Author Index

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'FAVEO 2013'

29th and 30th November 2013

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Chairman's address

It gives me immense pleasure to hand over the proceedings of National Conference on "Biodiversity: Status and Challenges in Conservation FAVEO 2013" to be held under the auspices of V.P.M.'s B. N. Bandodkar College of Science, Thane.

Twentieth century saw some revolutionary scientific break through leading to huge consumer industry growth. Every available opportunity was used to exploit the natural resources beyond its sustainability. Success was measured in terms of per capita consumption of natural resources. Modernity and development became synonymous with this consumption model, which totally ignored the interconnectedness of the nature and man. A new economic model and life style to suit this consumption model became *mantra* of progress and modernity. Respect to mother earth was the basis of traditional society. Every member of family was taught to make compromises at every stage of life in the traditional model of the society. This fabric was destroyed and society was nurtured to become self-centered to suit the consumer model. Obviously this model led to disastrous environmental consequences. Biodiversity became its first victim.

Scientific community did recognize this environmental impact of human life style and consistently advocating a sustainable model of development with respect to biodiversity. Ideologically committed environmental moments have done more damage and all efforts should me made to isolate them from science-based activity. Reform does not mean reckless change in traditional way of life. Indian culture did respect biodiversity, and all efforts to restore that fabric of the culture should be done with all priority as a part of biodiversity restoration moment.

I am sure deliberations of this conference will throw light on many dark corners of this subject and participants will be richer in knowledge by the end of the day.

I wish this conference a grand success.

Dr. Vijay V. Bedekar
Chairman
Vidya Prasarak Mandal, Thane

Convener's note

Biodiversity is the word which has gained a lot of importance in the last decade. When we talk about biodiversity, it includes the diversity of all living beings. But it also indicates the need for conservation of same.

The biodiversity on the land, water or air varies due to the adaptations of various organisms for the specific environment. Hence, we can see the biodiversity varying in different ecological conditions, climatic conditions as well as geographical conditions.

Thus, to conserve this we need to protect the environment; else the diversity of organisms will perish one day. Therefore, we have to bow in front of goddess 'Faveo' to bless the earth and the biodiversity existing on earth. An attempt is made by staff and students of departments of Zoology and Environmental Science for praying to the Goddess 'Faveo' to bless us.

I am thankful to both the departments for taking all possible efforts to make this conference successful and happy to hand over the proceeding to you.

Principal Dr. (Mrs.) Madhuri K. Pejaver
Convener
B. N. Bandodkar College of Science, Thane

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WORKSHOP 1 - 27th July 2013








WORKSHOP 2 - 28th September 2013









Peacock pansy

Red pierrot

Wonderer

Plain tiger

Grey pansy

Angled castor

Salmon arab

Sun beam

Zebra blue

Blue tiger

Black raja

Common palm fly

Honey bee

Drosera spp.

Utricularia sp

Spotted dear

Hanuman langur

Roux's forest lizard

Malabar whistling thrush

Bulbul

Fan throated lizard

White eye

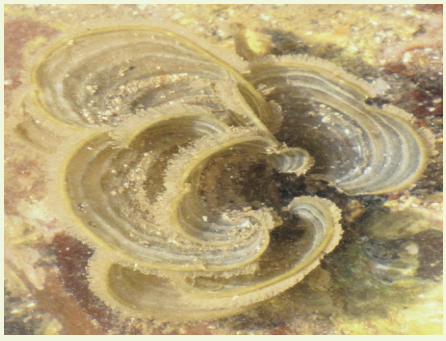
Glossy ibis

Collared scops owl

Sponge

Eel

Sea urchin



Padina

Feather star

Turbo

Diversity of Spiders and the free Economic Services by Them

Ganesh Vankhede
Indian Society of Arachnology
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Spiders are polyphagous and feed on a variety of available prey. They not only prey on adult insect pests but also feed on their eggs and larvae. They help in maintaining the ecosystem balance. Spiders are good friends of farmers as they control all types of pests on the crop. Some spiders like *Geolycosa* and tarantulas, make burrow in soil and thus help in water percolation. Most of the spiders in nature feed on mosquitoes and protect us from Malaria and similar other mosquito borne diseases. Some Pisaurid and tetragnathid spiders feed on mosquito larvae. The mud wasps and some birds feed their young ones with spiders as spiders are rich in simple proteins.

The secretions of spiders are boon for human beings. For example Silk. Spider silk has high tensile strength, four to five times more than that of iron. Hence, the recombinant silk produced on large scale is used to manufacture cloth from which bulletproof jackets are manufactured. If spider silk rods of 5mm diameter are used in building construction instead of iron rods, earthquake proof houses can be constructed as silk is elastic. This is the nature's gift which is of great use for the army of any country. Parachute ropes can also be manufactured from spider silk. German scientists have manufactured guitar strings from spider silk. Spider silk is antibiotic and hence surgical threads and bandages are prepared from the spider silk. This silk is biocompatible with human beings. Most of the birds internally line their nests with spider silk because the spider silk is smooth and antibiotic. If young ones are injured with grass-blades or their pointed tips, they do not get bacterial infection as they are in contact with antibacterial silk. Spider silk covering the egg sacs of spider reflects UV rays and thus protects the tiny delicate eggs. With this property, the spider silk is now a days used to manufacture UV reflecting cloths. Spider venom is used to manufacture medicines against cancer and now a days pesticides are also manufactured from spider venom. Astonishingly, the spider venom is not venomous for humans, only slight allergic responses are seen after envenomation.

According to the World Spider Catalog, Version 14.0 by Platnick (2013), the updated list documented 44,032 species of spider worldwide belonging to 3,905 genera and 112 families. However from India only about 1,600 spider species are known from 60 families.

Key words **:** Spiders, diversity, economic services

An Oveview of The Breeding Behaviour of Indian Grey Hornbill in Nagpur, Maharashtra

Dr. Raju Kasambe

Project Manager, IBA Programme, Bombay Natural History Society, Mumbai.

Indian Grey Hornbill (*Ocyceros birostris*) is the only hornbill species in India which is also found in urban habitats besides in forested areas. It's breeding behaviour was studied for two consecutive breeding cycles during 2007 and 2009 in an urban environment in Nagpur city, Maharashtra. In 2007, four nests were located and in 2008, two additional nests (thus a total of six nests) were located. The date of incarceration of the female was between 9 March and 2 April (mean date 20 March+12 days) (n=16). The average duration of incarceration of the female inside the nest was 65.5+4.5 days (n=12). The nesting cycle completed in 93.5+5days (n=9). Only 15 chicks edged from the 16 nesting attempts. In three nesting attempts, the chicks disappeared during the period of a few days after the female had left the nest and the nest cavity had yet to be sealed back by the chicks. This appeared to be the most vulnerable period of the hornbill's breeding cycle.

Inter-specific and intra-specific competition for nest sites and for food with other birds was documented. It was found that there is severe competition for nest sites and all the nests were occupied by other bird species as soon as the hornbills vacated the nest cavities. The social behaviour of the hornbills was studied and the hornbills were found to indulge in bill-grappling and aerial jousting behaviour which were not reported previously in the species. The nest sanitation methods were studied and some interesting findings were documented.

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Prominent Biological Indicators : Do we have in India?

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Indicators are signs that act as signals to tell us something is changing. Everyday experienced and the simplest indicators are traffic signals with green, yellow and red lights. The biological indicators obviously point out about the presence, condition and numbers of types of living organisms or species at community or ecosystem level. These organisms provide important information about the health of our ecosystems. Studying these indicators as a way of evaluating the health of a body of water is called biological assessment. The parallel to the assessment of human health is obvious. We go to doctor to get diagnosis and hopefully initiate treatment to bring us back to normal or healthy conditions. Doctors will apply several indicators such as pulse, blood pressure sugar in blood & urine etc to assess and diagnose the disease. The assessment of health of ecosystem is similar. We observe that an ecosystem is not healthy and ask what is wrong? And what can be done for bringing it back to normal? To answer these questions ecologists try to diagnose by certain biological, or more precisely, ecological indicators.

Often quoted and the most effective indicator was from a book, *Silent Spring* written by Rachel Carlson way back in 1962 that revealed want of birds' chirping, twittering and singing in North America during spring. It was an indicator of widespread pesticide pollution that killed several insect species; but the unscrupulous eradication of insects by the pollution was sensed cumulatively by the absence of birds. Primarily, biological indicators are species that can be used to assess the diversity of organisms (biodiversity) in the environment (in a particular ecosystem) and monitor the health of an ecosystem. The basic aim of use of bio-indicators is to warn about emerging catastrophes at an early stage. One simple example is the presence of "lichens" which indicates good quality of air in the pristine environment around us, while its absence would point out urban polluted air owing to emission of several obnoxious gases (SO_2, NO_x etc). Similarly, Tubifex worms indicate oxygen-poor and stagnant water unfit to drink while dwindling species of fish and amphibians in our aquatic environment indicates presence of pesticides. Recently, some parts of Karnataka and Kerala in India recorded abnormal fall in population of damsel fly and dragon fly which can be considered as prominent indicators of Endosulphan which is a banned pesticide in Europe and its impact was not investigated in India before it grabbed media attention when a doctor practicing in one of the villages noticed large number of cancerous abnormalities among his patients. These insects were the first creatures wiped out by pesticide use. If an ecologist or nature lover had detected the change, use of the pesticides and cancer among the people could have been averted. These are the simplest or qualitative indicators of change which can be easily understood by the layman and scientifically justifiable. Policy makers also look for such simplistic indicators that have great public appeal and impact.

The indicators should be based on who will be using the information from the indicators. There are generally three possible users, each with different information needs. They are: 1) technical experts and science advisors, 2) policy-makers, decision makers and resource managers, and 3) general public and media. The technical experts and scientists will be interested in detailed and complex indicators which should have scientific validity, sensitivity, responsiveness and have data available on past conditions. The policy-makers and resource managers will be concerned with indicators that are directly related to evaluating policies and objectives. They require their indicators to be sensitive, responsive and cost-effective and have meaning for public awareness. Finally, the general public responds to indicators that have clear and simple messages and are meaningful to them.

Bio-indicators are any biological species or group of species whose function, population, or status can reveal what degree of ecosystem integrity is present. They include species, biological communities and processes which are used to assess the quality of the environment and how it changes over time. Changes in the environment are often attributed to anthropogenic disturbances (*e.g.,* pollution, land use changes, habitat degradation) or natural stressors (e.g., global warming, drought, cold, cyclone etc), although anthropogenic stressors form the primary focus of bio-indicator research.

Macro-invertebrates are useful and convenient indicators of the ecological health of a water body or river. They are almost always present, and are easy to sample and identify. The sensitivity of the range of macro-invertebrates found will enable an objective judgement of the ecological condition to be made. In Australia, the SIGNAL method has been developed and is used by researchers and community *Waterwatch* groups to monitor water health. In the United States, the Environmental Protection Agency (EPA) has

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published *Rapid Bioassessment Protocols,* based on macro-invertebrates, as well as periphyton and fish. These protocols are used by many federal, state and local government agencies to design bio-surveys for assessment of water quality. The species identification procedures are conducted in the field without the use of specialized equipment and the techniques. In South Africa, the Southern African Scoring System (SASS) method was developed as a rapid bio-assessment technique, based on benthic macro-invertebrates and used for the assessment of water quality in Southern African rivers.

The widespread development and application of biological indicators has occurred primarily since the 1960s. Over the years, range of biological indicators has expanded to assist us in studying all types of environments using every major taxonomic group. The idea to apply an assessment of ecosystem health in environmental management emerged in the late 1980s. Therefore, these are more commonly called ecological health indicators. The advanced scientific indicators are not only qualitative but also quantitative which point out the degree of disturbance and damage to the ecosystem. They are expressed numerically as indices of integrity, stability, resilience, diversity and complexity of components of an ecosystem.

However, at this juncture it is better to distinguish between indicator species and the '*bio-accumulative indicator species*' used in pollution/toxicological studies. The bio-accumulative indicator species whose appearance and dominance is associated with deteriorating environment have high tolerance as compared to less resistant species. To understand degree of organic pollution Bellan (1967) used polychaete based index while Bellan and Santini (1981) used amphipod based index. Roberts *et al*. (1998) have proposed an index based on macrofauna species that accounts for ratio of species abundance in control and stressed areas. More recently, AMBI index uses species classification as tool for detecting pollution (Borja *et al*., 2000). This index has been considered useful for application in European Water Framework in coastal and estuarine ecosystems.

In marine and coastal ecosystem, vegetation of green algae *Ulva, Enteromorpha, Cladophora, Chaetomorpha* and red algae *Gracilaria*, *Porphyra* and *Corallina* is considered indicator of pollution while *Fucus* and *Laminaria* belonging to Pheophyta as well as all submerged marine Spermatophytae which are sensitive to any kind of pollution are indicators of good quality water. Most of the ecosystems are complex with multiple component species. Using a single or isolated species as indicator for a complex system is dangerous therefore, attributes of many species of the ecosystem are taken together to have a single indicator. This is a reductionist approach in which a single indicator is set which can be used easily understood for management of a resource in an ecosystem. In marine fisheries earlier indicators were based on the fish assessments of single species stocks and no consideration was given to the ecosystem for judging the impacts. It is increasingly realized now that changes in ecosystem could be due to ecological as well as exploitation parameters on in combination of both. In this situation a single indicator of fishery in balance (FIB) has been computed by taking in to consideration different ecological groups of exploited marine fishes and their mean trophic levels.

The ecological indicators applied today can be classified on eight levels from reductionist to holistic indicators (Jorgensen *et al*., 2010).

Level 1 covers presence or absence of specific species as shown by damsel fly and dragon fly in Karnataka and Kerala. The best known type of indicator is the 'Saprobien system' (Hynes, 1971) which classifies streams based on degree of pollution as shown by the presence of different species as indicators species.

Level 2 uses ratios between classes of organisms.

Level 3 is based on concentration of chemical compounds e.g. in eutrophication, PCB and heavy metal contamination.

Level 4 applies concentration of entire tropic level as indicators e.g. high concentration phytoplankton as indicator of eutrophication of lakes. Similarly, high fish biomass or good number of bird species are indicators of good water quality and healthy forest respectively.

Level 5 uses rates as indicators; for instance, primary production ($g/m^2/d$) determination is used as an indicator for eutrophication. Similarly, annual growth of trees is used as indicator of healthy forest and conversely high mortality in a population can be used as an indicator of unhealthy environment.

Level 6 covers composite indicators such as ratios of respiration/biomass, respiration/production, production/biomass and primary producers/consumers. However, these ratios are also used to indicate whether an ecosystem is in early stages of development or in a mature state.

Level 7 encompasses holistic indicators such as resistance, resilience, buffer capacity, biodiversity, connectivity of the ecological network and turnover of carbon, nitrogen etc. It is known that high resistance, high resilience, high buffer capacity, high biodiversity and high connectivity of the networks are indicators of a healthy ecosystem.

Level 8 indicators are thermodynamic variables which may be called as super holistic indicators. Such indicators are exergy, emergy, entropy production and mass and/or energy

retention time. Ecological benefits (services & utilities) belong to this level.

Many policy and management bodies with an interest in aquatic or marine systems have endorsed indicator-based approaches to management (FAO, 2002; World Bank, 2002). In all cases, the agencies note that ecosystems are so complex and unpredictable that suites of indicators are needed to give an adequate picture of their state. In fact, it is often noted that suites of indicators are needed for each dimension of sustainability: ecological, social, economic, and institutional (Charles, 2001; FAO, 2003). Indicators now have a prominent and legitimate role in monitoring, assessing, and understanding ecosystem status, impacts of human activities, and effectiveness of management measures in achieving objectives, and they have a growing role in rule-based decision-making. Recently work on the state of global biodiversity (Butchart *et al*., 2010) compiled 31 indicators to substantiate biodiversity loss at 3 levels namely state, pressure and response. Most indicators of the state of biodiversity covering species, population trends, extinction risks, habitat extent and community composition showed decline whereas those of pressure such as resource consumption, invasive alien species, overexploitation and climate change showed increase.

This symposium will open vistas to set indicators at species, community and ecosystem levels at local, state and national levels so that policy makers will be sensitized to save our environment and biodiversity.

Impact of pollution on the flora and fauna – a loss of ecosystem services

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Biodiversity has multiple values owing to the different ecosystem services it provides. The types of values include economic, social and environmental, many of which are poorly recognized and/or understood. Species provide a variety of functions and help maintain relatively stable ecosystems. Our understanding of the functioning of biodiversity within ecosystems needs to be improved. The information on the status and trends of biodiversity allows for patterns to be identified as well as to determine the consequences of biodiversity loss.

The increasing demand for food, fiber and fuel will lead to increasing losses of biodiversity and ecosystem services. The variety and variability of animals, plants and microorganisms are an important aspect of biodiversity. Globally most of the natural habitats including forests, wetlands and coral reefs are in a state of decline. The habitat loss, including degradation and fragmentation, is the most important cause of biodiversity loss globally. Some agricultural, aquaculture and forestry practices are also a major cause of biodiversity loss. Habitats, which are highly degraded or fragmented, are less likely to be able to support their full compliment of species or provide the same level of ecosystem services provided by intact habitats.

Pollution is a major concern of all countries and a known threat to biodiversity. Pollution refers to chemical contaminants that are introduced to the environment resulting in instability or harm. Pollution can take numerous forms as a variety of chemical compounds can cause environmental damage depending on their properties and concentrations. Nutrient loading in particular, primarily of nitrogen and phosphorus is a major and increasing cause of biodiversity loss and ecosystem dysfunction, especially in wetland, coastal and dryland areas. As nitrogen and phosphorus are often limiting nutrients in many ecosystems when they are present in excessive quantities they can result in rapid plant growth which can alter ecosystem composition and function. Common causes of excessive nutrients are sewage and agricultural runoff.

Pollution by invasive alien species (IAS) is also one of the main direct drivers of biodiversity loss at the global level. In some ecosystems such as island ecosystems the IAS are the leading cause of biodiversity decline. Any organism can become invasive; the phenomenon is not limited by taxonomic group and can occur in all types of ecosystems. The IAS primarily affect biodiversity by preying on native species or competing with them for resources. Increasing travel, trade and tourism have facilitated the movement of species beyond natural bio-geographical barriers by creating new pathways for their introduction. While a small percentage of introduced species become invasive, the negative impacts can be extensive. In addition to their environmental impacts, IAS can pose a threat to food security, human health and economic development.

All ecosystems provide goods and services. However, some ecosystems are particularly important for human well being because of the services they provide and fulfill their daily needs. The unsustainable use or over exploitation of these resources is one of the main threats to biodiversity. Overexploitation is a severe pressure on the ecosystems that leads to the loss of biodiversity and ecosystem structure. In addition, the unintentional impacts would result in loss of species and damage to habitats. Pressures on species and ecosystems must be kept at levels that do not undermine the long term sustainability of the ecosystems thereby allowing them to provide ecosystem services. Sustainable management not only contributes to biodiversity conservation but can also deliver benefits to production systems in terms of services such as soil fertility, erosion control, enhanced pollination and reduced pest outbreaks as well as contributing to the well-being and sustainable livelihoods of local communities engaged in the management of local resources.

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Biodiversity of Thane Creek.

R. P. Athalye

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Abstract: Thane creek (Long 72° 55' to 73° 00'E and Lat 19° 00' to 19° 15' N) is 26 kms long. It is connected to the Mumbai harbour on its south and joins by minor connection with Ulhas River on its North near Thane city. The creek supported diverse life forms around 1960 -1980 and earlier. A few decades back heavy industrialization and consequent urbanization have occurred along both the banks of the creek. The growing pollution in the creek has resulted in significantly low dissolved oxygen, high nutrients, siltation, declined fishery and biodiversity especially in the upstream part of the creek where pollution is higher. In the lower stretches of the creek the pollutants get diluted hence it supports relatively higher diversity. The creek supports good diversity of mangroves and birds including Flamingos. These observations suggest that in spite of the polluted status of the creek, it is possible to revive the creek ecosystem if remedial measures such as reduction of sewage and solid wastes at source, desiltation of the creek, plantation of mangroves, prevention of silt in runoff are implemented. The local fishermen can be encouraged to practice creek and mangrove based productive activities.

Introduction

Estuaries and creeks are coastal aquatic ecosystems which have connection with the open sea. Due to this reason they are influenced by the oceanic high and low tides. The tidal incursion of marine water produces brackish water conditions due to mixing of fresh and saline waters. This leads to formation of salinity gradient with high salinity on the seaward side and low salinity on the riverine end. Even at a station in the creeks and estuaries, the salinity varies with the tides, which is in fact the unique feature of these ecosystems. Many organisms that have physiological ability to tolerate the varying salinities take shelter in different zones and establish themselves. As there are many salinity zones, there are diverse faunal types in the creeks and estuaries.

In these ecosystems the sea water penetrates deeper and hence the wave force weakens to make the environment calm as compared to the sea. This facilitates settling of silt, clay and nutrient rich humus brought by the rivers leading to formation of mudflats. The soft sediment mudflats favor establishment and growth of specially adapted mangroves. The root system of mangroves enhances the mudflat formation, finally leading to development of dense mangrove vegetation.

Mangrove forests are very vital ecosystems as they provide support to a complex community assemblage, reduce coastal erosion and serve as sinks for macronutrients, micronutrients and heavy metals. The mangrove plants take nutrients from the tidal seawater and river water and in turn provide natural food to mangrove dwelling fauna (Odum *et al.,* 1982). The forest detritus comprising of fallen leaves and branches from the mangroves, provides nutrients to the marine environment and supports immense variety of sea life in intricate food webs associated directly through detritus and indirectly through planktonic and epiphytic algal food chain (Martinez *et al.,* 1982). As the creeks, estuaries and mangroves along their banks are nutrient rich ecosystems, many marine and freshwater fishes visit them for laying their eggs. The young ones grow in these sheltered breeding grounds and then migrate to the sea. There are others which venture into these ecosystems with high tide to exploit them as feeding grounds. Thus, estuaries creeks and mangroves being the feeding and breeding grounds of many marine organisms play an important role in supporting the fishery.

Thane creek (Long 72° 55' to 73° 00'E and Lat 19° 00' to 19° 15' N) is 26 km. long. It is connected to the Mumbai harbour on its south and joins by minor connection with Ulhas River on its North near Thane city (Plate 1). The creek is narrow and shallow at the riverine end due the presence of geomorphic head near Thane city and is broader and deeper towards the sea. It is tidally influenced with dominance of neretic waters and negligible fresh water flow except during monsoon. The substratum of the creek is made up of consolidated and unconsolidated boulders intermingled with the loose rocks and rarely with sand and gravel. Extensive mudflats are formed along the banks of the creek which are characterized by growth of mangroves.

The creek supported diverse life forms around 1960 - 1980. Though there are no systematic studies on the phytoplankton, zooplanktons, benthos during that period, the creek was famous for its fishery. A variety of fish types, prawns, crabs, mudskippers, bivalves like *(Cardium)* spp., Katalysia spp. were available in the creek till 1980. But then this picture changed gradually due to various anthropogenic activities.

A few decades back heavy industrialization and consequent urbanization have occurred along both the banks of the creek. On the east bank exists Asia's largest industrialized zone namely Thane Belapur industrialized area along with the Navi Mumbai Urban area. The west bank has

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highly urbanized Mumbai and Thane region along with a good number of industries. Not only the industrial effluents and domestic wastes are being released in the creek but since 1995 the creek is also being indiscriminately used as a dumping ground for huge quantity of solid wastes. In spite of these hazardous human activities the creek has still retained life in some areas and there are chances of its revival if we adopt certain remedial measures. This presentation is based on the work done in B. N. Bandodkar College since 1984. (Athalye,1989; Gokhale and Athalye, 1995; Quadros Goldin, 2001; Athalye *et al.*2003)

Materials and Methods:

For analysis of abiotic and biotic components standard methods (APHA, AWWA, WPCF., 1981) were used in all the studies. The study included the parameters of water, sediment, phytoplankton, zooplankton, benthos and fishery.

Discussion:

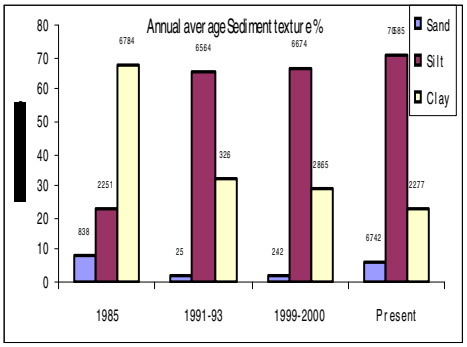
Following table shows the changes in the important water parameters that have occurred during period 1975 to 2002.

Table1. Comparison of the water parameters of Thane Creek during period 1975 -2002.

Sr. No.	Parameter	1975	1984-85	1991-93	1999-2000	2002	Remarks
1	Suspended solids g/l	--	0.731	0.953	6.12	2.017	Unpolluted water limits 1 gm/l
2	PH	--	7.83	7.49	7.71	7.82	
3	Salinity ppt	36.31	29.4	25.13	19.22	23.4	--
4	Dissolved Oxygen mg/l	6.79	5.21	4.09	2.4	2.1	Unpolluted water limits 2.4 mg/l
5	PO_4 –P mg/l	0.127	0.178	0.24	0.26	0.1	Unpolluted water limits 0.09 mg/l
6	NO_3-N mg/l		0.35	0.38	0.9	0.98	Unpolluted water limits 0.014 mg/l
	lower stretch						Semi healthy 1.26 mg/l
7	NO_3-N mg/l		2.5	18	1.5	1.7	
	Upper stretch						As above
8	SiO_3-Si mg/l		4.08	8.76	15.3	21.3	Very high
9	Copper ppm		0.011			1.12	100 times increase
10	Zinc ppm		0.093			0.404	4 times increase
Metals in sediments and organisms have also shown significant increase.							

The important changes to be noted include- significant decline in dissolved oxygen which is due the sewage and effluent load; increase in suspended solids due to various reasons such as reclamation, solid waste dumping, sewage and effluent load and growing construction activity in the urbanized area. The effluents and sewage have also increased the nutrient levels in general; they, along with hindrance in tidal movement (due to various anthropogenic factors such as dumping, constructions of roads, bridges, reclamation etc.) have also caused decline in average salinity. The growing metal pollution is not unexpected.

Fig.1. Comparison of the sediment texture of Thane Creek during period 1985-2002.



The above figure shows how the sediment texture changed in past two decades. The dominance of clay significantly changed to dominance of silt in 1991-93 which was reported by Gokhale and Athalye (1993). Thereafter, the siltation gradually increased. This had a major effect on biodiversity of the creek. Due to the reduction in clay, the mud flats did not remain hard and became silty, soft and sinking, which probably had adverse effect on the survival of the eggs affecting the breeding of prawns, crabs and fishes. The prawns got eliminated from the creek. The mud quality did not remain suitable for the burrows of the mudskippers especially, thus eliminating them from the creek. It was observed that as the pollution and siltation in the creek increased the mudskippers moved to relatively less polluted downstream and then finally got eliminated from the creek. Gokhale and Athalye (1993) have reported 67% decline in the fishery catch in the upstream part of the Thane creek.

In the study conducted during 2001 to 2003, the water and sediment parameters indicated growth in the pollution. In general, the upstream stations showed more pollution as compared to the downstream stations. There was eutrophication (Especially the phytoplankton) along the creek. The phytoplankton types recorded were 26 as against 36 recorded by Gokhale and Athalye in 1993, thus showing reduction in the diversity. The zooplankton types (11) were comparable with those observed by Gokhale and Athalye in 1993; however their density was low. The fishery showed further decline and in the upstream region no fish types were available except in monsoon. Towards the mouth of the Creek where there is more water mass and the pollutants get diluted, relatively better fish variety was reported (51 types). Interestingly, the creek fauna included 19 types of sea anemones of mud burrowing type, 8 types of polychaetes, 7 types of bivalves, the gastropods of 14 types. The bird variety had been good and there has been increase in the number of Flamingoes particularly. The study reported dominance of mangrove *Avicennia marina* along the creek but there were 11 true mangrove types, 12 types of mangroves associates and 5 types of non mangrove halophytes recorded during the study.

The above observations suggest that if the pollution is moderate the biodiversity can be good and maintained. The creek though is highly polluted presently, can be revived and its biodiversity can also be restored if proper remedial measures are applied. Following are some remedial measures recommended.

- Minimize the sewage load- a) use of septic tank method for treating excreta. b) reuse of water
- Minimizing the solid wastes- segregation of non-degradable and degradable wastes.
- Proper and frequent check on the industrial effluent.
- Dredging to clear accumulated silt.
- Education of masses regarding –
  1. Conservation of creeks and estuaries.
  2. Minimizing use of plastic.
  3. Plantation of mangroves.
  4. Mangrove based and creek/estuary based beneficial activities.
  5. Sustainable use of resources.

What can be done as an individual?

- Minimize the solid waste at source (i.e.at home) by separating the degradable and non degradable matter and convert the degradable matter into bio fertilizer by using bio compost techniques. Small Biogas plants to use vegetable garbage even at family level are available. This will reduce the solid waste load by at least 40 to 50 %.
- Educate others regarding the importance and need for conservation of our natural resources including Creeks, Estuaries and mangroves.

The following measures can be implemented at the community level.

- The water used for bathing and washing clothes can be collected in separate tank, and re-pumped so as to use it for flushing the toilets or even watering the gardens.
- Restart the septic tank method in which excreta is collected in the tanks; allowed to decompose to produce nutrient rich fertile water. This will significantly reduce the sewage load. Now a days, techniques are available to convert human excreta in to biogas.
- Sort the non-degradable solid wastes and recycle them in small scale industries set within the Corporation limits. The corporations can take initiative to do this.
- Treatment of industrial effluents and sewage before releasing them into the creek / estuary.
- Remove the accumulated debris from the creek / estuary by dredging so as to clear hindrance in tidal flow.
- As regards Thane creek, the siltation in many places has hampered the tidal flow and flushing ability of the creek. Dredging of the silt in certain regions of the creek is necessary. This however will have to be done carefully as it may cause large scale fish death due to clogging of gills, but the long term effects will be beneficial. The dredged silt can be dumped along the outer regions of the banks and mangrove plantation

should be done on it. This activity should be carried out in pre-monsoon months and experts from different fields need to involved in such work.

- **Encourage mangrove plantation, mangrove based activities and creek / estuary based activities** : Presently cutting of mangroves for fuel and other purposes is a major damaging factor. By educating the local people, the mangrove plantation should be encouraged. The people should be taught to harvest mangroves in a cyclical manner (rotation). This will conserve the mangroves and at the same time fulfill the needs of the local people. It is necessary to educate the masses regarding benefits of the mangrove forests. Following occupations can be encouraged in mangrove forests and also in the creek / estuary.

- **Mangrove based activities.**

i) Apiculture - Mangroves and their associates flower in different seasons and hence they can support 'Bee keeping' (Apiculture) as a supplementary occupation.

ii) Experiments have proved that certain species of mangroves have refreshing property like tea. If further studies are conducted and if they give good results, people will be motivated to plant mangroves, however care should be taken to avoid monoculture.

iii) The coastal plant *Prosopis juliflora* grows rapidly and can be planted in the back mangrove region. This plant can provide certain protection to the mangroves and even be used as an alternate source of fuel.

iv) If proper education is done and guidance is provided many useful products can be obtained from the mangroves. The mangroves are known to have many medicinal properties, though the detail studies are lacking. Further, scientists have found insecticidal properties in some species of mangroves. Moreover mangroves also help in desalination of land.

- **Creek and estuary based activities.**

i) Mussel Culture : Mussels can grow very well in the creek. They can be grown in captivity in cages using floats and require some monitoring.

ii) Growing protein rich algae: In the creek waters protein rich algae such as *Ulva* spp*., Enteromorpha* spp*., Sargassum* spp. and other sea weeds can be grown. These weeds apart from their food value (protein rich) also form a good fuel source either in dry form or as biogas.

iii) Crab pens: In Malaysia, crab growing is a common practice in the mangrove swamps along creeks and estuaries. For this purpose; a small area of mangrove is fenced with poles preferably of mangrove origin or bamboo and are stocked with crabs. The crabs are fed with trash fish, when the crabs have grown to marketable size they are separated and sold, thereby keeping a constant stock of the crabs and ensuring a minimum income.

iv) Fish cultivation in floating cages : This has been practiced on a trial basis in Indonesia wherein fine mesh nylon net cages with floats on the top are kept in the creek / estuary,. In thesee cages suitable sturdy fish is cultivated by introducing seed. Fishes like *Tilipia spp., Mugil spp., Mystus spp.*, etc., can be grown in this manner.

v) Brush pile fishery: This is the traditional method practiced in Srilanka, wherein the basic property of mangroves providing food and shelter is put to optimum use. In this method an enclosure is made with poles and branches of mangroves preferably *Avicennia* spp. are left in the water. After a few weeks when the fish have gathered the region surrounding the mangrove branches is encircled with nylon net keeping the fishes entrapped. Later the branches are removed and the fish are allowed to grow and then harvested.

vi) Additional prospects

1. It will be possible to promote ecotourism in Thane creek because it is already attracting birds like Flamingoes, Pintail ducks, Avocets, Osprey, Kingfishers, Gulls, Terns, Coots, etc. and will attract more if properly managed.

2. In Thane-Mumbai complex the creek can be useful for ferry transport, which will reduce the load on roads and trains.

With the initiative of NGO's, Environment Improvement societies, Social workers and with the support and encouragement of government such activities should be undertaken alongside of creeks and estuaries, which will protect the environment and provide lively-hood to the locals. For the deterioration of our precious ecosystems we cannot simply blame population explosion and industrialization because this has mainly happened due to our lethargy, neglect and irresponsible attitude. If we change ourselves and implement the available techniques positively we can still maintain the balance in the nature and conserve biodiversity.

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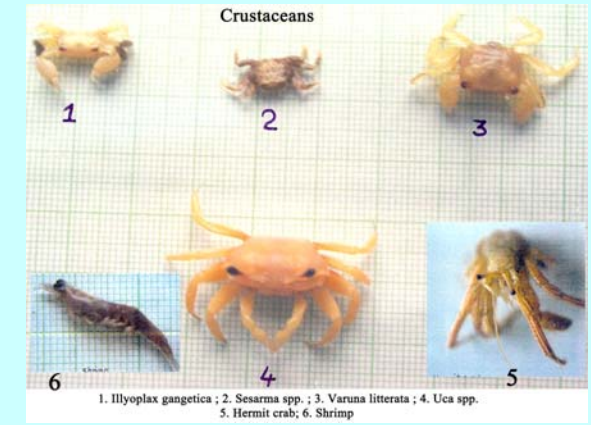
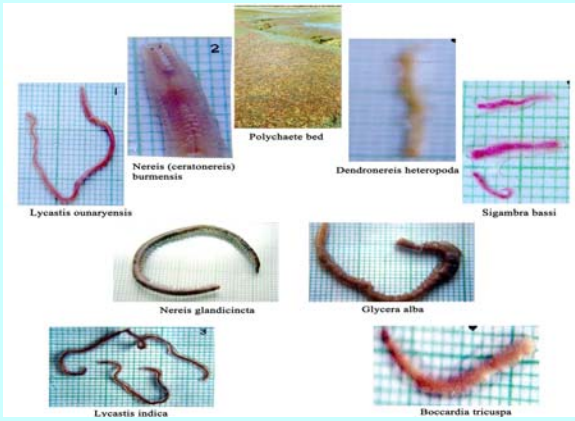
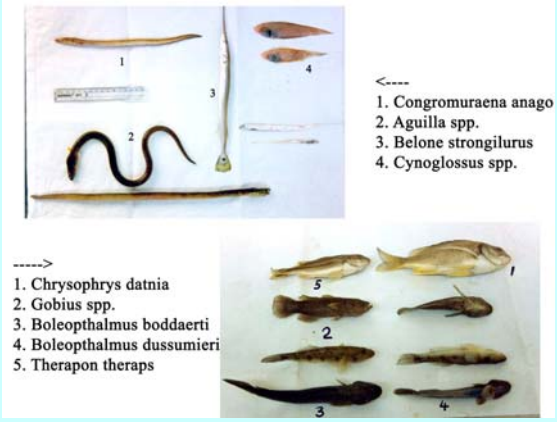


Polychaetes



Fish types



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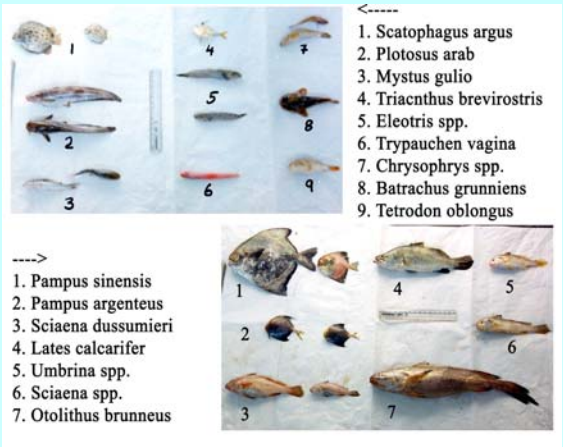
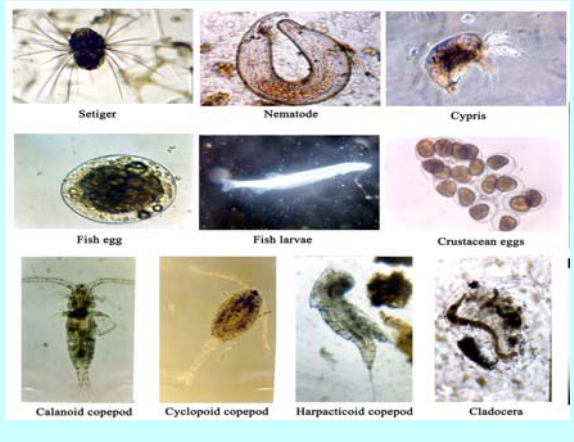
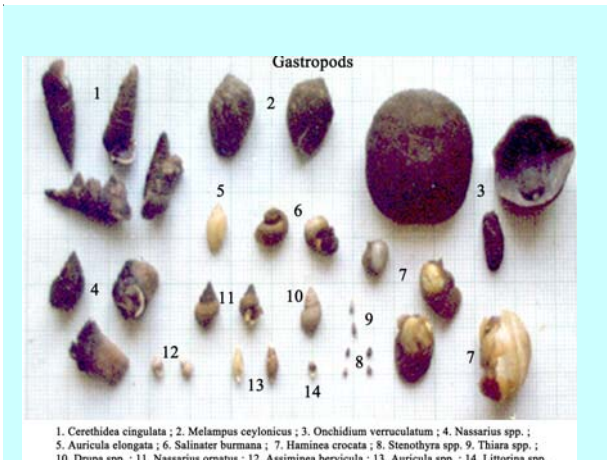


Zooplankton





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Foraging Behaviour of Mussel Feeding European Oystercatcher (*Haematopus ostralegus*)

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Oystercatchers are characteristically large and heavily built, with black or brownish-black plumage, often with a prominent white wing-bar, or totally dark. The European race, *Haematopus ostralegus ostralegus*, 40-45cm long with a wingspan of 80-90mm, is among the largest of the western Palearctic waders, has red-pink legs and feet and scarlet-red eyes, with orbital rings. The bill is 65-75mm long, stout and laterally compressed for chiselling and breaking into the shells of lamellibranch and gastropod molluscs, which constitute the main prey species in Exe estuary, England. The sexes are alike. In Britain overwintering adult Oystercatchers forage predominantly on marine invertebrates especially hard and well-protected molluscs at low water, particularly mussels (*Mytilus edulis*), cockles (*Cerastoderma edule*) and Baltic tellin (*Macoma balthica*). Also the Oystercatchers feed on polychaete worms (*Neris diversicolor* and *Arenicolor marina*), Limpets (*Patella* sp.), dogwhelks (*Nucella lapilus*), periwinkles (*Littorina* sp.) and shorecrabs (*Carcinus maenas*). At high waters some Oystercatchers forage on grassland on soft-bodied terrestrial invertebrates, particularly earthworms (*Lumbricidae*) and the larvae of insects (Coleoptera, Diptera, Dermaptera) (Goss-Custard et al. 1996). Although Oystercatchers feed on a variety of organisms, they tend to specialize on a single prey species and within the species they optimize their foraging tactics. In addition, they increase their intake rate by adopting different strategies. In this talk, I review the foraging specialization and optimization of mussel feeding Oystercatchers.

Study Area

The river Exe in Devon, England forms a small, mainly muddy, sheltered estuary which is in the Southwest of England between Exmouth and Dawlish to the west (Fig 1). The estuary is protected from the sea by twin sand spits which reduce the entrance to a narrow channel (McGrorty, 1997). The main supply of freshwater comes from the rivers Exe and Clyst which enter from north. Boalch (1980) summarised the details and descriptions of geology, hydrography, sedimentology, fauna and flora of the Exe. I collected field data from mussel bed number 4, which is located on the western side of the Exe estuary, between Starcross and Cockward (3° 27' W, 50° 37' N). This is one of the beds which support a good population of mussel feeding Oystercatchers. It is relatively free from anthropogenic disturbances and easily accessible for observation of birds.

Methods

Oystercatchers were observed from the hide through a 15x-60 magnification zoom telescope (Optolyth) mounted on a tripod by direct observations throughout the ebb tide period. A foraging Oystercatcher was selected at random for 10- minute focal animal sampling observation (Altman, 1974). Further, mussels were collected for different quantitative and qualitative measurements to identify the foraging specialization and optimization behaviour of Oystercatchers (Nagarajan 2000, Nagarajan et al. 2002a,b,c).

Results

I explored the foraging specialization and optimization of Oystercatchers across the winter and explained their foraging specialization, then showed how Oystercatchers specialized on different characters of mussel to increase their intake rate.

Foraging methods and selection

Oystercatchers open mussels in three ways, *viz.,* stabbing, dorsal hammering and ventral hammering (Hulscher, 1996).

Stabbing: Oystercatchers stab at the junction between the two valves. Mussels clump together by byssus threads that emerge from the ventral surface of the valves. The shells gape slightly under water and are closed only loosely when the shells are still moist. The stab is directed at the posterior adductor mussel which is then severed. As the tide receded and where no pools remain the substrate dries out, the bivalves close their valves. Many stabbers then turn to forcing apart the valves of the more firmly closed dry mussels.

Dorsal Hammering: Dorsal hammerers open the mussel *in-situ* from the above, breaking the shell at the dorsal posterior margin or at the side. The support provided by the attachment to other mussels in a clamp prevents the prey

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from being driven far into the underground in slightly soft areas. It attacks the shell at the point at which the posterior adductor is attached to the shell and where erosion and so shell thinning often take place.

Ventral Hammering: Ventral hammerers normally clasp the mussel between the mandibles and tear it off from the bed by pulling upwards until the byssus threads break and then carry it to a firm hammering place, or "anvil". Then, the ventral surface is turned upwards and the hammer blows can be directed at in the mid-ventral region. The hammer blows from the strong bill causes a semicircular chip of the shell to be fractured from the ventral margin of one valve, at which point the bird inserts its bill, cuts the posterior and anterior adductor mussels and prizes the valve apart.

Prey Selection

Of the mussels opened by Oystercatchers, 70.8% mussels were between 35 and 55mm long. Oystercatchers selected ventrally thin-shelled mussels especially if the size was more than 35mm. The Oystercatchers also took mussels which had fewer barnacles on the ventral surface. Generally the Oystercatchers consumed ventrally flat mussels, especially in the smaller length classes, and this preference was particularly strong in the preferred size class 30-45mm. Hence, the opened mussels found to be ventrally thin, flat, brown coloured and to have few barnacles on the ventral surface. The binary logistic multiple regression equation model indicated that the ventral thickness and colour had independent effects on mussel selection (Nagarajan et al. 2002a).

Seasonal selection

The frequency distribution of the lengths of the mussels consumed by Oystercatchers and present on the mussel bed are evaluated for early 'winter' (September-November), mid-winter (December and January) and late winter (February and March). Most of the mussels eaten by the Oystercatchers were between 25 and 55mm in length in all three winter periods. The proportion of mussel frequency in the larger length categories declined over the winter. The observed data suggest that Oystercatchers selected smaller mussels as the winter progressed. The modal value declined from 40-45mm in early winter to 35-40mm in mid and late winter. Furthermore, according to Jacob's index, the most preferred length classes were 35-55mm in early winter but decreased to 20-40mm in the remaining periods of winter. The analysis of seasonal changes in the length frequency distributions of the mussels on the bed and of those opened by the Oystercatchers, it seems likely that, as the frequency of the initially preferred 35-55mm on the bed declined, the birds took a greater proportion of smaller mussels (Nagarajan 2000, Nagarajan et al. 2006 and 2008).

Morph selection

Although the brown coloured mussels were rare in the population, the Oystercatchers showed a strong preference towards them. The Oystercatchers strongly preferred brown coloured mussels, probably because the flesh of black-coloured mussels was much wetter than that of the brown-coloured mussels. By avoiding the ingestion of this extra water, the Oystercatchers increased their intake rate by 1.99% to 17.7% in different length classes of mussels. Over the course of winter, Oystercatchers took mussels with increasingly thick shells relative to those that were on offer, particularly in the most preferred length class of 40-50mm (Nagarajan et al., 2002c).

Valve selection

Of the opened mussels, 72% were opened on the right valve and the remaining 28% were opened on the left valve, none was attacked on both valves A chi-square test clearly showed that this preference for attacking on the right was not likely to have arisen by chance. This preference did not change either with mussel length or across the season. The right valve was generally thinner than the left, but the preference for right valve attack was greater than could be accounted for by this factor alone. The preference would be explained if Oystercatchers were able to detect the thinner valve in a mussel when the difference in the ventral thickness between the two valves was more than 0.036mm. If they were unable to discriminate the thickness difference, then they attacked the right side because 58% of mussels are thinner on this side. By following this strategy, Oystercatchers would need 15.5% less blows than if they attacked either valve at random. The improvement in the overall intake that could be achieved by valve thickness discrimination was 3.6% (Nagarajan et al., 2002c).

Layer selection

Mussel shell is made of three layers viz., outer peristracum, middle prismatic and inner nacreous, the prismatic layer contributed a major role to the thickness of the valves. The peristracum was the thinnest layer. The thickness of prismatic layer showed significant variation between opened and comparator mussels whereas the thickness of peristercum and nacreous layers did not differ between opened and comparator mussels. The independent effect of individual shell layer on the oystercatcher mussel selection choices was tested using binary logistic regression model. The model revealed that the Oystercatchers opened the mussels that had significantly thinner prismatic and nacreous layers. The regression co-efficients for the thickness of the prismatic layer was almost four times greater than that for the nacreous layer. Earlier I showed that the Oystercatchers prefer to attack medium sized mussels and

that preference for length selection changes across the seasons. Furthermore the mussel shells have been shown to be structurally dynamic with both shell thickening and thinning taking place across the season (Nagarajan et al. 2006 and 2008). Therefore, the length and season were included as regressors in the model but neither of these variables yielded significant co-efficients. These analyses indicated that the Oystercatchers preferentially opened the mussels which had thin prismatic layer, irrespective of length and season. The nacreous layer is the oldest and strongest layer but the prismatic layer act as shock absorber due to its crossed lamellar which has highest nominal fracture toughness. The thicker prismatic layer produces non-catastrophic failures of mussel shell. To crack a mussel successfully the nacreous layers of the mussels needs to be damaged and for making such damage the prismatic layer would be thin enough to allow the crack to the reach the nacreous layer. Hence, oystercatchers would have selected the mussels which had thin prismatic layer (André Le Rossignol et al. 2011).

Conclusion

The Oystercatchers are extreme specialist and from the intensive research on this species, it is clearly understood that they optimize in all possible ways while foraging on different areas in various prey species to increase their intake rate. They are capable of discriminating the minute differences among the habitats/seasons, between the prey species and within individual preys to achieve the maximum intake rate. For example, in this paper, I showed that the Oystercatchers selected medium sized mussels which did not yield any waste handing time. Within the medium sized mussels, they selected thin-shelled and preferred to attack the brown coloured morphs. The thin-shelled mussels were easy to crack. On the other hand, by preferring brown coloured morphs, they avoided ingestion of extra water, and increased the intake rate by 1.99% to 17.7% in different length classes of mussels. When they selected such mussels, they managed to discriminate the thickness difference down to the level of 0.036mm and attacked the thinnest valves. Within the thinnest valve, they managed to detect the mussels with thinner prismatic layer which allowed the maximum load of hammering by the Oystercatchers to crack the hard nacreous layer. Therefore, it is clear that Oystercatchers are capable to discriminating the minute differences and increase their survival rates.

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Marine Biodiversity of Maharashtra coast and community role

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Biodiversity conservation and role of community are both two sides of the same coin. It is believed that if people are benefitting from the bioresources, they themselves will take conservatory measures. This is true to some extent as the localites understand the ecology of their region also. India adopted and notified its Biological Diversity Act in 2002 in line with the CBD for conservation and sustainable utilization. Indian coastline, particularly Maharashtra has been blessed with different coastal ecosystems ranging from estuarine – **Mangrove**, sandy and rocky intertidal and biologically sensitive like **Coral**.

Maharashtra coast is about 720 km long with 112000 sq. km of continental shelf providing livelihood to more than 80,000 fisher families. Apart from this major fisheries resource, there are other resources like mangrove forest, coral reef and intertidal crustacean and molluscan resources.

The Malvan Marine Sanctuary has spread over 29 sq km, the sanctuary is rich in coral and marine life. Malvan is in Sindhudurg district, a part of Konkan coast along the West coast of India. The coastal features of Malvan are rocky, dissected mainland with rias and lava promontories, occasional presence of overhanging cliffs, projecting headlands, stacks and erosion platforms, rocky shoals, several submerged reefs and boulders in aria type coast particularly towards south. On the north of Malvan the most striking feature is the 'littoral concrete' or 'beach rock'. The littoral concrete occurs as rocky beach either directly attached to the mainland or separated from the latter by a zone of sandy beach or muddy and marshy area. It has often afforded protection against the force of waves and helped the formation of sandy beach or muddy swamps between the rocky beach and the main land.

These ecosystems are enriched with diversified flora and fauna. Community Conserved Areas (CCAs) are best conserved areas for the local people . For a community to effectively conserve its natural resources, it must have a sense of responsibility or custodianship towards them. This develops through economic or cultural interaction and association with these resources. The biodiversity of any area has direct relationship with the local community. Mangrove forests are also being over-exploited for various reasons. One such example is 'Aquaculture' in the mangrove area. Thus the impact of change in coastal biodiversity affects the economics of coastal population.

Due to human interactions and developmental processes, some of biota are facing problems of being extinct. Hence, there is an urgent need to conserve the biodiversity along with sustainable utilization, conservation and management plans. The sustainable utilization of living resources can be managed by reforestation efforts in case of mangroves. This should be done by involving the local people. Regularizing the fishing activities, etc. on the Gram-Panchayat level. The conservation and management of the existing biodiversity involves many technical difficulties. Thus the "Socio-economical" studies of the selected sites along the coast are undertaken to estimate the effect of declaration of these areas as Marine Protected Areas on the livelihood of local communities. It is felt that there should be direct participation of the local communities to protect their traditional interests and to give them maximum opportunities (IUCN, 1997).

