME TO ACT

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Abstract:
This is an article written with a view to create awareness among the populace about the rare and threatened species of sea turtles and the need to conserve them. An effort has been made to present the information in a popular manner. Despite the growing awareness about sea turtle conservation the effort of government to protect the species of sea turtles though the establishment of nature reserves, initiation of special projects for the conservation of threatened species of sea turtles and development of legal and institutional infrastructure, we still have a long way to in creating popular awareness and enlightened public opinion in favour of conservation. In this context, it is hoped that the information brought together in this article would be found useful.
Keywards: Sea turtles; Threats (nature and human); Endangered ; Conservation.

Introduction

Although sea turtle first appeared during the early cretaceous period (140 million yrs ago) , this unusual evolutionary success did not prepare for the arrival of Homo sapiens, the most efficient predator ever to hunt on earth. In fact, sea turtle may hold the unenviable distinction of being the only marine animal to suffer tremendous human induced mortality both on land and in the sea. The obvious result that all seven living species of sea turtles described are declining in no. They routinely travel far from tropics easily reach the North Sea, Barents Sea, New found- land in the Atlantic and ranging from New Zealand to Alaska in the Pacific.

Each yrs thousand of hatchlings turtle emerge from their nest. Sadly, only an estimated one is 1000-10,000 will survive adulthood. The natural obstacles faced by young and adult sea turtles are staggering, because of increasing threats caused by interfere and pollution of the coastal area. These causes made many species of sea turtle rare and endangered.

THREATENED SPECIES OF SEA TURTLE:

1. Loggerhead (*Caretta caretta*)
2. Green turtle (*Chelonia* mydas)
3. **Leatherback** (*Dermochelys coriacea*)
4. Hawksbill (*Eretmochelys imbricata*)
5. Kemp's ridley (*Lepidochelys kempii*)
6. **Olive ridley** (*Lepidochelys olivacea*)
7**. Flatback** (*Natator depressa*)

Natural Threats:

In nature, sea turtle face a host of life and death obstacles to their survival. The turtle lay their eggs in the worm sandy beaches along the coast. Immediately, after hatching the young turtles instinctively dig themselves out of the sand. During this very short period, they are heavily preyed by predator such as raccoons, vultures, alligators, seabirds and large fishes. After they are beyond the hazards of shoreline and surf, they are presumably picked by the ocean current. When they are reaching the adulthood, sea turtle relatively immune to predation, except for shark attach. More recently, Green sea turtles have suffered from an epidemic. The cause is unknown, but is believed to be a tumor causing retrovirus or papillomavirus. (Morrisey. J.F , Sumich J.L 2009, In Biology Of Marine Life 9th ed - research in progress)

To understand what really threatens survival of sea turtles, we must look at the activities of humans.

Anthropogenic Threats:

Harvest for consumption:

Although sea turtle have spiritual or mythological importance in many cultures around the world, this has not prevented humans from consuming their eggs or meat. In many coastal communities, especially in Central America and Asia, sea turtles have provided a source of food. During the resting seasons, turtle hunters comb the beaches at night looking for nesting female. Often, they will wait until the female has deposited eggs to kill her. Then they take both the eggs and the meat. Additionally people may use other part of turtle for products, like oil, cartilage, skin and shell. In Caribbean region in 18th century were about 33million Green sea turtle, but today less than 5000 Green sea turtle have been estimated, because of over hunting for it's meat, eggs, and soup. A film shot in 1947 shows about

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40,000 female Kemp's ridley turtle coming ashore at Rancho Nuevo simultaneously in an incredible phenomenon known as an *arribada* (Spanish for ''arrival''), but in 1995 only 580 nests were counted. Historically, the eggs of Kemp's ridley turtle sold in local bar. (Morrisey. J.F , Sumich J.L 2009, In Biology Of Marine Life 9th ed - research in progress)

Illegal shell trade:

Hawksbill sea turtles which are found in all tropical seas, have their own unique problem unlike other sea turtle, they do not shed their skin by exfoliation, but recognized for their beautiful gold and brown shell, have been hunted for centuries to create jewelry and other luxury items. As a result, these turtle now listed as critically endangered. While illegal trade is primary cause of this decline, the demand for shells continues today on the black market.