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Ecologically Sensitive Marina

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The human colonization has been along the coastal areas and the oceans are explored extensively for trade and its resources for sustaining the growth of the populace. In past few decades, the rate of anthropogenic pressure and the resource exploitation have conspicuously accelerated the rate of degradation of marine ecosystem. Unfortunately, this has been understood/ realized when the marine ecosystem was already under extreme stress. The stress in general is any deviation of environmental condition beyond the expected range within the carrying capacity. The components of the ecosystem may be variably responsive/ sensitive to the stressor. The stressors are widely variable and distinct physical, chemical or biological components/ processes/ actions. The vulnerability of the ecosystem is the probability that a component (ecological feature) will exhibit stress following exposure to a stressor to which it is sensitive. The evaluation of the ecological features; biological, chemical or physical features/ processes/ structures supposed to have environmental/ social/ cultural/ economic significance; identify the vulnerable area. The correlation of the stressors, induced stress and the sensitive ecological component(s) exposed; comprehensively describe the vulnerability of an ecosystem/ habitat. The information then identify the stressors, actual stress potential, sensitive ecological components, monitoring of the spatio-temporal variations in the extent of ecosystem vulnerability and applied for the management and conservation of the ECOLOGICALLY SENSITIVE MARINA.

To understand the Ecologically Sensitive Marina it is necessary to appraise the components of the marine ecosystem. Apparently, the marine ecosystem necessitates a transdisciplinary research since it is an outcome of multifaceted structural and functional components and their interactions. The hydrodynamics features like geohydrology, hydro-engineering, oceanography, estuarine dynamics, riverine flow dynamics etc. lead to variations in habitat characteristics like geography, slope, geological formations, geochemistry, chemistry, sediment composition, estuarine gradation etc. These in turn lead to micro habitat distinctions and thus the spatio-temporal variations in community association patterns that include microbial/ floral/ fauna diversity and distribution, larval settlement and distribution pattern, animal–plant associations, existing food chains and webs, behavior and ecology of benthic/interstitial/coastal animals etc. The processes at the coastal region influence the intertidal ecosystem that represents special type of environment, which contrasts sharply with conditions that prevail elsewhere in the sea. The life in the inter-tidal area needs special adaptations to inhabit therein which is alternating marine and terrestrial. On the rocky area, tide pools of various sizes and depths are formed which indicate habitat variations. On the sandy shore or mudflats the slope, sediment composition, grain size and its distribution designate the microhabitats. Sediment disturbance due to foraging and burrowing activities of animals have impacts on other fauna. The keystone species alter recruitment patterns, site selection, survival/ mortality of settling larvae, control food availability, predation etc. Distribution and density of pelagic larval stages also differs indicating variable planktonic community structure and settlement probabilities and juvenile/adult distribution along the intertidal length. Coastal regions are breeding grounds for several species. Prey density and availability as well as sediment penetrability influences habitat use by shorebirds. Diurnal and seasonal changes in water quality influences biodiversity and its distribution. Thus, the marine ecosystem is an optimal study site for many physical, chemical and biological processes.

Over the decades,the marine ecosystem has experienced enhanced stress conditions and it is bound to increase multifold in the future. An assessment of prevailing status, monitoring of the activities and their impacts, ensuring sustainable exploitations of resources and mitigation/ conservation measures would describe the future of the marine ecosystem. With the changing scenario of rapid industrialization, it is necessary to obtain a baseline data on the status of the marine biodiversity present today, before it is too late. This database will be a vital component to assess the impacts of the industrial and human pressure on the marine biota, in time to come.

The coastline of Gujarat is longest in India, has a broad continental shelf and variable habitat characteristics, harboring very rich biota. The intertidal exposure during low tide is also extensive creating distinct micro habitats. The Gulf of Kachchh that is rich in coral and mangrove ecosystems, is a narrow cone with maximum tidal variation of about 5m while Gulf of Khambhat, that has much less biodiversity, is trumpet-shaped with maximum tidal variation of about 12m (second highest in the world).The development along the gulfs poses threat to the marine life. Several Environmental Impact Assessment studies carried out prior

to implementation of the projects for environmental clearance have not evaluated the collective threat. The largest chemical industrial estate of India (Ankleshwar) and the largest ship recycling yard of the world (Alang-Sosyo) are along the Gulf of Khambhat while, petroleum industries are located along the Gulf of Kachchh. The Saurashtra coast has two of the largest fish landing centers (Veraval and Okha) exploiting enormous marine biotic resources. Several small to large ports are located along the Gujarat coast. The developmental planning for next two decades depict that almost entire length of the coast will be utilized for commercial activities. The planning for sustainable development, mitigation of adverse impacts and implementation of conservation measures is also required. Fortunately, Gujarat is the only state of India to have witnessed the growth in total area under mangrove cover in the past decade indicative of genuine coastal conservation measures. The habitat restoration is also of sincere concern at several places. The basics of the coastal processes will be addressed to understand comprehensively the transdisciplinary research needs. The status of Gujarat coastal region will be discussed to describe the ECOLOGICALLY SENSITIVE MARINA.

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Molecular tools for the study of marine biodiversity

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The potential applications of molecular biology are of growing importance in many areas of life sciences, including biodiversity. During the past two decades, the development of sophisticated molecular technologies and instruments for biomedical research has resulted in significant advances in the biological sciences. However, the value of these techniques for studying the biodiversity has only recently begun to be cherished. Molecular tools like phylogenetic analysis, genotyping, DNA fingerprinting can be applied to study biodiversity in the marine environment. Molecular tools in general offer the possibility to estimate biodiversity at all levels (e.g. kingdom/class/family/species), in a comparatively small environmental sample. Phylogenetic analysis of marine organisms can be carried out by using marker gene (16S rRNA, 18S rRNA, COI etc.) sequences. General assessment of comparative biodiversity in a larger number of samples can be achieved with DNA fingerprinting methods like DGGE, RAPD, RFLP, SSR, ISSR etc. Presence or absence of a known species can be monitored with species-specific probes using fluorescent *in-situ* hybridisation (FISH) technique. In this presentation different molecular techniques related to biodiversity research are discussed by giving examples.

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Coastal Marine Biodiversity and Ecosystem Functioning

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It is a general perception that biological diversity enhances the ecosystem productivity because each species, have very unique and important role to play. Hence each species depends on the services provided by others. The solar energy is utilized by plants to convert carbon dioxide into organic compounds. This first stair of natural food chain provides food for all other living species on the planet. However this very step is being disturbed due to the release of carbon dioxide and other harmful gases. The disturbance is largely due to the human being, who is the integral part of the natural living resource and is the major beneficiary of the ecosystem services.

The human population is over growing which was 6 Billion in 2000 to 7 Billion in 2011 and is estimated to be over 9 Billion by 2050. This ever increasing hungry mouth will required enormous food material to fulfill their daily requirement. As per the ***Convention on Biodiversity*** ≈ 40% of the world's economy and 80% of the needs of the poor population are derived from biological resources. Moreover, rich diversity of life provides greater opportunity for medical discoveries and economic development, making biodiversity as a focal point of discussion for nutritional requirement and or industrial development. Nonetheless, the diversity of life on earth is changing dramatically and since the change is negative, it is already showing the warning signal. Therefore everyone have to be concern of the natural bioresources and get educated on the globally observed biodiversity trends so that every individual can participate in its sustainable utilization.

In this communication, I propose to address some of the important issues related to assessing the coastal biodiversity and conservation. Currently "BioSearch" complied data of~20,000 species within Indian EEZ . BioSearch is an online marine biodiversity database of CSIR-NIO Goa and is part of the global "Ocean Biogeographic Information System" (OBIS). Recent biodiversity review also identified clear gaps in knowledge extending to several smaller taxa and to large parts of the shelf and deep-sea ecosystems, including seamounts. Habitat loss, uncontrolled developmental activities in the coastal zone, overextraction of resources and coastal pollution are some of the main constraints on maintenance of highly diverse biota, especially in countries like India. Thus, I will be focusing on: Why Is Biodiversity Important? How biodiversity and ecosystem function in a given environment? Who should care for it? How biodiversity can be studies and managed?

Finally, I will attempt to give some evidences on people's perceptions on resource management and biodiversity conservation.

Key words : Biodiversity; assessment; inventory; resource management; conservation.

Avian diversity in Mahim Bay, Mumbai

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Abstract : The Mahim bay is situated on the west coast of Mumbai extending from Bandra to Worli. This area is home to many bird species, including winter visitors and residents. The migratory birds are attracted to the Mahim bay because this area has rich benthic fauna and fish diversity, which forms the food source. The Mahim bay is considerably polluted due to anthropogenic activities like, sewage disposal especially from the Mithi River and BMC drainage outlets, recreational activities and religious rituals such as Ganesh visarjan. Therefore the present survey was conducted to prepare a checklist of the birds occurring in the Mahim bay. Present survey was conducted from June 2011 to September 2013. We observed that the seashore and near shore water is inhabited by 27 different bird species of which 11 are residents and 16 are winter visitors. Birds belonging to the following families were observed: Accipitridae, Ardeidae, Charadriidae, Falconidae, Laridae, Phalacrocoracidae and Scolopacidae. Of these, Family Scolopacidae (8 species), Laridae (7 species), and Ardeidae (7 species) were dominant. Since most sea birds feed on the rich benthic fauna and fishes, pollution may affect these food resources impacting the avian diversity in the Mahim bay.

Key words **:** Migratory birds, Mahim bay, Mumbai, Avian fauna

Introduction

Many bird species are known to inhabit the urban Mumbai metropolis (Monga, 2004) and its surrounding areas including Mahul (Verma et al., 2003), Uran (Pawar, 2011), Vasai (Walmiki et al., 2013), and Thane Creek (Nitsure, 2002; Quadros, 2001). However, there is lack of thorough survey on the bird diversity of western coast of Mumbai especially in the Mahim Bay. This area is home to many bird species. The large congregations of migratory and resident water birds use this area as a wintering ground. The birds are attracted to the Mahim bay because it has rich benthic fauna and fish diversity, which forms the food source. The Mahim bay is considerably polluted due to anthropogenic activities like, sewage disposal especially from the Mithi River and BMC drainage outlets, recreational activities and religious rituals such as Ganesh visarjan. Therefore the present survey was conducted to prepare a checklist of the birds occurring in the Mahim bay.

Study area

The study area, Mahim bay, is situated on the west coast of Mumbai (Lat. 19°02'01"N; Long. 72°49'36.1" E). This area receives regular release of domestic sewage along with fresh water drainage from the Mithi River. Recently the Rajiv Gandhi sea link was constructed over the Mahim bay. All these factors have put enormous pressure on the environment and ecology of the Mahim bay thereby affecting its biota.

Figure 1: Satellite photograph of Mahim Bay, Mumbai.

Materials and methods

Present survey was conducted from June 2012 to September 2013. Birds in the Mahim bay were observed every fortnightly, during the low tides and high tides period, using 8 X 42 binocular. The waders feeding in the intertidal area were observed during the low tide. The bird species were identified using standard field guides (Ali and Ripley, 1995; Grimmett et al., 1999; Ali, 2002; Pande, 2003). Care was taken to avoid disturbances to the birds during the survey visits.

Results and discussion

Birds, besides enhancing the aesthetic beauty of a place, are an important component of the ecosystem. They occupy an important position in the food chain and are therefore sensitive to the changes in the ecosystem. The migratory birds are responsible for the fluctuations in bird population and help in understanding the ecology of an area. Drastic changes in the population of the migratory birds may also result due to alteration in ecology of a stopover sites or a wintering areas. Total absence of birds from an area may indicate pollution (Borale et al., 1994).

Earlier, few authors reported a general account of shorebirds around Mumbai: Verma et al. (2003) reported 150 species in Mahul area; Pawar (2011) reported 56 species from Uran area including terrestrial birds and waders; Walmiki et al. (2013) reported 143 species from Vasai area; Nitsure (2002) and Quadros (2001) reported 53 and 55 bird species from the Thane creek, respectively.

The present study showed that the Mahim bay is inhabited by 27 different bird species belonging to families including Accipitridae, Ardeidae, Charadriidae, Falconidae, Laridae, Phalacrocoracidae and Scolopacidae (Table 1). Family Scolopacidae (8 species), Ardeidae (7 species) and Laridae (7 species) were dominant during the study period. We observed that the shore water is inhabited by 27 different bird species of which 11 are residents and 16 are winter visitors. Winter migrants, like Whimbrel and Eurasian Curlew migrate from Europe and slender billed Seagulls come from Baluchistan (Pande et al., 2003). We observed that these winter visitor birds arrive in Mahim bay in September and depart during April to May. The initial flock of slender billed Seagulls arrived on 9th September in the year 2012 whereas in 2013 they arrived on 11th September in the Mahim bay. Although the present study was conducted for one year, from June 2012 to September 2013, we observed that the Mahim bay has a rich and varied bird life.

Conclusion

The present study revealed that Mahim Bay harbours rich bird diversity. However the anthropogenic activities like sewage disposal and religious rituals can have adverse effect on the environment of the Mahim bay. Since most sea birds feed on the rich benthic fauna and fishes, pollution may affect these food resources impacting the avian diversity in the Mahim bay. Further studies are required to thoroughly understand the avian diversity in the Mahim bay to create awareness among the general public and develop conservation strategies.

Table 1: List of birds observed in the Mahim bay, Mumbai.

Sl. No.	Common Name	Scientific Name	Family	Category	Population Status
1.	Common or Black Kite	*Milvus migrans*	Accipitridae	R	Very Common
2.	Brahminy Kite	*Hailiaster Indus*		R	Occasional
3.	Grey Heron	*Ardea cinerea*	Ardeidae	R	Common
4.	Indian Pond Heron	*Ardeola grayii*		R	Occasional
5.	Western Reef Egret	*Egretta gularis*		R	Very Common
6	Large Egret	*Ardea alba*		R	Very Common
7.	Inter-mediate Egret	*Egretta intermedia*		R	Very Common
8.	Little Egret	*Egretta garzetta*		R	Very Common
9	Black Crowned Night Heron	*Nycticorax nycticora*		R	Common
10	Little Ringed Plover	*Charadrius dubius*	Charadriidae	R	Common
11	Peregrine Falcon	*Falco peregrinus*	Falconidae	WV	Occasional
12.	Slender billed Seagull	*Larus cachinnans*		WV	Very common

13.	Little Tern	*Sterna albifrons*	Laridae	WV	Occasional
14.	Whiskered Tern	*Childonias hybridus*		WV	Occasional
15.	Gull Billed Tern	*Gelocheidon nilotica*		WV	Occasional
16.	Caspian Tern	*Hydroprogne caspia*		WV	Occasional
17.	Black Headed Seagull	*Larus ridibundus*		WV	Common
18.	Brown Headed Seagull	*Larus brunnicephalus*		WV	Common
19.	Little Cormorant	*Phalacrocorax niger*	Phalacrocoracidae	R	Very Common
20	Common Sandpiper	*Tringa hypoleucus*	Scolopacidae	WV	Common
21.	Common Red-shank	*Tringa tetanus*		WV	Common
22.	Common Green-Shank	*Tringa nebularia*		WV	Occasional
23	Eurasian Curlew	*Numenius arquata*		WV	Common
24	Whimbrel	*Numenius pheopus*		WV	Common
25	Curlew Sandpiper	*Calidris testacea*		WV	Occasional
26.	Black-tailed Godwit	*Limosa limosa*		WV	Common
27.	Marsh Sandpiper	*Tringa stagnatilis*		WV	Occasional

Abbreviations: R- Resident, WV- Winter Visitors

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Diversity of avifauna of Nigade in Raigad, Konkan, India A casefor conservation

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Abstract: India is rich in Biodiversity with two global Hotspots. The avifauna of India includes around 1301 species, (*Clements & James , 2000*), Maharashtra has 43.67% of it. Birds are the indicators of the health of an ecosystem as they indicate its needs and diversity. There are several studies on Birds of Kokan (*Shanbhag et al 2001*) indicating the richness of bird species in Kokan. However, detailed study, exclusively on birds of Nigade in Raigad district has not been carried out. Nigade shows diversity of habitat like low hills, plains, marshlands, estuary, mangroves etc. This diversity of topography and habitat offers suitable environment and opportunities for the bird population for breeding, feeding, resting and nesting.

Present study was carried out for two years from June 2011- to June 2013. Visits were planned periodically covering all the seasons of the year. The visits were made during early mornings and late evening, since activity of birds is at its peak during this time. Total of 131 birds were observed which included residents, winter visitors and also summer visitors. Few rare and threatened species were also occasionally spotted.

This work, will not only establish a base line data on bird diversity of Nigade but also assess probable and likely impact of expansion plans of administration for the highway and the rail route. As about 90% of the bird species observed in the region were residents, we strongly recommend the need for conservation of such sites.

Key words*: Avifauna, conservation, ecosystem, Biodiversity*

Introduction:

Conservation of natural resource like diversity of species is the key to the environmental concern of the day. Biodiversity is the degree of variation of life forms within a given species, ecosystem and biome, whether naturally occurring or modified by humans, (Delong, 1996).India has two global biodiversity hotspots.Birds are bipedal, egg laying warm blooded vertebrates with more than 9000 living species across the world. Maharashtra houses 43.67% of total Indian avifauna,(Clements and James 2000). Diversity of avifauna is one of the most important ecological indicators to evaluate the quality of habitats, (Blair 1999). Birds play various useful roles such as control of insect pests of agricultural crops, predators of rodents, scavengers, seed dispensers and as pollinating agents. Birds provide important ecological services that contribute to maintaining ecosystem processes and some of the necessary conditions on which humans and other organisms depend. These services range from food provisioning to modification of habitats and resource flows in biological communities.The estimation of local densities of avifauna helps to understand the abundance of various species of other organisms, (Turner 2003). Avifaunal diversity all over the world has been decreasing due to the destruction of natural habitat and various anthropogenic activities. Decline in the bird population can have negative impacts on an ecosystem, and their sensitivity to environmental change often lends them as useful indicators of environmental quality. Thus they form an important component of natural ecosystem, (Manjunath and Bhaskar Joshi 2012).

There are several studies on avifaunal diversity of Maharashtra. (Verma *et. al.* 2004) studied biodiversity of avifauna of Mahul Creek, while (Chauhan *et. al.* 2008) surveyed the avifauna of Borivali Mangroves. Recently (Kushwaha *et. al.* 2013) documented the bird diversity of Bhandup pumping station, Mumbai. However paucity exists in reports of avifauna exclusively fromKonkan region. (Pawar 2011) documented the species diversity of birds in Uran, while (Shanbhag *et al* 2001) studied impact of Konkan railway project on avifauna of Carambolim Lake – Goa and forest conservation in Konkan was reviewed by (Punde 2008). Thus literature survey revealed that reports on avifauna of Raigad region are scanty.

Materials and Methods

(i)Study Area:

Present study was undertaken at Nigade situated in Pen tehsil of Raigad district in Konkan, Maharashtra, India. It measures about 13.7 sq. km. It shows diversity of habitats like low hills, plains, marshlands, estuary and mangroves which offer suitable environment and opportunities for birds for feeding,resting,nesting and breeding.

Fig. a : Map showing the study area

(ii)*Data collection*

Nigade was surveyed for two years, from June 2011 to June 2013 at regular intervals covering all the seasons. Since the peak activity of most birds lasts for a short window of 2 to 3 hours, after sunrise or before sunset, visits were planned either early in morning or late evening. The study area was also surveyed randomly in addition to regular visits. Observations were made with the aid of 10 X 50 Nikon binocular and Nikon P500 Digital Zoom camera without disturbing their natural activities. Standard field guides were used for identification purpose (1, 5).

Results and Discussion:

During the study period 131 species belonging to 35 families were recorded from Nigade, Raigad. The avifaunal diversity of area comprises of 106 (80.91%) residents, 20 (15.27%) migrants (19 winter and 1 summer migrant) and 5 (3.82%) occasional visitors (Fig. b). The recorded species are given in Table 2. Of the recorded species, the highest number of species belonged to familyAccipitridae and Corvidae(14), followed by Passeridae(11), whereas 10 families were found to be represented bysingle bird species(Table1).The following formula was used for determining percentage of occurrence of Families (Basavarajappa, 2006).

$$\text{Percentage Occurrence} = \frac{\text{No of Species of each family}}{\text{Total no of Different species seen}} \times 100$$

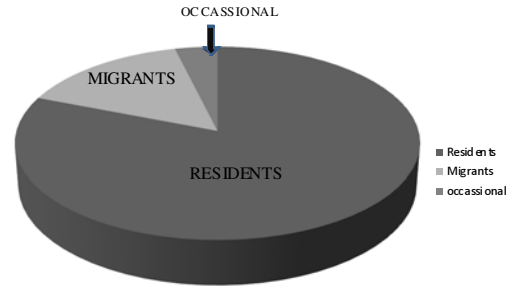

Fig. b: Percentage of resident, winter and summer migrant bird species recorded in the study area.

Table1: Percentage occurrence of avifauna recorded at Nigade, Raigadrepresenting families.

Sr. No.	Family	Number of bird species	% sighting of birds
1	Corvidae	14	10.69
2	Accipitridae	14	10.69
3	Passeridae	11	8.40
4	Ardeidae	10	7.63
5	Scolopacidae	6	4.58
6	Columbidae	6	4.58
7	Muscicapidae	6	4.58
8	Cuculidae	5	3.82
9	Sturnidae	5	3.82
10	Silvidae	5	3.82
11	Phalacrocoracide	4	3.53
12	Threskiomithidae	4	3.53
13	Hirundinidae	4	3.53
14	Rallidae	3	2.29
15	Alcedinidae	3	2.29
16	Nectarinidae	3	2.29
17	Ciconidae	2	1.53
18	Phasianidae	2	1.53
19	Recurvirostridae	2	1.53
20	Psittacidae	2	1.53
21	Strigidae	2	1.53
22	Meropidae	2	1.53
23	Megalaimidae	2	1.53
24	Alaudidae	2	1.53
25	Pycnonotidae	2	1.53
26	Anatidae	1	0.76
27	Charatridae	1	0.76
28	Laridae	1	0.76
29	Tytonidae	1	0.76
30	Apodidae	1	0.76
31	Coraciidae	1	0.76
32	Upupidae	1	0.76
33	Bucerotidae	1	0.76
34	Picidae	1	0.76
35	Lanidae	1	0.76

Table2: List of birds recorded in Nigade, Raigad.

Sr. No.	Common name	Scientific name	Status
Family: Phalacrocoracide			
1	Indian Cormorant	*Phalacrocoraxfuscicollis*	R
2	Great Cormorant	*Phalacrocoraxcarbo*	R
3	Little Cormorant	*Phalacrocoraxniger*	R
4	Darter	*Anhinga melanogaster*	R– T
Family: Ardeidae			
5	Grey Heron	*Ardeacinerea*	M
6	Purple Heron	*Ardeapurpurea*	R
7	Indian Pond Heron	*Ardeolagrayii*	R
8	Cattle Egret	*Bubulcus ibis*	R
9	Great Egret	*Casmerodiusalbus*	R
10	Intermediate Egret	*Mesophoyxintermedia*	R
11	Little Egret	*Egrettagarzetta*	R
12	Western Reef Heron	*Egrettagularis*	R
13	Black-Crowned Night Heron	*Nycticoraxnycticorax*	R
14	Cinnamon Bittern	*Ixobrychuscinnamomeus*	R
Family: Ciconidae			
15	Painted Stork	*Mycterialeucocephala*	R – T
16	Asian Openbill	*Anastomusoscilans*	R
Family: Threskiornithidae			
17	Black-Headed Ibis	*Threskiornismel-anocephalus*	R – T
18	Black Ibis	*Pseudibispapillosa*	R – T
19	Glossy Ibis	*Plegadisfalcinellus*	R
20	Eurasian Spoonbill	*Platalealeucorodia*	R
Family: Anatidae			
21	Spot-Billed Duck	*Anaspoecilorhyncha*	R
Family: Accipitridae			
22	Black Shouldered Kite	*Elanuscaeruleus*	R
23	Oriental Honey Buzzard	*Pernisptilorhyncus*	R
24	Black Kite	*Milvusmigrans*	R
25	Brahminy Kite	*Haliastur Indus*	R
26	Shikra	*Accipiter badius*	R
27	Crested Goshawk	*Accipiter trivirgatus*	O
28	Booted Eagle	*Hieraaetuspennatus*	M
29	White-Bellied Sea Eagle	*Haliaeetusleucogaster*	O
30	Long-Billed Vulture	*Gyps indicus*	O
31	Eurasian Marsh Harrier	*Circus aeruginosus*	M
32	Crested Serpent Eagle	*Spilornischeela*	R
33	Common Kestrel	*Falco tinnunculus*	R
34	Osprey	*Pandionhaliaetus*	R
35	Common Buzzard	*Buteobuteo*	O
Family: Phasianidae			
36	Rain Quail	*Coturnixcoromandelica*	R
37	Jungle Bush Quail	*Perdiculaasiatica*	R
Family: Rallidae			
38	White-Breasted Waterhen	*Amaurornisphoenicurus*	R
39	Common Moorhen	*Gallinulachloropus*	R
40	Purple Swamphen	*Porphyrioporphyrio*	R
Family: Recurvirostridae			
41	Black-Winged Stilt	*Himantopushimantopus*	R
42	Pied Avocet	*Recurvirostraavosetta*	M
Family: Charadridae			
43	Red-Wattled Lapwing	*Vanellusindicus*	R
Family: Scolopacidae			
44	Black-Tailed Godwit	*Limosalimosa*	M
45	Bar-Tailed Godwit	*Limosalapponica*	M
46	Wood Sandpiper	*Tringaglareola*	M
47	Common Sandpiper	*Actitishypoleucos*	M
48	Little Stint	*Calidrisminuta*	M
49	Common Greenshank	*Tringanebularia*	M
Family: Laridae			
50	River Tern	*Sterna aurantia*	R
Family: Columbidae			
51	Yellow-Footed Green Pigeon	*Treronphoenicoptera*	R

52	Rock Pigeon	*Columba livia*	R
53	Red Collared Dove	*Streptopeliatranquebarica*	R
54	Spotted Dove	*Streptopeliachinensis*	R
55	Laughing Dove	*Streptopeliasenegalensis*	R
56	Emerald Dove	*Chalcophapsindica*	R
Family: Psittacidae			
57	Rose-Ringed Parakeet	*Psittaculakrameri*	R
58	Plum-Headed Parakeet	*Psittaculacyanocephala*	R
Family: Cuculidae			
59	Pied Crested Cuckoo	*Clamatorjacobinus*	M
60	Common Hawk-Cuckoo	*Hierococcyxvarius*	R
61	Banded Bay Cukoo	*Cacomantissonneratii*	R
62	Asian Koel	*Eudynamysscolopacea*	R
63	Greater Coucal	*Centropussinensis*	R
Family: Tytonidae			
64	Barn Owl	*Tyto alba*	R
Family: Strigidae			
65	Jungle Owlet	*Glaucidiumradiatum*	R
66	Spotted Owlet	*Athenebrama*	R
Family: Apodidae			
67	Asian Palm Swift	*Cypsiurusbalasiensis*	R
Family: Alcedinidae			
68	Lesser Pied Kingfisher	*Cerylerudis*	R
69	Small Blue Kingfisher	*Alcedoatthis*	R
70	White-Breasted Kingfisher	*Halcyon smyrnensis*	R
Family: Meropidae			
71	Blue-Tailed Bee-Eater	*Meropsphilippinus*	M
72	Small Green Bee-Eater	*Meropsorientalis*	R
Family: Coraciidae			
73	Indian Roller	*Coraciasbenghalensis*	R
Family: Upupidae			
74	Common Hoopoe	*Upupaepops*	R
Family: Bucerotidae			
75	Indian Grey Hornbill	*Ocycerosbirostris*	R
Family: Megalaimidae			
76	Brown-Headed Barbet	*Megalaimazeylanica*	R
77	Coppersmith Barbet	*Megalaimahaemacephala*	R
Family: Picidae			
78	Yellow Crowned Woodpecker	*Dendrocoposmahrattensis*	R
Family: Alaudidae			
79	Rufous-Tailed Lark	*Ammomanesphoenicurus*	R
80	Malabar Crested Lark	*Galeridamalabarica*	R
Family: Hirundinidae			
81	Dusky Crag Martin	*Hirundoconcolor*	R
82	Wire-Tailed Swallow	*Hirundosmithii*	R
83	Barn Swallow	*Hirundorustica*	M
84	Red rumped Swallow	*Hirundodaurica*	R
Family: Lanidae			
85	Long tailed Shrike	*Laniusschach*	R
Family: Corvidae			
86	Eurasian-Golden Oriole	*Oriolusoriolus*	R
87	Black-Naped Oriole	*Orioluschinensis*	O
88	Black-Headed Oriole	*Oriolusxanthornus*	R
89	Black Drongo	*Dicrurusmacrocercus*	R
90	Ashy Drongo	*Dicrurusleuncophaeus*	M
91	House Crow	*Corvussplendens*	R
92	Large-Billed Crow	*Corvusmacrorhynchos*	R
93	Scarlet Minivet	*Pericrocotusflammeus*	R
94	Small Minivet	*Pericrocotuscinnamomeus*	R
95	Common Iora	*Aegithinatiphia*	R
96	Golden-Fronted Leaf Bird	*Chloropsisaurifrons*	R
97	Blue-Winged Leaf Bird	*Chloropsiscochinchinensis*	R
98	White-Browed Fantail	*Rhipiduraaureola*	R
99	White-Throated Fantail	*Rhipiduraalbicollis*	R
Family: Sturnidae			
100	Chestnut-Tailed Starling	*Sturnusmalabaricus*	M

101	Rosy Starling	*Sturnusroseus*	M
102	Asian Pied Myna	*Sturnus contra*	R
103	Common Myna	*Acridotherestristis*	R
104	Jungle Myna	*Acridotheresfuscus*	R
Family: Pycnonotidae			
105	Red-Whiskered Bulbul	*Pycnonotusjocosus*	R
106	Red-Vented Bulbul	*Pycnonotuscafer*	R
Family: Silvidae			
107	Jungle Babbler	*Turdoidesstriatus*	R
108	Plain Prinia	*Priniainornata*	R
109	Grey Breasted Prinia	*Priniahodgsonii*	R
110	Ashy Prinia	*Priniasocialis*	R
111	Common Tailor Bird	*Orthotomussutorius*	R
Family: Muscicapidae			
112	Oriental Magpie-Robin	*Copsychussaularis*	R
113	White-Rumped Shama	*Copsychusmalabaricus*	R
114	Common Stone Chat	*Saxicolatorquata*	M
115	Pied Bush Chat	*Saxicolacaprata*	R
116	Indian Robin	*Saxicoloidesfulicata*	R
117	Orange-Headed Ground Thrush	*Zootheracitrinacitrina*	R
Family: Passeridae			
118	Paddyfield Pipit	*Anthusrufulus*	R
119	Forest Wagtail	*Dendronanthusindicus*	M
120	Yellow Wagtail	*Motacillaflava*	M
121	Grey Wagtail	*Motacillacinerea*	M
122	House Sparrow	*Passer domesticus*	R
123	Yellow Throated Sparrow	*Petroniaxanthocollis*	R
124	Baya Weaver	*Ploceusphilippinus*	R
125	Red Munia	*Amandavaamandava*	R
126	White-Rumped Munia	*Lonchurastriata*	R
127	Black-Headed Munia	*Lonchura Malacca*	R
128	Scaly breasted Munia	*Lonchurapuntulata*	R
Family: Nectarinidae			
129	Purple-Rumped Sunbird	*Nectariniazeylonica*	R
130	Lotens Sunbird	*Nectarinialotenia*	R
131	Purple Sunbird	*Nectariniaasiatica*	R

(R-Resident, M-Migrant, T-Threatened, O-Occasional)

The present study reflects a moderately healthy diversity of avifauna at Nigade. In the recent times, the diversity of avifauna is impacted by various anthropogenic activities such as proposed expansion plan of administration for highways and rail routes near the study area. Such plans are likely to cause fragmentation of natural habitat decreasing its value for bird use. Due to such developmental activities, entire natural habitat of this area and its biodiversity is likely to become vulnerable to the upcoming changes. This, in turn may change the land use of the area impacting the avifaunal diversity in particular. The altered habitat may not be useful for the bird population of the area for nesting, breeding and feeding purposes and thus will affect the resident population of the birds. The change in the habitat may compel the migrant species to search for alternate habitat and thus then, may not attract the migrant species.The rare and vulnerable species may get lost in the course of time.

Therefore it is the need of an hour to monitor the areas scientifically in this rapidly changing environment. The study shall be focused on status, distribution and conservation of the species of avifauna of the region. This can be achieved through meaningful participation of local population in protection and conservation of bird species.There is a need to spread a word of awareness about the conservation of species to maintain the ecological balance. We propose to take this study forward to understand the level of participation of the local people for the cause and assess the probable impact of above mentioned developmental activities on the habitat.

It is recommended that town/city planners take such facts in to consideration while planning any developmental activities to conserve biodiversity of the region in general and of avifauna in particular. Bird species not only add aesthetic value to our life but also help in agriculture and in maintaining a healthy ecological balance. Exhaustive study of biodiversity of the region may ensure its conservation. The study of flora along with avifauna can help in drawing some conclusive inferences.

Conclusions

From present study following conclusions can be drawn,

1. The study area shows good avifaunal diversity which can help in establishing baseline data of birds of Nigade.

2. Considering the extent of anthropogenic activities in the region, there is a need for conservation of the study area.

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Avifaunal Distribution within Different Habitats of Karnala Bird Sanctuary, Maharashtra

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Abstract : Western Ghats is considered to be one of the biodiversity rich areas not only in India but also in the World. It possesses great diversity of flora and fauna and also endemism (Pramod, Daniels, Joshi, & Gadgil, 1997 and Watwe & Thakur, 2006)) to get counted in biodiversity hotspots of the world (Biodiversity hotspots - Western Ghats and Shrilanka, 2007) Karnala Bird Sanctuary (KBS) lies within these stretches of Western Ghats and comprises of an area of 12.11 km^2. Its close proximity towards city of Mumbai and on NH 17 Highway makes it a tourist attraction, not for the birds but for the fort. This situation has led to various problems including road widening issue faced by this forest. But the conservation efforts are limited due to lack of documentation and studies on this forest. This study was designed not only to document species richness of this small forest but also to find out distribution patterns of these birds along various microhabitats along the forest. Results obtained in study showed total of 144 bird species belonging to 46 families comprising of 16 orders throughout the study period. Results found during study suggest that different habitats of KBS are characteristically different from one another in terms of species distribution both horizontal as well as vertical. Results from study put an emphasis on habitat wise conservation of forest rather than forest as a whole is a key to better forest management.

Key words : Avifauna, Karnala Bird Sanctuary, Western Ghats, Sahyadri, Habitat, Bray Curtis analysis

Introduction

India has a great diversity of habitats, ranging from Alpine meadows in Himalaya to tropical forests, from wetland ecosystem to desert ecosystems. It also harbours 2 out of 34 biodiversity hotspots of the worlds, one of which being Western Ghats. Western Ghats has a great avifaunal diversity found in various habitats, harboring ca. 580 species of Birds (Pramod, Daniels, Joshi, & Gadgil, 1997**,** Daniels, 1997**,** Pandey , S.; Tambe, S.; Fransis, C. F.; Sant, N., 2003)**)** which is 47% of avifaunal diversity of entire country as India has 1237 species of birds **(Daniels, 1997).** Whereas Northern Western Ghats harbors ca. 168 bird species **(Gole, 1996).** The Karnala Bird Sanctuary is located within this Western Ghats. The sanctuary is quite small with an area of 14.12sq.km. Like other forests of India this forest also faces pressing issues due to development and tourism. Some of the pressing issues of this park include illegal lopping within forest, disturbances and pollution created by tourists and last but definitely not the least is the government proposal to widen the NH 17 that passes through the heart of this forest. All these activities are built on the belief that this park being smaller in size harbours no major population of birds and is being put under further pressure. To add to this strife this forest lacks scientific documentation which further jeopardises conservation efforts.

The problem of adequately describing and measuring complex habitats has always plagued students of ecology and evolution. Certain physical and chemical aspects of the environment are readily measurable, and their analyses have provided the basis for important ecological principles, particularly for plants and lower animals. Higher vertebrates, however, especially birds, seem to respond to broader and more elusive aspects of the habitat. Within an outer limit of physiological tolerance, a bird apparently responds psychologically to general features in the environment such as the physiognomy of the vegetation (Emlen, 1956) Bird species diversity is known to be affected by forest structure; therefore, several indices of forest structure have been proposed for the evaluation of birds' habitats (MacArthur & MacArthur, 1961). Higher vertical diversity of foliage distribution that can be numerically expressed based on these indices improves bird species diversity because each species can find their own ecological niche divided by feeding height. Birds have been considered good predictors of habitat quality, as they relate to changes in their associated habitats in numerous ways because they respond to habitat

structure (MacArthur & MacArthur, 1961) and represent several trophic groups or guilds. Habitat dimensions are important more often than food-type dimensions which are more important than temporal dimensions in resource partitioning. (Schoener, 1974)

After carrying out primary survey it was observed that the KBS was mainly formed form mosaics of 5 habitats viz. Grassy, Riparian, Evergreen, Deciduous and Rocky habitats. Conservation of this forest becomes less accurate if these microhabitats are not studied. Keeping all these things in mind this study was designed to document bird population within the park along with their distribution patterns within the microhabitats that form this park and also their vertical distribution.

Methods

The study was undertaken at Karnala Bird Sanctuary which located in Panvel Taluka of Raigad District, Maharashtra (18° 53' 15.89'' N and 73° 06' 52.14''). The sanctuary is quite small with an area of 14.12 sq.km. This forest is mainly classified under mixed deciduous forest and is majorly comprised of five distinct micro habitats.

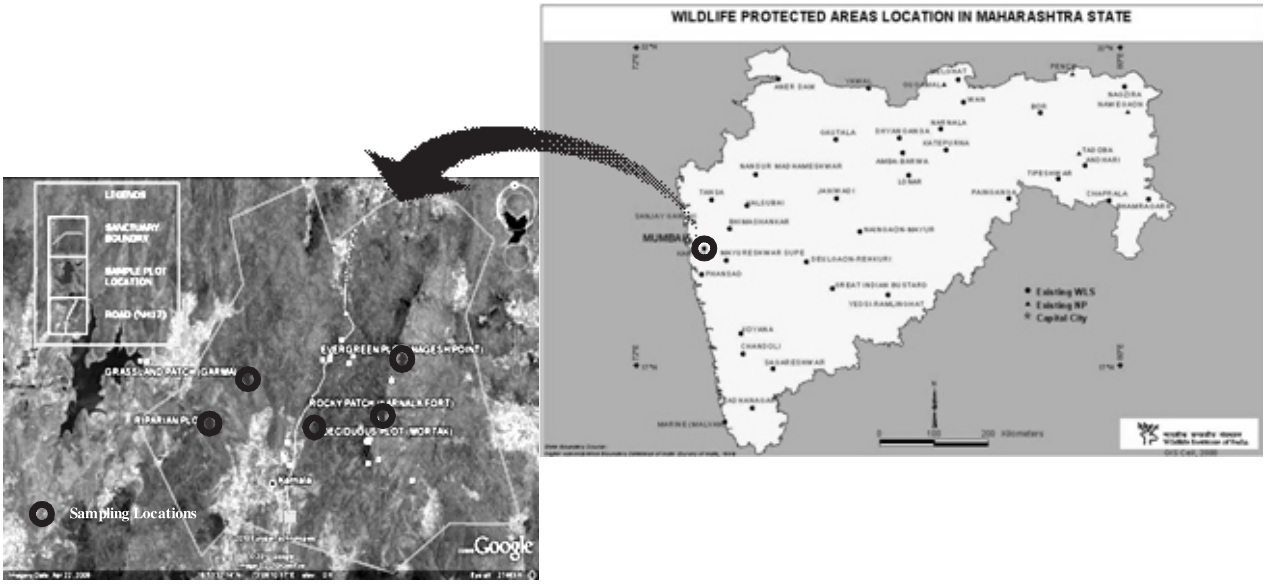


Fig. 1.1 Location of Karnala and Sampling locations map

To provide a more accurate representative sampling units of the forest a stratified sampling technique was undertaken after preliminary study in which five major microhabitats were located viz. Grassy, Riparian, Evergreen, Deciduous and Rocky, as mentioned in fig. 1.1.

Initially a vegetation structure and similarity at these locations was checked using quadrate method. Five random plots of 15m X 15m Quadrates were laid in each of the above said habitats to study the composition of trees. Four plots of 5m X 5m were laid in four different corners of this 15X15 m quadrate to study the shrub composition. Within each 5x5m quadrate, one 1x1m quadrate was laid for herb composition. Total count of trees, shrubs and major herb species was done. The herb plants species were identified (Kehimkar, 2000) and local herbarium as well as with the help of plant taxonomists at Wildlife Institute of India.

To study the bird diversity, random transects were undertaken on foot and on every sighting birds were carefully observed by checking the key characters. Standard reference books were used to identify the bird species. For the estimation of densities of birds in each habitat, Point count method (Hutto, Plerschet, & Hendricks, 1986) was used with a plot of 15m radius (decided according to actual visibility). The time period for each point count was two hours that is from 8:00 a.m. to 10:00 a.m. In the point count estimation, criteria such as species name, number of individuals, distance from the observer and height at which bird was located, were recorded in standard sheets. (Hostetler & Martin, 2009). Sampling was carried out for five months to compensate for seasonal variations in bird and vegetation distribution.

Data obtained was then analysed for density, abundance and species richness. Sampling efforts were slightly lesser than what is required for conclusive statistical analysis. Hence the species richness was adjusted using first order Jackknife 1 estimator was used to estimate the bird species richness across the Karnala BS (Heltshe & Forrester, 1983) using Colwell EstimateS 7.5 software (Colwell, 2009), with classic formula for Chao 1 and Chao 2 and

randomization at 1000 runs. Error plots were used to study the overall distribution of birds along vertical gradient in Karnala BS (Fig. 6).

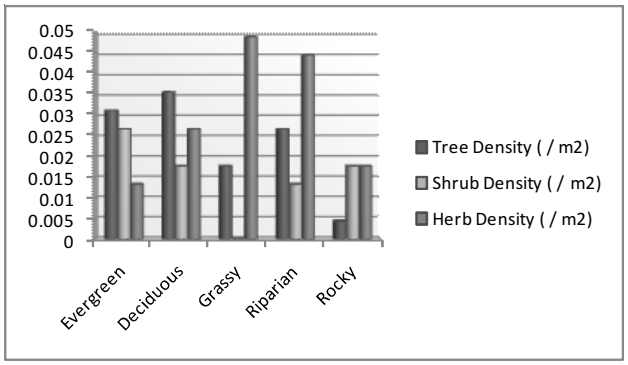
Error plots are used to indicate the uncertainty in data points. Here the main usage was to check the range of vertical gradient which are used by different species of birds throughout the Karnala BS. With the help of this graph, one can categorise bird into three different communities, like, those residing in upper canopy, middle canopy, lower canopy and ground dwelling birds. Sampling effort for this study is too low hence more study is needed on this aspect to conclude comprehensively about the particular vertical gradient used by a particular bird.

Further to check whether bird distribution was indeed affected by habitats; a comparison of similarities between these microhabitats was carried out by Bray Curtis cluster analysis using Biodiversity Pro (version 2) software

Results

Initially tree, herb, shrub densities were estimated for the five microhabitats to confirm the vegetative vertical gradient present in each of these habitats. This showed that all five habitats were considerably different from one another.

Figure: 1.2 Graph showing Densities of trees, herbs and shrubs at various Microhabitats



A total of 146 species of birds belonging to 46 families of 16 orders were observed during study period along the trail routes and in sampling units. Checklist of these birds has been published in the paper *"Avifaunal Diversity in Karnala Bird Sanctuary, Panvel, Maharashtra, "which is not considered for this paper.* But during study

A total of 101 bird species were observed during sampling whereas 146 species were observed during the whole span of work As the sampling effort was low, first order Jackknife 1 estimator was used (Heltshe & Forrester, 1983) to estimate the bird species richness across the Karnala, The estimated species richness was found to be 128 against the observed species richness of 101

Figure 1.3: Estimated Species Richness using Jackknife 1

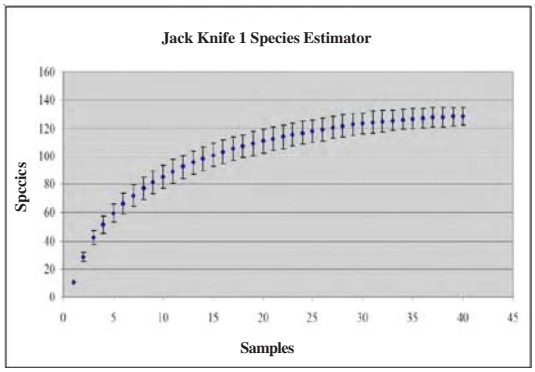
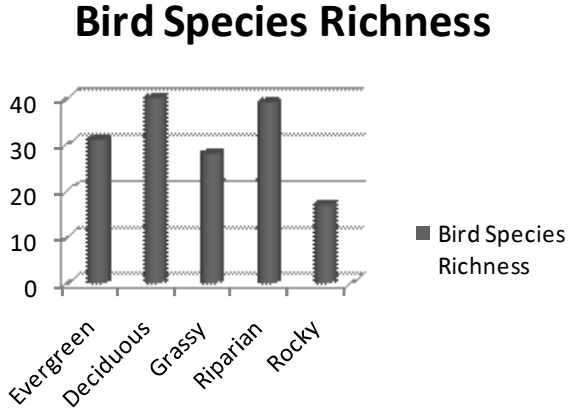


Figure 1.4: Species richness in Microhabitats



Across different habitats, highest bird species richness was found in deciduous forest habitat with 40 species, followed by 39 species in riparian habitat, 31 species in evergreen forest habitat, 28 species in grasslands and 17 species in rocky habitat (Refer Fig 1.4). On the other hand, highest bird density was found in the deciduous forest habitats, followed by Riparian habitat, evergreen forest habitats, grassland and lowest species richness was found in rocky habitat. The bird abundance in different habitats was in the following order: deciduous forest habitat > grassland habitat > riparine habitat > evergreen forest habitat > Rocky habitat.

Comparison among birds in the Karnala BS showed that Asian Black Drongo had highest density followed by Thick billed flowerpecker and Golden fronted leaf bird, whereas lowest density was shown by Asian Koel, Black Naped Oriole and Bronze Drongo

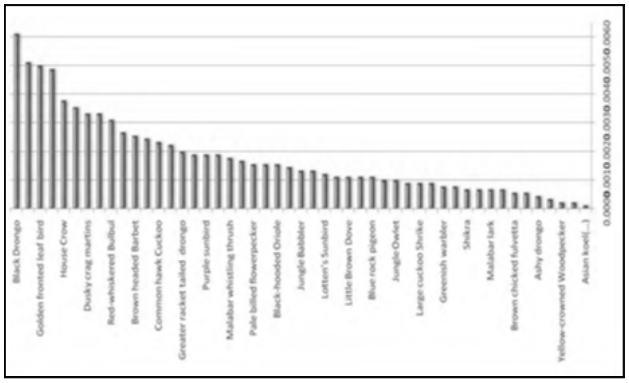


Fig. 1.5: Comparison of densities of bird species throughout Karnala Bird Sanctuary

Distribution of birds along vertical gradient in the forest habitat was studied. In all the habitats maximum birds were found at a height of 5 – 9.99 feet

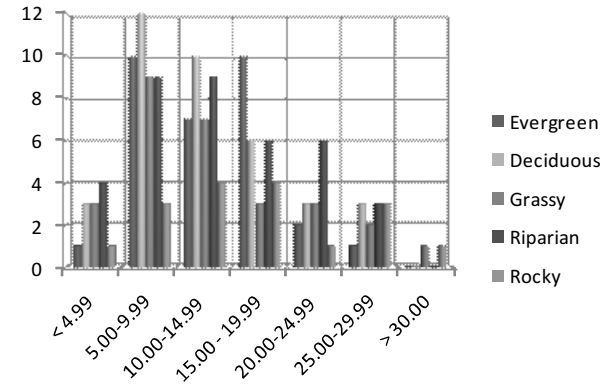


Figure 1.6: Bird distribution along vertical gradient in different forest habitats

In the error plots that were drawn Oriental honey buzzard, White eye Buzzard, Dusky crag Martin, Crested serpent Eagle and Asian palm swift prefers the highest vertical gradient whereas bird species like, Jungle Babbler, Eurasian Blackbird, Forest wagtail, Grey jungle fowl, Grey wagtail, Indian Pond Heron, Jerdons night jar, Jungle bush Quails, Malabar lark, Orange headed thrush, Oriental magpi Robin, Red wattled lapwing and White breasted waterhen prefers the lowest strata along the vertical gradient. Some of these birds of lower strata are ground dwelling birds.

Sampling effort for this study is too low hence more study is needed on this aspect to conclude comprehensively about the particular vertical gradient used by a particular bird. But this surely gives us abroad idea.

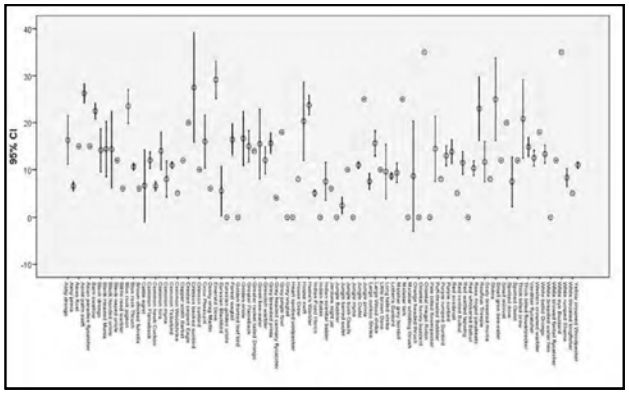
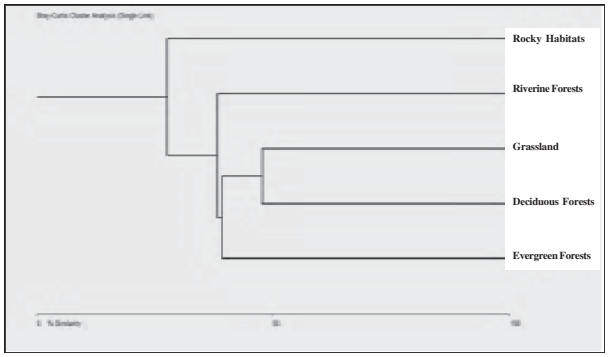


Figure 1.7 Error plot showing bird distribution along vertical gradient in Karnala Bird Sanctuary

During bray Curtis analysis, across different habitat types of Karnala BS, it is revealed from figure 1.8 that the species composition differs significantly. Bird species composition in Rocky habitats greatly differs from other habitats with only 27.5 % of common species. Riparian habitat shows 38.3% similarity in species composition when compared with other habitats. Grassy and Deciduous habitat shows maximum similarity in bird species composition with each other (47.8%) whereas evergreen habitat shows 39.39% similarity with grassy and deciduous habitats. On the whole, there is approximately 50% of bird species unique to each habitat which in turn depicts the uniqueness of each habitat too.

Figure 1.8: Bray-Curtis Cluster Analysis with respect to bird species composition similarity in microhabitats.



Discussion

During study it was found that evergreen patch and deciduous patch showed well-formed canopy structure with upper canopy made up of trees, middle strata made up of shrubs and ground cover of herbs and grasses. These habitats did not show similarity in species types and/or species composition. Five major habitat types were classified, namely, Evergreen forest habitat, Riparian forest habitat, deciduous forest habitat, Grasslands and Rocky Habitats. Tree density was highest in deciduous forests, where as it was lowest in rocky habitats. Shrub density was

highest in evergreen forest habitats, where as it was lowest in grasslands. Herb density was highest in grasslands and lowest in evergreen forest habitats.

Further the avifaunal studies indicated that Bird species richness was highest in deciduous forest habitats (40) where as it was lowest in rocky habitats (17). Bird density was found to be highest in deciduous forest habitats where as it was lowest in rocky habitats. Bird abundance was highest in deciduous forest habitats (0.0047) and lowest in rocky habitats (0.0011). High bird density as well as species richness could be higher in deciduous owing to the availability of wide range of micro habitats due to high tree density and openness of canopy. When the density of bird across the sanctuary was compared, Asian Black Drongo showed highest density whereas lowest density was shown by Bronze Drongo. Comparatively fewer birds had higher density. This was probably due to disturbed habitat in the region as little lesser disturbed areas showed greater densities as compared to disturbed areas. Also during the study period a record of 'Eurasian black bird' was reported which was recorded after 12 years within these areas.

Distribution of birds along the vertical gradient in the forest habitats of Karnala BS was studied. Comparatively, most preferred height by bird species was 5 – 9.99 feet in all the habitats. Across different habitats there seems to be a kind of formation of zones along vertical gradient. Some of these zones are used by majority of the birds. Just for example, predator birds will prefer greater heights for easy visibility of their prey; on the other hand, smaller birds which may be preys to predators will prefer lower zones to enable them to hide from their predators and also to save much of their energy to fly higher. But this aspect needs to be studied in detail so as to come up to proper conclusion.

Bray-Curtis cluster analysis showed distinction of habitats with respect to their bird species composition. The main reason which may be attributed to this fact is that the bird species are habitat specific some of which are very specific even about their food plant or insects (monophagous) where as there are birds which feeds on multiple food plants or insects (polyphagous). This shows that there is a need to protect these, each and every microhabitat to conserve the forest ecosystem and diversity. Also a change in these microhabitats could lead to permanently damaging biodiversity of this area. Hence there is a need to conserve these microhabitats in order to preserve the forest and further research is required to determine the nutritional niche of the bird species in order to check for the vegetative and food preferences of these species and hence a key to conserve these species.

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Bird diversity of Betawade, Thane, a Natural urban habitat.

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Abstract : Mumbai, one of the largest metro cities in the world, holds rich biodiversity in few green fragmented natural or manmade habitats. Betawade, an area, situated towards Northeast of Mumbai near Dombivli, attracts rich biodiversity due to various habitats such as shrubby grasslands, paddy fields, creek tributaries, mangroves and wetlands. A preliminary data of avifauna was collected between August 2012 to July 2013. A total of 135 species were sighted during the survey. They include residents, winter and summer migrants and even some IUCN red list categorized species. From conservation point of view, the study area which was once undisturbed with rich faunal diversity, has been however, now impacted by urbanization pressures. The present study can establish baseline data for future effective management and planning.

***Key words**:* Biodiversity, Betawade, avifauna, urbanization, baseline data

Introduction

Biodiversity is the variety and variability of life on Earth. Quantitative documentation of biodiversity is an important aspect of ecology and a popular topic in recent times. The Indian subcontinent, a part of the vast Oriental biogeographic regions, is very rich in biodiversity. Out of the more than 9,000 birds of the world, the Indian subcontinent contains about 1,300 species, or over 13% of the world's birds (Grimmet *et al.*, 1998). Birds and their diversity constitute a main part of the natural environment and play a functional role as agents of flower pollination, seed dispersal, source of food chain and agents in breaking seed dormancy (Nason, 1992). Birds are good environmental indicators revealing the state of the ecosystems. They also act as dispersal agents in transferring nutrients and spores from one place to another during their migration and local movements (Niemi, 1985). Unfortunately global diversity of birds is decreasing incessantly primarily due to anthropogenic disturbances (Rapoport, 1993).

Studies are available on avifaunal diversity in India; however paucity exists in study of Mumbai. Verma *et al* (2004) studied biodiversity of avifauna of Mahul Creek, while Chauhan *et al* (2008) surveyed the avifauna of Borivali Mangroves. Pawar (2011) reported the species diversity of birds in Uran. Recently Kushwaha *et al* (2013) documented the bird diversity of Bhandup pumping station. However this is the first documented report on the diversity of bird species in Betawade region of Thane.

Betawade, the area under study, is a rapidly developing area with substantial biodiversity values which are under urbanization pressures. It is marked by variety of habitats such as shrubby grasslands, paddy fields, creek tributaries, artificial water bodies, wetlands and mangroves. Existing habitat is likely to be impacted by human activities such as construction, industrial pollution and physical alteration of land use. Since most of its ecosystems are now influenced by various anthropogenic activities, it is essential for the land users to know overall diversity of an area along with rare and sensitive species.

To slow down the loss of biodiversity and to enhance its contribution to development, any strategy must integrate the conservation of biodiversity, sustainable use of its components and the equitable sharing of resources. This would need on priority to know the actual biodiversity surviving in the area. Hence, the study was set out to obtain information on the presence, richness, diversity and activities of various bird species in Betawade region of Thane. This is because outside the system of protected areas, India's biodiversity has often found refuge in many private lands. The study will also help to increase the local awareness towards biodiversity issues and prove to be fruitful in conservation efforts.

Materials and Methodology

(i) *Study Area*

Betawade village (19°11'40''N – 73°4'44''E), is situated in Dombivli, a city in Kalyan Tehsil of Thane District, in Maharashtra, India (Fig.1). The total area of the study site is approximately 8 Km^2. The prevailing climatic conditions in Betawade is typically tropical with mean annual temperature of 24.3°C (min) to 32.9°C (max). The temperature varies between 25-38°C in summer, whereas between 20-30°C during winter. The average annual rainfall in the region is in the range of 1286 to 1233mm.

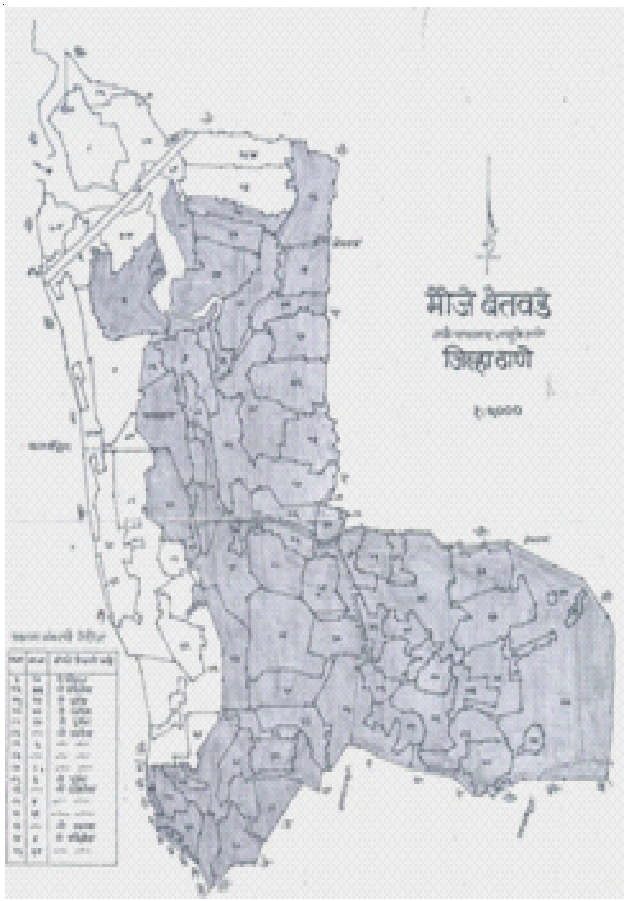
(ii) *Data Collection*

Betawade was surveyed from August 2012 to July 2013 at the regular interval of fifteen days covering all the seasons. The visits were carried out in the morning from 7.00 am to 10.00 am. and in the evening from 4.00 pm to 6.00 pm. Some of the basic methods used in this study as described by Bibby *et al*. (1992) are: (a) point counts - undertaking a bird count from a fixed location for a fixed period of time. The bird species seen or heard are recorded.

(b) line transect - moving along a fixed route (transect) and recording the bird species seen and heard on both sides of transect. Besides visits were also made during different hours of the day. The birds were photographed if not identified immediately. Observations were carried out with the help of 10×50 Olympus binocular and photography was done with Nikon P500 digital zoom camera. Identification of birds was done using field guides [1, 5]. The following formula was used for determining percentage of occurrence of Families (Basavarajappa, 2006).

$$\text{Percentage Occurrence} = \frac{\text{No of Species of each family}}{\text{Total no of Different species seen}} \times 100$$

Figure1: Map of Betawade, Thane



(Note: Shaded area indicates the areas surveyed in Betawade, Thane)

Result and Discussion:

During the present period of study a total of 135 bird species belonging to 47 families were recorded which includes 45 winter and 06 summer visitors [Fig.2]. Among these, the family Accipitridae contributed the highest number of species (14) followed by the family Ardeidae (09), whereas 15 families were found to be represented by single bird species [Table2]. Based on the food/foraging, from the present data it is apparent that the avifauna of this region is dominated by insectivorous (50 species), followed by piscivorous, frugivorous, grainivorous, carnivorous and omnivorous birds (30, 22, 21, 17 and 14 species respectively) [Fig.3]. R - Residents, species found in the study area throughout the year; WM – Winter Migrants, species found during the winter and SM - Summer Migrants, species visiting the area during the summer season.

Figure2: Numbers of resident, winter and summer migrant bird species in the study area.

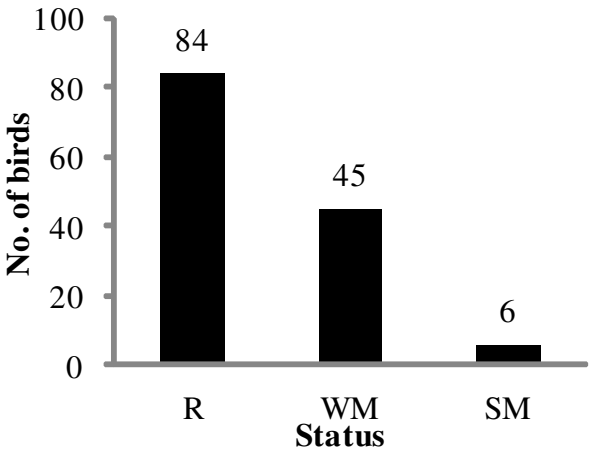


Table1a: Relative percentage of number of species in various families of birds in the study area.

Relative percentage of species			
0-2	**2-4**	**4-6**	**6 and above**
Podicipedidae	Phasianidae	Anatidae	Ardeidae
Phoenicopteridae	Ciconiidae	Strunidae	Accipitridae
Phalacrocoracidae	Threskiornithidae	Muscicapidae	
Charadriidae	Rallidae		
Psittacidae	Scolopacidae		
Strigidae	Columbidae		
Hemiprocnidae	Cuculidae		
Upupidae	Alcedinidae		
Coraciidae	Hirundinidae		
Meropidae	Alaudidae		
Ramphastidae	Cisticolidae		
Picidae	Slyviidae		
Pittidae	Nectariniidae		
Aegithinidae	Estrildidae		
Laniidae	Motacillidae		
Dicruridae			
Oriolidae			
Rhipiduridae			
Pycnonotidae			
Corvidae			
Leiothrichidae			
Timaliidae			
Zosteropidae			
Chloropscidae			
Dicaedidae			
Passeridae			
Ploceidae			

Table1b: Percentage occurrence of avifauna represented in families

Sr. No.	Families	Percentage Occurrence
1	Phasianidae	2.22
2	Anatidae	4.44
3	Podicipedidae	0.74
4	Ciconiidae	2.22
5	Phoenicopteridae	0.74
6	Threskiornithidae	2.22
7	Ardeidae	6.67
8	Phalacrocoracidae	1.48
9	Accipitridae	10.37
10	Rallidae	2.22
11	Charadriidae	1.48
12	Scolopacidae	3.70
13	Columbidae	2.97
14	Psittacidae	1.48
15	Cuculidae	2.97
16	Strigidae	1.48
17	Hemiprocnidae	1.48
18	Upupidae	0.74
19	Coraciidae	0.74
20	Alcedinidae	2.97
21	Meropidae	1.48
22	Ramphastidae	1.48
23	Picidae	1.48
24	Pittidae	0.74
25	Aegithinidae	0.74
26	Laniidae	1.48
27	Dicruridae	0.74
28	Oriolidae	0.74
29	Rhipiduridae	0.74
30	Corvidae	1.48
31	Hirundinidae	2.22
32	Alaudidae	2.97
33	Pycnonotidae	1.48
34	Cisticolidae	3.70
35	Sylviidae	2.22
36	Leiothrichidae	0.74
37	Timaliidae	0.74
38	Zosteropidae	0.74
39	Strunidae	4.44
40	Muscicapidae	4.44
41	Chloropseidae	0.74
42	Dicaedidae	0.74
43	Nectariniidae	2.22
44	Passeridae	1.48
45	Ploceidae	0.74
46	Estrildidae	2.22
47	Motacillidae	3.70

Table 2: A systematic list of birds with their habitat type, status, abundance and food/foraging in Betawade, Thane during the study period.

Sr.No	Common Name	Scientific Name	Type of Habitat	Status	Abundance	Food/Foraging
Family: Phasianidae						
1	Painted Francolin	*Francolinus pictus*	Grassland	R	U	O
2	Grey Francolin	*Francolinus pondicerianus*	Grassland	R	U	O
3	Jungle Bush Quail	*Perdicula asiatica*	Grassland	R	C	O
Family: Anatidae						
4	Lesser Whistling Duck	*Dendrocygna javanica*	Water	R	C	P
5	Indian Spot-billed Duck	*Anas poecilorhyncha*	Water	R	C	P
6	Northern Shoveler	*Anas clypeata*	Water	WM	C	P
7	Northern Pintail	*Anas acuta*	Water	WM	C	P
8	Garganey	*Anas querquedula*	Water	WM	C	P
9	Common Teal	*Anas crecca*	Water	WM	C	P
Family: Podicipedidae						
10	Little Grebe	*Tachybaptus ruficollis*	Water	R	C	P
Family: Ciconiidae						
11	Painted Stork	*Mycteria leucocephala*	Wetland	WM	C	P
12	Asian Openbill Stork	*Anastomus oscitans*	Wetland	WM	C	P
13	Wolly-necked Stork	*Ciconia episcopus*	Wetland	WM	U	P
Family: Phoenicopteridae						
14	Lesser Flamingo	*Phoenicopterus minor*	Water	WM	Rr	P-NT
Family: Threskiornithidae						
15	Black-headed Ibis	*Threskiornis melanocephalus*	Water	R	U	P-NT
16	Red-naped Ibis	*Pseudibis papillosa*	Water	R	C	P
17	Glossy Ibis	*Plegadis falcinellus*	Water	WM	C	P
Family: Ardeidae						
18	Cinnamon Bittern	*Ixobrychus cinnamomeus*	Wetland	SM	U	P
19	Black-crowned Night Heron	*Nycticorax nycticorax*	Water	R	A	P
20	Indian Pond Heron	*Ardeola grayii*	Water	R	A	P
21	Grey Heron	*Ardea cinerea*	Wetland	WM	C	P
22	Purple Heron	*Ardea purpurea*	Wetland	R	C	P
23	Cattle Egret	*Bubulcus ibis*	Wetland	R	A	P
24	Great Egret	*Casmerodius albus*	Wetland	R	A	P
25	Intermediate Egret	*Mesophoyx intermedia*	Wetland	R	A	P
26	Little Egret	*Egretta garzetta*	Wetland	R	C	P
Family: Phalacrocoracidae						
27	Little Cormorant	*Phalacrocoraxniger*	Water	R	A	P
28	Indian Cormorant	*Phalacrocorax fuscicollis*	Water	R	A	P
Family: Accipitridae						
29	Black-winged Kite	*Elanus caeruleus*	Raptor	R	C	C
30	Black Kite	*Milvus migrans*	Raptor	R	A	C
31	Black-eared Kite	*Milvus (migrans) lineatus*	Raptor	WM	U	C
32	Brahminy Kite	*Haliastur indus*	Raptor	SW	C	C
33	Black Eagle	*Ictinaetus malayensis*	Raptor	WM	Rr	C
34	Oriental Honey Buzzard	*Pernis ptilorhyncus*	Raptor	R	C	C
35	Short-toed Snake Eagle	*Circaetus gallicus*	Raptor	WM	Rr	C
36	Eurasian Marsh Harrier	*Circus aeruginosus*	Raptor	WM	C	C
37	Shikra	*Accipiter badius*	Raptor	R	C	C
38	White-eyed Buzzard	*Butastur teesa*	Raptor	R	C	C
39	Indian Spotted Eagle	*Aquila hastata*	Raptor	WM	Rr	C-V

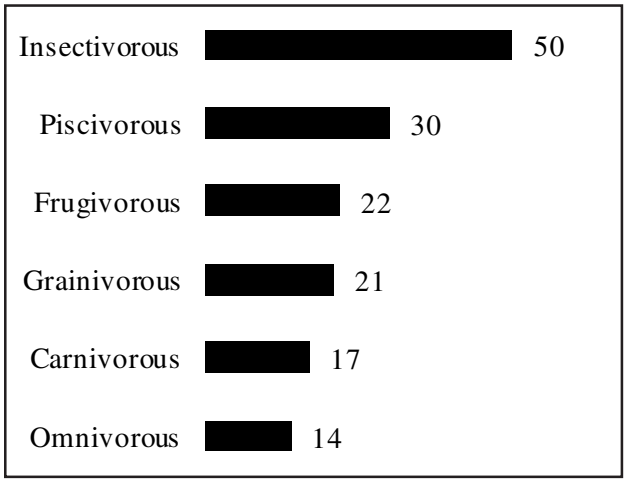
40	Greatter Spotted Eagle	*Aquila clanga*	Raptor	WM	Rr	C-V
41	Bonellis Eagle	*Aquila fasciata*	Raptor	WM	Rr	C
42	Booted Eagle	*Hieraaetus pennatus*	Raptor	WM	C	C
Family: Rallidae						
43	White-brested Waterhen	*Amaurornis phoenicurus*	Wetland	R	A	O
44	Purple Swamphen	*Porphyrio porphyrio*	Wetland	R	C	O
45	Eurasian Coot	*Fulica atra*	Water	R	C	O
Family: Charadriidae						
46	Red-wattled Lapwing	*Vanellus indicus*	Wetland	R	A	I
47	Pacific Golden Plover	*Pluvialis fulva*	Water	WM	Rr	P,I
Family: Scolopacidae						
48	Wood Sandpiper	*Tringa glareola*	Water	WM	U	I
49	Common Sandpiper	*Actitis hypoleucos*	Water	WM	C	I
50	Marsh Sandpiper	*Tringa stagnatilis*	Water	WM	C	I
51	Common Redshank	*Tringa totanus*	Water	WM	C	I
52	Common Greenshank	*Tringa nebularia*	Water	WM	U	I
Family: Columbidae						
53	Common Pigeon	*Columba livia*	Forest	R	A	F,G
54	Spotted Dove	*Streptopelia chinensis*	Forest	R	A	F,G
55	Laughing Dove	*Streptopelia senegalensis*	Forest	R	A	F,G
56	Yellow Footed Green Pigeon	*Treron phoenicopetra*	Forest	WM	U	F,G
Family: Psittacidae						
57	Alexandrine Parakeet	*Psittacula eupatria*	Forest	R	A	F
58	Rose-ringed Parakeet	*Psittacula krameri*	Forest	R	C	F
Family: Cuculidae						
59	Jacobin Cuckoo	*Clamator jacobinus*	Forest	SM	U	F
60	Common Hawk Cuckoo	*Hierococcyx varius*	Forest	WM	C	F
61	Asian Koel	*Eudynamus scolopacea*	Forest	R	C	F
62	Greater Coucal	*Centropus sinensis*	Forest	R	C	F
Family: Strigidae						
63	Barn Owl	*Tyto alba*	Forest	R	C	C
64	Short Eared Owl	*Asio flammeus*	Scrubland	WM	Rr	C
Family: Hemiprocnidae						
65	Asian Palm Swift	*Cypsiurus balasiensis*	Forest	R	C	I
66	House Swift	*Apus affinis*	Forest	R	A	I
Family: Upupidae						
67	Common Hoopoe	*Upupa epops*	Forest	WM	U	I
Family: Coraciidae						
68	Indian Roller	*Coracias benghalensis*	Forest	R	A	I
Family: Alcedinidae						
69	White Throated Kingfisher	*Halcyon smyrnensis*	Forest	R	A	P
70	Black-capped Kingfisher	*Halcyon pileata*	Mangrove	WM	Rr	P
71	Common Kingfisher	*Alcedo atthis*	Wetland	R	C	P
72	Pied Kingfisher	*Ceryle rudis*	Mangroves	R	C	P
Family: Meropidae						
73	Green Bee-eater	*Merops orientalis*	Forest	R	C	I

74	Blue-tailed Bee-eater	*Merops philippinus*	Forest	WM	U	I
Family: Ramphastidae						
75	Brown-headed Barbet	*Megalaima zeylanica*	Forest	R	U	F
76	Coppersmith Barbet	*Megalaima haemacephala*	Forest	R	A	F
Family: Picidae						
77	Eurasian Wryneck	*Jynx torquilla*	Forest	WM	C	F
78	Yellow-crowned Woodpecker	*Dendrocopos mahrattensis*	Forest	R	C	F
Family: Pittidae						
79	Indian Pitta	*Pitta brachyura*	Forest	SM	U	I
Family: Aegithinidae						
80	Common Iora	*Aegithinia tiphia*	Forest	R	U	I
Family: Laniidae						
81	Isabellian Shrike	*Lanius isabellinus*	Grassland	WM	U	I
82	Long-tailed Shrike	*Lanius schach*	Grassland	R	A	I
Family: Dicruridae						
83	Black Drongo	*Dicrurus macrocercus*	Forest	R	A	C
Family: Oriolidae						
84	Indian Golden Oriole	*Oriolus oriolus*	Forest	R	C	O
Family: Rhipiduridae						
85	White-throated Fantail	*Rhipidura albicollis*	Forest	R	A	F
Family: Corvidae						
86	Indian Jungle Crow	*Corvus macrorhynchos*	Forest	R	A	O
87	House Crow	*Corvus splendens*	Forest	R	A	O
Family: Hirundinidae						
88	Wire-tailed Swallow	*Hirundo smithii*	Water	R	C	I
89	Barn Swallow	*Hirundo rustica*	Water	R	C	I
90	Red-rumped Swallow	*Hirundo daurica*	Water	R	C	I
Family: Alaudidae						
91	Rufous-tailed Lark	*Ammomanes phoenicurus*	Scrubland	R	C	G,I
92	Greater short-toed Lark	*Calandrella brachydactyla*	Scrubland	WM	U	G,I
93	Ashy-crowned Sparrow Lark	*Eremopterix grisea*	Scrubland	R	C	G,I
94	Malabar Lark	*Galerida malabarica*	Scrubland	WM	U	G,I
Family: Pycnonotidae						
95	Red-whiskered Bulbul	*Pycononotus jacosus*	Forest	R	C	F
96	Red-vented Bulbul	*Pycnonotus cafer*	Forest	R	A	F
Family: Cisticolidae						
97	Ashy Prinia	*Prinia socialis*	Paddy field	R	A	G
98	Plain Prinia	*Prinia inornata*	Paddy field	R	C	G
99	Grey-brested Prinia	*Prinia hodgsonii*	Paddy field	R	C	G
100	Zitting Cisticola	*Cisticola juncidis*	Paddy field	R	A	I
101	Common Tailorbird	*Orthotomus sutorius*	Paddy field	R	A	I

Family: Sylviidae						
102	Clamorous Reed Warbler	*Acrocephalus stentoreus*	Grassland	WM	C	I
103	Paddy-field Warbler	*Acrocephalus agricola*	Paddy field	WM	U	I
104	Blyth's Reed Warbler	*Acrocephalus dumetorum*	Paddy field	WM	C	I
Family: Leiothrichidae						
105	Jungle Babbler	*Turdoides striata*	Scrubland	R	C	I
Family: Timaliidae						
106	Tawny bellied Babbler	*Dumetia hyperythra*	Grassland	WM	U	I
Family: Zosteropidae						
107	Oriental White-eye	*Zosterops palpebrosus*	Forest	R	U	I
Family: Strunidae						
108	Jungle Myna	*Acridotheres fuscus*	Forest	R	A	O
109	Common Myna	*Acridotheres tristis*	Forest	R	A	O
110	Asian Pied Starling	*Sturnus contra*	Forest	R	A	O
111	Chestnut-tailed Starling	*Sturnus malabaricus*	Forest	SM	C	F
112	Brahminy Starling	*Sturnus sturninus*	Forest	SM	C	O
113	Rosy Starling	*Sturnus roseus*	Forest	WM	C	O
Family: Muscicapidae						
114	Bluethroat	*Luscinia svecica*	Wetland	WM	C	I
115	Oriental Magpie Robin	*Copsychus saularis*	Forest	R	C	I
116	Indian Robin	*Saxicoloides fullicata*	Grassland	R	C	I
117	Common Stonechat	*Saxicola torquata*	Paddy field	R	C	I
118	Pied Bushchat	*Saxicola caprata*	Grassland	R	C	I
119	Desert Wheatear	*Oenanthe deserti*	Grassland	WM	U	I
Family: Chloropseidae						
120	Golden fronted Leafbird	*Chloropsis aurifrons*	Forest	R	C	F,I
Family: Dicaedidae						
121	Pale-billed Flowerpecker	*Dicaeum erythrorynchos*	Forest	R	A	F,G,I
Family: Nectariniidae						
122	Purple-rumped Sunbird	*Nectarinia zeylonica*	Forest	R	A	F,G,I
123	Purple Sunbird	*Nectarinia asiatica*	Forest	R	A	F,G,I
124	Loten's Sunbird	*Nectarinia lotenia*	Forest	R	C	F,G,I
Family: Passeridae						
125	House Sparrow	*Passer domesticus*	Forest	R	A	G,I
126	Chestnut-shouldered Petronia	*Petronia xanthocollis*	Forest	R	A	G,I
Family: Ploceidae						
127	Baya Weaver	*Ploceus philippinus*	Forest	R	A	G
Family: Estrildidae						
129	Red Avadavat	*Amandava amandava*	Grassland	R	A	G
130	Scaly-brested Munia	*Lonchura punctulata*	Grassland	R	A	G
131	Black-headed Munia	*Lonchura malacca*	Grassland	R	C	G
Family: Motacillidae						
131	Yellow Wagtail	*Motacilla flava*	Grassland	WM	C	I
132	White Wagtail	*Motacilla alba*	Wetland	WM	C	I
133	Paddy-field Pipit	*Anthus rufulus*	Forest	R	C	I
134	Tree Pipit	*Anthus trivialis*	Forest	WM	C	I
135	Olive-backed Pipit	*Anthus hodgsoni*	Forest	WM	C	I

[P- Piscivorous, I-Insectivorous, C- Carnivorous, G- Grainivorous, F- Frugivorous, O- Omnivorous, A- Abundant, C-Common, U- Uncommon, Rr- Rare, NT- Near Thretened, V- Vulnerable]

Figure3: Distribution of birds according to their feeding habits in the study area.



Betawade is a resident area and is now invaded by commercial activity due to expanding city limits. A lot of human interferences like constructional activities, deforestation, noise due to vehicles and people are posing threat to avifauna. The present work revealed that even though the urban sites are continuously disturbed, these sites have supported significant number of avifauna which is excellent indicator of ecosystem health. However human disturbances can damage birds in many ways, including disrupting foraging or social behavior, increasing nest predation, interfering with parent-offspring and pair bonds, increasing nesting failures, and reducing the viability of fledglings. Additionally, birds may perceive humans as predators and leave an area; resulting in decline in species abundance. Due to urbanization pressures, it is difficult for avifauna to find the nesting locations and sheltering place or foraging habitats in this urban site. To save the urban avifauna, reforestation is required to create gardens, parks and lakes besides the human habitation to facilitate the foraging, sheltering and breeding for birds. Fast growing species and fruit bearing trees suitable to the local environment should be planted within residential area to attract many frugivorous and insectivorous species of birds. Thus a conservation plan could be undertaken to save the urban species of birds.

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Avifauna of Thakurli, District Thane

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Abstract : Thakurli, a suburb of Kalyan-Dombivli Municipal Corporation, is situated between two densely populated cities Kalyan and Dombivli. With rampant concretization this small suburb is steadily losing its green cover – a threat to biodiversity. Birds are the indicators of biodiversity. To know the present status of bird biodiversity, Avifauna study was carried out at Thakurli east and west. East, showing rampant concrete construction, is a combination of rough, rocky area, farm and marshy land, while west is a combination of farmland and creek. The duration of study extended between May 2012 and April 2013. A total of 86 species of birds were recorded belonging to 38 families. Most of them were the residents but a few were migratory. Order Passeriformes dominated the birds' list. Birds found in human habitat were more than the rest – an indicator of progressive urbanization of the study area.

Key words: - Thakurli, Avifauna, Biodiversity, Residents, Migratory Birds.

Introduction

"Feathered Bipeds" (Ali, 2012), an apt and precise description for birds, forms the inevitable component of an ecosystem. As they usually occupy high trophic levels in food webs and relatively sensitive to environmental changes, they are good indicators of biodiversity.

Thakurli, an upcoming suburb of Kalyan-Dombivli Municipal Corporation, is situated between twin cities Kalyan and Dombivli. It is observing a steady growth in human habitation with a proportionate decrease in green cover. Bird biodiversity of nearby Thane creek has been documented. In 2001, Quadros, G. reported 55 species of birds in Thane Creek; Nitsure S.R. (2002) studied avifauna of Thane Creek near Rituchakkra Park. Varier, D. (2010) reported birds of Thakurli creek, but this report is based on her one day visit to the area. Thus, there exists paucity of scientific data regarding avifauna of the said area. The present study has attempted to document the avifauna of Thakurli.

Study Area

Geographically, Thakurli (Coordinates19.2255° N, 73.0967° E) is located towards the east and north of Dombivli. Its north is bordered by Thakurli Creek / Ulhas River estuary and towards east is Kalyan. The railway tracks passing through Thakurli divide it into two parts – west and east. The West of Thakurli is more a combination of farmland and creek whereas the East is a combination of rough, rocky area, farm and marshy land. It has two fresh water lakes, namely Chole and Bhoirwadi Lake. Thakurli is observing rampant growth in human habitation, thereby causing the loss of natural habitat for organisms. It's an example of developing urbanization. Hence this area was selected for the study. The study area was divided into two parts – Thakurli east and west.

Thakurli has a moderately humid tropical climate with maximum temperature of 41^0 C and minimum temperature of 17^0 C. The annual rainfall ranges between 1900 mm and 2700 mm. Vegetation of the study area includes *Ceiba pentandra* (Kapok), *Bombax ceiba* (Cotton tree), *Borassus flabellifer* (Toddy Palm), *Mangifera indica* (Mango), *Syzygium cumini* (Jamun), *Calotropis pprox.n* (Rui), *Vitex negundo* (Nirgudi), *Typha angustifolia* (Lesser Indian Reed Mace), *Cassia auriculata* (Legume tree), *Cassia fistula* (Common Laburnum), *Tamarindus indica* (Tamarind), *Delonix regia* (Gulmohar).

Materials and Methods

The study was conducted for the duration of 12 months from May 2012 to April 2013 at regular intervals of two visits per month. The study was carried out alternately either during morning (6:00 hr. to 10:00 hr.) or during evening (16:00 hr. to 19:00 hr.). The Avifauna was observed using binoculars (10 x 21) and Nikon Cameras P100 (26X Zoom) and P500 (30X Zoom), and also by direct spotting and counting method. The observed birds were identified and classified by using standard guides such as 'The book of Indian Birds' (Ali, 2012), and 'A Pictorial Guide to the Birds of the Indian Sub-Continent' (Ali & Ripley, 1995). The counting methodology was used from Counting birds in India: Methodologies and trends (Urfi *et al*., 2005) The status of the birds as **Common, Uncommon (UN), and Rare** is based on the frequency of spotting. The birds were divided into following categories in accordance with the classification suggested by Ali (2012): **R – Resident** (Indigenous birds); **RM – Resident Migratory** (Resident birds that migrate locally within the country also called as local migratory); **M – Migratory** (Birds from other countries visiting the area under study). Migratory birds are further subcategorized as **WM – Winter Migratory** and **MM – Monsoon Migratory.**

Observations:

A total of 86 species of birds were recorded representing 13 orders and 38 families in the study area as depicted in table no. 1. Order Passeriformes dominated the count with 40 species of birds belonging to 18 families (Fig. 1). The second most dominating order was Charadriiformes with 9 species of birds belonging to 5 families. Order Apodiformes was represented by only one species of bird namely Asian Palm Swift. Family Ardeidae (Order – Ciconiformes), Sturnidae and Muscicapidae (Order – Passeriformes) were found to be richest families with each representing 6 species of birds.

Out of 86 species of birds (Fig. 2), 68 (79%) were common, 16 (19%) were uncommon whereas 2 birds were rare. *Gallicrex cinerea* (Watercock), *Limosa limosa* (Black-tailed Godwit) were the rare birds of the study area. Watercock being very secretive was observed only once in small wetland area and its call were heard on few visits. Black-tailed Godwit was found in creek area on couple of occasions during winter season.

Resident birds dominated the birds list representing as high as 75% whereas 8% were local migratory, 15% were winter migratory and the rest 2% were monsoon migratory birds (Fig. 3). Birds like common tailorbird, Ashy prinia, Plain prinia, Jungle babbler, Common myna, Jungle myna, Asian pied starling, Brahminy starling, Oriental magpie robin, Indian Golden Oriole, House crow, House sparrow, Blue-rock pigeon, Laughing dove, Ashy drongo, Black drongo, Asian Koel, Greater coucal, White-breasted kingfisher, Green bee-eater, scaly-breasted munia, Rose-ringed parakeet, Red-vented bulbul, Red-wattled lapwing, Bronze-winged jacana, Cattle egrets, Indian pond heron, Common sandpiper, Black Kite were very commonly spotted in the study area – both east as well as west of Thakurli. Birds like Northern Shoveler, Black-tailed godwit, Northern Pintail, Curlew sandpiper, Black winged Stilt, Brown-headed Gull, Osprey, Brahminy Kite were observed only in Thakurli west where anthropogenic activity is very less.

Northern Shoveler, Northern pintail, Brown headed gull, Curlew sandpiper, Wood sandpiper, Black-tailed Godwit, Chestnut-tailed starling, Rosy Starling, White wagtail, Osprey, Western Marsh harrier, Common whitethroat, White wagtail birds were reported during winter season. Red Avadavat and Tricoloured munia were reported during the month of June and July. Habitat wise, at 44% the birds found in human habitat dominated the list, whereas the second most preferred habitat was of Creek (approx. 25%).

Table No. 1 Diversity, status and habitat preference of Avifauna of Thakurli

Sr. No.	Family	*Scientific name*	Common name	Category	Status	Habitat
Order – Ciconiformes						
1	Ardeidae	*Ardeola grayii*	Indian Pond-Heron	R	C	DG, SW
2		*Ardea purpurea*	Purple Heron	LM	UN	SW
3		*Nycticorax nycticorax*	Black-crown Night Heron	R	C	Cr
4		*Bubulcus ibis*	Cattle Egret	R	C	DG, SW
5		*Ixobrychus cinnamoeus*	Chestnut Bittern	R	C	SW
6		*Egretta garzetta*	Little Egret	R	C	Cr
7	Threskiomithidae	*Pseudibis papillosa*	Black Ibis	LM	UN	Ag
Order – Anseriformes						
8	Anatidae	*Dendrocygna javanica*	Lesser Whistling-Duck	R	C	SW
9		*Anas acuta*	Northern Pintail	WM	UN	Cr
10		*Anas poecilorhyncha*	Spot Billed-Duck	R	C	Cr
11		*Anas querquedula*	Garganey	WM	UN	Cr
12		*Anas clypeata*	Northern Shoveler	WM	UN	Cr
Order – Gruciformes						
13	Rallidae	*Porzana fusca*	Ruddy-breasted Crake	LM	UN	SW

14		*Amaurornis phoenicurus*	White-breasted Waterhen	R	C	SW
15		*Gallicrex cinerea*	Watercock	LM	R	SW
16	Jacanidae	*Metapidius indicus*	Bronze-winged Jacana	R	C	SW
Order – Charadriiformes						
17	Charadridae	*Limosa limosa*	Black-tailed Godwit	WM	R	Cr
18		*Vanellus indicus*	Red-wattled Lapwing	R	C	DG
19	Rostratulidae	*Rostratula benghaensis*	Greater-Painted-Snipe	LM	UN	Ag
20	Recurvirostridae	*Himantopus himantopus*	Black winged Stilt	R	C	Cr
21	Laridae	*Larus brunnicephalus*	Brown-headed Gull	WM	C	Cr
22		*Sterna aurantia*	River Tern	R	C	Cr
23	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	R	C	Cr, SW
24		*Calidris ferruginea*	Curlew Sandpiper	WM	UN	Cr
25		*Tringa glareola*	Wood Sandpiper	WM	UN	Cr
Order – Psittaciformes						
26	Psittacidae	*Psittacula krameri*	Rose-ringed Parakeet	R	C	HH
27		*Psittacula eupatria*	Alexenderine Parakeet	R	C	HH
Order – Strigiformes						
28	Strigidae	*Tyto alba*	Barn-Owl	R	C	HH
29		*Athene brama*	Spotted Owlet	R	C	HH
Order – Apodiformes						
30	Apodidae	*Cypsiurus balasiensis*	Asian Palm Swift	R	C	HH
Order – Coraciiformes						
31	Alcedinidae	*Alcedo atthis*	Small Blue Kingfisher	R	C	HH
32	Dacelonidae	*Halcyon smyrnensis*	White-breasted Kingfisher	R	C	HH
33	Meropidae	*Merops orientalis*	Green Bee-eater	R	C	S
Order – Piciformes						
34	Megalaimidae	*Megalaima haemacephala*	Coppersmith Barbet	R	C	HH
35	Picidae	*Dendrocopos mahrattensis*	Yellow-crowned Woodpecker	LM	UN	S
Order – Passeriformes						
36	Hirundinidae	*Hirundo concolor*	Dusky Crag Martin	R	C	HH
37		*Hirundo smithii*	Wire-tailed swallow	R	C	HH
38	Lanidae	*Lanius schach*	Long tailed shrike	R	C	HH
39	Oriolidae	*Oriolus kundoo*	Indian Golden Oriole	R	C	HH
40	Dicruridae	*Dicrurus macrocercus*	Black Drongo	R	C	HH
41		*Dicrurus leucophaeus*	Ashy Drongo	R	C	HH
42	Sturnidae	*Acridotheres tristis*	Common Myna	R	C	HH

43		*Acridotheres fuscus*	Jungle Myna	R	C	DG
44		*Sturnus pagodarum*	Brahminy Starling	R	C	S
45		*Sturnus contra*	Asian Pied Starling	R	C	HH
46		*Sturnus malabaricus*	Chestnut-tailed Starling	WM	UN	HH
47		*Sturnus roseus*	Rosy Starling	WM	UN	Ag
48	Corvidae	*Corvus splendens*	House Crow	R	C	HH
49		*Corvus macrorhynchos*	Large Billed Crow	R	C	HH
50	Irenidae	*Aegithina tiphia*	Common Iora	R	C	HH
51	Pycnonotidae	*Pycnonotus cafer*	Red-vented Bulbul	R	C	HH
52	Muscicapidae	*Turdoides striata*	Jungle Babbler	R	C	HH
53		*Chrysomma sinense*	Yellow-eyed Babbler	R	C	S
54		*Saxicoloides fulicatus*	Indian Robin	R	C	HH
55		*Copsychus saularis*	Oriental Magpie Robin	R	C	HH
56		*Saxicola maurus*	Siberian Stonechat	LM	C	S
57		*Saxicola caprata*	Pied Bushchat	R	C	S
58	Motacillidae	*Anthus rufulus*	Paddyfield Pipit	R	C	Cr
59		*Motacilla cinerea*	Grey Wagtail	R	C	SW
60		*Motacilla alba*	White Wagtail	WM	UN	SW
61	Nectarinnidae	*Cinnyris asiaticus*	Purple Sunbird	R	C	HH
62		*Nectarinia zeylonica*	Purple-rumped Sunbird	R	C	HH
63	Dicaeidae	*Dicaeum erythrorynchos*	Pale-billed Flowerpecker	R	C	HH
64	Passeridae	*Passer domesticus*	House Sparrow	R	C	HH
65		*Petronia xanthocollis*	Yellow-throated Sparrow	R	C	S
66	Ploceidae	*Ploceus philippinus*	Baya Weaver	R	C	HH,S
67	Estrildidae	*Lonchura punctulata*	Scaly-breasted Munia	R	C	Cr
68		*Amandava amandava*	Red Avadavat	MM	C	Cr
69		*Lonchura malacca*	Tricoloured Munia	MM	UN	Cr
70	Cisticolidae	*Prinia inornata*	Plain Prinia	R	C	Cr
71		*Prinia socialis*	Ashy Prinia	R	C	Ag
72		*Cisticola juncidis*	Zitting Cisticola	R	C	HH
73	Genera Incertae Sedis	*Orthotomus sutorius*	Common Tailorbird	R	C	HH
74	Silvidae	*Sylvia communis*	Common Whitethroat	WM	UN	Cr
75	Rhipiduridae	*Rhipidura albicollis*	White-throated Fantail	R	C	HH
Order – Columbiformes						
76	Columbidae	*Columba livia*	Blue-rock Pigeon	R	C	HH
77		*Streptopelia chinensis*	Spotted Dove	R	C	S
78		*Streptopelia senegalensis*	Laughing Dove	R	C	HH
79		*Streptopelia orientalis*	Oriental Turtle Dove	R	C	S

Order – Cuculiformes						
80	Cuculidae	*Eudynamys scolopaceus*	Asian Koel	R	C	HH
81	Centripopidae	*Centropus sinensis*	Greater Coucal	R	C	HH
Order – Falconiformes						
82	Accipitridae	*Milvus migrans*	Black Kite	R	C	HH
83		*Haliastur indus*	Brahminy Kite	R	C	Cr
84		*Accipiter badius*	Shikra	R	C	HH
85		*Circus aeruginosus*	Western Marsh-Harrier	WM	C	Cr
86		*Pandion haliaetus*	Osprey	WM	UN	Cr

HH – Human Habitat; **DG –** Dry Grassland; **S –** Scrubland; **Cr –** Creek; **SW –** Small Waterbody.

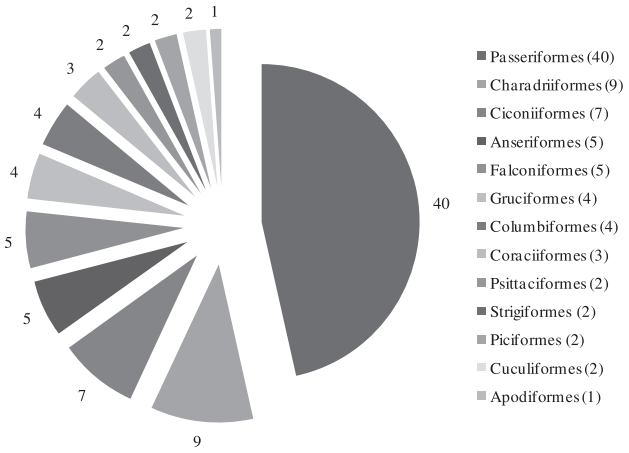

Fig. 1: Pie-Diagram showing species of birds belonging to different Orders

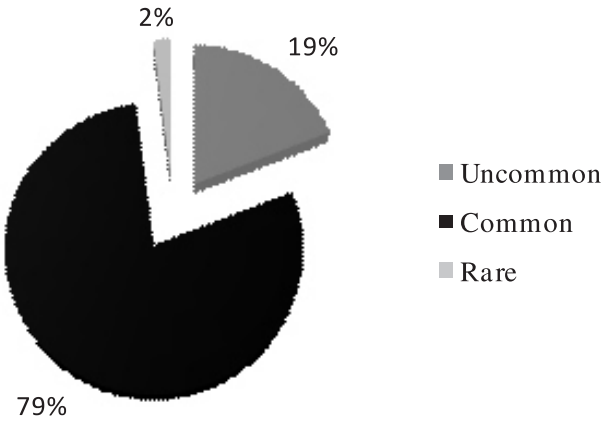

Fig. 2: Pie-Diagram representing the status of avifauna in Thakurli.

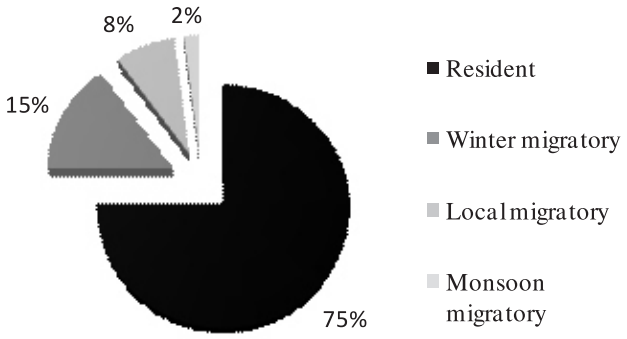

Fig. 3: Diagrammatic representation of resident and migratory birds of Thakurli.

Fig. 4: Brahminy Starling

Fig. 5 : Chestnut-tailed Starling

Fig. 6: Oriental turtle Dove

Fig. 7: Yellow-eyed Babbler

Fig. 8: Wire-tailed Swallow

Fig. 9: White-throated Fantail

Fig. 10: Tricoloured Munia

Fig. 11: Red Avadavat

Fig. 12: Grey Wagtail

Fig. 13: Shikra

Fig. 14: Black Ibis

Fig. 15: Watercock

Fig. 16: Bronze-winged Jacana

Fig. 17: Lesser Whistling Duck

Fig. 18: Black winged Stilt

Fig. 19: Black-tailed Godwit

Conclusion and Suggestions

Monitoring of species diversity is a useful technique for assessing damage to the system. Similarly maintenance of good species diversity is a positive management objective (Mann, 1982). With 86 species of birds observed, Thakurli provides a moderately healthy condition with reference to biodiversity. Of the birds list, 85 species come under the category of least concern whereas only one species belongs to the category of near threatened.

Thakurli Creek, though haven for a substantial number of resident and migratory birds, is facing threat in the form of fishing trawlers and dumping site for domestic sewage and industrial effluents. There is a need to take measures to restrict or dilute such threats. The defunct coal-based thermal power station near Thakurli creek is all set to be revived (Costa, 2011). Measures should be taken to see to it that such a revival should not disturb the delicate balance of the area.

Urbanization increases biological homogenization, causing the extirpation of native species and promoting the establishment of non-native, urban-adaptable species that are becoming increasingly widespread and locally abundant across the planet (McKinney, 2006). Abundance of human associated bird species shows trend of progressive urbanization (Palita, 2011). Thakurli, with 44% of human associated bird species is an indicator of progressive urbanization. Birds like Blue-rock pigeon, House crow, house sparrow, common myna were very commonly found. Urbanization and maintenance of biodiversity are equally important. Therefore all possible measures should be taken to see to it that both of them go hand in hand. Each building and society should have the space for garden with more of indigenous plants. Small waterbodies should be identified and conserved. The two lakes of Thakurli, which are currently more sort of dumping site, should be regularly taken care of.

Birds are indicators of healthy habitat and are sensitive to any change in it (Morrison, 1986; Ripley, 1978). As no earlier records are available for the avifauna of the study area, the presented information can form the baseline data for future assessment of impact of urbanization on avifauna in Thakurli.

Within Mumbai Metropolitan Region, bird biodiversity of certain area have been studied. Walmiki, N., *et al*., (2013) studied avian diversity in and around Bassein Fort and Creek; Prabhakar, P.R. (2011) reported species diversity of birds in mangroves of Uran (Raigad), Navi Mumbai; Thakur, K. N. (2010) studied the impact of special economic zone (SEZ) on birds in Uran; Chauhan, R. R., *et al*., (2008) surveyed the avifauna of Borivali mangroves along the coast of Mumbai; Verma, A., *et al*., (2004) gave a preliminary report on biodiversity of Mahul Creek with special reference to

Avian biodiversity on *Butea monosperma* tree during spring season and possible role of flavonoids

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Abstract : Present work was undertaken to study avian biodiversity on specific tree *Butea monosperma* during spring season for the year 2012 and 2013 respectively. Observations were carried out thrice a week at twelve sites in and around Nagpur, Maharashtra. Observations indicated that various local and migratory birds were mostly attracted to flowering trees like *Butea monosperma*(BM) variously named as Palas. Birds were observed feeding on nectar from open keel and some birds foraging freshly opened BM flower. FTIR and UV visible spectra of methanolic extract of BM flowers confirmed presence of flavonoids like Rutin, Quercetin, Butin and Isobutin. These flavonoids possibly play a role in reducing oxidative stress. Occurrence of migratory birds like Rosy Starling was found to be dependent on the early blooming of BM flower which also coincided with the rise in temperature and humidity. No such correlation was found with local birds. Conservation of BM tree may help in conserving the biodiversity of local as well as migratory birds.