Commercial fishing:

Each yrs thousands of adult and immature sea turtle are accidentally captured in fisheries ranging from highly mechanized operations to small-scale fisherman around the world. Other fisheries that accidentally take turtles include dredger, trawls, pound nets, pot fishers, and hand lines. Global estimates of annual capture, injury and mortality are staggering- 150,000 turtles of all species killed in shrimp trawls, more than 200,000 loggerheads and 50,000 Leatherbacks captured, injured or killed by long lines, and large nos. of all species drowned in gill nets. Extent of gill net mortality is unknown, and the drowning of sea turtles in gill nets may be comparable to trawl and long line mortality.(on www.jbpub,com.)

In U.S. the fedral government worked with the commercial shrimp trawl industry to develop Turtle Excluder Devices (TEDs). The grid is fitted into the neck of a shrimp trawl. Small animals are caught in the bag end of the trawl, whereas lager animals such as marine turtles are captured in the trawl they strike the grid bars and are ejected through the opening. Today, all U.S. shrimpers are required to put TEDs in their trawl nets. Unfortunately, not all fishermen comply with the law, and sea turtles continue to drown in shrimp nets.

Since, 1960, high mortality occurs in the nets of Gulf of Mexico shrimp trawlers when turtles accidentally down before the trawl gear is retrieved, even though Kemp's ridley turtles have received full legal protection from the Mexican government.

Marine debris:

It is estimated that more than 100 million marine animals are killed each yr due to plastic debris in the ocean. More than 80% of this plastic comes from land. For ex: In 1930s when plastics where introduced, it creates pressure on the Hawksbills. As a result thousands of sea turtles accidentally swallow these plastics, mistaking them for food. Leatherbacks especially, cannot distinguish between floating jellyfish (a main component of their diet) and floating plastic bags. Most the debris is recognizable- plastic bags, balloons, bottles, degraded buoys, plastic packaging and food wrappers.

Turtles are affected to an unknown, but potentially significant degree, by entanglement in persistent marine debris, including discarded or lost fishing gear steel and monofilament line, synthetic and natural rope, plastic onion sacks and discarded plastic netting materials. Some plastics aren't so easy to see, so small, in fact, that it is invisible to the naked eye. If sea turtles ingest these particles they can become sick or even starve.

Artificial lightening:

Sea turtles were pivotal in educating us that artificial lights affect the reproductive success of sea turtles. Under normal circumstances, the sea at night is brighter than adjacent land (because of the reflection of celestial bodies off its surface). Nesting turtle depends on dark, quite beaches to reproduce successfully. Today, these turtles are endangered, in part, because they must compete with tourists, business and coastal residents to use the beach.

Post nesting females and emerging hatchlings are attracted to this brightness and normally use it to find the sea. Unfortunately, artificial lights, such as street lights and other sources of shoreline illumination (such as high-rise hotels), overwhelm the dim reflections of the ocean's surface and cause nesting females and hatchlings to head for land rather than the sea. There they soon die because of predation, exhaustion, dehydration, or impacts by motor vehicles.

Oil spills:

The wreck of the tanker Torrey Canyon of the English coast in 1967 was the first oil spill that awakened the international community to the dangers of oil transport.(Levinton.J.S.-Marine Biology function ,biology ,ecology2nded) Marine pollution can have serious impacts on both sea turtles and the food they eat. New research suggests that a disease now killing many sea turtles may be linked to pollution in the oceans and in the near shore waters. When pollution enters the water, it contaminates and kills aquatic plant and animal life that is often food for sea turtles. The 1992, shrimp season in Saudi Arabia fell to 33% of the normal harvest. Hundreds of endangered sea turtles died in oily

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inshore waters. Oil spills, urban runoff from chemicals, fertilizers and petroleum all contribute to water pollution. Because the ocean is so large, many incorrectly assume that pollutants will be diluted and dispersed to safe levels, but in reality, the toxins released from these pollutants become more concentrated as they break down in size. As a result, these smaller, more toxic particles become food for many links in the food chain, including sea turtles.

Climate change:

Since, due to tireless effort of the scientific community, a fool proof case demonstrating the causal links between increased accumulation of carbon dioxide and other green house gases in our atmosphere, the resultant warming of our planet, concomitant climate change has been developed. Because sea turtles use both marine and terrestrial habits during their life cycles, the affects of climate change are likely to have a devastating impact on these endangered species. Climate change affects nesting beaches. With melting polar ice caps and rising sea levels, beaches are starting to disappear. As the water level begins to rise, the size of nesting beaches decreases. Stronger storms, predicted as a result of increasing temperature, will continue to erode coastal habitats. Higher temperatures can adversely affect sea turtle gender ratio. Increasing incubation temperature could result in more female sea turtle, which reduces reproductive opportunities and decreases genetic diversity.