Key words : Avian biodiversity, spring season, *Butea monosperma*, Flavonoids. Nagpur

Introduction

Avian biodiversity is the richness of bird species. Diet of birds may include insects like grasshoppers, fruits like berries, grapes, variety of seeds, and nectar of some flowers. Wild grain is also a valuable source of food for many birds. Even some birds can be seen foraging in tree bark for insects that apparently provide valuable protein. During spring season various flowers bloom, some of them can be observed where maximum biodiversity of birds can be seen. In Nagpur city various local and migratory birds were observed sucking nectar of Palas (*Butea monosperma*)(BM) and Semal (*Bombax ceiba*) flowers. The flowers are visited by a variety of insects, birds and some mammals. Birds dig into the keel-shaped lower petals of the flower to lick up the nectar. In turn the stamen pops out and smacks pollen on the forehead of the bird and some birds foraging freshly opened BM flower as they pollinate the flowers (Rajesh Tandon et al). Birds have high metabolic rate hence are subjected to oxidative stress (Kevin J. McGraw). The expression of most life history traits, such as immunity, growth and the development of sexual signals, is negatively affected by high levels of oxidative stress. Dietary antioxidants can reduce oxidative stress and have therefore been the focus of numerous studies in behavioral and evolutionary ecology in the last few decades (Xinyan Tang et. al). Oxidative stress reducing flavonoids are found in BM flowers. Flavonoids in food are important for birds as they act as antioxidant and restore intracellular immunity (Carlo Catony, et al.).

Study areas

To study food and feeding habit of birds during spring season 12 sites in and around Nagpur were selected. These sites are - 1. Gorewada lake and forest, 2. L.I.T.college campus, 3. Satpuda botanical garden, 4. Ambazari garden, 5. Surabuldi, 6. Zilpi lake, 7. Telhara lake, 8. Dahegoan, 9. Haladgaon, 10. Paradgoan, 11. Bhandara road and 12.Navegoan bandh.

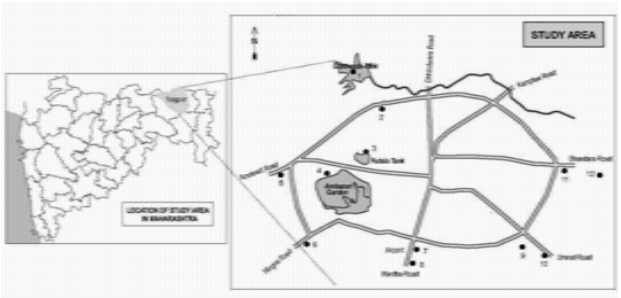

Fig 1-Location of Nagpur in the state of Maharashtra and study areas in Nagpur.

Butea monosperma (Palas)

Description: It is found throughout India and variously named as Palash, Palas, Flame of Forest etc. It is medium sized deciduous tree belonging to the family Fabaceae, growing up to 15 m tall. The leaves are pinnate with a petiole 7.5-20 cm long with small stipules and three leathery leaflets. Flowers are 2.5 cm long, bright-red, and produced in racemes up to 15 cm long. The fruit is a pod 15-20 cm long and 4-6 cm broad (http://www.worldagroforestry.org). Palas tree loses

its leaves as the flowers develop. Flowers start appearing in February and flowering season lasts up to end of April. The flowers form a gorgeous canopy on the upper portion of tree, giving appearance of a flame from a distance. The flowers show characteristics of bird pollination being large and bright orange red in color with copious amounts of nectar, and exhibiting diurnal anthesis. BM flowers are found to have antihyperglycemic activity (Rahul Somani et.al), (N.Sharma and V.Garg.), anticonvulsive activity(Venna S.Kasture), anthelmintic activity(D.Prashanth and M.K.Asha), antioxidative, and hepatoprotective potential (Neetu Sharma and Sangeeta Shukla).

Material and method

In the present study, twelve sites in Nagpur city have been selected. Observation sites were selected on the basis of presence of flocks of birds which also coincided with blooming of *Butea monosperma* (Palas) flowers. Observations were carried out thrice a week. Feeding behavior of birds was observed for two years (2012-2013) in the months from February to April. Regular field visits were made throughout this period from 7 a.m. to 9 a.m. in the morning. Data on present bird species was collected by direct observation method with the help of Olympus Binocular 10*50 X. For photography Cannon camera – EOS 550 D, Lens 100-400 was used.

Plant material and flower extract: Since birds were mostly observed sucking nectar of Palas flowers, these flowers were collected from Satpuda botanical garden Nagpur. Herbarium was authenticated and deposited at Post Graduate Teaching department of Botany RTM Nagpur University (Ref. No.9814). Flowers were shade dried for 10-15 days and then powered. Accurately weighed 15.0 g of powder was mixed with 150.0 ml of methanol and processed for Soxhlet extraction. Methanolic extract of *Butea monosperma* flower was obtained and used for UV-visible and FTIR spectroscopy.

UV-Vis analysis: 0.5 g BM flower extract was diluted with 10.0 ml methanol and spectra were recorded on Shimadzu UV 2450 spectrophotometer in the range 190-800 nm.

FTIR analysis: About 10.00 mg BM flower extract was mixed with 100.0 mg KBr (FTIR grade) and pressed into a pellet. The sample pellet was placed into the sample holder, and FTIR spectra were recorded in the range 500–5000 cm^{-1} in *Fourier Transform Infrared* (FTIR) spectroscopy (Shimadzu IR Affinity –I Spectrometer).

Observations

Table 1: Avian Biodiversity on *Butea monosperma* during spring season.

Order	Family	Species	Status
Psittaciformes	Psittacidae	Blossom Headed Parakeet	R
		Slaty Headed Parakeet	R
		Rose Ringed Parakeet	R
Columbiformes	Columbidae	Spotted dove	R
		Laughing dove	R
Coraciiformes	Bucerotidae	Indian Grey Hornbill	R
	Upupidae	Hoopoe	R
Piciformes	Picidae	Flame backed woodpecker	R
Passeriformes	Sturnidae	Common Myna	R
		Brahminy Myna	R
		Indian Pied Starling	R
		Chestnut Tailed Starling	R
		Rosy Starling	M
	Pycnonotidae	Red Vented Bulbul	R
	Timaliidae	Yellow Eyed Babbler	R
		Large Grey Babbler	R
	Nectarinidae	Purple Sunbird	R
		Purple–Rumped Sunbird	R

	Aegithinidae	Common Iora	R
	Corvidae	House Crow	R
		Jungle Crow	R
		Drongo	R
		Treepie	R
	Laniidae	Long Tailed Shrike	R
	Passeridae	sparrow	R
	Megalaimidae	Coppersmith barbet	R
	Zosteropidae	Oriental White Eye	R
	Chloropseidae	Leafbird	M
	Phylloscopidae	Greenish Warbler	M
		Tickell's Leaf Warbler	M
	Oriolidae	Golden Oriole	R

R-Resident, M-migrant (Ref- "Birds of the Indian Subcontinent" 2nd Edi, By-Richard Grimmett, Carol Inskipp and Tim Inskipp)

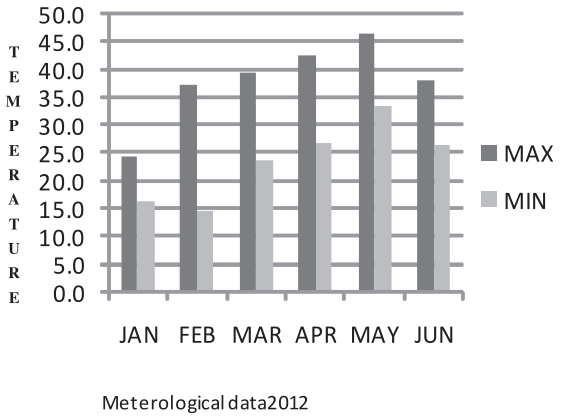

Figure-1.Maximum and minimum temperature for year 2012

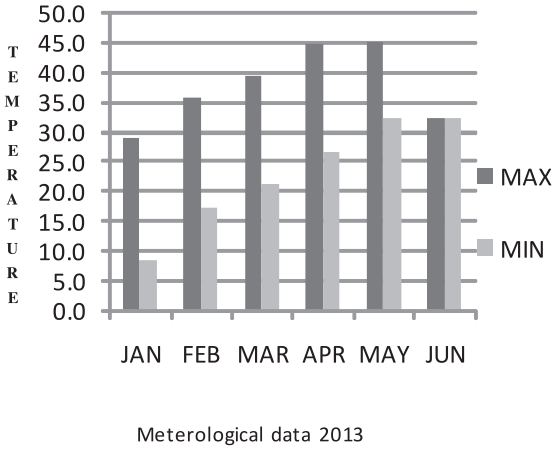

Figure-2. Maximum and minimum temperature for year 2013

Table 2 : Results showing presence of flavonoids in sample by UV-Vis Spectrophotometer

Instrument	Absorbance	Indicates Presence
UV-Vis Spectrophotometer	204nm	Flavonoids
	264nm,	
	372nm	

Table 3: - Results showing flavonoids are Rutin, Quercetin, Butin, Isobutin by FTIR

Instrument	Indicates Presence of flavonoids
Fourier Transform Infrared spectroscopy(FTIR)	Rutin
	Quercetin
	Butin
	Isobutin

Probable Identification of Functional Groups:

Aromatic Hydrocarbons: **Ar-H = 3000-3050 cm^{-1}**

Peaks in fingerprint region**: 500-1500 cm^{-1}**

Figure-3 and figure-4 Bird Photographed while foraging on *Butea monosperma* flower

Results and Discussion

According to the data from the table -1 it was observed that 5 orders, 18 families and 31 species of birds are found on *Butea monosperma* tree .They are either sucking nectar or foraging freshly opened BM flower. These birds are mostly local and some like Rosy Starling (*Sturnus roseus*) are migratory. Generally Rosy Starling sucks nectar of BM flower (Raju Kasambe and Tarique Sani), which arrived quite faithfully in mid-to-end February, and left fairly punctually at the mid to the end of April. From observations it was found that *S.roseus* arrived early in year 2013 i.e. at the end of January. From meteorological data comparative study of occurrence of *S. roseus* and temperature range was made. From figure 1 and 2, it was observed that during January 2012, maximum and minimum temperatures were 24.5°C. and 16.5°C respectively. During January 2013 maximum and minimum temperature was 28.9°C and 8.3 °C respectively. Temperature varied more than the previous year. It could be a possible cause of early blooming of *Butea monosperma* as compared to the previous year, which perfectly coincided with the early arrival of *S. roseus.* Comparatively departure dates were noted to be uniform all around mid to end-April. No such correlation was observed with local birds. According to table-2, absorbance wavelength at 204nm, 264nm, 372nm confirmed presence of flavonoids in sample by UV-Vis Spectrophotometer As evident from table-3 FTIR showing functional groups are aromatic hydrocarbons present on 3000-3050 cm-1. FTIR confirmed that these flavonoids are Rutin, Qurcetin, Butin and Isobutin. It was noted that birds prefer food enriched with flavonoids. Birds can obtain immunological benefits from the ingestion of flavonoids (C.Catoni et.al.). It has been reported that free radicals arising as by-products of normal metabolic activities have deleterious effects on cellular proteins, lipids and DNA, this phenomenon is known as oxidative stress. Since reproduction is an energy demanding activity, which increases both basal and field metabolic rates, hence breeding efforts generate oxidative stress (Alonso-Alvarez,C.et al). It was shown that the radicals scavenging activity may be present in flavonoids (Wolf Bors., et. al). It has been also reported that antioxidant flavonoids could restore the intracellular antioxidant system and promote primordial germ cells proliferation via their antioxidant action involving the protein kinase A (PKA) signaling pathway (Kevin J. McGraw).

Conclusion

Butea monosperma plant was found to be requisite for local and migratory bird. Possibly it provided immunological support and reduced oxidative stress produced due to various physiological activities. The arrival period of Rosy Starling on BM appeared to be related to flowering, which in turn was found to be dependent on fluctuation in temperature. Therefore it is necessary to plant more and more trees. Conservation of existing trees is equally important.

Acknowledgement

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A Report on Heronary in Mahad Taluka Dist Raigad Maharashtra

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Introduction

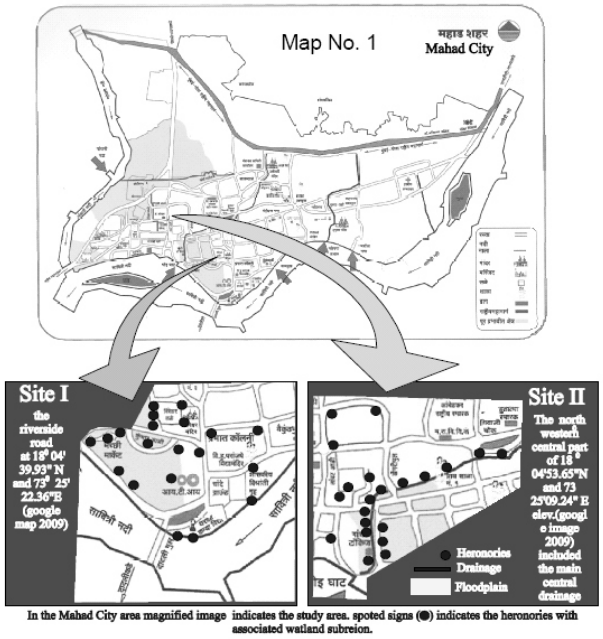
Raigad district is situated along the west coast of Maharashtra and is located between latitude N 17^0 51' and 19^0 08' and longitude E 72^0 50' and 73^0 40'. Mahad is an urbanised area on the bank of River Savitri and has historical importance. It is well known port used for import and export of goods through Savitri river creek basin since historical period.

The natural floodplain lakes, the hydrological variability of flood zone of Mahad contributes substantially to the environment for flora and fauna. The town also consists of lakes named as Chawdar Lake, Kakar Lake, Koteshwari Lake, Vireshwar Lake, Hapshi Lake, Gadi Lake. The lakes were lined by wild vegetation and filled partially with lotus and other weeds showed the presence of Ardeidae family birds like bitterns egrets and herons, family - Anatidae - ducks, family – jacanidae - jacanas, family - Scolopacidae - snipes and sandpipers, family - Pedicipedae - grebs etc. and many other waders were noted. It was the period of 1980 to 1990s when Mahad was well known for migratory birds roosting and nesting sites. But due to industrialization and launch of urban development projects from 1990 the paddy fields, the lakes have been reclaimed for construction purposes. The pressure of this has polluted the land form and has changed not only physical factors but also the whole biome.

The study was started to observe nesting colonies of egrets herons and cormorants from 1996 to 2000. The axing of nesting trees and increasing pollution have been responsible for the declining number of birds. Indiscriminate use of pesticides has been a major environmental issue due to their toxicity, persistence, health problems and endocrine effects (Webel et al 2010). These materials do not undergo degradation and remain in the soil affecting the dynamic ecosystem (Sing 2001). Pesticides may reach the soil through direct application and invade the top few inches of soil (Mc Even and Stephenson 1979). The impact of pesticide residues on soil health includes risk of injury and death of non target species like insects which form major component of diet for egrets and herons particularly during breeding season.

Site I and II
Distribution of Heron and Egrets nesting colony sites

In the Mahad City area
Bold Dash lines (----) indicates the study area.
spoted signs (O) indicates the heronories with associated wetland subregion.



In the Mahad City area magnified image indicates the study area. spoted signs (●) indicates the heronories with associated watland subreion.

Stud y location

The study area comprises of area affected by flood plains in Mahad Taluka, District Raigad. Two sections from Mahad city were selected having dense nesting sites. The south eastern river lined road situated in $18^0$04' 43.04" N and $73^0$25'18.80" E (Google image 2009). The Vireshwar lake and Tambad bhuvan area, the fish market and Kumbhar lane. The other one was north western central part of $18^0$04'53.65"N and $73^0$25'09.24" E (Google image 2009) included the main city's central nullah, Chawdar Lake, Phule market area. The climate of the district is typical of west coast with regular heavy yet seasonal rainfall (average rainfall is about 3942mm Raigad Gazette pg 172) and high humidity throughout the year. The stagnant flood water at Mahad basin with alluvial organic matters provides the larvae, fish, tadpoles, reptiles and amphibian rich food for egrets, herons and many migratory and waders (Dune and Leopold 1978). The city's main drainage passes from east to south west

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part (map no. T1) and opens in to the river Savitri. The heronaries are of natural floodplains and consist of crowded places. Lakes with hydrological variability contribute substantially to nesting habitat of birds. It is also considered to be vital part of river as it is rich in nutrient cycling process, the spawning success of fishes, and tadpoles, and nearest foraging area.

Most of the heronaries are situated in the private compound and crowded public place of the city. These two areas are sharing the river side lanes and major drainage (nullahs) the central lakes, the sewage, and dumping areas. Thus, the area shows the streaming of sewage and the water flow to meet the river at ghats of kumbhar ali and khot ali etc.

Material and methods

The egrets, herons and nesting trees were identified by using Field Guides of Dr. Salim Ali and D Ripley's The Book of Indian Birds (1996) and the book of Indian Trees by S. D. Mahajan (2002). The present study is to report observations made in year 1997 and 2000, by regular visits and awareness programmes conducted in Mahad. Survey of the "Heronaries", the bird's nesting colony was done during breeding season from the month of June to September. The pre-breeding and post-breeding activities were also been noted. The data was collected by visiting various places to check the problems of heronaries and the remedies to conserve and protect the nests. To start, attempts were done initially by involving municipal council and other government bodies like forest dept so as to have proper legal pressure and authenticity to initiate conservation activity.

Observation sites were selected according to flood level zone, the urban sewage caring drainage (nullahs) and the dense populated area of the bird's nesting trees.

The observations were made by visiting the site and interacting with the owners of private compounds where the Heronaries have been found.

The records were made twice a week and the data has been collected monthly to discuss the future applications. Each site was visited on regular basis to understand the problems of heronaries and other related activities during breeding periods. Further action plan decided accordingly.

Results and discussion

The Heronaries are the trees which are used by egrets and herons for purpose of nesting and breeding activities. The table no. 1 and no. 2 depicts drastic fall in the population of egrets and herons in the study area. This data clearly shows decreasing number of heronaries, and consequently the number of birds and their nests.

Table 1: Number of nests in the study area and the total population observed in the year 1997 and 2000

Name of study Area	No. of trees (heronaries)		Avg. Nests on each Heronary		Total No. of Nests		Mat. And Pat. Population		Mat. and Pat. population + Individual Pltn.		Total Population	
	1997	2000	1997	2000	1997	2000	1997	2000	1997	2000	1997	2000
The Savitri river side road area East Southern part of Mahad. Vireshwar lake, Tambad Bhuwan, Police Line near, Raja Ghat, Schools Area, ITI area, Kumbhar Lane, BhoiLane, etc.	36	12	30	30	1080	360	2360	720	4720	1440	4720 ±	1440 ±

Table 2 : Number of nests in the study area and the total population observed in the year 1997 and 2000

Name of study Area	No. of trees (heronaries)		Avg. Nests on each Heronory		Total No. of Nests		Mat. and Pat. population		Mat. and Pat. population + Individual Pltn		Total Population	
	1997	2000	1997	2000	1997	2000	1997	2000	1997	2000	1997	2000
The Central Mahad and Main Drainage (Nallahs) area Chavadar Tale, Fule Market, Fish market yard, Gandhi Talkies-Gaval lane, Dongari Lane, etc.	54	16	30	30	1620	480	3240	960	6480	1920	6480 ±	1920 ±

Fig. 1: Nest in Private Compounds.

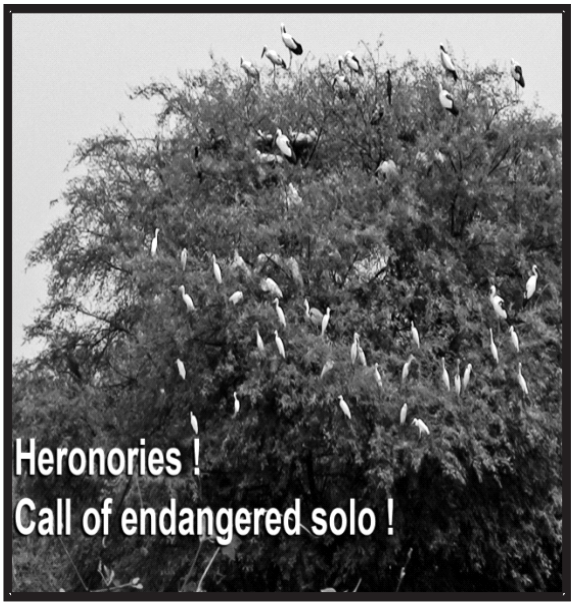

Fig 2: Mixed population.

These selected sites supported the egrets and herons colonies from 1994 to 1997. The abundance of nests of all these species was stable or increased in the year mentioned. The concentrated population area of the heronaries was observed to be the river side road, lakes, city's main drainage and fish market.

But the observations of the year 2000 show drastic fall in the number of birds as compared to the number of nests counted. The sites were developed for reconstruction of drainage (nallahs) and the buildings, new cement road under township planning by Mahad Municipal department. In this development plan the roadside heronaries and heronaries around the lake bordered were cut down. This data proves that urban development directly affects number of nesting sites of birds.

The urbanization has put great and rapid pressure on the nesting sites of the birds. The local people have destroyed their old Mangalore roofed houses with the specious gardens and compounds etc to construct the buildings for getting better housing facilities and also revenue. To achieve this development, largest paddy fields of Mahad area were filled by debris from nearby hills. This is considered the first cause of deterioration of habitat. The subsequent problem was due to polluted water and vanishing lakes and reservoirs.

Beautification of lakes for tourism is the next reason for adversely affecting the heronaries existence. The lakes reclaimed for renovation projects were the Chawdar lake, Vireshwar lake, Koteshwari lake, etc. beautification of these lakes was planned and executed without considering importance of huge old trees as heronaries. The tiled and fenced walkways were constructed leading to lakes. These have become stagnant brackish ponds rather than previous lakes with natural glory.

The other common problems generated by heronaries are droppings and other wastes of the nests. These birds are colonial nesters. Each colony consists of minimum 20 and maximum 120 nests on a single tree. Bird droppings and waste falling from nests contain fishes, crabs, tadpoles, snakes, eggs, chicks, sticks, etc. observed in mass debris. These materials decay and stench making it unbearable for humans to live in the vicinity. Therefore, owners of these lands either throw out the nests by hiring tribals [adivasis]. Sometimes fire crackers were used to drive away birds. People were observed cutting down branches or trees which the birds were nesting. Such acts force these bird to leave their routine nesting places instead the birds selected other trees like rain tree, acacia, fig tree, etc. In such a case, the falling of chicks and eggs was observed. The most suited trees for nesting sites or heronaries were trees like mango, tamarind, banyan, Glyricidia etc.

On considering the above points, an action plan to save the heronaries was designined. Land owners were requested to save the heronary trees while planning their buildings. Many of them have appreciated our attempts and have responded positively for conservation of nesting sites. Staff was appointed and volunteers were invited to clean the droppings and waste after communicating with the land owners. Site proposed for residential hubs are not being available for maintaining heronaries. These townships

happen to carry sociopolitical values. Schools and public are being focused for conservation and protection of heronaries. Appropriate participation of municipal council is being solicited in these activities. Planting of trees suitable as heronaries is being considered so as to have nesting sites in future, new sites are identified annually by field visits and are being developed. Persistent awareness attempts and regular field work for decades have made presence of egrets and herons noticeable for the residents. Wetland birds are supposed to be an important indicator of the degraded and deteriorated ecosystem. The study also reveals that though the pollution, constructions, drainage, sewage and debris of urban waste problems has proved to be signs of deteriorated environment, best of efforts can be made to conserve the bird species in the area.

Conclusion

There has been considerable success in conserving the nesting sites at surveyed area. Yet, more inputs are needed to keep it regular during breeding periods. The data about nesting sites of birds and their problems has solicited the need for conservation of nesting sites of these birds in time to come. In view of this, awareness programs were taken up to convey the importance of heronaries and the breeding of the birds.

Acknowledgements

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Survey of vertebrate fauna from Malawada Forest from Vikramgad Taluka, District Thane

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Abstract : Malwada forest is well known for its mixed deciduous forest with few patches of evergreen broad leaf forest ,which is typically a rich habitat for species diversity. Survey was conducted for a period of six months from Sept 2009 till Feb2010. The study involved documentation of vertebrate fauna for its abundance and distribution. These included fishes or class Pisces, Amphibians or class Amphibia, the reptiles or class reptilia, the birds or class Aves and mammals or class Mammalia. The field survey did not produce sighting of any large mammals. During survey significant number of reptiles and birds were observed. Threats to the species are principally due to reduction of their habitats, fragmentation of habitat for various purpose, decline in the habitat quality and illegal hunting.

Key words : Malwada Forest, Vertebrates.

Introduction

Malwada Forest region is situated on the outskirts of Vikramgad Taluka occupying a vast area. River Pinjal, one of the important tributary of Vaiterna river forms a southern border of the Malawada forest, separating Vikramgad taluka from Vada taluka. The survey area falls in Vikramgad taluka, District Thane.

Malwada region shows three types of forest zones as:

1. Forest compartment No. 394: which covers 191.56 hectare area, out of this 59.24 hectare area falls in adjoining Vaki region and 132.32 hectare area falls in Malawada region. This forest area comes under forest department and is protected by the department.

2. Gairan Forest: Preserved for cattle grazing and is rich in grasses. It (Plot no. 174) covers 13.34 hectare area toward North East and (Plot no. 137) covers 18.79 hector area towards North West direction.

3. Forest area under private ownership (Khajgi forest): covers about 82.79 hectare area. This forest area is under maximum stress, as owners are selling this area by converting it in to small plots.

Malwada forest is well known for its mixed deciduous forest that is typically rich habitat for species diversity.

Survey is primarily aimed at studying the diversity of vertebrates found in Malwada forest and identifies the same for creating a baseline data. River Pinjal, one of the important tributary of Vaiterna river forms a southern border of the Malawada forest, separating Vikramgad taluka from Vada taluka also supports a good freshwater fish fauna.

The study provides the first step in identifying biological diversity of the area. It is necessary to undertake a number of surveys over an extended period of time but due to limited resources and time constraints, it is possible only to offer a biological snapshot of the area over that time.

Material and methods

Survey was conducted for a period of six months from Sept 2009 till Feb 2010. The study involved documentation of vertebrate fauna for its abundance and distribution. The study involved 8 field visits and the methodology undertaken to document is detailed below.

The fish from river Pinjal were noted by observing the fish catch from local fisherman.

The Reptiles and Amhibians were studied by direct sighting and indirect signs like moults as well as road kills along the survey area.

The birds in the forest were studied by direct sighting, listening to the calls as well as by locating nest on the trees. The survey was conducted during dawn to midmorning, since most avian species are active during that time. For observation of birds optic binocular (16 × 50) Zenith Hi-Lux was used. All field observations were verified by using field guide by Dr. Salim Ali.

The mammals in the forest were listed by direct sighting and by other indirect signs like calls, pug marks, fecal matter as well as road kills along the survey area.

Observations and discussion

The fauna survey included 5 classes of vertebrate animals.

These included fishes (class Pisces), Amphibians (class Amphibia), the reptiles (class Reptilia), the birds (class Aves) and mammals (class Mammalia). To list Ichthyofauna of river Pinjal, fish captured by local fishermen were taken in to consideration. Most of the fishermen use local indigenous nets which they operate from banks. One objectionable method of capturing fish is use of poison or use of explosives to kill the fish and then collection of the dead fish which float on the surface.

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The Ichthyofouna of the river is as follows:

- The Indian major carps: *Labeo rohita, Labeo calabasu, Cirrhinus mrigala, Catla catla*.
- Minor Carps: *Puntius spp., Cirrhinus cirrhosa*
- Catfishes: *Wallao attu, Pangasius* spp*., Heteropnustus fossilis, Clarius* spp.
- Feather backs: *Notopterus* spp.
- Mullets: *Mugil spp.*
- Murrels: *Channa spp.*
- Others: *Gambusia affinis, Tilapia* spp.
- Amphibians observed during the survey were mainly anurans like Indian bull frog *Hoplobatrachus tigerinus*, Fungoid frog *Hylarana malabarica* and tree frogs. Caecilians *Ichthyophis spp.*, were also found under rocks which escaped very quickly leaving mucous tracks behind. Large number of toads were also located during survey.
- Reptiles were represented by abundant lizards and snakes. Common reptiles found were Russell's viper *Daboia russelii*, Saw scaled viper *Echis carinatus*, Boa *Eryx conicus*, Cobra *Naja naja*, Common Krait *Bungarus caeruleus,* Blind snake *Typhlop*s spp. and Jerdon's Many-tooth Snake or Dumeril's black-headed snake *Sibynophis subpunctatus*, Bronze backed Tree snake, Buff striped keelback, Rat snake etc. Common lizards and geckos found were Monitor lizard *Varanus bengalensis*, Common Garden lizard *Calotes versicolor,* Roux's Forest lizard *Calotes* rouxii, Kollegal Ground Gecko *Geckoella collegalensis*, Fan throated lizard *Sitana ponticeriana,* Indian chameleon *Chamaeleo zeylanicus*, Common skink *Mabuya carinata.*
- Avifauna comprised of local as well as migrant species. Waders include, Asian openbill, Common teal, Little grebe, Western cattle egret, Indian pond heron, Chestnut bittern, Glossy ibis, White breasted water hen, Little ringed plover, Marsh sandpiper, Common sandpiper, Little stint, Little tern, etc.
- Other birds include, Buzzard, Black kite, Shikra, Common quail, Grey jungle fowl, Rock pigeon, Indian emerald dove, Spotted dove, Little brown dove, Rose ringed parakeet, Asian koel, Common hawk cuckoo, Spotted owlet, Indian little nightjar, Asian palm swift, Common kingfisher, White throated kingfisher, Little green bee eater, Common hoopoe, Coppersmith barbet, Indian bush lark, Malabar lark, Wire tailed swallow, White browed wagtail, Paddy field pipit, Long billed pipit, Black headed cuckoo, shrike, Asian paradise flycatcher, Fantail flycatcher, Red vented bulbul, Red whiskered bulbul, Common iora, Bay backed shrike, Common blackbird, rock thrush, Indian blue robin, Oriental magpie robin, Common stone chat, Pied bush chat, Jungle babbler, Common tailorbird, Nilgiri flowerpecker, Crimson sunbird, Purple sunbird, Small sunbird, Scaly breasted munia, White rumped munia, House sparrow, Baya weaver bird, Common myna, Indian golden oriole, Black drongo, Racket tailed drongo, Rufous treepie, House crow, Indian jungle crow, Crow pheasant and gray hornbill, etc.
- Mammals recorded during the study were Wild boar, Jungle rat, Fruit Bat, Porcupine, Small Indian mongoose, Bandicoot, Indian Hare, Five striped palm squirrel and monkeys like rhesus monkey and Hanuman langur.

The field survey did not produce sightings of any large mammals. During survey significant number of reptiles and birds were observed. Anecdotal evidence from villagers is that species like porcupines, jackals and hyenas were present during the past in the survey area. Hunting and depredation of wildlife population is a serious problem throughout the forest. Due to increased interference of human beings in the forest area fauna is facing a danger of extinction. New road construction through the forest is killing many forest animals like snakes. Frequent visitors throw lot of garbage like plastic bottles and bags creating lot of problems to animals. In a field visit, a cobra was found trapped inside a big plastic water bottle. Many damaged bodies of snakes like vipers were found lying on roads, adivasis (tribals) were found killing amphibians like *Ichthyophis* spp. considering them as poisonous snakes. All these incidences show significant danger to forest animals. Threats to the species are principally due to reduction of their habitats, fragmentation of habitat for various purpose, decline in the habitat quality and illegal hunting. Fragmentation leads to extinction risk because isolated subpopulation goes extinct one by one without being repopulated. Proper awareness is needed to save this prestigious property of our nation**.**

Conclusion

- It was concluded that vertebrate fauna of the project area presents a fairly regular representation of a typical forest species composition.
- Malawada forest habitat is facing increased development.
- Deforestation for the construction of houses, roads and other infrastructure is disturbing wild life by reducing the availability of food and shelter to many wild animals.

- Many animals die in the road accidents especially during night as vehicular flow has increased tremendously in the last few years.
- Loss of vegetation having a great potential value is leading to loss of critical or sensitive habitat.
- City people are purchasing these virgin forest areas in the interest of making second home. The developers of the property should pay attention to conserve this natural environment in its original splendor.
- The habitat can also serve as wild life and bird watching area for nature lovers.

Acknowledgement

Authors are sincerely thankful to University of Mumbai for funding Minor Research Project. Authors are also thankful to Vidya Prasarak Mandal for providing infrastructural and computing facilities free of cost for the research work. Sincere thanks to our Principal, Dr. (Mrs.) M. K. Pejaver who constantly encourages to undertake research projects.

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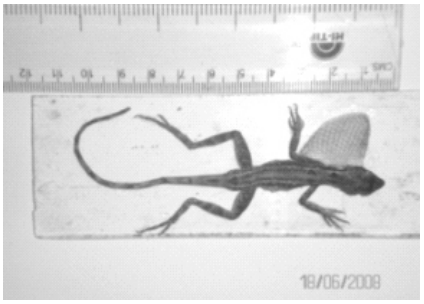
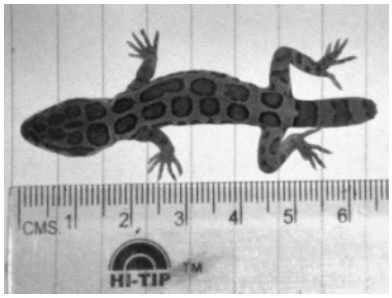
Common Indian tree frog
(Polypedatus maculates)

Caecilian ***(Ichthyophis spp.)***



Fan throated lizard
(Sitana ponticeriana)



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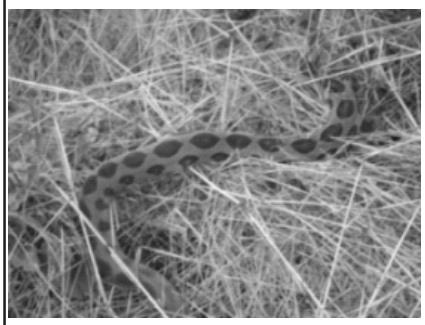
(Geckoella collegalensis)

Cobra ***(Naja naja)***

Boa ***(Eryx conicus)***

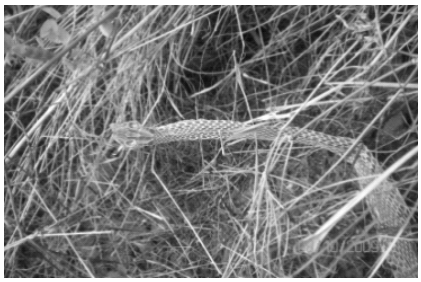


Russelsviper
(Daboia russelii)

Chameleon Zeylanicus

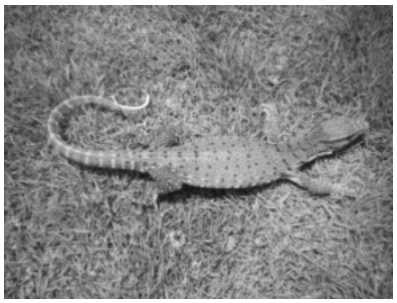
Saw Scaled Viper
(*Echis carinatus*)

Pug marks of wild boar



Moult of snake skin

Smashed body of krait



Monitor lizard
(***Varanus bengalensis)***

Blind Snake (Typhlops spp.)

Indian Grey mongoose
(***Herpestes edwardsii)***

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Some New Species of *Ophiochorchis* from Freshwater Fish

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Abstract : Living organisms are very important biotic component of life on this earth which includes all plants and animals from micro-organisms upto huge plants and animals. Many animals like birds, reptiles, mammal, amphibians and fishes are useful for food, skin, bones, teeth, fossil fuel etc. But under certain circumstances, all living organisms are susceptible to diseases and fishes are no exception. A majority of fishes carry heavy infestation of Helminth parasites which cause deterioration in their food value and may result in heavy mortality. Besides, infected fishes act as a very potent source of helminth infection of man and they are transmitted to man only through eating of fish. The faunal morphophology of four species belonging to genus *Ophiochorchis* was investigated. It reveals that four sub-species were found to be new. The main objective of the study was to find out the taxanomy of trematodes found in freshwater fish *Ophiocephalus gauchua* fromJayakwadi Dam in Paithan (M.S.). This parasite is found in large number specially in summer season while it is less in winter and rarely seen in monsoon.

Key words : *Ophiochorchis*, trematodes, Jaykwadi, infestation, helminth.

Introduction

Looss (1899) created the genus *Progonus* to include *Genarches mulleri* Levinsen, (1881). Ozaki (1925) described the genus *Genarchopsis* for his species *Genarchopsis gappo*. Srivastava (1933) synonymised *Genarchopsis* with *progonus* and described *Progonus piscicola* and *Progonos ovacaudatum*. In the same year Srivastava created the genus *Ophiochorchis* to describe *Ophiochorchis lobatum* and *Ophiochorchis singularia* on account of the presence of oesophageal pouch. Gupta (1951) emended the diagnosis of the genus *Ophiocorchis* and added three more species *Ophiochorchis dasus*, *Ophiochorchis indicus* and *Ophiochorchis faruquis*. The genus *Genarchopsis* was erected by Ozaki (1925) from *Mogurnda obscura* in Japan as the type species. Srivastava, 1933 described *Genarchopsis singularis* from the intestine of *Channa striata* from United Province, India. Yamaguti (1958) taking into consideration one common character the presence of caudal anastomosis in all the genera synonymised the genus *Ophiocorchis* Srivastava, (1933) (*Genarches* Looss, (1902), preoccupied and *Progonus* Looss 1899 preoccupied) with *Genarchopsis Ozaki* (1925), retaining *G. goppo* as genotype. He maintains eleven species under the genus *Genarchopsis* viz. *Genarchopsis goppo* Ozaki, (1925); *Genarchopsis anguillae* Yamaguti, (1938); *Genarchopsis dasus* Gupta, (1951); *Genarchopsis faruquis* Gupta (1951); *Genarchopsis gigi* Yamaguti, (1919); *Genarchopsis indica* Gupta, (1951); *Genarchopsis lobata* Srivastava, (1933); *Genarchopsis mulleri* (Levinsen, 1881) *Progonus* m. (L.) Looss; *Genarchopsis ovacaudata* Srivastava, (1933); *Genarchopsis piscicola* Srivastava, (1933), and *Genarchopsis singularis* Srivastava, (1933). All these species were reported from fishes.Gupta (1951) reported *Ophiocorchis dasus*, *Ophiochorchis indicus* from the intestine of *Ophiocephalus punctatus* (Bloch) and *Ophiocorchis faruquis* from the intestine of freshwater fish *Mastacembelus armatus* (Lacep) from Saharanpur.Rai (1971) synonymized eight Indian species of the genus with *Genarchopsis gappo*. Pande (1973) concurred with a view and further synonymized the remaining Indian species as well as *G. ozakii* Basherullah *et.al.* (1972). Mulay (1972) reported *Genarchopsis pisciola* Srivastava, (1933) from the intestine of freshwater fish *Ophiocephalus guachua* (Bloch) from Aurangabad,(M.S.), India.Bashirulla at.el. (1972) described *Genarchopsios ozaki* and *Genarchopsis bangladensis* from the intestine of *Channa (Ophiocephalus) punctatus* (Bloch) from Dacca, Bangladesh. Bhadauria *et.al*., (1984) described *Genarchopsis* (*Ophiocorchis*) *folliculata* from the stomach of freshwater fish *Mastacembelus armatus* (*Lacepede*) and *Channa punctatus* (Bloch) from Gwalior. Bilqees and Khan (1991). collected from the small intestine of fish *Channa* and identified as G.. *kalriai* . M. P. Chandra at.el., (1993) described *Genarchopsis wallagonia* from the Intestine of freshwater fish *Wallago attu* from Mymensingh, Bangladesh. Ghulam s.s. at.el 2011 described collected from the small intestine of fish *Channa* (*Ophiocephalus*) *striatus* (Bl.) and *Channa* (*Ophiocephalus*) *maculatus* (Bl.) and identified as *Genarchopsis gibsoni* new species and *G. kalriai* Bilqees and Khan, 1991. Pardesi (2012) described G. paithainensis n.sp. from freshwater fish *Mastacembelus armatus* from Jayakwadi reserviour in Paithan , Aurangabad.

Material and Methods

The trematodes were studied in live condition using Neutral Red and Methylene Blue. For morphological studies, specimens were fixed in 4% formalin or 70% alcohol. They were stained in Delafield's haematoxylin and Acetocarmine.

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After staining the specimens were dehydrated in graded alcohols i.e. 30%, 50%, 70%, 90% and absolute alcohol. In order to remove traces of moisture they were passed through 50% absolute alcohol + 50% Acetone and then they were passed through 50% Acetone + 50% Benzene and then Benzene. Finally they were passed through 50% Benzene + 50% Xylol. They were cleared in Clove oil and finally mounted in D.P.X. mountant. For the study of cuticular structures, Glycerine – alcohol of various percentages was found to be suitable. The drawings are made with the help of a Camera Lucida. All measurements are in millimeters unless otherwise mentioned. In the present collection numerous specimens belonging to the genus *Ophiochorchis* were collected from the fish *Ophiocephalus gachua* from Paithan region, (M.S.), India in the year 2009-10

Results and Discussions

The present specimen differs from the other in the presence of different course of uterus, position of vitelline gland and measurement.

Host : *Ophiocephalus gachua*

Habitat : Intestine

Locality : Paithan, (M.S.), India.

Type species : *Ophiochorchis acetabuli. N.sp.*

Fig No 1: ***Ophiocorchi acetabuli. N.sp.s***

Host : *Ophiocephalus gachua*

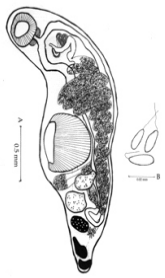
Locality : Intestine

Habitat : 1 Paithan., M.S.,India

Type Species : *Ophiocorchis caudli.n.sp.*

Fig No 2: ***Ophiocorchis caudle.n sp.***

The present specimen differs from the other form in the position of testies, vitelline glands outside caeca and a tail like projection.



Host : *Ophiocephalus gachu*

Locality : Intestine

Habitat : Paithan., M.S.,India

Type Species : *phiocorchis extracaece. N..sp.*

Fig No 3 : ***Ophiochorchis extraceae .n.sp***.

The present species differ from all the other in the presence of position of testes, ovary and vitelline gland which are all extracaecal in position.

Host : *Ophiocephalus gachua*

Habitat : Intestine

Locality : Paithan (M.S.), India.

Type species :*Ophiocorchis twisti. N.sp.*

Fig No 4: ***Ophiochorchis twisti.n.sp.***

The present species differ from all the other in the position of caeca which is below seminal vesicle, acetabulum which is partly extracaecal and vitelline glands nearly stuck together.

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Investigation of environmental impact of heavy metal pollution on *Lantana camara* and *Solanum xanthocarpum*

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Abstract : Traditional technologies for cleaning contaminated soils have been used for a long time. Natural metal hyperaccumulator plant species are important to remove heavy metals from contaminated soils. The hypertolerance of these metals is the key characteristic of the plants required for hyperaccumulation. The phytoremediation of metal-contaminated soils offers a low-cost method for soil remediation and some extracted metals may be recycled for value. Phytoextraction of heavy metals by plants offer great scope for commercial development. These are effective, environmentally safe, easily bio-degardable, inexpensive and easily available. Therefore the present paper focuses on qualitative and quantitative estimation of different heavy metals ions from *Lantana spp.* and *Solanum spp.* by atomic absorption spectroscopy. In *Solanum xanthocarpum* microquantities of heavy metals play an important role in enzyme activation while metal co-ordinated with Lantanoid inhibits wood destroying agents in *Lantana camara*. This study supports exploitation for their application in phytoremediation and this can be further rationalized towards developing transgenic improved phytoremediation cultivars for commercial use.

Key words **:** Hyperaccumulator, Phytoremediation, Heavy Metal, Lantana camara, Solanum xanthocarpum.

Introduction

Lantana camara and Solanum xanthocarpum are waste land weeds found throughout India .

Lantana camara

Ecology

Lantana camara is one of the natural biomass sources from nature. It belongs to Verbenaceae family and found in tropical and subtropical region of world (Sharma O.P. et al., 1989) Currently, it is commonly distributed throughout India as an obnoxious weed. Contains about 150 species of perennial flowering plants.

Biodiversity

Lantana's aromatic flower clusters are mix of red, orange, yellow or blue and white florets. The flowers typically change color as they mature, resulting in inflorescences. These weeds grow well on nutrient rich and also on nutrient deficient barren soils and light availability. Most variant species needs fertile organic soil while others can survive on siliceous sands. *Lantana camara* Linn contain wide array of compounds exhibiting diverse range of bioactivity (Sharma M et al., 2011).

Uses

In herbal medicine, infusions of the leaves and other plant are used as an anti-inflammatory (Oyedapo et al., 1999), a tonic and expectorant, and besides it is added to baths as an anti-rheumatic. Lantana extracts have also been shown to be a powerful febrifuge (Liogier H.A, 1990). Storing potatoes lantana leaves nearly eliminates damage by *Phthrorimaeperculella Zeller*, the potato tuber moth (Lal L. 1987).

Solanum xanthocarpum

Morphology

The plant occurs throughout India ascending to 2200m on the Himalaya (Sharma PC et al., 2001) and often as waste land weed (Indian Herbal Pharmacopoeia, 1998). The leaves are up to 10 cm in length, their midribs and other nerves with sharp yellow prickles. The flowers are purple, about 2 cm long, few together in small bunch opposite the leaves. The fruits are glabrous, globular drooping berries, 1.5-2 cm, yellow or pale with green veins.

Uses

Solanum xanthocarpum is used especially in treating Kasa (cough), Shwasa (bronchial asthma), Genetic Diseases (anaemia, diabetes, breast cancer, Parkinson's disease, thalassemia, etc.). This plant is nontoxic and has been reported to be safe for human practices (Govindan S et al., 2004) and is clinically safe to consume.

Figure 1: Diversity in colour of flowers (images 1-2) and fruits (images 3-4) of Lantana; Flowers (images 5-6) and fruits (images 7-8) of *Solanum xanthocarpum* due to geographical and metallic diversity.

Biological role of metals

1. Iron

Iron is an essential constituent for all plants and animals. High level of iron causes tissue damage due to the formation of free radicals (Rehmnan A *et al*. 2013).

2. Zinc

Zinc is also an essential element for normal growth, cell processes, brain development, bone formation and wound healing. A zinc deficient diabetic fails to improve their power of perception and also causes loss of sense of touch and smell (Khan SA *et al*.. 2008).

3. Manganese

Manganese is another essential element for plant and animal growth. The main sources for manganese in soil are fertilizers, sewage sludge and ferrous smelters. (Khan MA *et al*., 2007)

4. Nickel

Nickel plays important role in the production of insulin. Its deficiency results in the disorder of liver but its high level causes an allergic dermatitis known as nickel itch, further more Ni adversely affects nasal cavities and lungs and also has been identified as a suspected carcinogen (Chishti KA. *Et al*., 2011)

5. Lead

Lead is one of the toxic elements that is highly risky for plants, animals and mostly for microorganisms. Lead intoxication leads to nausea, headache, constipation fatigue, muscle aches and anaemia. (Karayil S *et al*.. 2011)

6. Chromium

Trivalent chromium is a trace element which is required for normal metabolism of fats, cholesterol and glucose while hexavalent chromium is a skin and mucous membrane irritant as well as a strong oxidizing agent (Hussain I *et al*., 2006)

7. Cadmium

Cadmium is a lethal metal and can cause severe health problems. In recent times attention has been focused on its presence in water, soil, milk, dietary products, medicinal plants, herbal drugs, etc. The most common sources for cadmium in soil and plants are combustion of fossil fuels, phosphate fertilizers, lead and zinc mines, non-ferrous smelters and sewage sludge application (Pendias, A. K. *et al.*, 1992)

Above their optimum concentration the heavy metals cause a photosynthesis perturbation in plants by stomatal limitations and a dysfunction of photosystem II. The details of the above heavy metals with names and the biological role of these elements have been given in Table No.1.

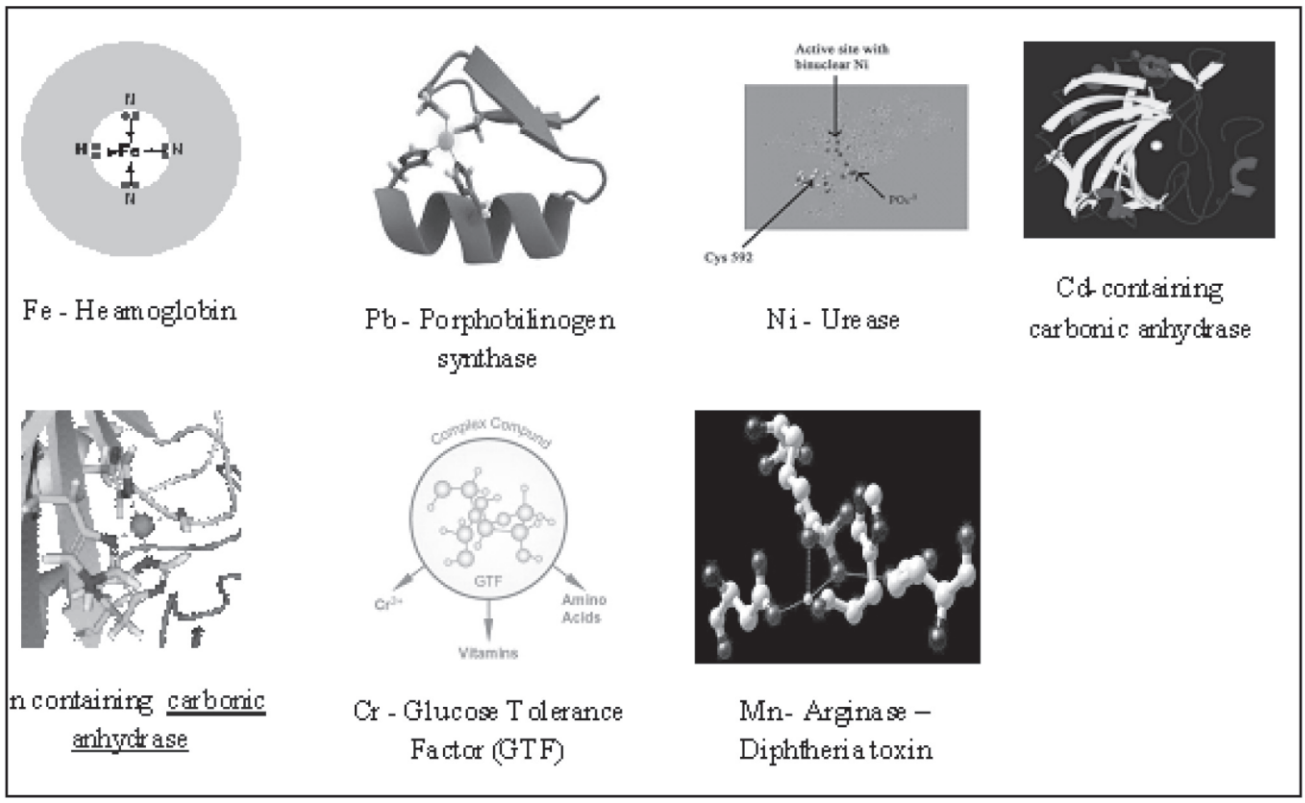

Table 1 – Heavy metals and their biological role.

Current status of phytoremediation

Phytoremediation of polluted soils, is based on the cultivation of plants that have demonstrated a high capability to absorb metals from soils by formation of organometallic complexes, which indicates their possible utilization in phytoremediation processes. Several species of Lantana among others have been already tested in pilot projects or are currently in commercial application in phytoremediation projects. More recently, the use of these plants in metal extraction (phytoremediation) has appeared as a promising alternative in the removal of heavy metal excess from the soil. This paper focuses primarily on the presence and distribution of heavy metals in *Solanum and Lantana* species. This study shall support application of these species in phytoremediation and can be further rationalized towards developing transgenic improved cultivars for commercial use.

Material And Methods:

Plant materials: The leaves, fruits and flowers of *Solanum xanthocarpum* and *Lantana camara* were collected from the campus of B.N.Bandodkar College of Science, Thane Maharashtra, India.

Methods: Flowers, leaves and fruits were sun dried for a week. Ground to fine powder and stored in packed jar to protect from humidity and light. This powder was used for extraction and estimation of heavy metals. For extraction of selected metals, dry ash of plant samples was prepared. The contents of crucibles were cooled to room temperature in desiccators and 10 ml of 20% HCl was added, the mixture was heated to dissolve its content. Further it were run on Flame Atomic Absorption Spectrophotometer under standard conditions for quantitative determination of Fe, Zn, Mn, Ni, Pb, Cr and Cd.

Results And Discussion

The estimation and concentrations of heavy metals analyzed are appended in table 2 and 3.

	Sample	Fe	Zn	Mn	Ni	Pb	Cr	Cd
SX	Flower	15.71+0.11	13.66+0.20	17.21+0.10	1.10+0.10	3.71+0.11	0.21+0.10	0.13+0.01
	Leaves	17.37+0.28	10.54+0.12	19.31+0.12	0.97+0.1	2.46+0.10	0.09+0.04	0.07+0.02
	Fruits	12.01+0.09	7.33+0.11	13.10+0.11	0.45+0.02	1.98+0.13	0.01+0.00	0.03+0.00
LC	Flowers	40.01+0.24	25.43+0.11	32.11+0.11	4.96+0.09	13.56+0.05	3.10+0.12	1.00+0.08
	Leaves	46.91+0.45	17.86+0.23	30.23+0.09	4.85+0.10	17.47+0.19	2.00+0.01	0.76+0.23
	Fruits	32.03+0.12	15.78+0.23	17.37+0.04	2.10+0.12	6.23+0.10	0.99+0.12	0.40+0.13

Table-2: Heavy metals (mg/kg) in *S. xanthocarpum* (SX) and *L. camara* (LC) aerial parts

Solanum xanthocarpum flowers showed highest content of Zn, Ni, Pb, Cr and Cd compared to leaves and fruits whereas leaves showed higher content of Fe and Mn compared flowers and fruits. In the case of (*L. camara*,) flowers showed highest content of Mn, Zn, and Ni compared to leaves and fruits whereas leaves showed higher content of Pb and Fe content compared to flowers and fruits. Among the two species, *Lantana camara* showed higher concentration of all metals compared to *Solanum xanthocarpum*. Figure 2 gives a graphical representation of the comparative concentrations of the above heavy metals in the flower, leaves and fruits of the two species.

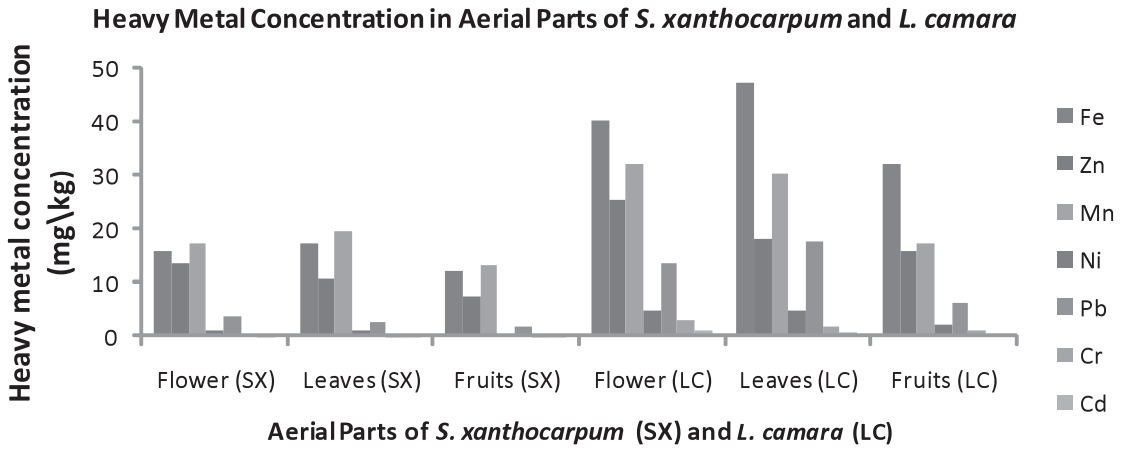

Figure 2: Comparative concentrations of heavy metals in flower, leaves and fruit samples of *Solanum xanthocarpum* (SX) and *Lantana camara* (LC)

Conclusion

Heavy metals were investigated in *Solanum xanthocarpum* and *Lantana camara* collected from the campus of B.N.Bandodkar College of Science. These species threaten agriculture and pasture production, forestry and biodiversity of conservation areas and may be toxic to stock. The highest priority for Lantana control is preventing its spread by herbicide which is effective but expensive or with integrated control should combine fire, mechanical, chemical and biological methods and revegetation. These weeds may be used for the determination of various compounds which may acts as reactant or primer in the various processes having potential applications in the society. *Solanum xanthocarpum* might be useful for the phytoremediation of soil cocontaminated with Zn, Ni, Pb, Cr, Cd, Fe and Mn whereas *Lantana camara* for Mn, Zn, Ni, Pb and Fe. Among these two species, *L. camara* showed higher concentration of all heavy metals making it a better choice for phytoremediation compared to *S. xanthocarpum*. The results also showed that the accumulation of heavy metals in medicinal plants depends upon the climate of locality, air pollution, soil contamination and other environmental factors where the plants grow. In order to revegetate in soil polluted by metals, the physiological impact of the pollution on plant species should be studied in further details. As the heavy metals fluctuate in plant as well as in soil samples

from site to site therefore each medicinal plant should be analyzed before utilization for pharmaceutical or traditional medicinal purposes.

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Production of Bacterial Pectinase from Agro - industrial Wastes

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Abstract : Currently, the fundamental exploitation of agricultural and food wastes, which participate in pollution, is the controlled biological degradation of the wastes by microorganisms for the production of valuable compounds such as vitamins, enzymes etc. for medicinal and industrial uses. Pectin is a major component of primary cell wall of all land plants and encompasses a range of galacturonic acid rich polysaccharide. There are very few reports of Pectinase enzyme production by bacterial strains. In the present study, forty seven bacterial isolates from rotten vegetable and fruit samples were screened for Pectinase production. The strains showing maximum activities were identified as *Bacillus* sp. (VM1) and *Bacillus* sp.(R2).and used for further studies. Maximum quantities of Pectinase were produced when a 18 Hrs. old inoculum was used at 4.0 % (v/v) of production medium under shaking conditions for 72 Hrs. The optimal temperature and pH for bacterial growth and Pectinase production were found to be 40°C and 7.0, respectively. With both the isolates, maximum enzyme production resulted when 5% citrus peels were used as the carbon source. Peptone among organic nitrogen and Potassium nitrate among inorganic nitrogen source with Glucose as carbon source in presence of Magnesium sulphate as metal ion showed best results. The supplementation of media with 0.9% (w/v) D-Galacturonic acid led to a 20% & 14% increase in activity for *Bacillus* sp.(VM1) and *Bacillus* sp.(R2). Both the isolates were effective in fabric Bioscouring and decreasing fruit juice viscosity. Both the isolates due to their pectinase production at neutral pH would be potentially useful and suitable for the vegetable purees or other preparation which need almost neutral pH range.

Key words : *Bacillus* sp., Pectinase, Agro industrial wastes.

Introduction

Many plant pathogenic bacteria and fungi are known to produce pectinolytic enzymes useful for invading host tissues. Moreover, these enzymes are essential in the decay of dead plant material by non pathogenic microorganisms and thus assist in recycling carbon compounds in the biosphere (Soares Marcia C.N. etal., 1999).Pectic substances are glycosidic macromolecules with high molecular weight. Pectinases are produced by a large number of organisms, such as bacteria, fungi, actinomycetes and yeast (Nadaroglu H. et al., 2010). At present almost all the pectinolytic enzymes used for industrial applications are produced by the fungi .There are a few reports of pectinases production by bacterial strains. (Jayani R. et al., 2010). Pectinases have been used in processes and industries where the elimination of pectin is essential; fruit juice processing, macerating of plants and vegetable tissue, waste water treatment, extracting vegetable oil, bleaching of paper, adding poultry feed , in textile and alcoholic beverages and food industries(Nadaroglu H. et al., 2010). The selection of a particular strain remains a tedious task and the choice gets tougher when commercially competent enzymes yields are to be achieved. Due to optimal pH of fungal pectinase (3.0 – 5.5) such preparations are not suited for production of vegetable purees or other preparations in which pH values are close to neutral. Furthermore, due to the relatively low temperature stability of the fungal enzyme preparations, maceration needs to be carried out at temperatures not exceeding 45°C, necessitating the incorporation of a pasteurization step to limit the growth of mesophillic microorganisms (Marcia M.C.N.Soares et al., 1999). Therefore bacterial strains producing commercial enzymes are always preferred over fungal strains because of ease of fermentation process (for production) and implementation of strain improvement techniques or any modern technique to increase the yield of production (Kumar A. and Sharma R., 2012).

The objective of the present research work was to enrich and isolate pectinase producing bacterial strains from decomposing and rottened agro industrial wastes followed by characterization and optimization of bioprocess parameters for the best producer of enzyme.

Materials and Methods

Isolation and identification of pectinase producing bacteria

The Agricultural and vegetable waste dump soil samples along with rotten fruits and vegetables in and around Ulhasnagar, District Thane, Maharashtra. were collected and serially diluted up to 10^7 dilutions. It was plated on Nutrient agar medium and incubated at room temperature for 24 hours. The isolated pure strains were screened for extra cellular pectinase production using Pectate agar medium : Peptone - 3g, Yeast extract -0.5g, kH_2PO_4 – 0.15g, $CaCl_2$ – 0.001g, Pectin – 0.5g, Na_2CO_3 – 0.5g at pH – 8. The substrate utilized zone around the colony was observed by flooding the plate and by agar cup method using 3.3% Cetyltrimethyl Ammonium Bromide (CTAB) solution overlaid on the medium and incubated for 10 min. (Elangovan Namasivayam et al., 2011)., the positive strain that produced

maximum pectinase enzyme was selected and identified by Bergey's manual of Determinative Bacteriology . The cell free supernatant was used for Pectinase assay and purification. The supernatant was partially purified by using Ammonium sulphate precipitation method followed by dialysis using cellophane membrane (Klug- Santner B.G. et al., 2006).

Pectinase Assay

Pectinase activity was assayed by the colorimetric method of Miller (1959). The standard graph was generated using standard glucose solution. One unit of Pectinase activity was defined as the amount of enzyme which liberated 1µm glucose per min.

Protein determination

Protein of all enzymatic preparations was determined by the method of Lowry et al.(1951).

Parameters controlling the Pectinase activity

Effect of Incubation Time, Temperature, pH, Inoculum sizes and aeration conditions

The bacterial isolate was subjected to different culture conditions to derive the optimum conditions for pectinase production. Pectinase production was estimated at regular time intervals (24 , 48, 72, 96, and 120 h) . For selected temperatures (30 - 70 °C) and pH (4.0 to 8.0), the relative activities (as %ge) for both were expressed as the ratio of the Pectinase activity obtained at certain point of temperature / pH to the maximum activity obtained at the given temperature /pH range. Effect of varied Inoculum sizes of 0.1 OD at 615 nm (1 – 5 ml) and effect of aeration was studied by using different flasks volumes (100, 150, 250,500 and 1000ml) with fixed media volume(25 ml).

Effect of D-Galacturonic acid on Pectinase production

To study the effect of D-galacturonic acid on Pectinase production, it was added to the culture broth at a final concentration of 0.3 to 1.5 % w/v under aseptic conditions. The resulting extracellular Pectinase activity produced were measured by estimating the reduced groups produced (Jayani R. etal., 2010).

Effect of Carbon and Nitrogen sources

The carbon sources such as Maltose, Sucrose, Mannitol, Lactose, Glucose, Cellulose and Starch and Nitrogen sources such as Ammonium chloride, Potassium nitrate, Sodium nitrite, Ammonium citrate, Gelatin, Peptone and Casein were supplemented as individual components to the mineral salt media to check their effect on pectinase production, by keeping all predetermined factors constant.

Effect of metal ions

To determine the influence of metal ions viz. Ca^{+2}, EDTA, Cu^{+2}, Mg^{+2}, Ba^{+2} and Co^{+2} on Pectinase activity. The listed ions were added to the reaction mixture at concentration (1mM). Pectinase activity without added metal ions was taken as 100% activity (EI- Batal.A.I etal. 2013).

Effect of natural pectin

The growth medium was prepared and synthetic pectin was replaced by different natural pectin substrates such as Sugarcane baggase, Orange peels, Potato peels, Banana peels, Tea waste, Apple peels and Citrus peels . All other predetermined factors were kept constant .The cell free supernatant was analyzed for Pectinase activity (Marcia M.C.N. Soares et al., 1999).

Growth and enzyme production profile under optimized parameters

The growth and enzyme production profile of the microorganisms was studied by withdrawing the samples from the optimized media and parameters at regular intervals up to 96 Hrs. (Jayani R. et al., 2010).

Effect of mutagens

For the sake of strain improvement, the identified pectinolytic strains were treated with two mutagens viz. Ultraviolet irradiation as physical mutagen and hydrogen peroxide as chemical mutagen (Akbar S. et al., 2013). A loopful of parental strains were inoculated into the plate and was exposed to UV radiation for 10, 20,30,40,50 and 60 minutes time interval under beam of UV lamp (Germicidal lamp, UV tube, T-15c, 15W, 254 nm). The distance between lamp and the Petri plate was adjusted to 10 cm for each trail to obtain 95% death rate. On completion of predetermined time the plates were retained in dark for overnight to prevent photo reactivation of mutants.

Similarly, for chemical mutagen treatment, selective media was prepared and molten agar was mixed with different concentration of hydrogen peroxide ranging from 0.5-5% and inoculated with potential strain. The cfu count was recorded to plot a survival /kill curve. Further after physical / chemical treatments , the strains were tested quantitatively for enzyme production by shake flask culture fermentation.

Bioscouring of Cotton and Change in viscosity of fruit juice

Cotton fabric was treated with crude pectinase enzyme at R.T on shaker for 24 hrs. After treatment, fabric was dried, weighed and then weight loss was determined (Rajendran R. etal., 2011). Decrease in viscosity of apple juice was studied after treatment with extracted crude Pectinase enzyme by using viscometer (Prathyusha K. and Suneetha V.2011).

Results and Discussion

In the present study, forty seven bacterial isolates were isolated using agro industrial wastes from different vegetable markets and restaurants of Ulhasnagar, Dist.-Thane (MS). On screening of pectinolytic productivities of the forty seven bacterial isolates, eleven isolates were using pectin as sole carbon source. From these isolates, two potent isolates were selected on the basis of their Pectinase production and used for further studies.

Both the isolates were identified with reference to Bergey's manual of Determinative Bacteriology (2000) as *Bacillus* sp. and named as *Bacillus* sp. VM1 (isolated from discarded rotten vegetables and fruits from vegetable market) and *Bacillus* sp. R2 (isolated from Restaurant and juice centre discarded wastes).

Pectinase produced by isolates was purified using Ammonium sulphate precipitation, followed by dialysis. Results (data not shown) indicate a decrease in total proteins and total activity, where as specific activity increased. After purification, specific activity for pectinase from *Bacillus* sp. (VM1) was 5 micro mol/mg with increase in 4.24 purification fold while *Bacillus* sp.(R2) showed specific activity 3.96 micro mol/mg with 3.14 increase in purification fold compared to crude enzyme.

Maximal pectinase activity was observed between 72-96 Hrs.(Fig.-2), after which a decline in enzyme activity was observed . This might be due to denaturation and /or decomposition of pectinase as a result of interaction with other compounds in the fermented medium or due to sugar consumption.

The enzyme was active over a broad pH range (Fig.-3), displaying over 45 % of its activity in the pH range of 4.0 upto 9.0 with an optimum pH of 7.0. Concerning to the pectinase at pH 9.0, the relative activity decreased down upto 61% for *Bacillus* sp. (VM1) and 49 % for *Bacillus* sp. (R2). This could be attributed to histidine residues that have ionizable side chains, increasing the net negative charge on the molecule in the alkaline pH range and leading to repulsion between the strands, resulting in destabilization of the hydrogen bond structure of the enzyme. The optimum pH for PGase was higher than the majority of fungal PGase described, and they are acidic enzymes as reported by many workers. *Monileilla* sp. showed its maximum activity at pH 4.5 and at pH 4.5-5.0 for *Penicillum* sp. (EI-Batal A.I. et al., 2013).

The activity of the pectinase increased gradually at temperature ranged from 30°C up to 60°C (Fig.-4) .Moreover the optimum temperature was achieved at 40°C, meanwhile the relative activity was attained approximate 25% at 70°C, this clearly evidenced that the higher temperature resulted in a decrease in the enzyme activity. It was reported that extremely high temperature lead to deamination, hydrolysis of the peptide bonds, interchange, and destruction of disulphide bonds and oxidation of the amino acids side chains of the enzyme protein molecules ((EI-Batal A.I. et al., 2013).

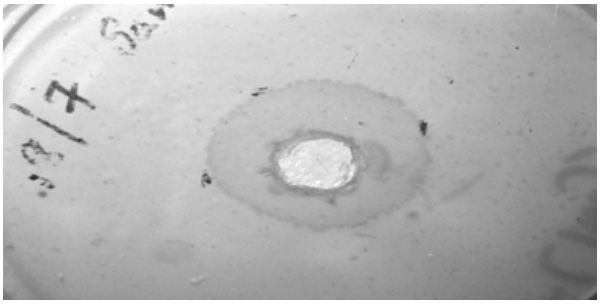


Fig.1- Pectinase activity by Agarcup method

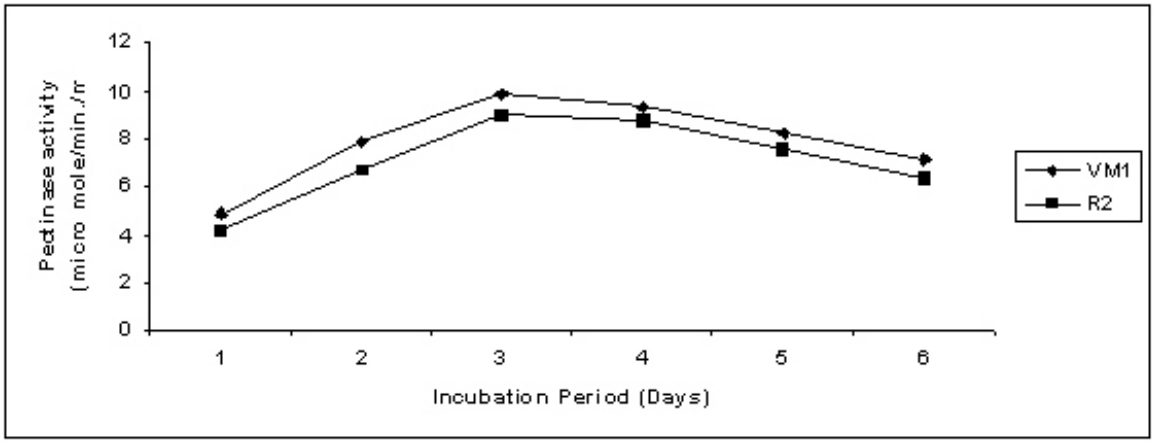


Fig.2 : Effect of Incubation period on the Pectinase activity of *Bacillus* isolates .

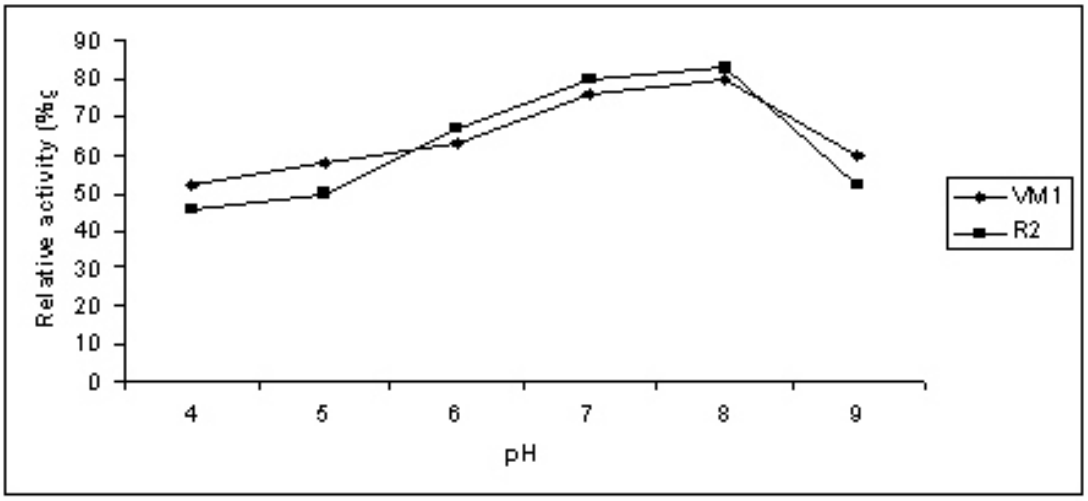


Fig. 3 : Effect of pH on the Pectinase activity of *Bacillus* isolates .

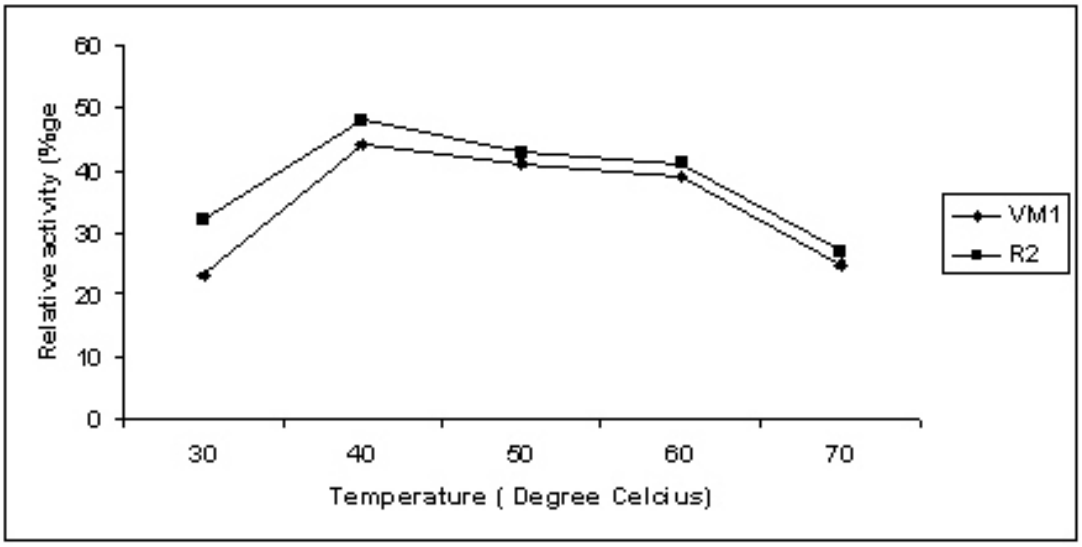


Fig. 4 : Effect of temperatures on the Pectinase activity of *Bacillus* isolates .

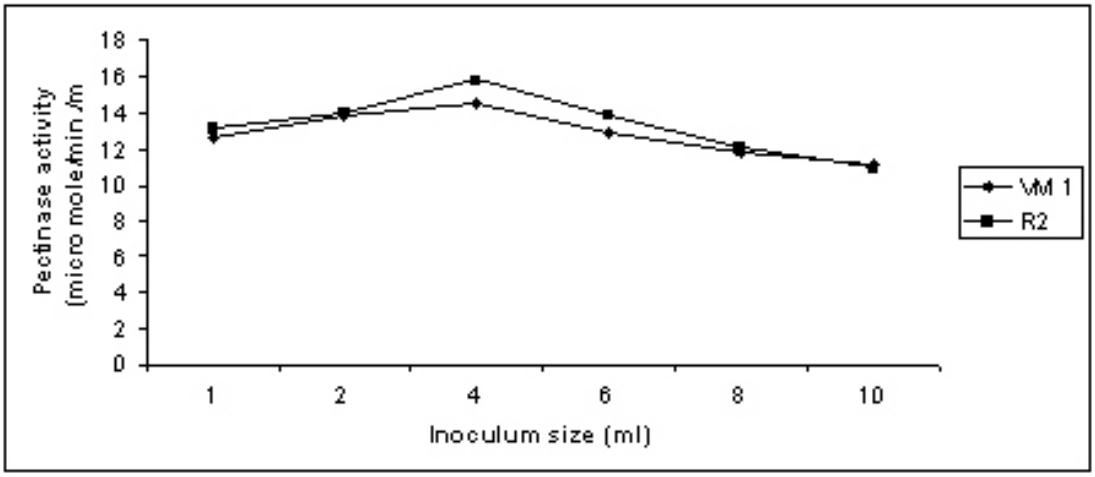


Fig.5 : Effect of inoculum size on the Pectinase activity of *Bacillus* isolates .

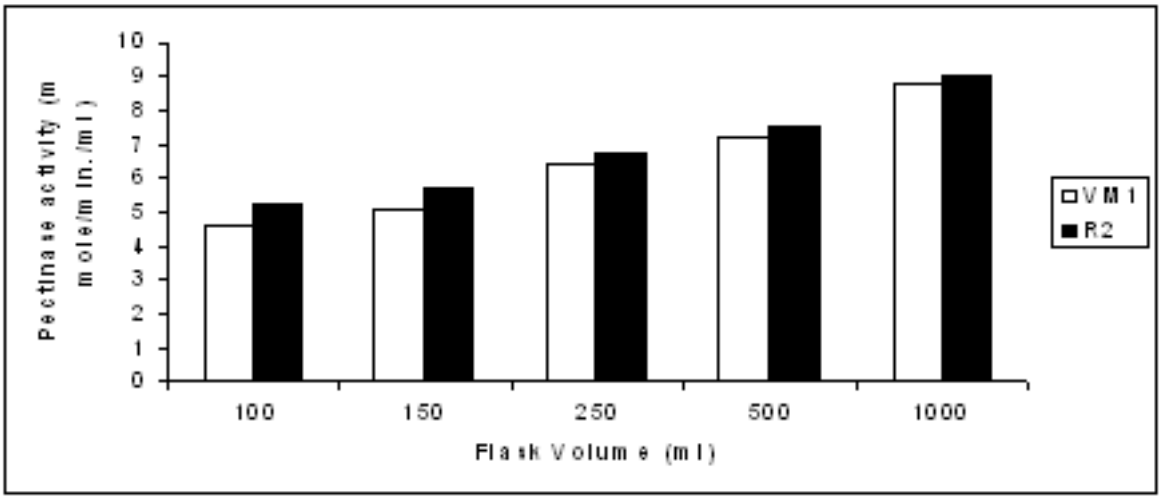


Fig. 6 : Effect of different flask volumes (aeration)on the Pectinase activity of *Bacillus* isolates.

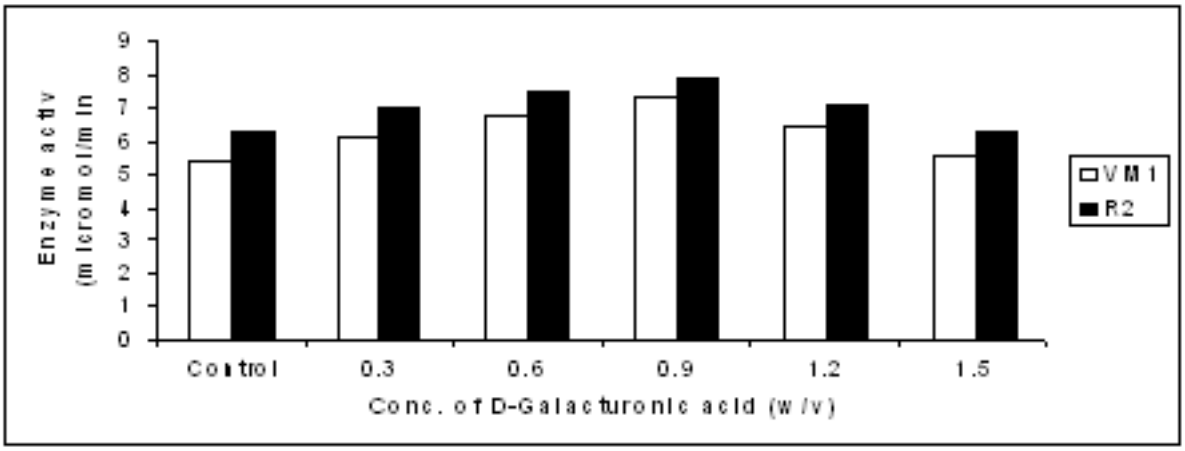


Fig. 7 : Effect of D-galacturonic acid on Pectinase production by *Bacillus* isolates.

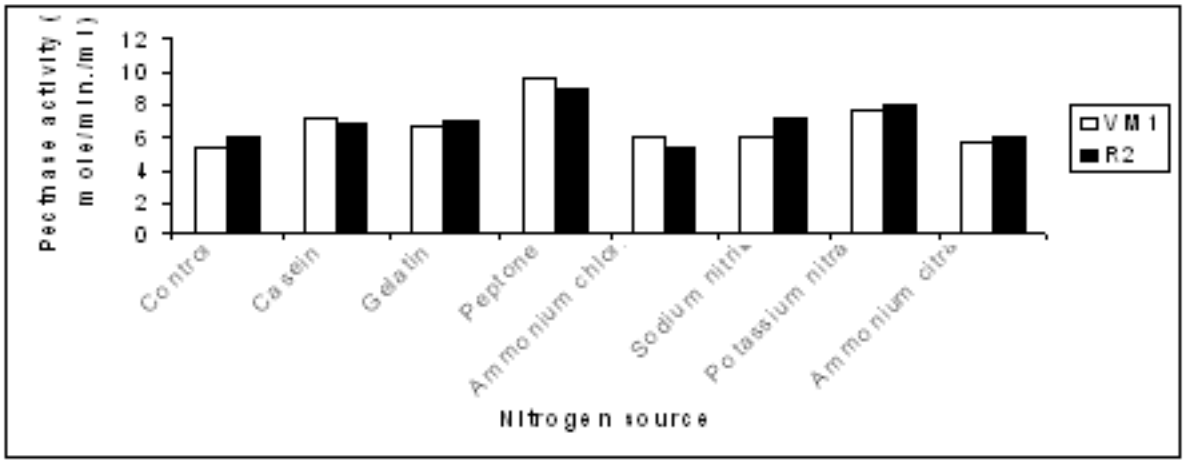


Fig. 8 : Effect of Nitrogen source on the Pectinase activity shown by *Bacillus* isolates.

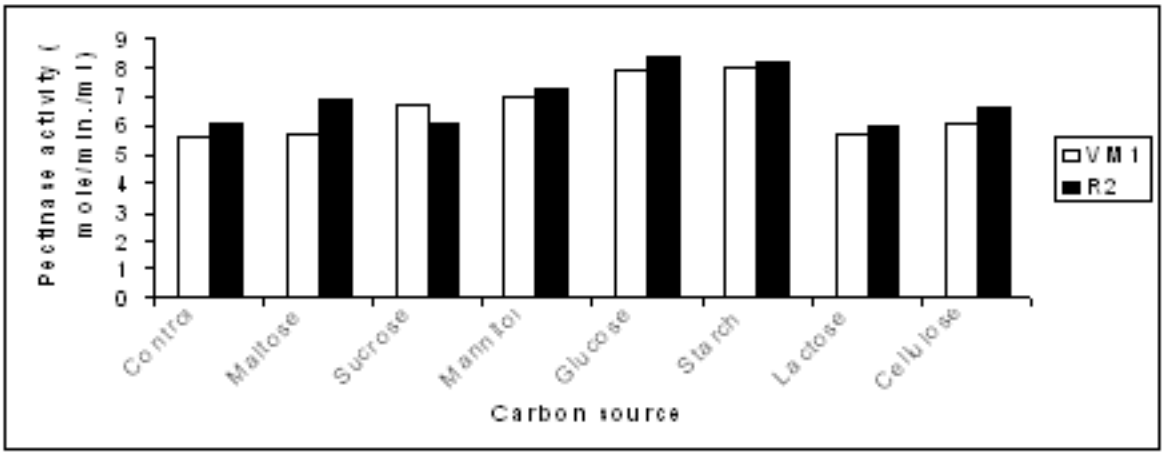


Fig. 9 : Effect of Carbon source on the Pectinase activity shown by *Bacillus* isolates.

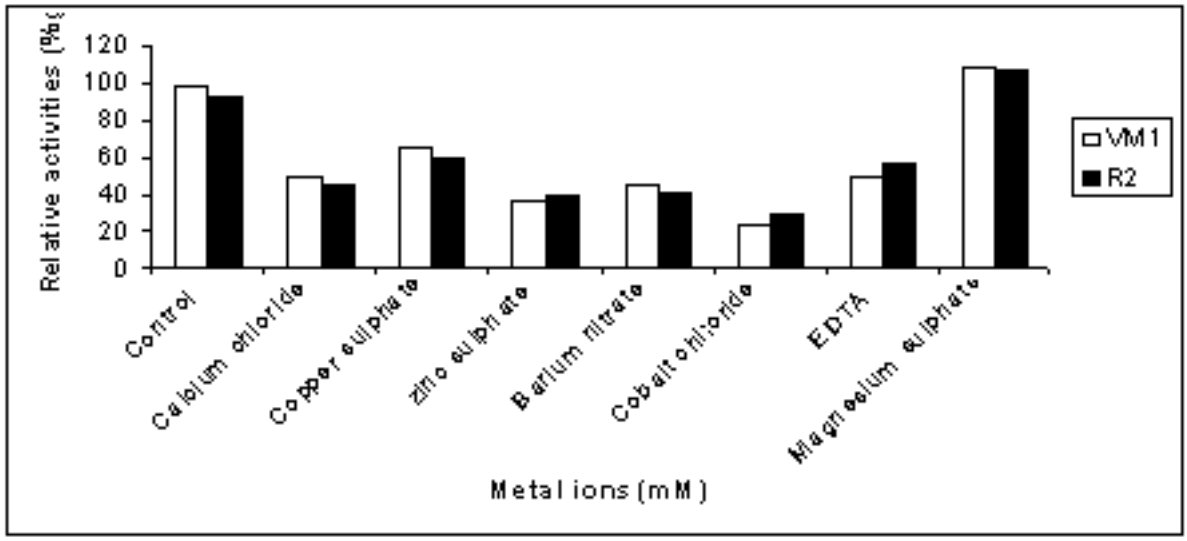


Fig.10 : Effect of metal ions on the Pectinase activity of *Bacillus* isolates.

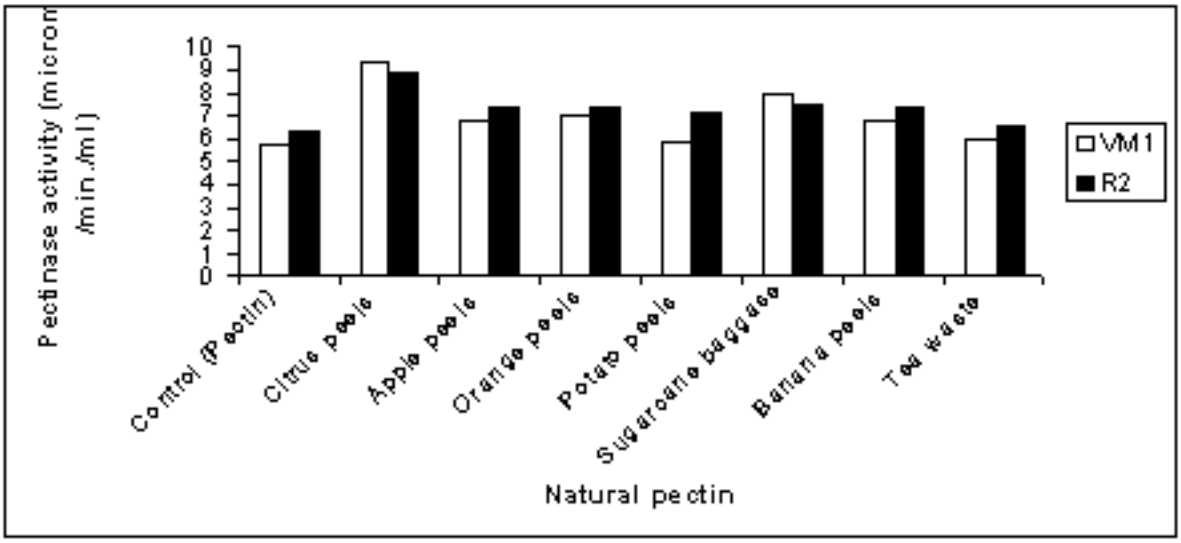


Fig.11 : Effect of natural pectin sources on the Pectinase activity of *Bacillus* isolates.

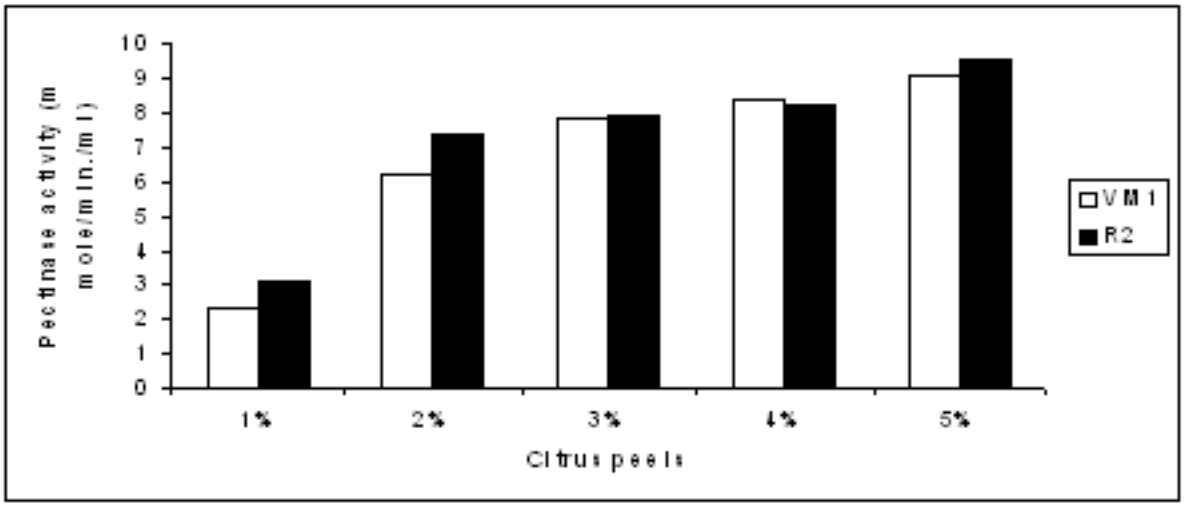


Fig. 12 : Effect of Citrus peels concentration on the Pectinase activity of *Bacillus* isolates.

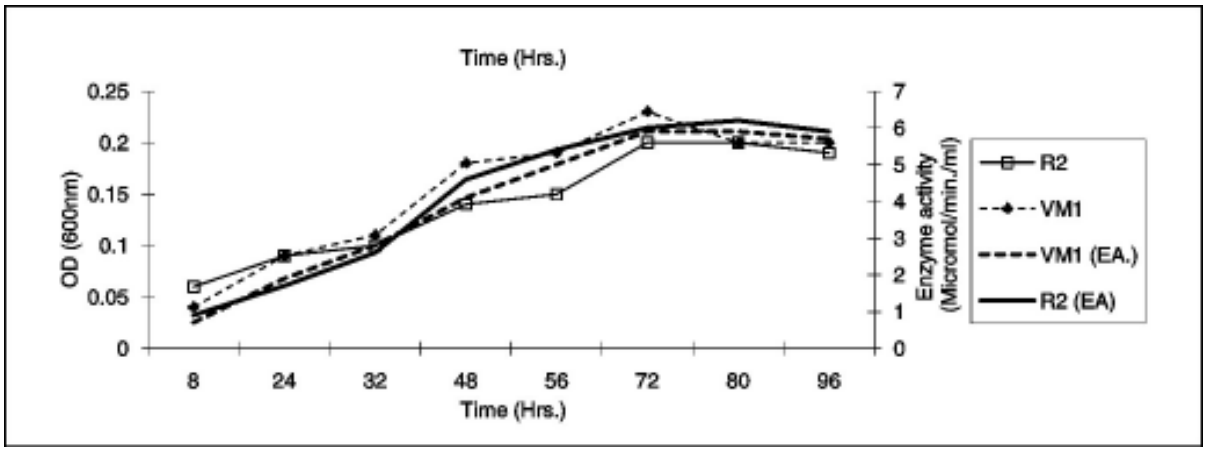


Fig. 13 – Growth and enzyme production profile of *Bacillus* isolates under optimized parameters and media.

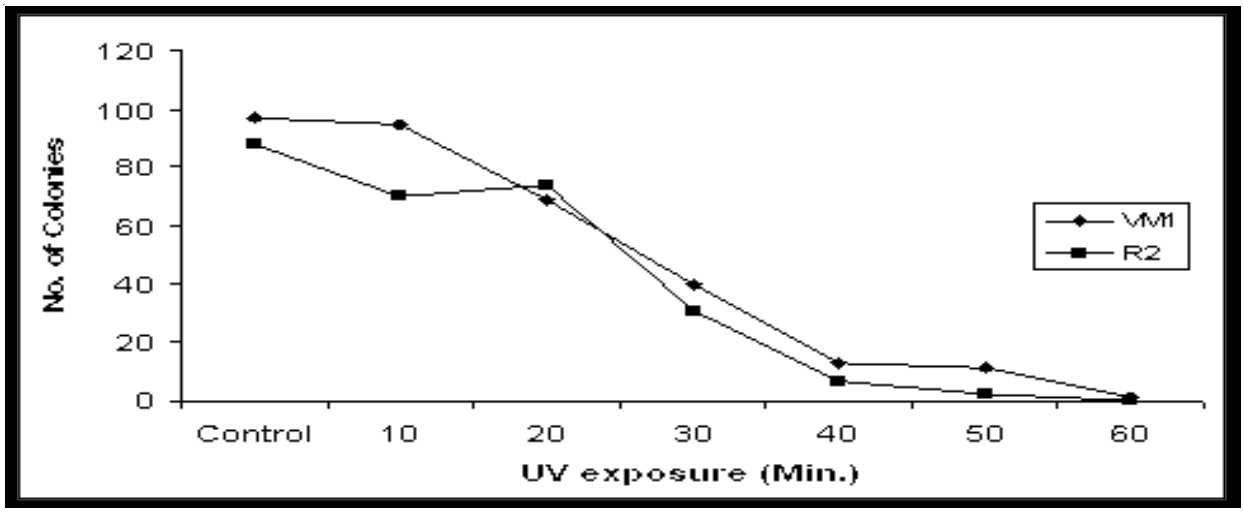


Fig. 14 - Survival curve of UV mutant *Bacillus* isolates

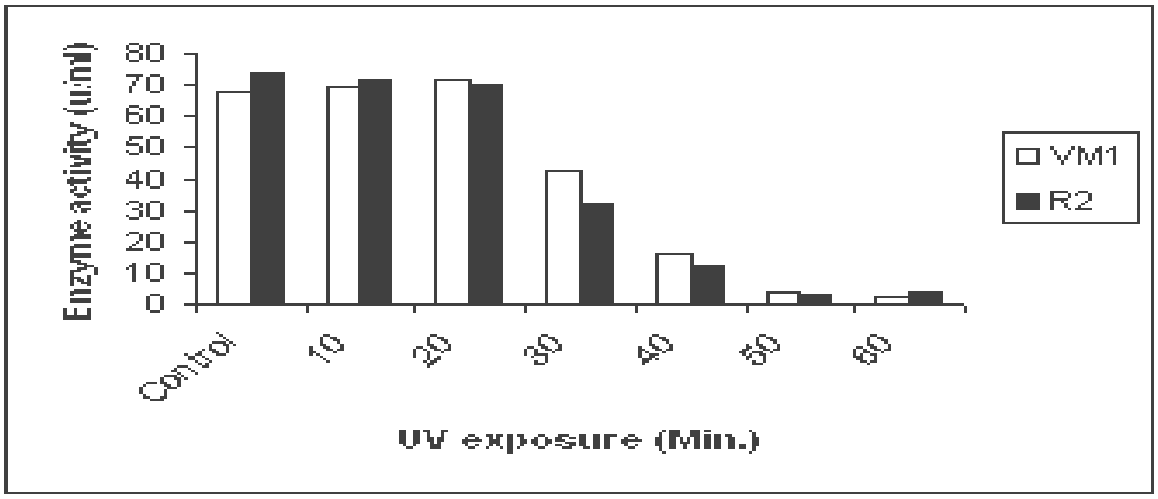


Fig.15– Pectinase activity of UV mutant isolates

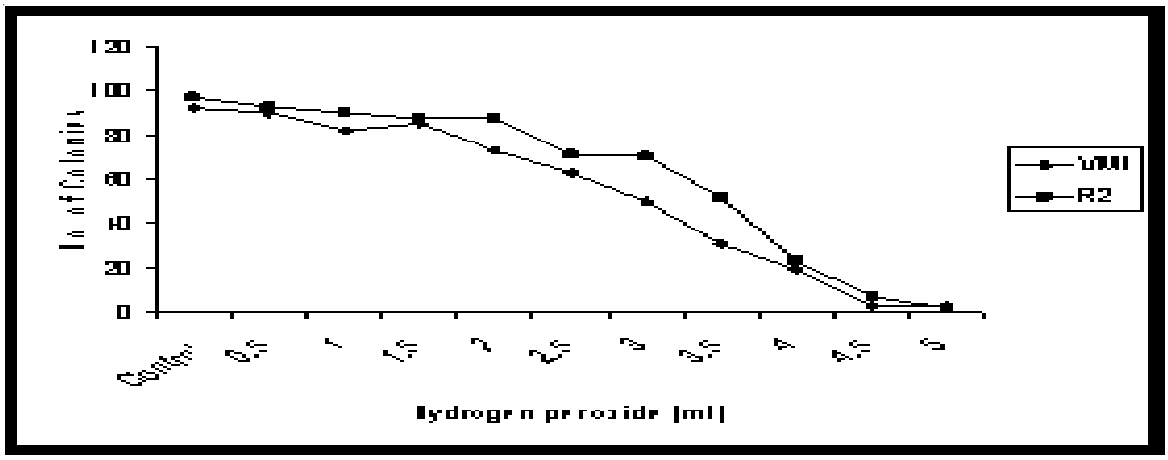


Fig.16 - Survival curve of H_2O_2 mutant isolates

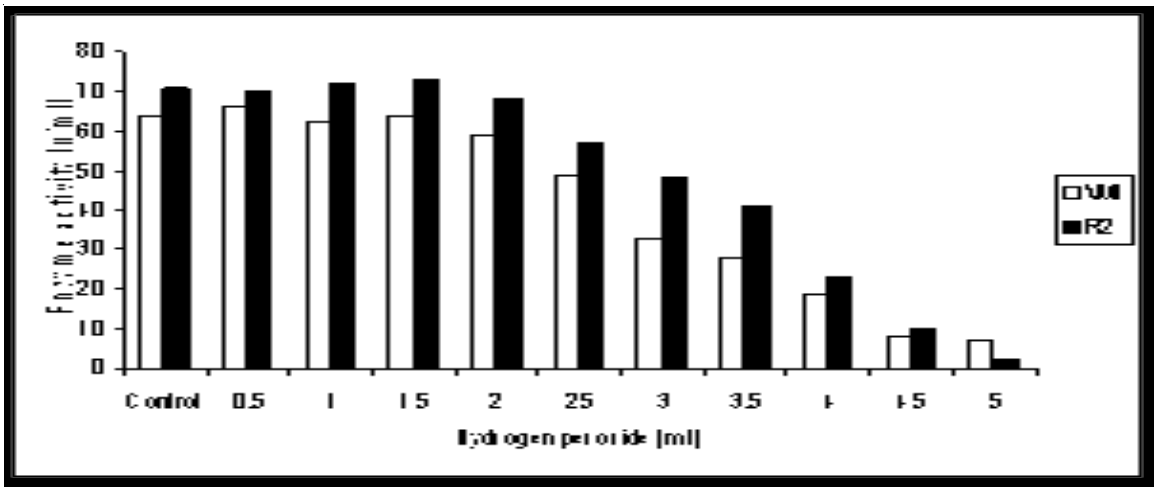
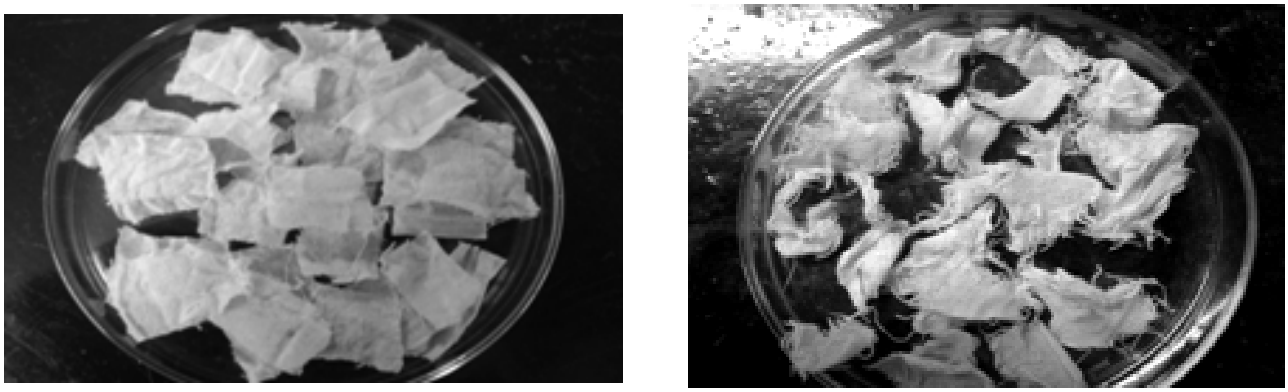


Fig.17 – Pectinase activity of H_2O_2 mutant isolates.