Ocean acidification caused by climate change results in affecting the size and weight of shells and skeletons, and the trend is wide spread across marine species; said by British Antarctic Survey (BAS), (9th Aug'2012 in times of India). The IPCC publishes an assessment report at regular intervals, the first of which appeared in 1990, the second report appeared in 1995, the third appeared in 2001 and the fourth was appeared in Feb 2007, predicted that if the emission are not decreased the climate change will keep on coupling. . (Morrisey. J.F , Sumich J.L 2009, In Biology Of Marine Life 9th ed - research in progress)

Conclusion; it is time to act!

It is estimated that only 1500 individuals of ridley turtle exist today. The conservation of sea turtles has achieved considerable success thanks to concentrated efforts of the research organizations. The forest and fisheries departments of several state governments are also assisting the conservation programme. The coast guards need special mention for the yeoman service being rendered by it in conserving the marine life, especially the sea turtles by constantly patrolling the nesting beaches frequented by sea turtles and restraining the illegal operations of mechanized trawlers and high power launches of poachers.

In the nongovernment sector, the field biologists have been carrying out field surveys along the entire coastal belt of the country including the remote areas to study the status and ecology of the sea turtles. In so far as the conservation of turtles inhabiting the inland waters is concerned, the government has taken up an ambitious programme of conserving turtles. The forest department is also taking similar measures to conserve the turtle resources. Olive ridley sea turtle is protected under schedule 1 of the India Wildlife Protection Act (1972) as coastal pollution and development projects on sea coasts have had an adverse effect on the species.(S.M. Nair 2006-Endangered Animal Of India and their Conservation)

BIBLIOGRAPHY

- Murthy,T.S.N. (2010). "The Reptile Fauna of India" 1st ed. B.R. Publishing corporation. pp.47-56,230-231.
- Young, J.Z. (1969). "The life of vertebrate" 2nd ed. pp.397
- Bellairs, A.A. (1990). "Reptiles" 3rd ed. pp. 68-71
- 4."The world book encyclopedia of science: The animal world." World book INC .A Scott Fetzer company Chicago. pp.80
- Kalman, B. (2004). "Endangered sea turtles''. Crabtree publishing company. pp. 8-10
- Morrissey , J.F. and Sumich, J.L.(2009). "Biology of Marine Life''-9th ed. Jones and Bartlet publishers. pp. 175-379
- Nair, S.M. (2006). "Endangered Animals of India and their Conservation''. National book trust India pp.73-77
- 8. Committee of sea turtles conservation et.al. "Decline of the sea turtles: Causes and Prevention" Washington D.C. National Academy Press, 1990 pp. 118-153
- Pritchard, P. (1967). ''Living turtles of the world''. T.F.H. Publication, Neptune, New Jersey pp.261-263
- Agastheesapillai, A. and Thiagarajan, R. (1979). ''Biology of green turtles in the Gulf of Mannar and Palk Bay''. J. Mar Biol. Assn. India pp. 45-60
- Levinton, J.S. (2001). ''Marine Biology –Functions,Biodiversity,Ecology''-2ndEd. Oxford University Press. pp.470-472
- http://www.conserveturtles.org http://www.seeturtles.org http://www.turtles.org http://en.wikipedia.org http://www.nmfs.noaa.gov http://www.wwf.org.au http://oceana.org

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STUDY OF HEAVY METALS IN COASTAL ECOSYSTEM OF ELEPHANTA CAVES ISLAND, MUMBAI

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ABSTRACT

Water is essential for life. Oceans form 70% of total landmass and have a large diversity in life forms. With the advent of industrialization man has explored almost the whole of the Universe and living hutments have come on almost all parts of earth despite the fact that some of them are unable to conceive life. Once inhabited the human activities towards modernization have started taking its toll on these places which have disrupted the ecological balance.

Water pollution is a growing concern and a lot of research is being carried out in this field. Though Elephanta Caves is a famous tourist spot of Mumbai city, this island in the coastal region has not received much attention pertaining to the ecological and water pollution status. The present investigation has been undertaken to study hydrological parameters, heavy metals in the water, marine fauna and mangrove species in and around Elephanta Caves. This tourist spot is open for public and attracts many foreign tourists. It is therefore important to maintain not only the ecological balance but the natural beauty of its surroundings as well.

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