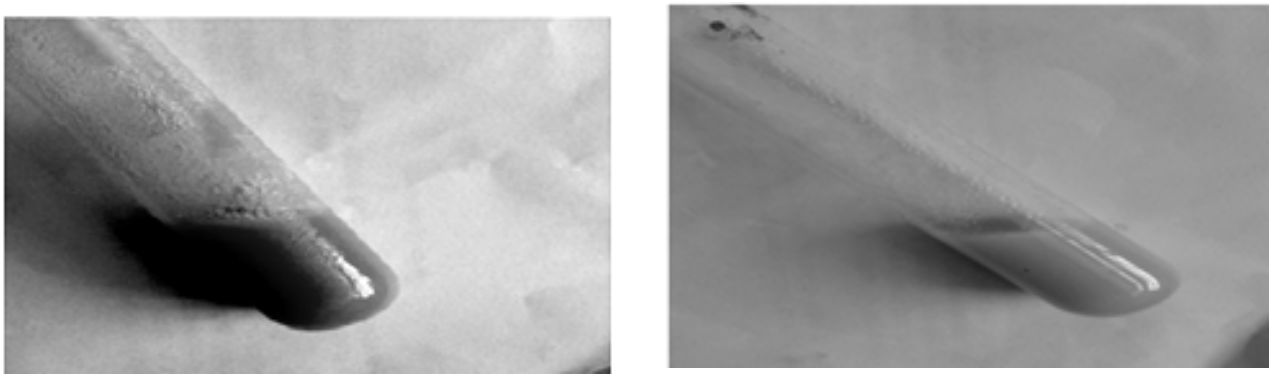
Table 1 : Applications of Pectinase

No.	Treatment	*Bacillus* Isolate	Before treatment	After treatment	%ge decrease
1	Bioscouring of cotton fabric	VM1 R2	1.09 1.10	0.97 0.95	11.01 13.64
2	Decrease in viscosity of Apple juice	VM1 R2	290 Sec. 287 Sec.	67 Sec. 59 Sec.	79.93 82.61



Before treatment **After treatment**

Fig. 18 : Bioscouring of Cotton fabric



Before treatment **After treatment**

Fig 19: Decrease in viscosity of apple juice

The optimal inoculum size needed to produce the highest yield of pectinase production was 4.0 ml (10^8 cells/ml) for both the isolates (Fig.-5). Beyond this Inoculum density, enzyme activity gradually decrease, may be due to the limitation of substrate concentration in the flask.

The effect of aeration conditions, (Fig.-6) revealed that, 1000 ml flask volume was more favorable for pectinase production with activities viz. 8.8 micro mol/min./ml for *Bacillus* sp. (VM1) and 9.1 micromole/min./ml for *Bacillus* sp. (R2).This may be due to 1000 ml flask volume supply enough aeration needed for respiration and metabolic activities. Some workers had reported that improvement in product yield is expected in the fermenter as compared to that in flasks, because of better control of process parameters in the former (Bayoumi R.A. et al., 2008).

An increase in activity of about 20 % for *Bacillus* sp. (VM1) and 14 % for *Bacillus* sp. (R2) was observed when the production medium was supplemented with 0.9% w/v D-Galacturonic acid (Fig.-7). Decreasing or increasing the concentration of D-galacturonic acid had an antagonistic effect on the production of the enzyme. The stimulatory effect of the addition of D-Galacturonic acid in the production medium on pectinase production by *Sclerotina sclerotiorum* and *Aspergillus niger* has been reported previously (Jayani R. et al., 2010).

Among different nitrogen sources (Fig.-8),Peptone, Gelatin, Casein and Potassium nitrate were the best Pectinase inducers for both the *Bacillus* sp. This might be due peptone and gelatin are natural nitrogen sources. Where as in the case of remaining nitrogen sources Pectinase production was affected might be due to poor growth of the *Bacillus* isolates on these nitrogen sources.

Among carbon sources (Fig.-9), Glucose proved the best supporting carbon source for both the isolates in competition with Starch and Mannitol followed by with moderate response showed by Cellulose, Sucrose and Maltose. While lactose had no any supportive role in pectinase production.

During study for effect of metal ions (Fig.10) on the enzyme activity, among different ions, Magnesium sulphate showed increase in enzyme activity viz. 10% for *Bacillus* sp. (VM1) and 14% for *Bacillus* sp. (R2) while other ions were responsible for decrease in enzyme activity. It was reported that the formation of a chelate complex between the substrate and the metal ions could form a more stable metal- enzyme- substrate complex and stabilizing the catalytically active protein confirmation.

On use of natural pectin source (Fig.11 & 12) , citrus peels had shown maximum activity for both the isolates. On comparison for pectinase production under solid state fermentation (SSF) and submerged fermentation (SmF), The SSF (data not shown) showed higher pectinase for both the isolates viz. for *Bacillus* sp. VM1 (9.7 micro mol/min./ml) and for *Bacillus* sp. R2 (9.3 micro mol/min./ml).The SSF is usually simpler and can use wastes of agro industrial substrates for enzyme production (Abhasi H. etal., 2011). The minimal amount of water in SSF allows the production of metabolites in a more concentrate form making the downstream processing less time consuming and less expensive. Higher production of pectinase in solid state fermentation process may be due to reason that solid substrate not only supplies the nutrient to the microbial cultures growing in it, but also serves as anchorage for the cells allowing them to utilize the substrate effectively (Bayoumi R.A. et al., 2008).

When the growth and enzyme production profile of *Bacillus* isolates was studied, a rapid increase in biomass during first 72 Hrs. of fermentation was observed, after which the growth became almost constant probably due to exhaustion of nutrients in the culture medium. The enzyme production started increasing after 32 Hrs. and reached its maximum after a 72 Hrs. remain stagnant for longer .The results under optimized conditions were compatible with enzyme production under non optimized conditions(Fig.13).

The adverse effects of physical & chemical mutagen were seen as decrease in cfu/ml and enzyme activity after 20 min. of UV exposure and at 2.0 ml concentration of Hydrogen peroxide in media (Fig.14 to Fig.17). Therefore strain improvement can be tried by using other standard conditions/agents in order to achieve strain improvements for enzyme production.

On applications of crude enzyme for Bioscouring of cotton fabric and decrease in viscosity of apple juice, pectinase from both the isolates showed good response in the given time with enhanced activity for pectinase from *Bacillus* sp.(R2) comparatively (Table-1 and Fig.18 -19).

Conclusion

The present study made a successful primary attempt to enrich and isolate the potential bacterial strain from the natural reservoir (rotten agro-industrial wastes) producing industrially important pectinase enzyme. The isolated both bacterial strains were identified as *Bacillus* sp. The production and optimization studies revealed that isolates requires 40^{o}C, pH 7.0, 72 Hrs. of incubation time , 4.0 ml of 1X10^{8} cells/ml culture density, Glucose(Carbon source), Peptone (Nitrogen source), 0.9 % (w/v) of D-Galacturonic acid (w/v), and Large volume flask for higher pectinase enzyme production. Citrus peels and Magnesium sulphate acts as a good agro waste substrate and supplement respectively. Weighing all its potent pectinase applications, more emphasis is to be laid not only on screening the novel pectinolytic bacteria, but also on production of high yielding strains. Utilization of fruit processed industrial byproducts and wastes as substrate acts to recycle the waste and to decrease the production cost making it economical. Hence furious work in this area is found to be an adept opportune both to the researches and to be industry.

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Assessment of Community Participation in Ecotourism and Conservation at Dandeli Wildlife Sanctuary, Karnataka, India

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Abstract : Community involvement is emerging as a key element of both sustainable tourism and ecotourism. Community involvement in decision-making and residents' receipt of benefits from tourism is expected to play a vital role in sustainable tourism as well as preservation and conservation of biodiversity. Local communities living in the forest areas of Dandeli suffered a great neglect economically in the past. This study aimed at evaluating the participation of community residents in ecotourism and conservation activities at Dandeli Wildlife Sanctuary; review benefits received by residents from wildlife sanctuary. A multi-stage sampling procedure was used for the selection of respondents. Structured questionnaire were used to measure issues relating to the objectives of the study. Many respondents indicated that non active participation between community residents and Karnataka Tourism Development Corporation. The level of participation of community residents in ecotourism venture is very low. The tourism agencies failed to take community into confidence in planning and management process of wildlife sanctuary. The community residents were completely neglected while preparing action plan and evaluation and monitoring process of ecotourism project in Dandeli. The community residents were respecting policy towards conservation of biodiversity. They have reduced their involvement in illegal trading of forest products. The study also reveals that community residents were not involved in planning and management process of conservation of wildlife and biodiversity of Dandeli located in Western Ghats section of Karnataka. However, the ecotourism project has generated lot of entrepreneurship opportunities in Dandeli to the local people. Results also revealed that majority of community residents were not given priority for job in the Dandeli Wildlife Sanctuary. The ecotourism had a negative impact on tradition skills, social customs and local life style. Dandeli Wildlife Sanctuary project failed to offer some community services to community residents such as HIV/AIDS education and skill up-gradation training programme, Microcredit etc.

Key words **:** Ecotourism, Dandeli Wildlife Sanctuary, Conservation, Community residents

Introduction

India is often termed as hotspot of bio-diversity and India's rich natural heritage already in existence in India. But, ecotourism was not properly planned in India. If planned and practiced in mutually complementing manner, ecotourism would be an import instrument for ecologic conservation and source of livelihood for people living in those areas. India has some successful examples of ecotourism i.e. Thenmala Ecotourism Project in Kerala. Western Ghats section of India is known for tourism. Few tourists spot in the Western Ghats section of south India has already been developed as ecotourism hubs in the form of national park, wildlife sanctuary and reserve forests. Among them Dandeli Wildlife Sanctuary located in Karnataka State is attracting national and international tourists. In the year 2012, UNESCO had declared Western Ghats as one of the biodiversity hotspot. But, unplanned growth of tourist destinations in Western Ghats is causing disturbance to flora and fauna. Therefore, the need of the hour is to protect the biodiversity of Western Ghats in a sustainable way without affecting the livelihood of local people and other stakeholders. Limited literature is available in India about ecotourism, policy initiative for protecting eco-system of the country, local community participation in ecotourism, etc. No research has been done in India focusing on local community participation in ecotourism and conservation activities, review benefits received by residents, conflicts between residents and promoting agencies, problems faced by local community, impact of ecotourism on biodiversity, etc. This has encouraged the researchers to take up the present study. Dandeli Wildlife Sanctuary in Karnataka has been selected for the purpose of study.

Review Of Literature

International Status

Michael J. Stone (2002) conducted a study on "International status of Ecotourism & Community Development: a case study of Hainan, China". The study sought to assess the current status of ecotourism at two destinations where it is being promoted as a regional development strategy. The existing tourism-park/resource-community relationships and impacts are evaluated at Jianfengling and Diaoluoshan National Forest Parks, in Hainan Province, China. According to him Ecotourism is an important provincial strategy for balancing economic growth and conservation. The study is intended to enhance the capacity of ecotourism to generate benefits for both the local communities and destinations, and thus contribute to

the sustainable development of the region more generally. According to researcher, socioeconomic benefits for the local communities have been very limited. Eugene E. Ezebilo (2012) threw a light on Economic Value of Ecotourism to Local Communities in the Nigerian Rainforest Zone. The study aims to assess community willingness to contribute for an ecotourism improvement project. The study showed that the respondents were willing to contribute an average of about one percent of their mean annual income per year. The results showed that willingness to contribute were influenced by factors such as income, distance of respondents' residence to the park, post-high school education, occupation and membership of an environmental conservation group. The results generated from this study are expected to contribute to the knowledge of sustainable management of ecotourism projects. Mohd Rusli Yacob*, Ahmad Shuib** and Alias Radam (2008) conducted a study on "How Much Does Ecotourism Development Contribute to Local Communities? An Empirical Study in a Small Island". The paper aims to estimate the local economic benefits of the ecotourism development in a small island. The results show that the development of ecotourism has definitely generated local employment opportunities. According to Bola Olusola Adeleke1 and Thandi Nzama (2013) communities have suffered a great neglect economically in the past. The study aimed at evaluating the participation of community residents in ecotourism and conservation activities at HUP; review benefits received by residents from park and determine the existence of conflicts between residents and park management. The study revealed that there was active participation between community residents and park management. Ecotourism and conservation projects are largely determined by the park system as residents are yet to be fully integrated into the planning process. According to researcher the major cause of conflict is restriction of residents from access to wildlife resources in the park. The researcher suggested that park system should to improve its relationship with communities.

National Status

Santosh. P. Thampi (2005) has conducted a study on "Ecotourism in Kerala, India: Lessons from the Eco-Development Project in Periyar Tiger Reserve"**.** The purpose of the study was to describe and evaluate the ecotourism project at the Periyar Tiger Reserve, Kerala, India. According to him, the inhabitants of the forest use to make living by illegal trading of forest goods. Their activity was thus detrimental to the conservation of the forest. However, their intimate knowledge about the plants and animals, and their survival instincts could be best used for participatory ecotourism activities. V. Kumar and arvind kumar (2009) had conducted a study on assessment of socio-economic impact of tourism/eco-tourism at Barabar and Nagarjuni Hills in Bihar (India). The study aims to assess the tourism/ ecotourism potential of Barbara and Nagarjuni Hills caves site in Bihar (India) and to assess its potential socio-economic impact on the local Population. It was found that in spite of its huge potential for declaring it as a eco-tourist site, it has not been done so owing to various reasons like lack of Infrastructure, lack of awareness about such a site amongst tourists from outside, lack of political will etc.

Objectives of the Study

The present study was undertaken with the following objectives:

1. To identify demographic profile of community residents
2. To assess the participation of community residents in ecotourism and conservation of biodiversity at Dandeli Wildlife Sanctuary
3. To review the benefit received by community residents from ecotourism
4. To draw conclusions and offer suggestions

Methodology

The study is empirical in nature. Dandeli Wildlife Sanctuary, Karnataka has been selected for the purpose of study. The sample size consists of 50 community residents and 10 respondents from tourism and forest departments. The selection of the community residents for the purpose of data collection was on random basis. Data for the study has been collected from primary as well as from secondary sources. The questionnaires were administered to the respondent. The secondary data was collected from government reports, research reports, and working papers and from the website of National Commission of Higher Education, Ministry of tourism, GOI, Karnataka Tourism Development Corporation, etc. The data was also collected by means of personal interaction with environmentalist, educationist, and local community in Dandeli Forest areas and through observations. The data so collected were analyzed by using tools such as percentage. The data was presented in tabular form. The period of study has been confined to December 2012, January-February and July 2013 – peak tourists' season.

Limitations Of The Study

Other ecotourism spot in Western Ghats section of Karnataka State were excluded from the preview of the study due to time constraint. Few of the community residents refused to interact with the researchers due to time constraints.

Meaning of Key Words Used

a) **Eco-Tourism**: Travel to natural areas where flora,

fauna, fragile, pristine and cultural heritage are the primary attractions. The travel should not lead to disturbing and damaging the eco-system and local value system. But, it should help the local people to improve their economic conditions. The travel should also help in spreading the message of preservation of the biodiversity, educating people about preservation of biodiversity but also lead to promotion of local culture.

b) **Biodiversity:** A natural area made up of living organisms such as plants, animals, marine and other living things in a particular geographical region. These inhabitants are rare living organism and are very sensitive to civilization. The civilization, urbanization and industrialization may cause huge damage and disturbance to these inhabitants. Therefore, it is the responsibility of each citizen, government, industry and society to preserve and protect such rare living organisms on the earth.

c) **Community Residents:** community residents refers to group of people living in forest areas having cultural, ethnic, social customs and practices, social values and beliefs or other characteristics in common

Results and Discussion

The findings and discussion are presented according to the set objectives

Demographics of Residents in the Communities

The table-1 reveals that majority of respondents (40.8) being females could be indication that females participate more in ecotourism and conservation ventures in Dandeli Wildlife Sanctuary than males. It could also be because many women in India maintain life in homes through daily food supply and payment of education fees for their kids. High population of youths was recorded in the communities as majority was between ages 18 and 44.

Table-1: Gender and Age of Community Residents

Demographics		**Percentage**
Gender	Male	39.2
	Female	40.8
Age	18-24	24.0
	25-34	31.8
	35-44	22.5
	45-54	10.0
	55-65	6.4
	65 and above	5.3

Table-2: Education Level of Community Residents

Level of Education	No. of Respondents	Percentage
No Education at all	14	28
Primary Education	29	58
Secondary Education	6	12
College/Vocational	1	2
University Education	0	0
Total	50	100

The table-2 exhibits that majority of community residents have completed only primary education. Further, 28 percent of community residents did not have any formal education. This indicates high level of illiteracy in the communities, and this could lead to restiveness and conflicts especially when the youths are not fully occupied.

The table-3 depicts that many of the respondents (22%) agreed that residents were employed by the Karnataka Tourism Development Corporation and Forest Department in wildlife sanctuary. However, majority of community residents were self employed out which 44 percent depended on wood and forest products for their livelihood. Few of the community residents were involved in trading and selling handicrafts products to tourist visiting sanctuary. The result revealing that very few of the respondents were hunters, suggesting that there would be less pressure on the fauna population in the sanctuary.

Table-3: Occupation of Community Residents

Occupation	No. of Respondents	Percentage
Farming	05	10
Animal husbandry	04	8
Gathering of wood & forest products	17	34
Hunting	03	6
Fishing	03	6
Handicrafts	01	2
Employment in sanctuary	11	22
Trading	06	12
Employment	00	00
	50	100

Table-4: Income Level of Community Residents

Income Per Month	No. of Respondents	Percentage
Up to 2250	34	68
2250-4500	05	10
4500-6750	11	22
6750-9000	00	00
Above 9000	00	00
Total	50	100

The low level of income per month by majority of the respondents (2250 per month) could be as a result of the prevailing poverty in the area and they fall under below poverty line income category notified by government of India. 22 percent of the community residents were earning in the rage of 4500-6750 as they were employed by tourism and wildlife protection agencies. However, the earning of employed category was also below the OBC income level notified by government of India.

Participation of Community Residents in Ecotourism and Conservation Activities

Table 5 shows that majority of the respondents reported that they did not have any idea and knowledge about participation of community residents in ecotourism ventures. This clearly speaks of tourism promoting agencies and forest department were not involving the community people in ecotourism planning and management process. The community residents were completed neglected while preparing action plan and evaluation and monitoring process of ecotourism project in Dandeli. However, the implanting agencies have taken the help of community residents as they find it difficult to implement the project indicating residents were used as lender of last resort.

Table-5: Participation of Communities in Ecotourism Planning & Mgt.

Variable	No of Respondents		
	Yes	No	No Idea
Planning	-	-	50
Preliminary Study	-	-	50
Action Plan	-	-	50
Implementation	23	-	27
Monitoring & Evaluation	-	21	29

Table-6: Participation of Communities in Conservation

Variable	No of Respondents		
	Yes	No	No Idea
Policy respect by community	29	-	21
Illegal Trading of forest Products	09	41	-
Health Services for Wildlife	17	-	33
Guide Service in restricted areas	05	38	07
Information supply about wildlife behaviour and living style	36	-	14
Social Forestry	00	00	50
Planning for conservation	00	14	36
Conservation Action Plan	00	00	50
Implementation of action Plan	00	00	50
Monitoring & Evaluation	00	00	50

Majority of the respondents agreed that they do respect policy of conservation biodiversity. They also opinioned that residents' involvement in illegal trading of forest products had drastically came down because of awareness, opening of different avenues of income and tight policing activities in sanctuary. The community residents also argued that the tourism promoting agencies as well as forest department were not involving the community residents in planning and management process of conservation of wildlife and biodiversity of Dandeli located in Western Ghats section of Karnataka.

Table-7: Participation of Communities in Ecotourism Business

Variable	No of Respondents		
	Yes	No	No Idea
Trading in restricted areas	43	-	07
Illegal Trading of forest Products	41	9	00
Use of Animals as means of transportation - cattle, horse and camel	35	15	00
Use of plastic	17	31	02
Selling Pots and baskets, traditional Dish	49	01	00
Practicing local crafts, dance, folk-art etc	42	00	8
Selling fruits and Ayurvedic Products	50	00	00

The respondents (table-7) expressed that the ecotourism projects has generated lot of entrepreneurship opportunities in Dandeli to the local people. The new source of income for the community residents includes animal transportation, selling basket, pots, traditional Dish, local crafts, fruits and Ayurvedic Products. The dance and folk-art shows is also emerging as a new source of revenue for them.

Benefits Received by Community Residents from Park

Table-8: Benefits Received by Communities from Dandeli Wildlife Sanctuary

Benefits	Strongly Disagree	Neutral	Agree	Strongly Agree
Community receive priority in Jobs	30	09	11	00
Exposure to Traditional skills	41	04	05	00
Access to Wildlife Resources	00	11	02	37
Opportunity to sell product available in Sanctuary	19	23	08	00
HIV/AIDS education to youths and adults	05	43	02	00
Empowerment of local community	00	50	00	00
Income from practicing local crafts, dance, folk-art, bird-watching helpline, selling Pots, baskets & traditional Dish	00	00	42	08
Training – skill up-gradation	23	20	07	00
Infrastructure development – schools, clinics, linking roads, transportation, toilet facility, etc	41	00	09	00
Awareness about Govt. schemes and Assistance	46	00	04	00
Increase in Income from Trading	00	00	43	07
Access to Microcredit	00	43	07	00

Results from Table 8 reveal that majority of respondents (60%) were of the opinion that locals were not given priority for job in the Dandeli Wildlife Sanctuary. This might have resulted from low educational background of the majority of the residents as shown in Table 2 and as such many might not be employable by the Sanctuary. Many of the community residents (82%) were not of the opinion that ecotourism will help to build traditional skills of residents. Actually the ecotourism in Dandeli is having negative impact on tradition skills, social customs, local life style due to influence of tourist visiting Dandeli. Many of the respondents (74%) were of the opinion that residents were restricted access to sanctuary resources. However, many of the respondents agreed that income of locals had increased through ecotourism businesses. There is evidence that the sanctuary had attempted to empower community members as much as possible as some respondents (82%) believed residents were given opportunities to market their local products in the sanctuary which had helped in improving their standard of living. However, the Dandeli Wildlife Sanctuary project did not improve the linking roads to communities and other infrastructure in the area such as schools, clinics, transportation, toilet facility, etc. The project also failed to offer some community services to community residents such as HIV/AIDS education and skill up-gradation training programme, Microcredit etc.

Conclusion

The majority of the community residents fall under below poverty line income category notified by government of India even though the ecotourism had opened up new avenues of revenues for them and helped in improving their standard of living. They had different approach towards standard of living. So, the local community did not benefited much from ecotourism project in Dandeli. The level of participation of community residents in ecotourism venture is very low. The tourism agencies failed to take community into confidence in planning and management process of wildlife sanctuary. The community residents were completey neglected while preparing action plan and evaluation and monitoring process of ecotourism project in Dandeli. However, the implanting agencies have taken the help of community residents as they find it difficult to implement the project indicating residents were used as lender of last resort. It is observed that majority of the respondents were respecting policy towards conservation of biodiversity. They have reduced their involvement in illegal trading of forest products. The study also reveals that community residents were not involved in planning and management process of conservation of wildlife and biodiversity of Dandeli located in Western Ghats section of Karnataka. The respondents expressed that the ecotourism projects has generated lot of entrepreneurship opportunities in Dandeli to the local people. Results also revealed that majority of community residents were not given priority for job in the Dandeli Wildlife Sanctuary. The ecotourism had a negative impact on tradition skills, social customs, local life style due to influence of tourist visiting Dandeli. Dandeli Wildlife Sanctuary project did not improve the linking roads to communities and other infrastructure in the area such as schools, clinics, transportation, toilet facility, etc. The project also failed to offer some community services to community residents such as HIV/AIDS education and skill up-gradation training programme, Microcredit etc.

Suggestions

The Karnataka Tourism Development Corporation in association with NGOs and Business Management Educational Institutions should conduct market orientation programme for community residents. Such programme will help them to equip themselves with latest marketing techniques to boost the sales of their produce. The government schemes meant for tribal and below poverty line category have not reached the community residents living in forest areas of Dandeli. The need of the hour is that government machinery to immediately develop a comprehensive plan for integrated development of community residents living in forest areas of Dandeli wildlife sanctuary. The Karnataka Tourism Development Corporation as well as Karnataka Forest Department should develop an integrated plan for developing ecotourism as well conservation of biodiversity in Dandeli. They should involve all the stakeholders right from the planning process to monitoring and evaluation process. The community

residents should be assigned with key responsibility in all areas of planning and management. Measure should be taken to preserve the local culture, tradition social customs, local life style by creating platform for exhibiting art, culture, tradition on the occasion of tourism and environmental day. Dandeli wildlife festival should be organized for the same. The government machinery should also take measures to improve the linking roads to communities and other infrastructure in the area such as schools, clinics, transportation, toilet facility, etc. The high flow of tourist to Dandeli may put community residents into the risk of HIV/ AIDS infection. Therefore, NGO in association with Health department should conduct HIV/AIDS awareness programme and organize health camp at regular interval. The Microcredit concept which was so popular throughout the country had not reached the community living in forest areas of Dandeli. The NGO can a play vital role in improving standard of living of community residents through the provision of microfinance. They should also conduct customized vocational training programmes for community residents. Finally, all the stakeholders need to play their role in promoting ecotourism which will go a long way in preserving and protecting the biodiversity as well as wildlife for the next generation. They also need to share responsibilities for preserving the biodiversity but also participate in equitable sharing of the benefits.

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Mapping of Mangrove area of Curtorim Village- South Goa District- Goa-India- Using Remote Sensing and GIS Techniques

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Abstract : Human activities like agriculture, aquaculture, navigation and mining in coastal area led to destruction of mangrove habitat. Estuarine regions are densely populated due to its high productivity and prone to rising human pressures causing greater mangrove fragmentation and losses. Lack of spatial quantitative maps on mangroves for the west coast has often crippled restoration programmes. This study has been undertaken to understand mangrove area of Curtorim village (South Goa district) and also help to plan the strategies to monitor and protect such great biodiversity.

An analysis of remotely sensed images of May 2000 and April 2010 gives the clear idea about mangrove area of Curtorim village.

Key words **:** Goa, Curtorim, Remote Sensing and GIS, Mangrove flora, Diversity

Introduction

Mangroves are trees and shrubs that grow in saline coastal habitats in the tropics and subtropics. They fall into two groups according to their habitats in nature: true mangroves and mangrove associates. True mangroves refer to species that specifically grow in intertidal zones, while mangrove associates are capable of occurring in either littoral or terrestrial habitats. Mangrove formations depend on terrestrial and tidal waters for their nourishment and silt deposits from upland erosion as substrate for support. Mangrove forests perform multiple ecological functions: they produce woody trees, provide habitat and detritus food for fish and shellfish and act as spawning ground for a variety of fishes, prawns and shellfishes. They harbour a variety of valuable fauna, including migratory birds. Remote sensing is used as a tool for monitoring the changes, especially in forests, as it is inaccessible. It provides relatively accurate information regarding the status of vegetation in the forest and is cost-effective and time saving. Geographic Information System (GIS) and remote sensing tools are being extensively used to understand the changes in mangrove areas, for purposes of planning and management.

Curtorim is located at 15.28°N 74.03°E. It has an average elevation of 38 metres (125 feet). Zuari river flow from this village and meets to Arabian sea. Zuari River occupies approximately 5790 ha of water body, along about 145 km stretch of which 64 km is navigable. The estuarine mouth (Marmugao Bay) is about 6 - 7 km wide, while the upstream region narrows down to 0.5 km (Untawale *et al.*, 1982).

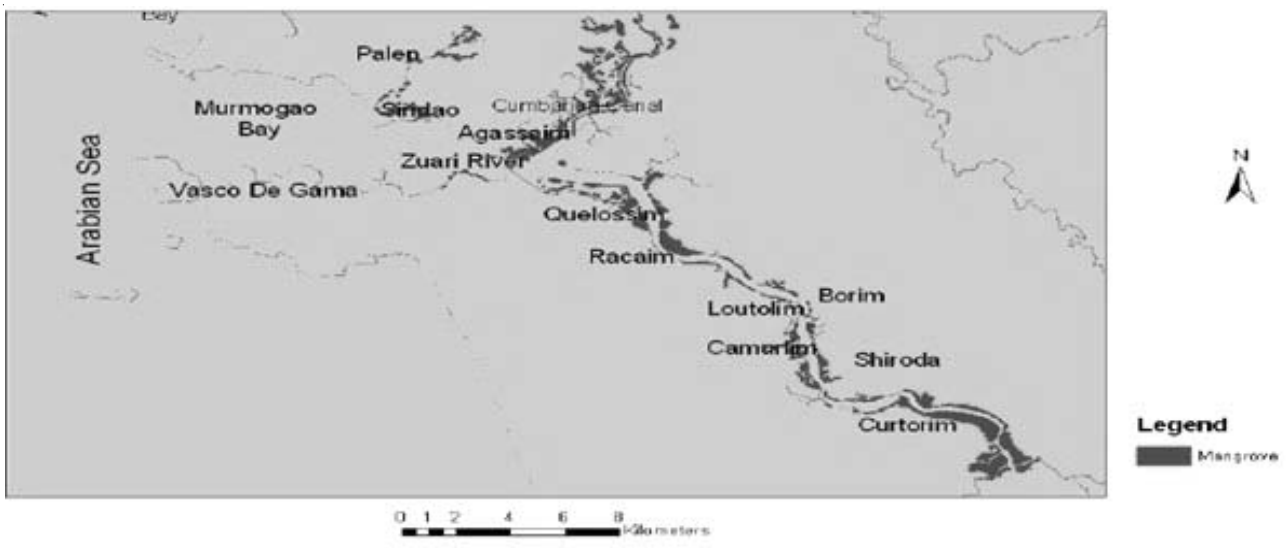

Fig 1: Distribution of Mangrove flora along Zuari River- Curtorim Village, Goa-India

Materials and Methods

For the above study simple image classification method and some primary data has been used. To record location of mangroves areas images, DGPS (Differential Global Positioning System) has been used. The secondary data like Google Earth image (April-2010, 1 m resolution) and Liss-III (9 May 2000, 23.5 resolution) image were used. Extraction of study area has been done from Google and Liss-III images with the help of Arc GIS software. On Google image visual vector classification has been done with help of ground survey. On the other hand Supervise classification has been done on Liss-III image with the help of ERDAS 9.1 software.

Results and Discussion

Table-1- Sampling Stations

Sampling stations	Latitude	Longitude
Station-I	$15^0$18'27.91658"	$74^0$00'51.58836"
Station-II	$15^0$18'16.90022"	$74^0$00'58.72388"
Station-III	$15^0$18'13.92315"	$74^0$01'05.96435"
Station-IV	$15^0$18'37.77878"	$74^0$00'37.68192"

Table-2 The Diversity of true mangroves and mangrove associate in selected sampling station at Curtorim village

Sr. No.	Botanical Name	Family Name	Life Form	Stn. -I	Stn. -II	Stn.- III	Stn -IV
1.	*Acanthus ilicifolius*	Acanthaceae	S	+	+	+	+
2.	*Avicennia officinalis*	Avicenniaceae	T	+	+	+	–
3.	*Sonneratia caseolaris*	Sonneratiaceae	T	–	+	+	+
4.	*Kandelia candel*	Rhizophoraceae	T	+	+	+	+
5.	*Rhizophora mucronata*	Rhizophoraceae	T	–	+	–	–
6.	*Acrostichum aureum*	Pteridaceae	S	–	–	+	–

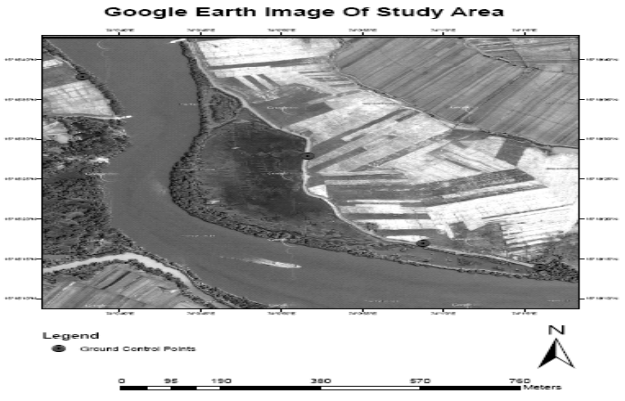

Figure1- Ground Control Points in Study Area

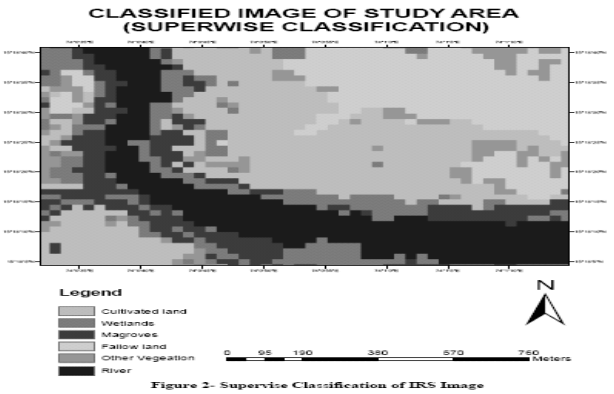

Figure 2- Supervise Classification of IRS Image

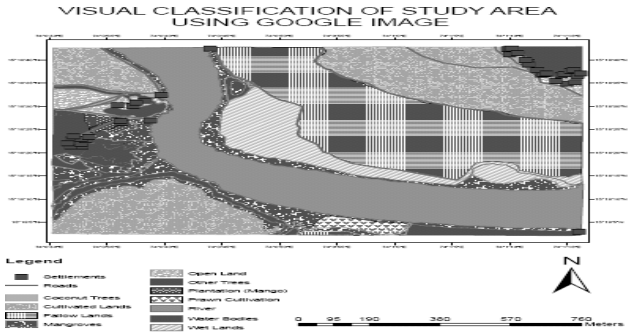

Figure 3- Classified Image of Google Earth

Supervise classification has been done with 89% accuracy and we got the area under mangroves is around 190 sq. Km. While visual classification on Goole image gives area under mangrove vegetation is around 195 sq. Km. This difference has occur due to difference in spatial resolution of both the images.

However the sampling stations which are located on images shows following mangrove flora (Table-2)

Station-I

The selected station is an island along the Zuari river-Curtorim village. The area is dominated by *Kandelia candel* and along the border *Acanthus ilicifolius*, *Avicennia officinalis were* also recorded during survey.

Station-II

Five mangrove species were recorded in this area namely *Acanthus ilicifolius, Avicennia officinali, Sonneratia caseolaris, Kandelia candel,* and *Rhizophora mucronata.* Here the first three species are dominant and others are rare.

Station-III

At a distance of 1km-from stn.-II four true mangroves species called *Acanthus ilicifolius, Avicennia officinalis, Sonneratia caseolaris* and *Kandelia candel* were recorded along with one mangrove associate i.e. *Acrostichum aureum.*

Station-IV

This station is on other site of river bank and species like *Acanthus ilicifolius, Sonneratia caseolaris* and *Kandelia candel* are present here. On this site all three species of true mangroves are dominant.

Conclusion

As we know that mangroves grow in saline habitat but in this study area presence of *Sonneratia caseolaris* indicates that the water of this estuary is less saline.

Villagers use forest as resources for their livelihoods. This area has no protection. There is need to develop local support to protect this area and to restrict the human interference. The present information would form a useful tool for further studies and monitoring of these coastal ecosystems. The present study can help in formulating strategic plans to afforest mangroves.

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Preparation of organic compost using waste tea powder

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Abstract : The present study was carried out to use the tea-powder that is any how wasted, especially in urban areas which is not utilized for any purpose and discarded as wet garbage. Tea powder can be a great source of biodegradable garbage but it can make a good source of compost as well. The research is about preparing compost using waste tea powder which is generally thrown away and analyzing the physico-chemical parameters of the compost. The compost prepared by using waste tea powder has increased concentration of essential nutrients needed for plant growth and development as compared to the regular soil which are Chloride, Sulphate, Total Phosphorus, Available Phosphorus, Organic matter, Calcium and Magnesium. By using this compost, the plants grow very rapidly and there is increment in the leaf area, leaf density, height, and germination period and germination frequency of the plant. The use of this compost also reduces environmental pollution and also gives better yield of crops.

Key word **:** Tea powder, organic matter, pH

Introduction

Compost application to agricultural land can result in changes in soil physical properties such as structure, water retention and infiltration rates, biological properties and crop yields. Moreover, organic materials such as compost can act as a valuable source of plant available nutrients (e.g. nitrogen (N), phosphorus (P), potassium (K), sulphur (S) and magnesium (Mg)) and thereby reduce the need for manufactured fertilizer inputs (Rollett *et al;2010*).

Compost is rich source of nutrients with high organic matter content and use of compost can be beneficial to improve organic matter status. Physical and chemical properties of soil can be improved by using compost, which may ultimately increase crop yields. The soils, which were, once well supplied with available nutrients, are now gradually becoming deficient (Zia *et al.*, 1994). So use of compost is the need of the time and beneficial to improve organic matter status. Physico-chemical properties like pH, conductivity, sulfate, chloride, total phosphorus, available phosphorus, calcium, magnesium, organic matter and silica were significantly improved resulting in enhanced *Tagetes* spp., *Cicer arietinum* and *Vigna radiata* yields in sodic soil (Hussain *et al.*, 2001).

The present study is conducted with the tea compost and assesses its effects on crop yield.

Materials and methods

Compost was prepared at the campus of the C.K.Thakur college, New Panvel using tea powder that is thrown after use. It was collected from houses, tea stalls and hotels.

Table 1: Methods for Physico-Chemical Analysis of the Soil

Parameter	Method
PH	Digital pH meter
Conductivity	Digital Conductometer
Sulfate	Turbidimetric Method
Chloride	Argenometric Method
Organic Matter	Walkely-Black Method
Total Phosphorus	StannouslChloride Method
Available Phosphorus	Stannous Chloride Method
Silica	Ammonium Molybdate method
Calciumand Magnesium	EDTA Method

Equal layers of soil, cow-dung and soil were laid at the top of the other. The material was allowed to decompose for three months. The temperature was monitored regularly to check the process of completion of the decomposition. The temperature rose initially and when the compost was ready, it remained constant. The compost thus made was analyzed for its following physico-chemical properties, by using methods (Table 1) prescribed in Trivedy and Goel (1986).

The following seed were selected to check the efficiency of the compost as they are important in one or the other aspects as described below-

Vigna Radiata sprouts have been part of Asian cuisine for centuries. It is one of the most familiar beans in the country. It is familiar to many because of its use for bean sprouts common in salad bars across the country. Sprouts are considered a "superfood" because of their high nutrient qualities.

Cicer arietinum has long been valued for their fiber content. They are a very good source of carbohydrates and proteins which altogether constitute about 80% of the total dry seed weight. Starch, which is the principal carbohydrate

component, varies in content from 41-50% and is lower in Desi varieties than in Kabuli varieties. Total seed carbohydrates vary from 52-71%. The crude protein content of chickpea varieties ranges from 16-24%. Crude fibre, an important constituent of chickpeas is mostly located within the seed coat.

Tagetes plants are stout and branching. They vary in size from 0.1 to 2.2 m tall. They are cultivated all over the world for their decorative and ornamental purposes. They are highly valued in festive seasons. They are also known for their antibacterial, insecticidal and antihelminthic activities.

The efficiency of the compost was checked by pot assay of using the above mentioned plants. Two test pots were made varying in the proportion of the compost and soil as 1:1 and 1:3 and compared with the control pots.

Results

The pH of control soil was 7 which was slightly decreased to 6.4 (table 1) indicating insignificant change in soil pH. Elevated pH are responsible for losses of nitrates (Rhoades *et al.* 1976). Though there is slight decrease in pH, it can be taken as a sign as restoration of nitrates through the process of composting.

In non-saline soils, conductivity variations are primarily a function of soil texture, moisture content, and CEC (Rouached *et al.* 2009). The present study reveals indicates increased conductivity. It may indicate the availability of nutrient to the plants through increased free ions.

Sulfur (S) is an essential macronutrient for all living organisms. Plants require large amounts of sulfate for growth and development, and this serves as a major entry point of sulfate into the food web. Plants acquire S in its ionic form from the soil; they have evolved higly controlled mechanisms for the regulation of sulfate uptake in response to its external and internal availability (Marschner, 1995). The enhanced sulfur is good indicator of the compost. In the present study sulphates are elevated from 0.05% to 0.5%.

Table 3: Physico-chemical Analysis

Parameters	Control	Tea Compost
pH	7	6.8
Conductivity	0.540 ms	7.80 ms
Sulphate	0.05%	0.5%
Chloride	0.7%	1.0%
Total phosphorus	0.03%	1.2%
Avail. phosphorus	0.02%	0.05%
Calcium	1%	1.3%
Magnesium	0.26%	0.58%
Organic Matter	8 %	45%

Chlorine is an essential micronutrient for plant and its minimal requirement for crop growth of 1 g kg^{-1} dry weight has been suggested (Pfeiffer 1954).

Increase concentration of chloride is indicator of availability of nitrogen and health of the plants. The chlorides in the compost increased from 0.7% to 7% indicating enhancement in the compost.

Total phosphorus and available phosphorus also increased in the compost. The homemade compost usually has phosphorus ranging between 0.5 to 4 %. The increase from 0.03 to 1.2% indicates the phosphorus enrichment during the present study.

Calcium plays double role in soil fertility as a plant nutrient at the same level as N, P and Mg and as a regulator of soil pH which determines to a large extent solubility, toxicity and absorption of various soil nutrients. The compost formed during present study had elevated calcium concentration from 1% to 1.3%.

Magnesium is the only metal constituent of the chlorophyll and is related to the phosphorus metabolism which activates number of plant enzymes. The present study reveals increased concentration of magnesium from 0.26 to 0.58%.

Organic matter in compost improves soil structure and water holding capacity. The percent of organic matter for general garden compost ranges between 12-20%. In the given compost, organic matter has not achieved increment upto 45% and is appreciable. (table 3).

The morphological features of the plants were also seen in response to compost to see the efficiency of the compost as a good fertilizer. As seen in table 4, leaf length, leaf density, germination rate and height of the Moong, Chick peas and Mari gold are found to be enhanced. The period of germination has been decreased after application of compost. It is also apparent that positive control I is showing improved growth than control II where the later has more amount of compost than earlier. It indicates that the use of this compost should be done optimally.

Table 4: Results of Pot Assay

Parameters	Control			Positive Control (Expt. 1)			Positive Control (Expt. II)		
	I	II	III	I	II	III	I	II	III
Leaf Area (cm^2)	--	--	3	--	--	4	--	--	4
Leaf Density	7	80	08	15	120	17	08	80	12
Height (cm)	5	15	8	07	18	13	03	12	07
Germination Period (days)	5	3	3	4	2	2	5	3	3
Germination Frequency %	80	70	80	90	80	90	80	80	80.

Note - I Tagetes* spp., *II- Cicer arientinum, III- Vigna radiata

An estimate of cost efficacy is as mentioned in table 5. The daily approximate amount of tea powder after its use is given in the form of wet weight. If so collected as mentioned below we can have 260 kg day^{-1}. So, in a month we can have 7800 kg of used tea powder. The amount of compost thus generated may be approximately 10,000 kg in its dry weight. If sold at the rate Rs. 20 kg^{-1}, won can have Rs. 2 lakh out of it. If labour and travelling charges are also excluded considering the amount of Rs. 50,000/-, then also there is profit of Rs. 1.5 lakhs.

Table 5: Cost Efficacy

Houses (per day)	Restaurants (per day)	Tea stalls (per day)
1 = 100 gm 100 x 100 = 10 Kg	1 = 1 Kg 1 x 100 = 100 Kg	1 = 1.5 Kg 1 x 100 = 150 Kg

Conclusion

The used tea powder is the suitable substrate for making compost. The composition of various nutrients showed increment in their concentration. The pot assay results show the improvement in plant growth. The approximate of cost efficacy is also in the favour of making compost in this way.

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Butterfly diversity of Phansad – Preliminary study

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Abstract: Total 153 species of butterflies distributed in five families have been reported from Phansad wildlife sanctuary. Further to this there are seven species which might be existing in the area. Nymphalidae and Lycaenidae were the co-dominant families with 47 species each. Pieridae represented by 17 species, Hesperidae by 31 species and Papilionidae by 11 species.

Key words : Phansad, butterflies

Introduction

Phansad wildlife sanctuary (73.05908°N 18.3441°E) is located in Raigad district of the Konkan region of Maharashtra. It is spread over 6979 hectares. It was declared as sanctuary in 1986. Before independence it was the private hunting ground of the Nawabs of the princely state of Murud Janjira. Some parts of the sanctuary touch the Arabian Sea. Geographically it can roughly be divided into north and south part; the arm extending north north west of Supegaon and the other arm extending south south east of Supegaon. The primary forest type is moist deciduous dominated by Anjani *Memecylon umbalatum*. On the western boundary are some regions of broad leaved forest dominated by Teak *Tectona grandis*. Few grasslands are spread across the forest which are the good place for sighting other mega fauna. As per the forest department data there are at least 30 perennial water streams locally called as 'Gaan'.

There are no published data of the butterfly diversity of this region except Padhye *et.al* (2013) who reported 91 species. The area seems to be very rich with 718 species of plants reported further studies will increase the knowledge of its diversity.

Materials and Methods

The area was visited in all the seasons throughout the year from 2002 to 2011. The standard observation time was from 07.00 hrs in the morning to 12.00 noon however observations were made for the entire day if required. The butterflies were observed along paths inside the forest and along water streams. They were observed on both sides of the paths. Lycaenids and hesperids were caught in the net whenever required, identified and released. In case of uncertain identity photographs were taken. The identification was done with the keys of Evans (1932), Kehimkar (2008), Kunte (2000) and Wynter Blyth (1957). The classification follows Kehimkar (2008). Their status was decided on visual observations as C - common, VC - very common, NC – not common, R – rare, VR – very rare. This status does not correlate to the entire geographical distribution status of a corresponding species.

Results and discussion

Total 153 species distributed in five families have been identified from the study area. Lycaenidae and Nymphalidae were co-dominant family with 47 species each (30.72% each) followed by Hesperidae 31 species (20.26%), Pieridae 17 species (11.11%). The swallowtail family was the least diverse with 11 species (7.19%). (Fig. 1)

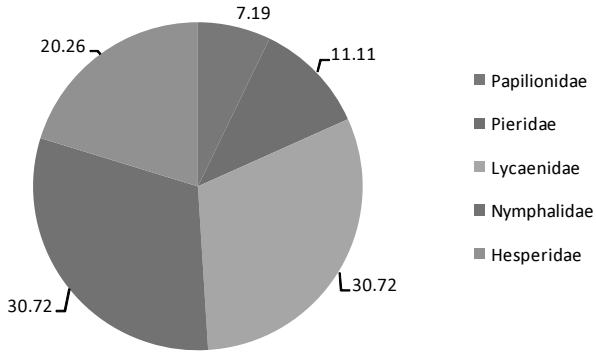

Fig.1. Family wise composition of butterflies

Total 21 subfamilies were recorded with Nymphalidae distributed in 10 subfamilies while Papillionidae 11 species distributed in only 1 subfamily. Lycanidae dominated the list by having most Rare (8 species) and Very rare (3 species) status. Fig. 2 shows distribution of diversity amongst different status.

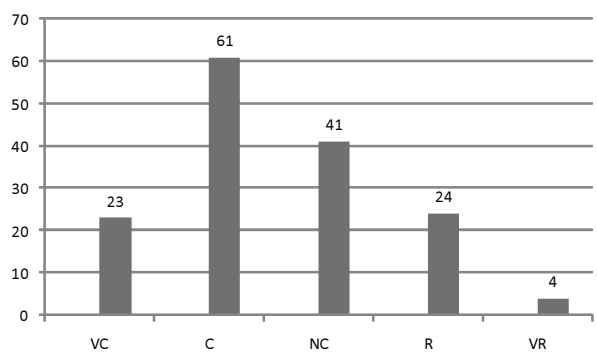

Fig. 2 Status wise distribution of species

The different landscapes present in the forest are grasslands, dense forests, perennial streams and clearings near road. Most diversity recorded at perennial streams and at the edge of the forests and grasslands. Water level in the streams near water bodies reduces drastically during February-March thereby exposing wet soil below it. Most of the diversity was recorded here on these wet soil patches.

It is interesting to note that few diurnal species of butterflies got attracted towards the tubelight of the rest house during night. Bushbrowns, Common Tinsel, Black prince female, Orange ail awl, Brown awl were seen on the wall lit by tubelight.

H.L. Naik (2002) reported 71 species in a local publication. In the same publication unknown author has compiled a list of 718 plant species.

Following are the species which are suspected to be present in the area and requires further study for the confirmation.

Suspected occurrence

Southern Birdwing *Troides minos.* Naik (2002) stated to have spotted Southern Birdwing *Troides minos* on 14th June 2000 in compartment no. 683. This observation needs authentication.

Plain Puffin *Appias indra* (Moore, 1857)

I have recorded Abnormal Silverline *Spindasis abnormis* from Yeoor, Sanjay Gandhi National Park during 2010. This is a Western Ghat endemic species spotted from Coorg (Moore, 1883), Lonavla (Beans, 1965), Chiplun (Kunte et al. 2011) and by me. The last record is the northernmost limit of species recorded. Phansad lies south of this limit hence there is a probability of existence of this species.

Double Banded Crow *Euploea Sylvester* (Fabricius, 1857)

Pale Four Lineblue *Nacaduba hermus* (C. Felder)

Transparent Six Lineblue *Nacaduba kurava* (Moore, 1857)

Orchid Tit *Chilaria othona* (Hewitson, 1865)

Table 1: Family composition of butterflies recorded from Phansad WLS

	Family	No. of Species	%	Sub families	VC	C	NC	R	VR
1	Papilionidae	11	7.19	1	1	6	3	1	-
2	Pieridae	17	11.11	2	3	9	1	3	1
3	Lycaenidae	47	30.72	5	5	17	14	8	3
4	Nymphalidae	47	30.72	10	9	19	13	6	-
5	Hesperidae	31	20.26	3	5	10	10	6	-
	Total	**152**	**100**	**21**	**23**	**61**	**41**	**24**	**4**

Table 2: Species composition of butterflies

		Status
I	**Family Papilionidae**	
A	Subfamily Papilioninae	
1	Common Rose *Atrophaneura aristolochiae* (Fabricius, 1775)	C
2	Crimson Rose *Atrophaneura hector* (Linnaeus, 1758)	NC
3	Common Mime *Chilasa clytia* (Linnaeus, 1758)	NC
4	Lime butterfly *Papilio demoleus* (Linnaeus, 1758)	C
5	Common Mormon *Papilio polytes* (Linnaeus, 1758)	C
6	Red Helen *Papilio helenus* (Linnaeus, 1758)	R

7	Blue Mormon *Papilio polymnestor* (Cramer, 1775)	NC
8	Common Blue Bottle *Graphium sarpedon* (Linnaeus, 1758)	C
9	Common jay *Graphium doson* (C & R Felder, 1864)	C
10	Tailed jay *Graphium agamemnon* (Linnaeus, 1758)	C
11	Spot swordtail *Pathysa nomius* (Esper, 1785-98)	VC
II	Family Pieridae	
A	Subfamily Coliadinae	
1	Common Grass Yellow *Eurema hecabe* (Moore, 1886)	VC
2	Spotless Grass Yellow *Eurema laeta* (Moore, 1906)	C
3	Small Grass Yellow *Eurema brigitta* (Wallace, 1867)	C
4	Common Emigrant *Catopsilia pomona* (Fabricius, 1775)	C
5	Mottled Emigrant *Catopsilia pyranthe* (Linnaeus, 1758)	C
B	Subfamily Pierinae	
6	Common Jezebel *Delias eucharis* (Drury, 1773)	C
7	Psyche *Leptosia nina* (Fabricius, 1793)	VC
8	Common Gull *Cepora nerissa* (Fabricius, 1775)	VC
9	Lesser Gull *Cepora nadina* (Moore, 1857)	C
10	Pioneer *Anaphaeis aurota* (Fabricius, 1793)	R
11	Common Albatross *Appias albina* (Boisduval, 1836)	R
12	Striped Albatross *Appias libythea* (Fabricius, 1775)	R
13	Chocolate Albatross *Appias lyncida* (Boisduval, 1836)	VR
14	White Orange Tip *Ixias marianne* (Cramer, 1779)	NC
15	Yellow Orange Tip *Ixias pyrene* (Butler, 1989)	C
16	Great Orange Tip *Hebomoea glaucippe* (Linnaeus, 1758)	C
17	Common Wanderer *Pareronia valeria* (Fabricius, 1787)	C
III	**Family Lycaenidae**	
A	**Subfamily Miletinae**	
1	Apefly *Spalgis epius* (Westwood, 1852)	R
B	Subfamily Curetinae	
2	Indian Sunbeam *Curetis thetis* (Westwood, 1882)	C
3	Angled Sunbeam *Curetis dentata* (Moore, 1882)	C
C	Subfamily Theclinae	
4	Large Oak blue *Arhopala amantes* (Hewitson, 1862)	NC

5	Western Centaur Oak blue *A. pseudocentaurus* (Doubleday, 1847)	NC
6	Common Acacia blue *Surendra quercetorum* (Moore, 1857)	C
7	Leaf blue *Amblypodia anita* (Hewitson, 1862)	NC
8	Silverstreak blue *Iraota timoleon* (Stoll, 1790)	R
9	Yamfly *Loxura atymnus* (Cramer, 1782)	NC
10	Monkey Puzzle *Rathinda amor* (Fabricius, 1775)	NC
11	Redspot *Zesius chrysomallus* (Hubner, 1819)	VR
12	Peacock Royal *Tajuria cippus* (Fabricius, 1798)	R
13	Tufted White Royal *Pratapa deva* (Moore, 1884)	VR
14	Guava blue *Deudorix isocrates* (Fabricius, 1793)	R
15	Cornelian *Deudorix epijarbas* (Moore, 1858)	R
16	Indian Red Flash *Rapala iarbas* (Fabricius, 1787)	C
17	Indian Slate Flash *Rapala manea* (Moore, 1879)	C
18	Indigo Flash *Rapala varuna* (Hewitson, 1863)	C
19	Common Tinsel *Catapaecilma elegans* (Druce, 1873)	VR
20	Common Silverline *Spindasis vulcanus* (Moore, 1881)	NC
21	Long banded Silverline *Spindasis lohita* (Moore,)	NC
22	Shot Silverline *Spindasis ictis* (Hewitson, 1865)	R
D	**Subfamily Polyomamtinae**	
23	Pointed Cilliate blue *Anthene lycaenina* (R. Felder, 1868)	R
24	Common Pierrot *Castalius rosimon* (Fabricius,1775)	C
25	Angled Pierrot *Caleta caleta*(Hewitson,1876)	NC
26	Rounded Pierrot *Tarucus nara* (Kollar, 1848)	NC
27	Zebra blue *Leptotes plinius* (Fabricius,1793)	C
28	Dark Grass blue *Zizeeria karsandra*(Moore, 1865)	VC
29	Pale Grass blue *Pseudozizeeria maha* (Kollar, 1844)	NC
30	Tiny Grass blue *Zizula hylax* (Fabricius,1775)	C
31	Lesser Grass blue *Zizina otis* (Fabricius,1787)	C
32	Grass Jewel *Chilades putli* (Freyer, 1845)	NC
33	Gram blue *Euchrysops cnejus* (Fabricius, 1798)	VC
34	Pea blue *Lampides boeticus* (Linneaus, 1767)	C
35	Common Cerulean *Jamides celeno* (Cramer, 1775)	VC
36	Dark Cerulean *Jamides bochus* (Stoll, 1782)	C

37	Forget – me –not *Catochrysops strabo* (Fabricius, 1793)	NC
38	Common Line blue *Prosotas nora* (C. Felder, 1860)	C
39	Tailless Line blue *Prosotas dubiosa* (Semper, 1879)	VC
40	Dingy Lineblue Petrelaea dana (de Nicéville, 1883)	R
41	Malayan *Megisba malaya* (Moore, 1879)	C
42	Common Hedge blue *Acytolepis puspa* (Horsfield, 1828)	C
43	Dark Pierrot *Tarucus ananda* (de Nicéville, 1883)	NC
44	Indian Cupid *Everes lacturnus* (Godart, 1824)	NC
45	Plains Cupid *Chilades pandava* (Horsfield, 1892)	C
46	Lime blue *Chilades laius* (Cramer, 1878)	C
E	**Subfamily Riodininae**	
47	Plum Judy *Abisara echerius* (Moore, 1878)	VC
IV	**Family Nymphalidae**	
A	**Subfamily Libytheinae**	
1	Club beak *Libythea myrrha* (Fruhstorfer, 1914)	R
B	Subfamily Danainae	
2	Plain Tiger *Danaus chryssipus* (Linneaus, 1758)	VC
3	Striped Tiger *Danaus genutia* (Cramer, 1779)	VC
4	Blue Tiger *Tirumala limniace* (Butler, 1886)	VC
5	Dark blue Tiger *Tirumala septentrionis* (Butler, 1874)	C
6	Glassy Tiger *Parantica aglea* (Moore, 1883)	VC
7	Common Crow *Euploea core* (Cramer, 1790)	VC
8	Brown king Crow *Euploea klugii* (Moore, 1858)	C
C	Subfamily Charaxinae	
9	Tawny Rajah *Charaxes bernardus* (C. & R.Felder, 1867)	NC
10	Black Rajah *Charaxes solon* (Fabricius, 1781)	R
11	Common Nawab *Polyura athamas* (Drury, 1770)	NC
12	Anomalous Nawab *Polyura agraria* (Swinhoe, 1887)	R
D	**Subfamily Satyrinae**	
13	Common Evening brown *Melanitis leda* (Cramer, 1775)	C
14	Bamboo Tree brown *Lethe europa* (Fruhstorfer, 1911)	NC
15	Common Bush brown *Mycalesis perseus* (Fabricius, 1798)	C
16	Dark brand Bush brown *Mycalesis mineus* (Linnaeus, 1765)	NC

17	Long Brand Bush brown *Mycalesis visala* (Moore, 1858)	C
18	Common Four Ring *Ypthima huebneri* (Kirby, 1871)	NC
19	Common Five Ring *Ypthima baldus* (Fabricius, 1775)	C
20	Common Palmfly Elymnias hypermenstra (Linneaus, 1763)	NC
E	**Subfamily Heliconinae**	
21	Tawny Coaster *Acraea violae* (Horsfield, 1829)	C
22	Common Leopard *Phalanta phalantha* (Drury, 1770)	VC
23	Rustic *Cupha erymanthis* (Drury, 1773)	NC
F	**Subfamily Limenitinae**	
24	Commander *Moduza procris* (Cramer, 1777)	C
25	Color Sergeant *Athyma inara* (Doubleday, 1850)	R
26	Chestnut Streaked Sailer *Neptis jumbah* (Moore, 1857)	C
27	Common Sailer *Neptis hylas* (Moore, 1872)	C
28	Short banded Sailer *Neptis columella* (Cramer, 1780)	NC
29	Common Lascar *Pantoporia hordonia*	NC
30	Grey Count *Tanaecia lepida* (Fruhstorfer, 1913)	R
31	Common Baron *Euthalia aconthea* (Hewitson, 1874)	C
32	Gaudy Baron *Euthalia lubentina* (Cramer, 1777)	NC
33	Baronet *Symphadra nais* (Forster, 1771)	VC
G	**Subfamily Cyrestinae**	
34	Common Map *Cyrestis thyodamas*	R
H	**Subfamily Biblidinae**	
35	Common Castor *Ariadne merione* (Cramer, 1771)	C
36	Angled Castor *Ariadne ariadne* (Linnaeus, 1763)	C
I	**Subfamily Apaturinae**	
37	Black Prince *Rohana parisatis*	NC
J	**Subfamily Nymphalinae**	
38	Painted Lady *Cynthia cardui* (Linnaeus, 1758)	NC
39	Yellow Pansy *Junonia hierta* (Evans, 1923)	NC
40	Blue Pansy *Junonia orithya* (Huebner, 1816)	NC
41	Lemon Pansy *Junonia lemonias* (Linnaeus, 1758)	C
42	Peacock Pansy *Junonia almana* (Linnaeus, 1758)	C
43	Grey Pansy *Junonia atlites* (Johanssen, 1764)	C

44	Chocolate Pansy *Precis iphita* (Cramer, 1779)	C
45	Danaid Eggfly *Hypolimnas missipus* (Linnaeus, 1764)	VC
46	Great Eggfly *Hypolimnas bolina* (Linnaeus, 1758)	VC
47	Blue Oak leaf *Kallima horsfieldi* (Kollar, 1844)	C
V	**Family Hesperiidae**	
A	**Subfamily Coeliadinae**	
1	Brown Awl *Badamia exclamationis* (Fabricius, 1775)	C
2	Plain Banded Awl *Hasora vitta* (Butler, 1870)	C
3	Common Banded Awl *Hasora chromus* (Cramer, 1780)	C
4	Common Awl *Hasora badra* (Moore, 1858)	NC
5	Orange tail Awl *Bibasis sena* (Moore,1865)	R
6	Orange Awlet *Bibasis jaina* (Moore,1866)	R
B	**Subfamily Pyrginae**	
7	Malabar Spotted Flat *Celaenorrhinus ambareesa* (Moore,1866)	VC
8	Common Spotted Flat *Celaenorrhinus leucocera* (Kollar, 1844)	C
9	Tricolored Pied Flat *Coladenia indrani* (Moore,1866)	C
10	Fulvous Pied Flat *Pseudocoladenia dan* (Fabricius, 1787)	NC
11	Common Small Flat *Sarangesa dasahara* (Moore,1866)	NC
12	Spotted Small Flat *Sarangessa purendra* (Moore, 1882)	R
13	Golden Angle *Caprona ransonnetti* (R. Felder, 1868)	VC
14	Angled Flat *Tapena thwaitesi* (Moore, 1881)	NC
15	Indian Skipper *Spialia galba* (Fabricius, 1793)	NC
16	Water Snow Flat *Tagiades litigosa*	R
17	Chestnut Angle Odontoptilum angulata	R
C	**Subfamily Hesperiinae**	
18	Tamil Grass Dart *Taractrocera ceramas* (Hewitson, 1868)	C
19	Dark Palm Dart *Telicota ancilla* (Herrich-Schaeffer, 1869)	C
20	Pale Palm Dart *Telicota colon* (Fabricius, 1775)	C
21	Grass Demon *Udaspes folus* (Cramer, 1775)	VC
22	Common Red Eye *Matapa aria* (Moore, 1866)	C
23	Straight Swift *Parnara guttatus* (Bremer & Grey, 1852)	C
24	Rice Swift *Borbo cinnara* (Wallace, 1866)	VC
25	Small Branded Swift *Pelopidas mathias* (Fabricius, 1798)	NC

26	Great Swift *Pelopidas assamensis* (de Niceville, 1882)	NC
27	Conjoined Swift *Pelopidas conjuncta* (Herrich-Schäffer, 1869)	NC
28	Chestnut Bob *Iambrix salsala* (Moore, 1866)	VC
29	Vindhyan Bob *Arnetta vindhiana* (Moore, 1884)	NC
30	Indian Palm Bob *Suastus gremius* (Fabricius, 1798)	NC
31	Moore's Ace *Halpe porus* (Mabille, 1877)	R

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Insect Biodiversity At Mangrove Ecosystem

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Abstract : A lot of attention being paid to the study of biodiversity has led to increasing interest in assessing the diversity of insects because this group dominates terrestrial and freshwater ecosystems and are valuable indicators of the healthof these ecosystems. Presence of insects in the mangrove ecosystem is of importance because they feed, reproduce on plants and help in pollination. Certain level of natural damage caused by pest insects is of ecological significance in mangrove ecosystem. Study of insect biodiversity is useful in managing the forest resources. The study area selected for this research project is a private land owned by Godrej & Boyce Mfg.Co.Ltd located along the Eastern Express Highway at Vikhroli, Mumbai. This land is covered with mangrove forest. Total eleven sites were selected randomly so as to cover maximum area of mangrove forest. At each site, during low tide, different insects were observed and photographed. Photo-essay of these insects was prepared. Diversity index, evenness index and dominance index was calculated. As per the results, Shannon index is 0.4, Simphon's diversity index is 0.93 and evenness index is 0.1. Species richness index is 1.94**.** The result shows that the study location being in the industrial area of Mumbai, the insect diversity is less but there is a natural balance of damage and reproduction. The present research paper highlights the need of conservation of floral and faunal biodiversity to preserve the natural balance of the ecosystem.

Key words **:** Mangrove ecosystem, Insect biodiversity, diversity index, evenness index, dominance index, Godrej Company

Introduction

Mangrove conservation is very important as they are extremely productive ecosystems. Because mangroves occupy the intertidal zone, they interact strongly with aquatic, inshore, upstream and terrestrial ecosystems and in this way mangroves help to support a diverse flora and fauna of marine, freshwater and terrestrial species (Donald J. Macintosh and Elizabeth C. Ashton, 2002). Mangrove species diversity is well known for the larger animals and plants, but poorly known for micro-organisms and insects. Study of its insect biodiversity can help in determining its potential productivity and in better management of mangroves. Insects can be either harmful like pest insects which are to be managed or beneficial like honeybees which can be helpful in gaining economical productivity. They play a very important role in ecology of mangrove ecosystem. Insects, can be either permanent residents or temporary visitors of mangrove environment (Macintosh & Ashton 2002). Hence they provide linkage between mangrove ecosystem and other ecosystems. There are herbivores that feed on leaves, flowers, seeds or mangrove propagules; detritivores that eat dead wood or decaying leaves; more general foragers and predators. Some insects play crucial roles as pollinators and all in turn represent a major food source for predators. Study of insects is done to maintain an indigenous plant in a healthy state under local conditions. One needs to know what level of natural damage is normal. Insects are rarely severely damaging to a healthy host but respond rapidly to declining resistance. Significant changes may well indicate stress from pollution or deteriorating soil or water regime, perhaps in time to take corrective action. Measures of species diversity are important, as their stability over (long) periods of time are frequently seen as indicators of the well-being of ecological systems.

In studies related to mangrove insect biodiversity, numerous butterfly and moth species have been undertaken. Termites are an important component of the fauna but little is known about them. They burrow inside the trunks and branches of mangrove trees and maybe very important in breaking down dead wood. Ants are often abundant in the mangrove tree canopy suggesting their ecological significance but again not much is known about ants. Mosquitoes are often incredibly numerous and the degree of abundance is exceptional (Macne, 1968). They are often a nuisance because of their biting of humans but also because they can be vectors of diseases such as malaria and yellow fever (Macintosh & Ashton 2002). This has often been a reason for mangroves to be regarded as wastelands. For this resource to be conserved and managed much more research is needed.

Mangroves at Godrej

Although Mangroves along the Mumbai coastline are vanishing, a stretch of 1,750 acres of mangroves preserved by the Godrej Company continues to flourish. The vast mangroves of Pirojshanagar include over 16 species of mangroves and their sub-varieties. The Soonabai Pirojsha Godrej Marine Ecology Centre and Mangrove Interpretation Center works towards caring for these mangroves. The center

also conducts programmes for mangrove preservation like regular monitoring to keep a check on miscreants and protecting rare species of fauna, raising nurseries and through artificial regeneration.

Study Area: The study area selected for this research project is a private land owned by Godrej & Boyce Mfg.Co.Ltd located along the Eastern Express Highway at Vikhroli, Mumbai. This land is covered with mangrove forest that is being maintained by The Godrej for the past 65 years. The Western bank of the Thane Creek is the single largest mangrove belt in Mumbai. A substantial tract of mangrove land is adjoining the Godrej & Boyce township, Pirojshanagar, in Vikhroli a suburb of Mumbai..

Materials and methods

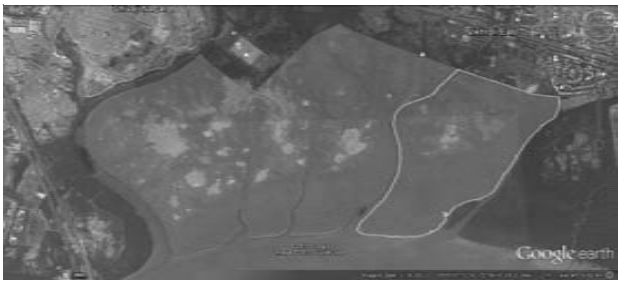
Mapping: GIS mapping of mangroves near Godrej area was studied and 11 locations were decided for field work to carry out the study at the periphery of mangrove patches.

Field visits: field visits were taken every day for 11 days (one day for 11Location) in summer season, at the time of low tide.

Data collection: Data collection was done by taking the photographs of insects and noting down on which plant which insect was observed.

Identification: Identification was done by using Google images and field guides such as insect in colour by N.D.Riley .GPS Location

North	East	South	West
$19^{0}06'52.31s"N$	$19^{0}5'08.00s"N$	$19^{0}03'34.44s"N$	$19^{0}05'23.05s"N$
$72^{0}56'32.71s"E$	$72^{0}57'27.57s"E$	$72^{0}56'27.78s"E$	$72^{0}55'46.94s"E$



Result and discussion

Table1: Insect diversity

Insects / Site	1	2	3	4	5	6	7	8	9	10	11	n_i
Pseudococcidae(Mealy bugs)	8	3		5	10	20	5	8	5	15	5	**84**
Attacephalotes(Leaf cutter ant)	7	6		5	5	5	5	15	8	6		**62**
Luciliasericata (Metallic fly)	1							4		3		**8**
Muscadomestica(Housefly)	1			1			1	1	1	1	2	**8**
Adisegipty(Dengue mosquito)	5			4	15			3			2	**29**
Lasiusniger (Common blackants)	2			5								**7**
Camponotouspennysylvanicus (Black carpenter ant)		1				1					1	**3**
Apisindica(honey bee)		4		6			10		5	2		**27**
Xylocopaviolacea(Carpenter bee)		1		1								**2**
Hymnoptychissordid (Pneumatophore moth)								1	7	10		**18**
Cicadellaviridis(hopper bug)		1	1									**2**

Anisoptera (Dragonfly)		4		2			4		1		3	**14**
Diptera(Dipterian fly spp 1)				1		1		2				**4**
Diptera(Dipterian fly spp 2)							1	2			1	**4**
Diptera(Dipterian fly spp 3)								1	1			**2**
Diptera(Dipterian fly spp 4)											1	**1**
Diptera(Dipterian fly spp 5)											1	**1**
Gryllidae(Cricket)				1								**1**
Eristalinussyrphidae (Hoverfly)					1					1	1	**3**
Nabissp(Damsel bug)					1							**1**
Micropezidae(Ichneumon wasp)					1							**1**
Harmoniaaxyridis (Ladybird beetle)						1					1	**2**
Pseudomyrmexferrugine (Pagoda ant)	1	1		1		1	1				1	**6**
Formica (Wood ants)						5						**5**
Euremahecabe(Small grass yellow butterfly)							1	1				**2**
Phalantaphalanta (Common leopard butterfly)							1					**1**
Tabanidae (Horsefly)							2	1				**3**
Colotisamata(Small Salmonarab)				15							10	**25**
1. Eggs												
2. Caterpillar	10											**10**
3. Adult	4						1		1		5	**11**
Aphisfabae(Red aphids)										3		**3**
Xylosandruscrassiusculus	1							1		1		**3**
(Wood boaring beetle)												
Aleurocanthuswoglumi(Blackfly)										45		**45**
Eumenesfraternus (Potter wasp)											1	**1**
Lymantria (Tussock moth pupa)								1				**1**
Mantodea(Praying mantis)											1	**1**
Danauschrysippus (Plain tiger butterfly)							1					**1**
Chrysomelidaebruchinae									2			**2**

Table 2 : Diversity indices

Insect / Site	n_i	Pi= n_i/N	ln Pi	H= $\Sigma pi*lnpi$	D= $\Sigma(pi)^2$	E= H/logS	D=s/N
Pseudococcidae(Mealy bugs)	84	0.2	1.6	0.125	0.04		
Attacephalotes(Leaf cutter ant)	62	0.15	1.89	0.079365079	0.0225		
Luciliasericata (Metallic fly)	8	0.019	3.96	0.00479798	0.000361		
Muscadomestica(Housefly)	8	0.019	3.96	0.00479798	0.000361		
Adisegipty(Dengue mosquito)	29	0.07	2.65	0.026415094	0.0049		
Lasiusniger (Common blackants)	7	0.017	4.07	0.004176904	0.000289		
Camponotouspennysylvanicus (Black carpenter ant)	3	0.007	4.96	0.00141129	0.000049		
Apisindica(honey bee)	27	0.066	2.71	0.024354244	0.004356		
Xylocopaviolacea(Carpenter bee)	2	0.004	5.29	0.000926276	0.00002401		
Hymnoptychissordid (Pneumatophore moth)	18	0.04	3.21	0.012461059	0.0016		
Cicadellaviridis(hopper bug)	2	0.0049	5.29	0.000926276	0.00002401		
Anisoptera (Dragonfly)	14	0.034	3.38	0.010059172	0.001156		
Diptera(Dipterian fly spp 1)	4	0.0098	4.62	0.002121212	0.00009604		
Diptera(Dipterian fly spp 2)	4	0.0098	4.62	0.002121212	0.00009604		
Diptera(Dipterian fly spp 3)	2	0.0049	5.29	0.000926276	0.00002401		
Diptera(Dipterian fly spp 4)	1	0.0024	6.03	0.00039801	0.00000576		
Diptera(Dipterian fly spp 5)	1	0.0024	6.03	0.00039801	0.00000576		
Gryllidae(Cricket)	1	0.0024	6.03	0.00039801	0.00000576		
Eristalinussyrphidae (Hoverfly)	3	0.007	4.96	0.00141129	0.000049		
Nabissp(Damsel bug)	1	0.0024	6.03	0.00039801	0.00000576		
Micropezidae(Ichneumon wasp)	1	0.0024	6.03	0.00039801	0.00000576		
Harmoniaaxyridis (Ladybird beetle)	2	0.0049	5.29	0.000926276	0.00002401		
Pseudomyrmexferrugine (Pagoda ant)	6	0.014	4.26	0.003286385	0.000196		
Formica (Wood ants)	5	0.012	4.42	0.002714932	0.000144		
Euremahecabe (Small grass yellow butterfly)	2	0.0049	5.29	0.000926276	0.00002401		
Phalantaphalanta (Common leopard butterfly)	1	0.0024	6.03	0.00039801	0.00000576		
Tabanidae (Horsefly)	3	0.007	4.96	0.00141129	0.000049		
Colotisamata(Small Salmonarab) 1. Eggs	25	0.061	2.79	0.021863799	0.003721		
2. Caterpillar	10	0.024	3.72	0.006451613	0.000576		
3. Adult	11	0.027	3.61	0.007479224	0.000729		
Aphisfabae(Red aphids)	3	0.007	4.96	0.00141129	0.000049		
Xylosandruscrassiusculus (Wood boaringbeetle)	3	0.007	4.96	0.00141129	0.000049		

Aleurocanthuswoglumi(Blackfly)	45	0.11	2.2	0.05	0.0121		
Eumenesfraternus (Potter wasp)	1	0.0024	6.03	0.00039801	0.00000576		
Lymantria (Tussock moth pupa)	1	0.0024	6.03	0.00039801	0.00000576		
Mantodea(Praying mantis)	1	0.0049	5.29	0.000926276	0.00002401		
Danauschrysippus (Plain tiger butterfly)	1	0.0024	6.03	0.00039801	0.00000576		
Chrysomelidaebruchinae	2	0.0049	5.29	0.000926276	0.00002401		
	N=405			**H= 0.40**	**D= 0.93**	**E=0.1**	**d=1.94**

Discussions:

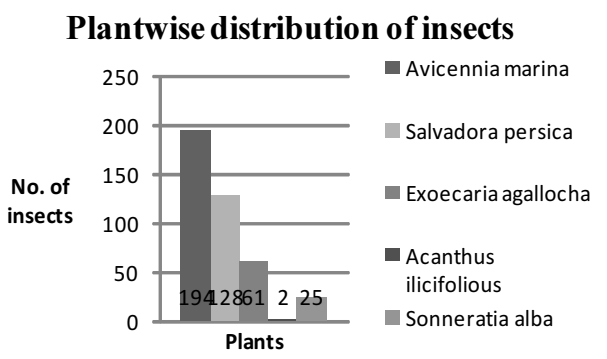
1. Shannon index (H) is a measure of diversity of community. According to the calculations, Shannon index is equal to 0.4. This shows that insect community is less diverse. During field visits, similar types of insects were found at each location.

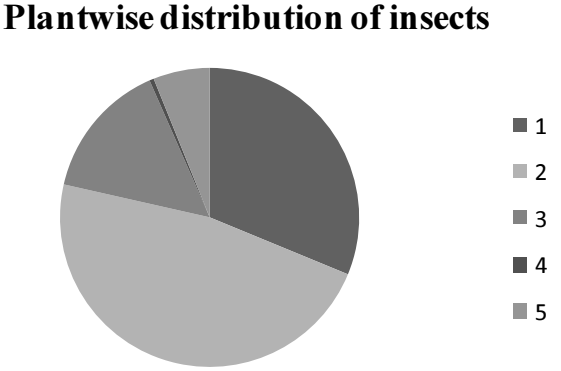
2. Simpson's dominance index (D) provides measure of diversity which takes into account both richness and evenness. Simpson's Index (D) is an index of dominance whose maximum value is one which is obtained in case of single species dominating a given area. Near zero values are obtained when numerous species are present (no dominance). Here, Relative abundance of Mealy bugs is 0.2 (which is maximum) followed by that of leaf cutter. For most of the species relative abundance is less than 0.05. This shows that mealy bugs were dominant and most of the trees are infested by it.

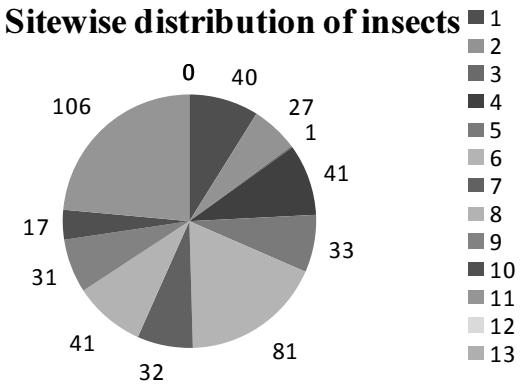
3. Eveness index (E) provides information about distribution i. e. whether the distribution is patchy or even. It is a measure of relative abundance of the different species making up the richness of an area. According to the results that are obtained, evenness index is equal to 0.1.

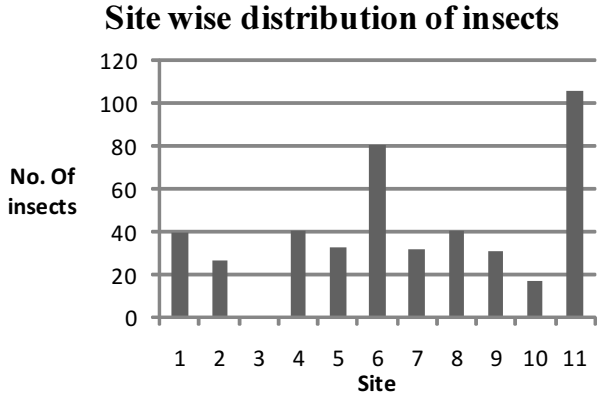
   This shows that distribution is not even. At one site (site 3), there was not a single insect. While at station 10 there were maximum population of insects. Here, black citrus flies (45 in number) were maximum in numbers which were not found previously on any station.

4. Species richness index (d) shows high diversity of species. Richness is a measure of different kind of organisms present in a particular area. Species richness is found to be 1.94. That means, species are rich in diversity. Many pest insects were found in this mangrove ecosystem. Mealy bugs were the most dominant species. At one sites (Canal site) almost whole plant of apple mangrove was affected by mealy bug. There were many bumble bees, honey bees and dipterian flies which are required for pollination. Most affected plant was *Salvadora persica.*









Conclusion

113 species of insects were recorded from Muthupet mangroves. Insects belonging to 11 families of Lepidoptera and 14 families of Coleoptera were dominant (Rahaman, 2002) Season in which these observations are taken is not stated in the research paper. Dominance of Lepidopterans was also observed in Pichavaram mangroves, Cuddalore District, Tamil Nadu (Senthil, 1992).

Most abundant insects in the salt marsh are the Dipteraand Homoptera, Coleoptera, Orthoptera, Lepidoptera, Hemiptera, Hymenoptera, and Odonata respectively.

According to the species richness index, the diversity is also good. However, Mangrove ecosystem of Godrej Company is protected from human interference in naturally maintained ecosystem. This mangrove ecosystem has pest species as well as beneficial species. Therefore we can say that there is a natural balance of damage and reproduction. But being in the industrial area of Godrej, there are chances of pollution. Also, there are dumping grounds in Kanjurmarg area which are nearer to jetty area (site showing least insect number). This may be the cause of water pollution which ultimately pollutes the soil and affects growth of insect species.

We sampled the area for the period of less than one month during summer season.We feel that our visits were less as compared to those required for insect diversity studies. Rainy season is considered as best season for insect study.Therefore there is a possibility of getting more diversity of insect if the study is done during the monsoon season and study time is increased.

Insect diversity in mangrove ecosystem is difficult to undertake because of the marshy conditions as well as there are several reasons for getting low insect biodiversity.

Only few insects have been able to invade habitats characterized by high salinities or tidal influences (Merrit and Cummins 1996), both of which are typical of salt marshes. Two common explanations include inability to deal with the high osmoregulatory stress and competition with other invertebrates.

Suggestions and recommendations

Following things can be done to protect biodiversity:

1. Amateurs can help also by telling non-entomologists how important it is to conserve insect habitats throughout the landscape.
2. Nature Trails can be arranged specially for showing insect biodiversity.
3. Further study needed to be done on insect biodiversity for a longer period of time.

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Recent study on butterfly diversity at Jnandweepa, V.P.M. campus, Thane, Maharashtra

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Abstract : Thane, a sister city of Mumbai, shows variety of ecosystems that provides suitable habitat for diverse fauna. The study area, "Jnandweepa" (college campus) is located on the edge of thane creek with mangroves on the periphery and well maintained garden with variety of plants species in 13.5 acre area providing natural habitat for biodiversity. In the present study, diversity of butterflies and their resources such as food plants within the college campus were studied. 52 species of butterflies were recorded with Nymphalideae showing dominance over other 4 families with 22 species, followed by Pierideae and Lycinideae with 10 species each, Papilionideae with 7 and Hespirideae with 3 species. The survey of plants showed around 30 species of larval food plants which justifies the diversity of butterflies. The survey also recorded some uncommon species such as Black Rajah and Common Palmfly in the campus which were not found in the earlier reports. Their presence can be attributed to newly introduced plant species during horticultural and gardening activities.

Key words **:** "Jnandweepa", Biological indicators, Larval food Plants,

Introduction

Insects are the dominant group of organisms on earth in terms of both taxonomic diversity (50% of all described species) and ecological function (*Wilson E.O., 1992*). Insects represent the vast majority species in almost all types of ecosystems. Among insects, butterflies have proved to be invaluable flagship species for conservation (*Thomas, 2005*). Butterflies are those members of class Insecta which are not only known for adaptability to habitats but also for magnificent colours and patterns on their wings. India presents extremely diverse terrain, climate and vegetation owing to which, there is tremendous diversity of flora and fauna. India hosts about 1,501 butterfly species, 350 in peninsular India and 333 in the Western Ghats alone (*Gaonkar H. 1996*), from 5 different families, viz., Papilionideae, Pierrideae, Lycinideae, Nymphalideae and Hesperideae. Butterflies being very sensitive towards any type of change in their habitat are considered as excellent Biological Indicators (*Parmesan et al. 1999*). Thus, the butterfly diversity portrays good picture of ecological status of an area.

Study Area

The current study deals with the diversity of butterflies in Vidya Prasarak Mandal's Jnandweep campus, Thane, Maharashtra. Thane city is surrounded by Yeoor hills and Parsik hills. It is also called as Lake City due to the presence of many fresh water lakes. Thane shows such variation in landforms that provides suitable habitat for vast and interesting biodiversity.

Study area is located on the bank of the Thane Creek and at an elevation of 7 m MSL. The campus is unique because of its proximity to the Thane creek on one end and a well maintained garden in the interiors. The study area is thus juxtaposed to mangrove swamps which are characterized by species like *Avicennia marina* and *Avicennia officinalis,* mangrove associates like *Salvadora persica, Acanthophora spp.* etc.

Presence of food plants for butterflies acts as an ideal base for flourishing these beautiful insects in the 13.5 acre campus. The campus has mangrove ecosystem and terrestrial ecosystem in close vicinity to each other. The availability of sufficient irrigation water also adds to floral diversity of this area.

Material and Methods:

The garden pathway known as "Jnanpath" (Knowledge Path) of around 750 m which runs along the campus periphery was trailed to record the diversity of butterflies. All Out Search sampling strategy was adopted for the study and every species encountered during the survey was recorded along with activity and nectar/food plant species, if observed nectaring or egg lying.

Identification of the butterfly species on field was confirmed with the help of identification keys, such as Haribal, 2003, Kunte, 2008 and with photographs captured time to time. Identification of plant species was carried out using available literature (*Ingalhallikar, 2009*).

Opportunistic sampling events encountered elsewhere in the campus (other than "Jnanpath") were also recorded and considered for the study. The study was carried out from November 2012 to October 2013.

Results and Discussion

The study has focused on collecting fundamental

information on change in diversity of butterfly and their resources such as larval food plants within the college campus. The diversity and abundance of species is highly correlated with the availability of food plants in the surroundings (*Kunte, 2000*). The variety of food plants documented at the study location in fairly good.

Similar study has been carried out in 2002-03 (*Kurve and Pejaver, 2004*), in 2005 (*Kurve and Patwardhan*, 2005) and in 2008 (*Patwardhan and Kurve*, 2008) on the same campus. In the present study, change in the diversity over a period of almost 10 years, was assessed for comparative aspect.

During the survey 52 species were recorded. Their family wise distribution is represented in Table: 1. Previous studies of 2002-03, 2005 and 2008 have revealed 41 species, 48 species and 56 species respectively from 5 different families.

In the present study, 52 species of butterflies were identified from 5 families. Butterflies from family Nymphalideae showed maximum species diversity dominance with 22 species followed by family Pierideae and Lycinideae both represented by 10 species each. 7 species belonging to the family Pappilionideae were seen and the least number of species 3 were recorded from the family Hesperideae (Fig: 1 and Table: 1).

When a survey of the food plants was conducted, it was seen that maximum species belonging to the family Caesalpinae followed by Malvaceae. There were 27 species of food plants in the campus which accounts for the diversity of butterflies. The common plants like *Ficus spp. Cocos nucifera* among many others flourished at many places within the campus. Monsoon allows a variety of herbaceous food plants to grow abundantly. Food plants include *Polyalthia longifolia, Michelia champaka, Citrus spp. Bryophyllum spp.* among many others. The nectar plant species include *Lantana camara, Tridax spp, Verbina spp, Vernonia spp*.

Recent developments like gardening and horticultural activities have also added to the flora of the college campus. Few of these plants are food plants of butterflies. For example, horticultural palm species and Coconut trees are food plants for larvae of Common Palmfly. This butterfly was commonly seen in College campus during present study; which was absent during previous studies. Yet, the decline in diversity of butterfly species could be due to infrastructural development in the campus.

Black rajah (regarded as 'Not Rare' by Evans (1932) and Wynter Blyth (1957)), was regularly recorded in campus probably because of the presence of the food plant, *Tamarindus indicus* in campus. It was also frequently observed on ripe pods of *Cassia fistula.*

However; as the maximum number of species of butterflies found in the study area belong to the family Nymphalidae whose food plants generally belong to the family Acanthaceae (*Kunte, 2008*). The observation shows that, though the number of plant species belonging to family Caesalpinae is high the abundance of the species from the family Acanthaceae is better. This justifies the higher occurrence of butterfly species from family Nymphalideae.

Table: 1. Family wise distribution of Butterfly species in college campus

Sr No.	Papilionideae	Pierideae	Lycinideae	Nymphalideae	Hespirideae
1	Tailed jay	Common grass yellow	Common cerulean	Peacock pansy	Grass demon
2	Common Jay	Common jezebel	Common pierrot	Grey pansy	Indian skipper
3	Common Bluebottle	Common emigrant	Red pierrot	Lemon pansy	Swift
4	Lime	Psyche	Tiny grass blue	Chocolate pansy	---
5	Common Mormon	Salmon arab	Gram blue	Black rajah	---
6	Blue Mormon	Yellow orange tip	Indian sunbeam	Common leopard	---
7	Common rose	White orange tip	Dark cerulean	Great eggfly	---
8	---	Mottled emigrant	Hedge blue	Danaid eggfly	---
9	---	Common wanderer	Oriental plain cupid	Common sailer	---
10	---	Common albatros	Indian cupid	Painted lady	---

11		---	---	---	Common castor	---
12		---	---	---	Angled castor	---
13		---	---	---	Common baron	---
14		---	---	---	Common crow	---
15		---	---	---	Plain tiger	---
16		---	---	---	Blue tiger	---
17		---	---	---	Striped tiger	---
18		---	---	---	Common evening brown	---
19		---	---	---	Palm fly	---
20		---	---	---	Baronet	---
21		---	---	---	Tawny Coster	---
22		---	---	---	Commander	---

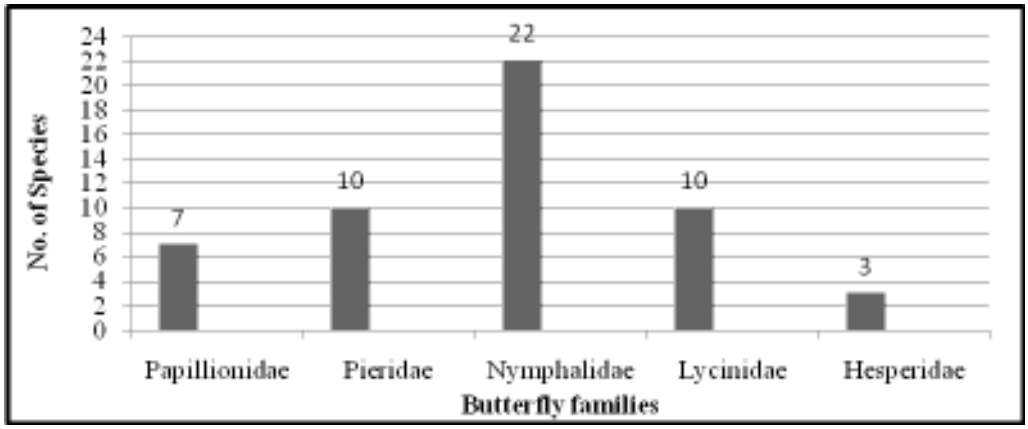

Fig: 1

Table: 2 List of food plants in campus

Sr No	Plant species	Family	Food Plant
1	*Ancardium occidentale*	Anacardiaceae	Common Barron
2	*Annona squamosa*	Annonaceae	Common Jay, Tailed Jay
3	*Aristolochia indica*	Aristolochiaceae	Common Rose
4	*Bombax ceiba*	Bombaceae	Common Sailer
5	*Bryophyllum spp.*	Euphorbiaceae	Red pierot
6	*Caesalpinea spp.*	Caesalpiniaceae	Common grass yellow
7	*Calotropis gigantea*	Asclepiadeacea	Blue tiger, Plain Tiger
8	*Camara lantana*	Verbenaceae	Tiny Grass blue
9	*Cassia fistula*	Leguminosae	Common Emigrant, Mottled emigrant Common grass yellow
10	*Cassia siamia*	Leguminosae	Common Emigrant
11	*Cassia tora*	Leguminosae	Common Emigrant, Mottled emigrant, Common grass yellow

12	*Citrus spp.*	Rutaceae	Lime, Common Mormon
13	*Ficus racemosa*	Moraceae	Common Indian Crow
14	*Hibiscus spp*	Malvaceae	Danid eggfly, Indian Skipper
15	*Mangifera indica*	Anacardiaceae	Common Barron
16	*Michelia champaka*	Magnoliaceae	Common Jay, Tailed Jay
17	*Nerium indicum*	Euphorbiaceae	Common crow
18	*Passiflora spp.*	Passifloraceae	Tawny Coster
19	*Polyalthia longifolia*	Annonaceae	Common Bluebottle, Tailed jay
20	*Ricinus communis*	Euphorbiaceae	Common Castor, Angled Castor
21	*Rosa spp.*	Rosaceae	Common Barron
22	*Salvadora persica*	Salvadoraceae	Salmon arab
23	*Saraca asoca*	Annonaceae	Common Cerulean
24	*Sida Spp.*	Malvaceae	Lemon Pansy, Indian Skipper
25	*Vigna spp.*	Fabaceae	Common Sailer, Gram Blue
26	*Zornia spp.*	Fabaceae	Painted Lady
27	*Coccos rucifera*	Palmae	Common Palmfly

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Ant Diversity in an urban garden at Mumbai, Maharashtra

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Abstract : Ants are considered as one of the most diverse, abundant and ecologically significant organisms on earth. The parks, gardens and small patches of natural vegetation provide suitable environment for ecological communities in urban habitats, like Mumbai. The diversity of ants (Hymenoptera) was studied in 2010-2012, at Maharashtra Nature Park Society (MNPS), Mumbai. During the present study, 28 species of ants representing six subfamilies- Aenictinae, Dolichoderinae, Formicinae, Myrmicinae, Ponerinae and Pseudomyrmicinae were recorded. The highest diversity was exhibited by the subfamily Myrmicinae with eleven ant species represented by seven genera. The ants belonging to *Crematogaster spp.* exhibited the highest diversity, represented by four species. This was followed by Formicinae with 28% contribution and represented by six genera and eight species including the invasive ants, Black crazy ants, Red Fire Ants and Yellow crazy ants. Ten ant species were commonly observed at Maharashtra Nature Park, four species of Myrmicinae, four of Formicinae and one each from Dolichoderinae and Pseudomyrmicinae.

Common occurrence of *Tetraponera rufonigra* (Family: Pseudomyrmicinae), an arboreal species, at Maharashtra Nature Park indicated availability of suitable trees providing microhabitats for the species at this site. Two species of *Diacamma* and two species of *Leptogenys* (Family: Ponerinae) were occasionally recorded at Maharashtra Nature Park. These are predator species indicating availability of prey organisms at this site.

Key words **:** Ant species, distribution, classification, urbanization, disturbance gradient, indicator species.

Introduction

Biodiversity deals with the life of different living organisms on the planet earth, their homes or habitats, and the systems that support them. It also deals with the complex interaction and interdependence on each other. Under the current scenario of biodiversity loss, and in order to preserve it, it is essential to achieve a deep understanding on all the aspects related to the biological interactions, including their functioning and significance.

According to Quadros *et al.,* (2009), the studies of biodiversity have now assumed greater significance as ecologists try desperately to document global biodiversity in the face of unprecedented perturbations, habitat loss and extinction rates. Biodiversity is intrinsically valuable as a means of improving our understanding of the structure and functioning of ecological communities (McArthur and Kitchen, 2007).

The fauna forms an important aspect in biodiversity studies and mainly comprises of invertebrates and vertebrates. Invertebrates are the most successful and prolific animals on the planet. Among invertebrates, insects are the most numerous and diverse organisms on Earth. Moreover, because many insects are highly mobile, their presence in an ecosystem may be temporary, thus reducing the ability of biological monitoring to detect changes. Being less transient, many researchers have turned using ants (Hymenoptera: Formicidae) and ant functional groups as bioindicators (Andersen, 1997; Stephens and Wagner, 2006; Underwood and Fisher, 2006; Majer *et al.,* 2007, Fagan *et al.,* 2010, Gomez and Abril, 2011).

Overall literature survey indicates that, there exists extensive research on several aspects of insect diversity with more emphasis on the Lepidopterans, beetles of household compost vegetation of Maharashtra. There is a neglect to Myrmecology i.e. the study of ants in and around Mumbai. Hence the present study to document the diversity of ants is undertaken. The sampling area selected was Maharashtra Nature Park Society, Sion, Mumbai

Material and Methods

Maharashtra Nature Park Society **(Latitude 19° 02'N; longitude 72° 48'E) is 15 hectare (37 acres) manmade park on garbage dump** resembling a mini forest. This vegetated area provides suitable environment for ecological communities in urban habitats, like Mumbai. Insects can be effectively used to assess biodiversity status of these ecosystems.

The study transect approximately measured about 1023 feet. This area is characterized with number of trees and human influence due to the park visitors. Hand picking method was employed for the collection of specimens because it is less labour intensive, does not involve time consuming placement of pitfall traps and can be safely used in too wet or with heavy disturbance activities. Ellison *et al.,* (2007), has discussed comparisons of sampling efficiency by hand collecting accumulates species more efficiently than other commonly used pitfall traps or baits. Sampling was done in premonsoon, monsoon and post monsoon periods

from December 2010 to January 2012 of morning as well as later afternoons. 5 samples of each ant were collected using gloves and were transferred to vials with 70% ethyl alcohol and glycerol for preservation. Forceps and brush were used for collection. These specimens were mounted using standard procedure for identification using light microscope as well as compound microscope in the laboratory. The individuals were identified up to species level, using Narendra and Kumar, (2006) and Tiwari, (1998). Ant Web was used for confirmation of species.

The ant nests in the study transect were recorded by observing nest entries and movements. Nests were categorized as suggested by Amarasinghe (2010). The flora of the study site was identified with help of botanists, and using keys, Cook (1967) and Randhawa (2004).

Observation

During the study, twenty eight ant species were recorded in Maharashtra Nature Park represented in the following Table 1.

Table 1. List of ant species recorded

Sr No	Common name	*Scientific name*	Occurrence	Premonsoon	Monsoon	Postmonsoon
1	Lesser Army ants (Aenictinae)	*Aenictus ceylonicus*	Occasional	+	-	-
2	Odour ant (Dolichoderinae)	*Tapinoma melanocephalum*	Common	+	+	+
3	White footed ghost ant (Dolichoderinae)	*Technomyrmex albipes*	Occasional	+	-	-
4	Common. Godzilla ant (Formicinae)	*Camponotus compressus*	Common	+	+	+
5	Golden backed ant (Formicinae)	*Camponotus sericeus*	Seasonal	+	-	+
6	Pentagonal ant (Formicinae)	*Lepisiota frauenfeldi*	Occasional	+	-	-
7	Red antler ant (Formicinae)	*Lepisiota opaca*	Occasional	-	-	+
8	Common. Bullhorn ant (Formicinae)	*Polyrhachis lacteipennis*	Seasonal	+	-	+
9	Black crazy ant (Formicinae)	*Paratrechina longicornis*	Common	+	+	+
10	Yellow crazy ant (Formicinae)	*Anoplolepis gracilipes*	Common	+	+	+
11	Weaver ants (Formicinae)	*Oecophylla smaragdina*	Common	+	+	+
12	Tetramorium species (Myrmicinae)	*Tetramorium bicarinatum*	Occasional	+	-	-
13	Miniscule house ant (Myrmicinae)	*Tetramorium smithi*	Occasional	+	-	-
14	Red fire ant (Myrmicinae)	*Solenopsis geminata*	Common	+	+	+
15	Glossy slender acrobat ant (Myrmicinae)	*Crematogaster ransonneti*	Seasonal	-	+	+
16	*Crematogaster sp* (Myrmicinae)	*Crematogaster sp 1*	Occasional	+	-	-
17	Common. Broad acrobat ant (Myrmicinae)	*Crematogaster subnuda*	Common	+	+	+
18	Crematogaster species (Myrmicinae)	*Crematogaster rothneyi*	Occasional	+	-	-
19	Silky shield ant (Myrmicinae)	*Meranoplus bicolor*	Seasonal	+	-	+

19	Silky shield ant (Myrmicinae)	*Meranoplus bicolor*	Seasonal	+	-	+
20	Pharaoh ant (Myrmicinae)	*Monomorium pharaonis*	Seasonal	+	+	-
21	Spiny harvester ant (Myrmicinae)	*Pheidole watsoni*	Common	+	+	+
22	Deceptive. Serrated ant (Myrmicinae)	*Cataulacus taprobanae*	Common	+	+	+
23	Diacamma species (Ponerinae)	*Diacamma ceylonense*	Seasonal	+	-	+
24	Lesser striated bispinous ant (Ponerinae)	*Diacamma rugosum*	Seasonal	+	-	+
25	Procession ant (Ponerinae)	*Leptogenys processionalis*	Seasonal	+	+	-
26	Slender jawed sail ant (Ponerinae)	*Leptogenys chinensis*	Seasonal	+	-	+
27	Shy spineless bark ant (Ponerinae)	*Platythyrei sagei*	Occasional	+	-	-
28	Arboreal bicoloured ant (Pseudomyrmicinae)	*Tetraponera rufonigra*	Common	+	+	+
				26	13	18

Table 1. The above table indicates seasonal data, where (+) indicates presence of ants while (-) indicates absence of ants.

Table 2. Percentage contribution of various subfamilies

Subfamily	Species	Percentage (%)
Myrmicinae	11	39.28
Formicinae	8	28.57
Ponerinae	5	17.85
Dolichoderinae	2	7.14
Aenictinae	1	3.58
Pseudomyrmicinae	1	3.58

The nests observed were classified based on the location using the key described by Amarasinghe (2010).

1] Subterranean nests (S) – Cone or mound,

2] Arboreal nests (A) – Made with leaves among living tree

3] Lignicolous (LG) – Constructed in or outside stems of living plants and among dead decaying leaf litter.

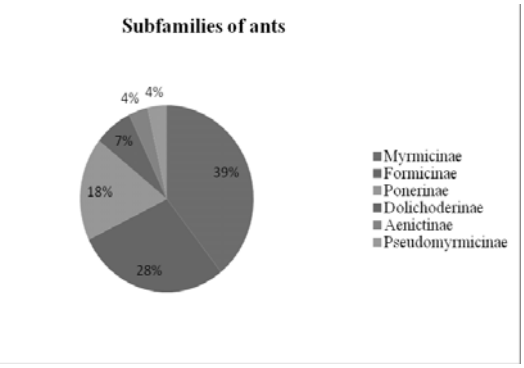
Paratrechina longicornis, Tapinoma melanocephalum, Cataulacus taprobanae, Crematogaster subnuda species were observed with arboreal nesting. *Solenopsis geminata, Pheidole watsoni* followed Subterranean nesting, while lignicolous nesting was seen in *Tetraponera rufonigra, Meranoplus bicolour, Camponotus compressus*. These were found in association with different plants, the plants diversity in MNPS is found to be varied and rich with 59 species of trees in the study area.

Result And Discussion

During the present study, we recorded 28 species of ants representing six subfamilies- Aenictinae, Dolichoderinae, Formicinae, Myrmicinae, Ponerinae and Pseudomyrmicinae.

The highest diversity was by the subfamily Myrmicinae with eleven ant species represented by seven genera. The ants belonging to *Crematogaster spp*. exhibited the highest diversity, represented by four species. This was followed by Formicinae with 28% contribution and represented by six genera and eight species including the Invasive ants, Black crazy ants, Red Fire Ants and Yellow crazy ants.

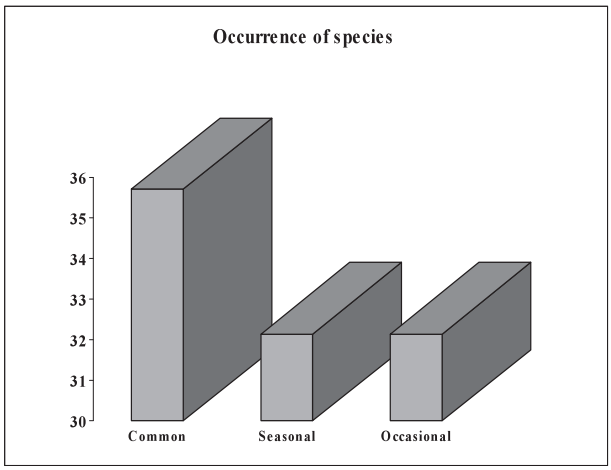
Fig 1.1– Maharashtra Nature Park Society



Dominance of Myrmicinae in terms of diversity was common at Maharashtra Nature Park. Dominance of Myrmicinae at urban sites was also recorded by, Kumar and Mishra (2008) at Vadodara, Barve and Davidar (2008) at Bangalore, Chavhan and Pawar (2011) at Amravati and Bhagat *et al.,* (2008) at IIT Campus, Mumbai.

Occurrence of species: The ant species that were recorded in almost all visits in all the three season, were designated as "common" species, whereas, the species which were recorded in 1 or 2 seasons were considered as "Seasonal" species. The species which were recorded only during one or visits, were considered as "occasional"

Fig 1.2- Occurrence of species (percentage contribution)



Ten ant species were commonly observed at Maharashtra Nature Park, four species of Myrmicinae, four of Formicinae and one each from Dolichoderinae and Pseudomyrmicinae.

It is noteworthy that *Camponotus compressus* (Family: Formicinae) and *Anoplolepis gracilipes* (Family: Formicinae) were the common species. *Camponotus compressus*, is a general predator and is common in variety of habitats including gardens. *Anoplolepis gracilipes* is an invasive species, indicating disturbance in the habitat.

Common occurrence of *Tetraponera rufonigra* (Family: Pseudomyrmicinae), an arboreal species, at Maharashtra Nature Park indicates availability of suitable trees providing microhabitats for the species at these sites. *Lepisiota opaca* rarely occurs in urban region. It can be present only in undisturbed environment. (Narendra and Kumar, 2006). Occassional presence of this species in MNPS is significant.

Two species of *Diacamma* and two species of *Leptogenys* (Family: Ponerinae) were occasionally recorded at Maharashtra Nature Park. These are predator species indicating availability of prey organisms at this site. Three species of *Crematogaster* ants were common in this area. *Crematogaster* species have been reported as being able to tap the high productivity of canopy foliage by feeding on plant and insect exudates (Davidson, 1997) this can be the reason for their common occurrence during the present study.

Nesting: In Maharashtra Nature Park area, nests of nine species were observed. *Tetraponera rufonigra,* the arboreal bicoloured ant is reported to nest in dead wood of trees and posts (Narendra and Kumar, 2006). During this study, it showed lignicolous nests in Maharashtra Nature Park, especially on *Ficus tsiela* species. Similar observations were recorded by Amarasinghe, (2006). Kumar and Mishra (2008), observed its nesting on *Caesalpinia crista* at Vadodara. Few other ant species also showed arboreal nesting. This included *Cataulacus taprobanae* and *Crematogaster species*. *Cataulacus taprobanae* selected *Ficus arnotiana* for its colony at Maharashtra Nature Park, while nesting of *Crematogaster subnuda* was recorded on *Barringtonia.* Narendra and Kumar, (2006) stated that feathers are taken for nests decoration. We observed *Crematogaster sp* as one of the species taking feathers in arboreal nest on *Barringtonia* tree. However, these feathers contrary to the observation of Narendra and Kumar (2006) were not being used for decoration of the nest entrance to act as visual signal; but the feathers were taken inside the nest, the reason is unknown and needs further study.

At Maharashtra Nature Park, various ant species were recorded in association with plants, either in search of food or nesting. This included true arboreal species like *Tetraponera rufonigra* and *Cataulacus taprobanae*, nesting in tree hollows. In addition to this various species of *Crematogaster* ants and generalist species like *Paratrechina longicornis* were also recorded to associate with plants for shelter or feeding purpose. It is noticed that these four species are highly adaptable and are found associated with maximum number of trees.

The study reveals the following salient features of the ants and the study area are noted-

- Higher ant diversity in the urban garden areas with diverse vegetation.
- Better association of ant species with native trees like *Ficus* species.
- Higher ant diversity recorded in premonsoon season.
- Dominance of subfamily Myrmicinae in urban garden area.

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Conserving through composting- the lifecycle study of pest turned partner

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Abstract : Preserving biodiversity through programmes which will engage public policies and communities along with ecosystems will help in conserving biodiversity. Composting is one such activity which safeguards and conditions diversity of decomposing ecosystem that leads to preservation of certain kind of biodiversity in environment. While conducting this study, the infamously labelled agricultural pest, a scarab beetle lived through compost, not only propagating but helping the composting process in its own way. This pest turned partner accelerated the process as well as increased the nutrient value of compost. Thus the present work aims to educate people about understanding this detritus ecosystem as it leads to conservation of environment and ultimately the biodiversity.

Key words **:** Composting, pests, detritus ecosystem, biodiversity conservation

Introduction

Biodiversity is the variety of life in the world or in a particular habitat or ecosystem. We visit forests to appreciate splendid greenery and to study the diversity of thousands of beautiful plants and animal species. As a responsible citizen, we never throw trash in forests or even on road. But the trash that is already present in the forest is seldom observed. Since the natural waste found in forest is biodegradable, nature takes care of it by recycling through composting. Composting consists of detritus material thus there exists a detritus ecosystem (Sagade and Pejaver 2009) which helps cleaning up the environment with its team of scavengers along with aerial, terrestrial, wetland and aquatic ecosystem. The micro-organisms like bacteria, fungi and actinomycetes initiate composting, but along with them many silent participants make this process speed up. Among these is soil macrofauna which affect organic matter transformation directly by the incorporation and redistribution of various materials and indirectly by shaping the microbial community with both constructive (e.g., transport of fungal spores) and destructive means (e.g., selective reduction of viability) (Lavelle et al. 1997; Wolters 2000). During present study, many of such compost assistants were found but one of the beetles which was a compost assistant completed its entire life cycle in the compost. Since composting matter can be considered as a micro ecosystem, it was found essential to study it further and educate masses to look at this ecosystem and understand its diversity.

Materials and methods

Site selection: For present study, household biocompost plant in Thane city was selected. The compost feedstock included biodegradable kitchen waste, household and garden waste. **Collection:** The beetles, their larvae and pupae were handpicked from the different levels/depths of the compost.

Identification: The references and keys used to identify beetles included- A general textbook of entomology by A.D. Imms (Ninth edition) and Fauna of British India by G. J Arrow (1910). The beetle was identified as *Protaetia aurichalcea* (Cetoniinae: Scarabaeidae) using the identification keys.

Rearing: A laboratory culture was raised for beetles as well as their larvae and pupae. Optimum air, temperature and moisture conditions were maintained in the units in which these were reared. The food of larvae under study consisted of organic matter, decaying wood or trash and other debris accumulated. Ritcher in 1966 described the similar food habits for all larvae belonging to sub family Cetoniinae.

Life cycle Observation

Protaetia aurichalcea

Taxonomy

Phylum- Arthropoda
Sub-phylum – Hexapoda
Class- Insecta
Order- Coleoptera
Family- Scarabaeidae
Sub-family- Cetoniinae
Tribe - Cetoniini
Genus- Protaetia (Burmeister, 1842)
Species- *aurichalcea* (Fabricius, 1775)

Description of life stages: The beetle showed holometabolic life cycle i.e. Egg-Larva- Pupa – Adult were observed.

The egg- The egg was oval while but as the embryo grew inside, it became spherical (Image 1.1).

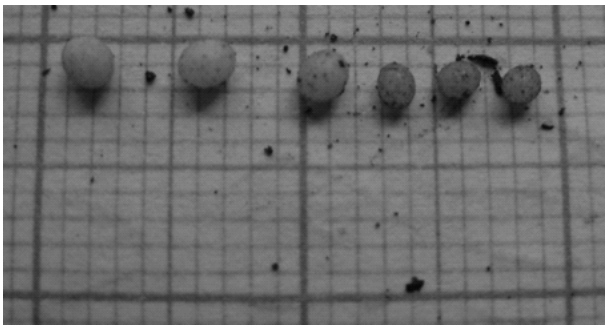

Image 1.1

The colour of egg was milky white to pale white. The incubation period under laboratory conditions varied seasonally. It was minimum 8 days in all seasons while maximum duration varying from 11 to 26 days. Kumbhar *et al* (2012) reported that eggs of Chiloloba orientalis hatched within 11-18 days. Whereas according to Bhattacharjee and Bhatia (1980) incubation period for Melolonthinae grub *Holotrichia serrata,* was 2-3 weeks.

Larva-: The C shaped larva showed growth in three instars before undergoing pupation. The body length measured between 3.0 mm to 35.0 ± 0.2 mm from 1st to 3rd instar and the girth ranged between 0. 1 to 0.8 mm ± 0. 2 mm in the 3rd instar(Image 1.2, 1.3, 1.4)

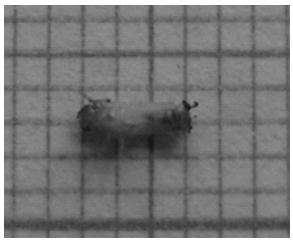

Image 1.2

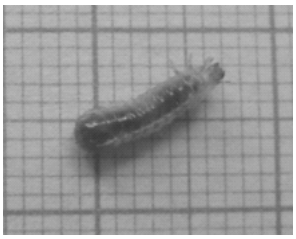

Image 1.3

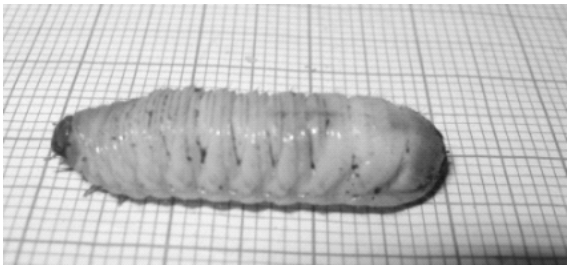

Image 1.4.

The larva in all instars crawled on its back and kept tunneling throughout the compost at various depths, circulating air through it for better action by microbes. The weight of the larva was as less as 0.01 mg in 1st instar while it grew as heavy as 160.0 mg in its 3rd instar. The larva gained this much weight by eating only compost organic matter throughout their span. Similar observations were made by Sipek (2009). Among the three instars, larva of third instar fed voraciously in the first few days and later became less active and sluggish. As there were 3 larval instars, 3 moults were seen (Image 1.5, Image 1.6, Image 1.7)

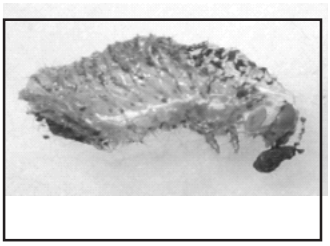

Image 1.5

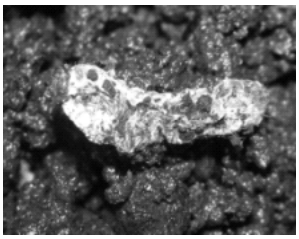

Image 1.6

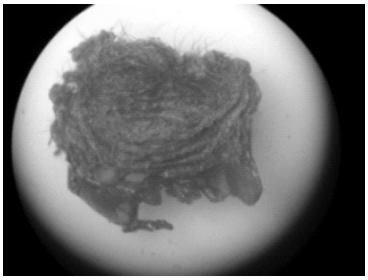

Image 1.7

When matured 3rd instar larva prepared the earthen cocoon for pupation, it moulted inside the cocoon unlike the previous 2 moultings. Hence the 3rd larval moult was found inside the cocoon. As reported by Veenakumari and Veeresh (1996) and Kumbhar *et al* (2012), the larva before attaining the pupal stage does not feed further and considerably shrinks its size and shows very little movement even when disturbed. The larval duration under laboratory conditions ranged between 46-111 days with least (46) in summer and longest (111) in winter. In *Holotrichia serrata*, the average larval duration was 148.7 days as noted by Majumdar and Teotia (1965).

Pupal chamber/Earthen cocoon- : Larva took almost 8-11 days to build the cocoon. The cocoon's rough exterior was of fecal pellets while even walled smooth interior was of fine soil particles adhered with the saliva of the grub (Image 1.8)

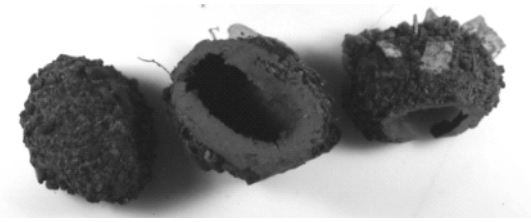

Image 1.8

Last larval moult and pupal moult enclosed was seen inside the empty cocoon after adult broke it and emerged out (Image 1.9).

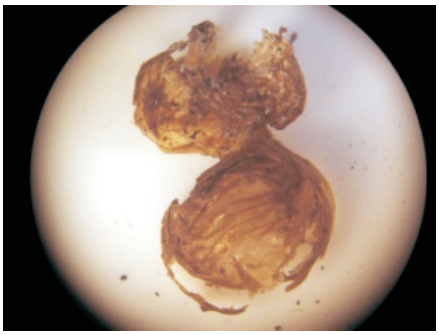

Image 1.9

Similar observations were recorded by Simpson (1990) for the pupal chamber of *Protaetia fusca* and by Veenakumari and Veeresh (1996) in another scarab beetle *Onthophagus gazella*. The larva to pupa duration was varying according to different seasons. The shortest larval period including all the instars and before undergoing pupation was observed to be 46 days in winter and monsoon while the longest was recorded in summer which comprised of 111days.

Pupa-: Pupa was exarate i.e. the wings and legs were free from the body and the abdomen was movable (Image 2.0)

Image 2.0

After complete metamorphosis, adult remained in the cocoon for next 1- 2days and then emerged out by breaking the cocoon. Duration of pupa varied from 20-36 days with minimum 20 days in summer and maximum 36 days in winter. In *Protaetia fusca* this pupal period was recorded up to 4.0 ± 0.2 weeks by Simpson (1990).

Adult-: Imago was deep bronze in colour and had very shining appearance on the dorsal and ventral surface (Image 2.1).

Image 2.1

The approximate length was 14-20 mm and breadth was 8-10.5 mm. Variation in size of male and female was not prominent (Image 2.2)

Image 2.2

The only conspicuous sexually dimorphic feature was presence of elytral spine/ spinose end of elytra in male. With the help of its strong mandibles, the adult cut vegetable leftover in the feedstock and fed on it.

Results: This beetle was attracted to the compost fauna due to the added feedstock in it. The beetle fed itself and laid eggs as it found the compost favourable for the larvae. This was corroborated with the observations by Dutto (2005, 2007). The larvae consumed the organic matter, pupated and the life cycle continued. Larval excreta were in the form of pellets and he study of its chemical parameters revealed that they are equally nutrient rich in Nitrogen, Phosphorus and Potassium when compared to vermicompost. The shortest lifecycle duration was 78 days in winter while longest was 137 days in summer. Another species of same genus, *Protaetia orientalis* took one year to complete as reported by Lijima and Takeuchi (2007).

Conclusion: Sighting of scarab beetle *Protatetia aurichalcea* during the study led to the study if its lifecycle. In its subject review, it was observed that this beetle was

not studied, though the other beetles belonging to family Cetoniinae (Scarabaeidae) were recorded as agricultural pests in India as well as abroad. According to Kühnelt (1976), the larvae of the rose chafer (Cetoniinae) are very active digesters of organic materials in the soil. They mix organic and inorganic materials and redeposit them in the form of cylindrical pieces of excrement Since, it was the first time this beetle was observed in the compost; its study was considered essential. After observing it in all the stages, it was noted that this beetle helped in composting in larval as well as adult stage. The constant tunneling of larva transferred the microbes and air through the compost and its excreta improved the nutrient status. Similarly adult fed on leftover vegetable matter and this cutting of leftover food in small pieces provided more surface area for the microbes to act upon it. Moreover, the beetles never came out of the compost plant and therefore never caused any nuisance. Thus it can be concluded that, along with microbes in compost, the macro organisms should also be studied and rather than labelling all the scarabs as pests and killing them, they should be put to better use by rearing them in compost.

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Study of intertidal distribution of *Cerithium scabridum*, Philippi, 1848 (Mollusca, Gastropoda) along the coastal Saurashtra, Gujarat, India

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Abstract : Intertidal distribution of *Cerithium scabridum* was studied on rocky Intertidal areas at Sutrapada (SP), Dhamlej (DH) and Kodinar (KO) along the coastal Saurashtra, Gujarat, India. Total 10 Line transect intercepted with 0.25 m^2 quadrate were laid perpendicular to the shore line at each study site every month (December, 2011 to December, 2012). Total 6 quadrates (0.25 m^2) were laid randomly per line transect from upper to lower intertidal mark for the quantification of the species. Maximum abundance of the *C. Scabridum* was observed in upper intertidal zone of all the study sites. Ecological attributes like abundance, density and frequency of occurrence of species were also calculated and they exhibited significant spatio-temporal variations at different study sites. Seasonal variability of sea water parameters like sea water temperature, salinity and pH were also studied and correlated with ecological attributes of species. Sea water temperature showed significant correlation with mean seasonal abundance of the species at all the study sites (SP: R^2=0.77, P<0.05, DH: R^2=0.91, P<0.05, KO: R^2=0.78, P<0.05). In the present study, It was observed that seasonal changes in abiotic factors and chemical properties of sea water has prominent effect on the intertidal distribution of the species.

Key words **:** *Cerithium scabridum,* Intertidal zone, Saurshtra coast, Seasonal abundance.

Introduction

The coastal marine ecosystem supports variety of habitats that consequently support high species diversity. In coastal areas, the intertidal zone is considered as most diverse and productive because with in the area of few meters various kinds of flora and fauna are observed (Underwood, 2000). The intertidal zone has been studied extensively for its biodiversity in last two-three decades (Little and Kitching, 1996). Vertical zonation is the most important process or phenomena observed on the rocky intertidal area in which from upper to lower intertidal area, different bands or zones containing different biodiversity are observed (Stephenson and Stephenson, 1949; Bandel and Wedler, 1987; Ellis, 2003). The variation in the distribution and abundance of organisms in different zones of intertidal zone has provided basis for so many ecological experiments and such complex patterns of variation have been studied well specially for the organisms of rocky intertidal area (Archambault and Bourget 1996; Blanchard and Bourget 1999; Trivedi et al., 2012). Intertidal distribution pattern, population structure and seasonal variation in abundance have been studied extensively to know the various ecological processes (Raffaelli and Hughes, 1978; Myers and McGrath, 1993). Intertidal distribution pattern and abundance variation related to different season have been studied for many molluscan species (Chapman, 1994; Olabarria and Chapman, 2001; Sagarin and Gaines, 2002). Molluscan shells have been found important for various commercial purposes like poultry food, medicines, industrial raw material, fisheries, handicrafts and interior decoration.

Gujarat has approximately 1650 km long coastline and the total coastal area covered by different kinds of marine habitats 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 gastropod fauna of Gujarat have been studied well and total 188 species were identified (Apte, 1998). The commercially important gastropods are harvested extensively from various marine areas of India and their population is declining at alarming rate. So for the conservation of the gastropod species, studies are required to carve the real picture of the population status of various species (Apte, 1998). Few studies have been done on the intertidal distribution of gastropod species along the coastal region of Saurashtra, Gujarat (Mishra and Kundu, 2005; Gohil and Kundu, 2013). The main aim of the present investigation was to study the spatio-temporal distribution of *Cerithium scabridum* with relation to various abiotic factors.

Materials and Methods

The study was conducted at three different sites of coastal area of Saurashtra, Viz. (1) Sutrapada (20^0 49' 53" N, 70^0 29' 17" E), (2) Dhamlej (20^0 46' 29" N, 70^0 36' 19" E) and (3) Kodinar (20^0 45' 29" N, 70^0 39' 39" E) (Fig. 1). 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 (Trivedi and Vachhrajani, 2012).

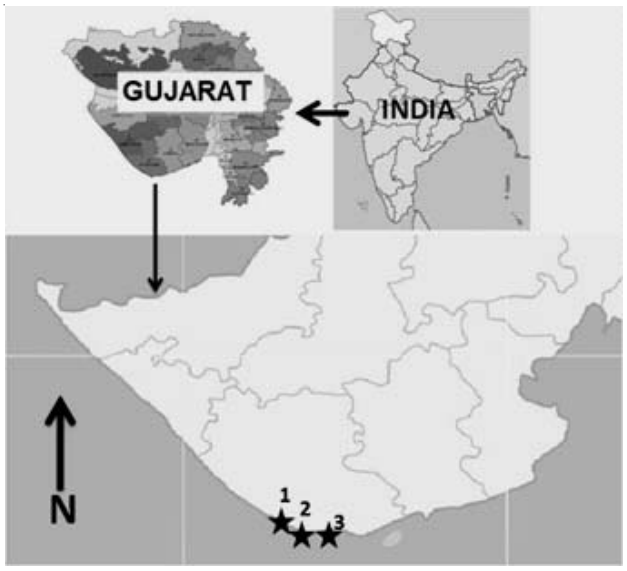

Fig. 1 Map of study area (1) Sutrapada (2) Dhamlej (3) odinar

In the present study, the intertidal area was divided into three zones including upper, middle and lower intertidal zone. The population of *Cerithium scabridum* was surveyed using line transect intercepted with 0.25 m^2 quadrate. Total 10 line transects were laid randomly perpendicular to the shore line covering all three zones and three quadrates (one quadrate per zone) were laid randomly on each transect. Among the abiotic factors, surface water temperature, pH and salinity were recorded using digital instruments. Each study site was sampled monthly for different kinds of ecological attributes like abundance, density and frequency of occurrence of the species. The monthly data was complied for different seasons viz. winter (November to February), summer (March to June) and monsoon (July to October). Monthly data was also recorded for three different abiotic factors. In statistical analysis of the data two way ANOVA without replication was applied to know the spatial and temporal differences between four sites and between three seasons. The kite diagram was plotted to know the intertidal distribution of the species. Regression and correlation coefficient tests were applied to assess the influence of abiotic factors on the population abundance of the species.

Results and Discussion

The mean seawater temperature varied between different stations. The maximum temperature was observed at Dahamlej (32.45 ± 1.62) in summer season while minimum temperature was observed at Sutrapada (28.46 ± 0.78) in winter season. The mean sea water pH did not fluctuate between different stations in different seasons. Maximum pH 8.36 was observed at Kodinar during monsoon season while minimum pH 7.77 was recorded at Dhamlej in monsoon. The mean sea water salinity varied between different stations in different seasons. At Kodinar the mean sea water salinity varied between 39.63% in summer to 30.1% in monsoon, possibly due to the addition of fresh water in sea water during monsoon (Table. 1).

Table 1. Seasonal variation in the mean values of different abiotic factors at different stations

	Sutrapada	Dhamlej	Kodinar
Sea water temp.(^{0}C)			
Winter	28.46 ± 0.78	30.8 ± 0.92	29.76 ± 1.59
Summer	30.42 ± 0.55	32.45 ± 1.62	32.27 ± 1.68
Monsoon	29.15 ± 0.55	28.7 ± 1.41	30.75 ± 1.06
Sea water pH			
Winter	8.27 ± 0.29	8.06 ± 0.09	8.18 ± 0.07
Summer	8.12 ± 0.17	8.34 ± 0.19	8.27 ± 0.19
Monsoon	8.14 ± 0.10	7.77 ± 0.26	8.36 ± 0.29
Salinity			
Winter	36.62 ± 1.09	37.66 ± 1.60	37.63 ± 1.38
Summer	39.42 ± 1.78	38.32 ± 1.57	39.63 ± 1.38
Monsoon	32.25 ± 0.34	33.7 ± 0.97	30.1 ± 1.80

Cerithium scabridum belonging family certhiidae is one of the common gastropod of rocky intertidal area. The species has got high spired shell that is three time as long as wide. The species has got 9- 10 whorls. The species is brownish in color with contrasting pattern of brown and white mottles on the cord. The distribution of the species is wide spread ranging from red sea to western and southern Indian Ocean (Houbrick, 1992). In the present study the maximum abundance of the species was observed in the upper intertidal zone as compare to other zones of intertidal area. Maximum abundance of the species was observed at the upper intertidal area of Dhamlej followed by Sutrapada and Kodinar (Fig. 2).

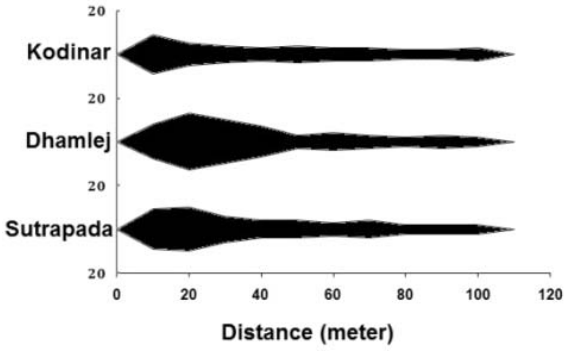

Fig. 2 Intertidal distribution of *Cerithium scabridum*

The abundance of the *Cerithium scabridum* showed fluctuations in different season between different stations. maximum abundance of the species was observed at Dhamlej (7.7±5.89) followed Sutrapada (6.69±5.85) and Kodinar (4.8±4.99) in summer season while in case of winter and monsoon season the abundance was more or less same at all the study sites (Fig.3). The result of ANOVA showed significant variation for the mean values of the seasonal abundance of the species but significant variation was not observed between station specific abundance of the species (Table 2).

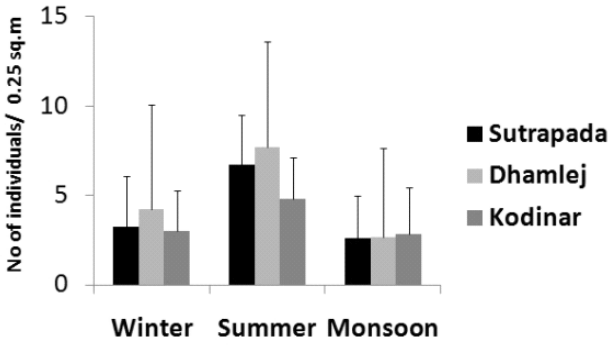

Fig. 3 Seasonal mean variation in abundance of *Cerithium scabridum* at different study sites

The Density values of the *C. scabridum* showed similar trend like abundance. The density of the species was observed low as compare to abundance of the species. Maximum abundance of the species was observed at Dhamlej (3.08±5.87) followed by Sutrapada (2.78±5.84) and Kodinar (1.23±2.59) in summer season while in case of winter and monsoon the density of the species observed more or less same (Fig. 4). The result of ANOVA showed significant variation for the mean values of the seasonal abundance of the species but significant variation was not observed between station specific abundance of the species (Table 2)

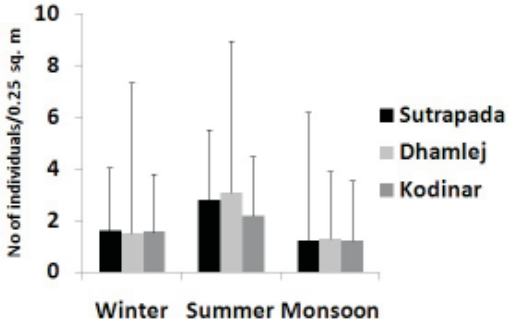

Fig. 4 Seasonal mean variation in density of *Cerithium scabridum* at different study sites

The frequency of occurrence values of the *C. scabridum* also showed similar trend like abundance. The values of the frequency of occurrence of the species were observed very high as compare to density and abundance of the species because the species lives in the congregation and the distribution of the species was observed very patchy at all the study sites. Maximum frequency of occurrence of the species was observed at Dhamlej (49±5.27) and Sutrapda (49±5.67) followed by Kodinar (38±4.56) in summer season while in monsoon season little increase in frequency of occurrence of the species was observed at Dhamlej (Fig.5). The result of ANOVA showed significant variation for the mean values of the seasonal abundance and station specific abundance of the species (Table 2).

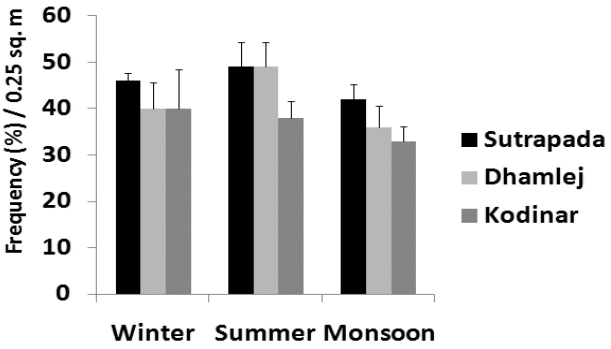

Fig. 5 Seasonal mean variation in freq. of occurrence (%) of *Cerithium scabridum* at different study sites

Table 2. Results of the Two – way ANOVA without replication analysis of the mean seasonal density, abundance and frequency values of *C. scabridum* sampled at three different sites (* p < 0.05; ** p < 0.01).

	source of variation	Density	Abundance	Freq. of occurrence
C. scabridum	stations	1	1.97	**3.57****
	seasons	**23.28****	**17.51****	**2.41***

In the present study it was observed that abundance of the species was recorded maximum in the upper intertidal area as compared to other zones because Cerithium species prefers tide pools to live that are present in the intertidal area (Houbrick, 1992; Gohil and Kundu; 2011). The rocky intertidal area of Saurashtra coast is mostly covered by tide pools that provides excellent habitat for gastropod species (Vaghela, 2010). Gohil and Kundu, 2013 have conducted study on population structure of *Cerithidum caeruleum* and observed that the maximum abundance of the species was observed at upper and middle intertidal zone where tide pools are available.

Table 3. Results of the regression and correlation coefficient analysis between mean seasonal abundance of *C. scabridum* and mean sea water temperature, salinity and pH (* p < 0.05; ** p < 0.01).

	Equation	R^2 value
Temperature		
Sutrapada	y=1.93x-52.59	**0.77***
Dhamlej	y=1.31x-35.59	**0.91***
Kodinar	y=0.76x-20.13	**0.78***
Salinity		
Sutrapada	y=0.53x-14.96	0.76
Dhamlej	y=0.84x-26.16	**0.67***
Kodinar	y=0.15x-2.04	0.51
pH		
Sutrapada	y=- 12.95x+110.0	0.23
Dhamlej	y= 8.83x-66.36	**0.94****
Kodinar	y=- 0.94x+11.35	0.006

The values of seasonal and site wise frequency of occurrence of the species were observed high as compare to seasonal and site wise abundance and density of the species that shows that the species is slightly colonial in nature. Gohil and Kundu, 2011 have conducted study on ecological status of *Rhinoclavis sinensis* at the intertidal zone of Dwarka and they noted same phenomena for density abundance and frequency of occurrence of the species. Maximum abundance and density of the species was observed at Dhamlej as compare to other sites. The intertidal area of the Dhamlej is flat in nature and also covered with small and large tide pools that remain filled with water during low tide that provides appropriate habitat for different macrobenthic species. It was reported that different kinds of abiotic factors, seasons, and geomorphology of the intertidal area have immense effect on the intertidal distribution of benthic fauna along the Saurashtra coast (Sarvaiya, 1977; Prasad and Mansuri, 1982; Mishra and Kundu, 2005). Regression and correlation analysis between sea water temperature and abundance of the *C. scabridum* showed significant correlation at all the study sites that show that sea water temperature plays an important role in the distribution of the species. Among all the study sites, significant correlation was observed between all the abiotic factors and abundance of the species at Dhamlej only which shows that the intertidal area of Dhamlej presents healthier habitat for *C. Scabridum* as compared to other sites (Table 3). The contamination of different pollutants into the sea water affects the quality of the sea water that on the other hand affects the distribution, density and abundance of the molluscan species (Bishop et al., 2002).

Conclusion

Genus *Cerithium,* a microphagous herbivore, spans a broad variety of habitats, but the great majority lives intertidally or in shallow water. Most species have a planktotrophic larval stage and wide geographic distribution. The Indo-Pacific Marine Province supports 68 percent of all *Cerithium* species. Total 42 living species have been reported so far from the world under the genus (Houbrick, 1992). *Cerithium scabridum* is one of the most common gastropod species utilized by different carnivore species as a food, while hermit crabs use the empty shells of the species as a shelter (Trivedi et al., 2013). The species requires specific set of microhabitat and abiotic factors for survival and little alteration in microhabitat or abiotic factors may affect the population of the species.

Acknowledgments

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To study molluscan shells diversity of two fun beaches of Mumbai, Maharashtra

Saritha Joshi, Priyanka Tambe, Gayatri Oak and Dr. (Mrs.) Poonam Kurve

Introduction

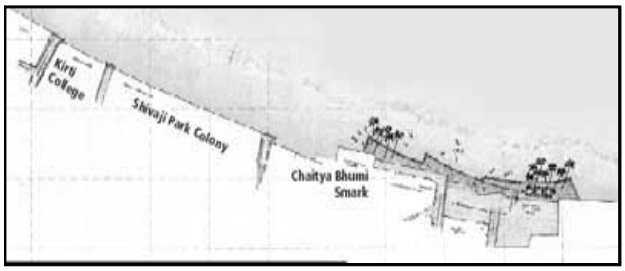
Mumbai being a metropolitan island city and the commercial capital of India, its ever increasing population and infrastructures tend to take a toll on the environment. The beaches of Mumbai have been used extensively for the recreational and holistic purposes. The Dadar beach in Central Mumbai and Juhu beach in northwestern Mumbai are the most famous and highly visited parts of the Mumbai coast.

The constant human interference, exploitation of the marine resources and water pollution make it a prime necessity that the health of the marine ecosystem be assessed. Molluscs are an important link in the food chain and also are the most diverse of all phyla. The comparison of the 2 beaches of Mumbai by studying the Molluscan diversity will help to determine the impact of pollution to some extent. Anthropogenic interference have damaged the marine biodiversity to such extent that immediate conservation measures are required.

Study location

Beach at Juhu

Beach at Dadar and sewage outlet



Location of Dadar beach

Location of Juhu

Material and Method

The Dadar beach (19° 08’78"N, 72° 82’63"E) in Mumbai and Juhu beach (19° 08’78"N, 72° 82’63"E) in the suburban region of Mumbai were studied to compare the Molluscan diversity for a period of one year from December 2011 to November 2012. The monthly observations were pooled season wise. The seasons are defined as follows:

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December- January- February: Late Post Monsoon

March – April- May: Pre-Monsoon

June- July- August: Monsoon

September- October- November: Early Post Monsoon

The abundance of organisms were studied using a transect of 300 m and was calculated by point method wherein the organisms were rated on a scale of 1 to 10 where 10 indicated maximum abundance.

Results and Discussions

Parameters	Late Post monsoon		Premonsoon		Monsoon		Early Post monsoon	
	Juhu	Dadar	Juhu	Dadar	Juhu	Dadar	Juhu	Dadar
Temp (^{0}C)	24	24	25	25	24	24	24	24
pH	8.1	8	8.4	7.7	8	7.9	7.8	8.2
DO (mg/l)	4.9	3.2	4.55	3.25	5.02	3.8	5.4	4.4
Salinity $\%_0$	32.5	30	36.03	29	29.7	28	30.1	29.4
Phosphates (mg/l)	17	6.2	17.1	0.7	14	4.2	11.2	4.7
Nitrates (mg/l)	17	21	23	8	19	15	13	16
Ammonia (mg/l)	7.1	8.5	8.8	3.7	4.2	5.8	3.4	7.3
TDS (gm/l)	18.77	19.32	24.82	25.24	25.42	26.8	17.64	20.45

The physico-chemical parameters of both the beaches didn't show much variation one another thereby justifying the similarity in the nature of water along the coast of Mumbai. The marked difference can be seen in the availability of oxygen which is lower in Dadar than in Juhu. However, the levels of oxygen are higher than the required limit of 3 mg/l to sustain life. All the remaining constituents were within the limits specified by WHO except ammonia which throughout the study period exceeds the prescribed limit of 10 mg/l. Ammonia is found in excess in these waters mainly due to the discharge of sewage in the sea.

Molluscs representing 19 genera and 14 families were found on both the coastlines. Of the recorded species, 7 were Bivalves and 12 were Gastropods. Most number of Bivalves belonged to the Cardidae family while maximum Gastropods were from Trochidae family.

Table 1.The family- wise distribution of the molluscan diversity at both the coasts.

Sr.no	Species	Family
Bivalves		
1	Arca	Arcidae
2	Cardium	Cardidae
3	Carditaantiquate	Cardidae
4	Donax	Donacidae
5	Siliquaradiate	Solenidae
6	Mactra	Mactridae
7	Pernaviridis	Mytilidae
Gastropods		
1	Babylonia spirata	Buccinidae
2	Cantharus	Buccinidae
3	Euchelus	Trochidae
4	Umbonium	Trochidae
5	Trochus	Trochidae
6	Murex	Muricidae
7	Nassa	Muricidae
8	Natica	Naticidae
9	Nerita	Neritidae
10	Oliva	Olividae
11	Telescopium	Potamididae
12	Turitella	Turritellidae

Table 2.Specieswise abundance of Molluscs in Juhu and Dadar

Sr No	Species	Late Post Monsoon		Pre Monsoon		Monsoon		Early post monsoon	
		Dadar	Juhu	Dadar	juhu	Dadar	juhu	dadar	juhu
1	Arca	2	2	1.67	1.67	0	0	2	2
2	Cardium	2	2	1	1	0	0	1	1
3	Cardita antiquata	1.33	1.67	1.33	1.33	0	0	1.33	2
4	Donax	2	2.67	1.67	1.67	0	0	2.33	2.67
5	Siliquaradiata	1	1	1	1	0	0	1	1
6	Mactra	2.33	2.67	1.67	1.67	0	0	2.67	3
7	Pernaviridis	0	0.33	0	0	0	0	0	0
8	Babylonia spirata	1	1.67	1	1	0	0	1.67	1.33

9	Canthrus	2	2	1.33	1.33	0	0	1.33	1.33
10	Euchelus	0	0	0	1	1	0	1	1
11	Murex	0.67	0.67	1	1	0	0	1	1
12	Nassa	2	2	1	1	0	0	1	1
13	Natica	2.67	2.67	1	1	0	0	0.33	0.33
14	Nerita	2.33	2.67	1.33	1.33	0	0	1.67	2
15	Oliva	1	1	1	1	1	0	1	1
16	Trochus	1.67	1.67	1.67	1.67	0	0	1.33	1.33
17	Telescopium	1	1.33	1.33	2	0	0	1.33	1.67
18	Turitella	0	0	0	0	0	0	0	0.33
19	Umbonium	4	4.67	4	4	0	0	4	4.67
	Total	26	32.66667	23	24.66667	0.66667	0	29	28.66667

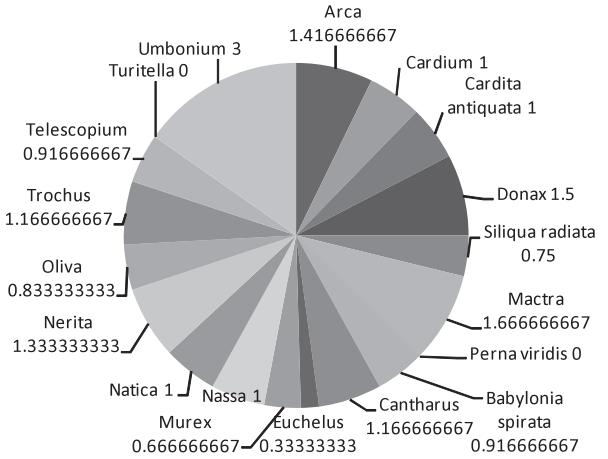

Fig.1 Representation of Molluscan diversity at Dadar coast

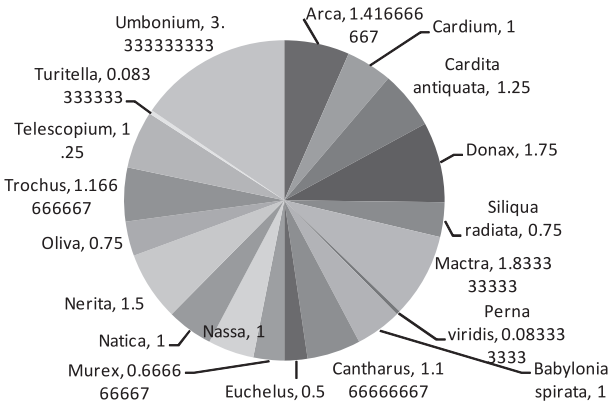

Fig.2 Representation of Molluscan Diversity at Juhu in a Pie Chart

Seasonal variations

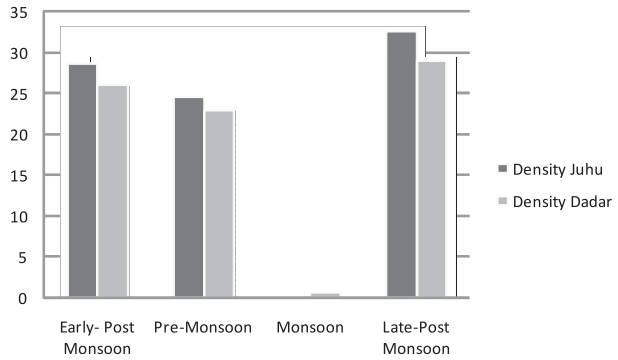

Fig. 3 Seasonal variations in the density of molluscan shells at Dadar and Juhu

The abundance of molluscs was minimal on Dadar beach and absent on Juhu beach was the shore was washed away due to the heavy rainfall in the monsoon season. The abundance of all the molluscs was below 3 except for *Umbonium* spp. *Umbonium* spp. showed maximum abundance of 4.67. It has been already been stated that only Molluscan shells were collected as most of the organisms were empty. Only *Umbonium spp. s*howed the presence of animals. The abundance of *Umbonium spp.* was common along the Mumbai Coast as the conditions there are suited for its growth and development. Also Umbonium spp are supposed to be the dominant organisms in the inter tidal zones on the west coast of India (Sivadas et. al, 2012).

Conclusions

The number of shells have decreased with time and most of the shells collected are in the broken form. Number of Shells having live organisms inside them was very low. The physico-chemical analysis of the sea water also shows that the water is slightly polluted and any further impact of pollution will damage the marine ecosystem thereby further hampering the abundance of molluscs.

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Seasonal variations of polychaete diversity, east coast of Tamilnadu, Southern India

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Abstract : Totally six species of polychaetes were identified and they belong to five families. Maximum turn over of abundance and diversity of polychaete were observed during the month of January 2009 (winter month) and minimum during the month of November 2008. There was a significant relationship between abundance of polychaetes and among the months studied (P<0.5) in the Tharangambadi tidal flat. With reference to cluster analysis, two major groups were identified from six species of polychaetes. The present study revealed that the abundance of benthic form of polychaete worm differs with seasonal variations.

Key words **:** Benthic forms, polychaetes, abundance, tidal flats, conservation.

Introduction

When it comes to quantitative studies on the distribution of benthic invertebrates on the Tharangambadi coastal tidal flat of Tamil nadu region, southern India very little information is available. In fact, polychaetes occur in almost all benthic marine and estuarine sediments (Fauchald, 1977) and are often the dominant components of the macrobenthos both in terms of number of species and individuals (Grassle and Maciolek, 1992; Ward and Hutchings, 1996). Over 10,000 species have been described to date (Minelli, 1993), belonging to 83 families, and various estimates have been made as to the total polychaete fauna ranging from 25,000 to 30,000 (Snelgrove et al., 1997). The ratio of described to undescribed species varies according to habitat and biogeographical region. Intertidal and shallow subtidal communities are best known for the abundance of polychaete diversity in Northern Europe (Fauvel, 1923, 1927; Hartmann-SchroÈ der, 1971), and North America (Hartman, 1968, 1969; Pettibone, 1963; Blake et al., 1996, and earlier volumes). Many other regions of the world rely on monographs produced for Europe (Fauvel, 1923, 1927), North America (Hartman, 1968, 1969) and South Africa (Day, 1967) for identification of their fauna. But in Asia, it is still not much explored.

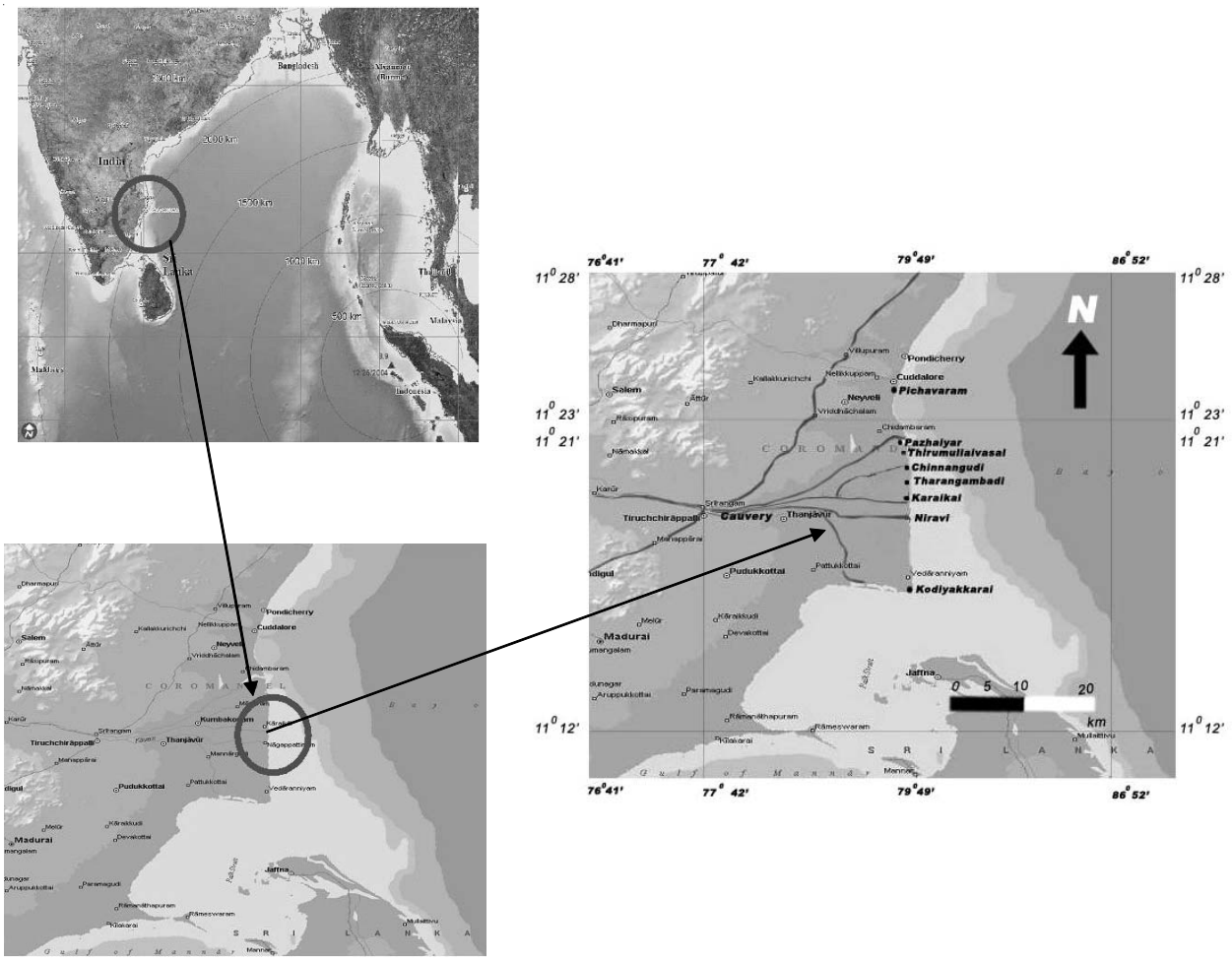
As such, this is first quantitative study of macro invertebrates in the area. The macroinvertebrates collected provide baseline information on standing crop of benthic macroinvertebrates gathered as compared to baseline data reported elsewhere (Stewart, 1983). Based on the above said information the polychaete abundance and diversity in the proposed study area was surveyed and assessed with following objectives: 1) To identify the presence of polychaete species in the Tharangambadi tidal flat and; 2) to understand the status and distribution of the polychaete sp. in Tharangambadi tidal flat.

Material and Methods

Study area

Thrangambadi is situated about 29 kms souththeast of Mayiladuthurai town. The former area is about 40 kms south of Chidambaram and the latter is about 11 kms north of Karaikal. The study area is located at a latitude and a longtitude of 79° 51' 19" E; 11° 01' 35" N. The study sites include six major habitat types viz, agricultural wetland, agricultural dryland, human habitation, coconut (*Cocos nucifera*) vegetation, palmyrah (*Borasus flabellifer*) vegetation and scattered trees. (Fig.1)

Fig. 1. Map of the study area showing the six tidal flats studied at the east coast of southern India.



Collection and identification of Polychaetes

To determine the availability of polychaetes, mud samples were collected at three random points from Tharangambadi tidal flat within the depth 0–20 cm (Masero *et al.*1999). At each point, three core samples were taken to a depth of 10-cm diameter (78.5 cm^2) were taken to a depth of 20 cm (Masero *et al.*1999). The mud collected was sieved through a 0.5µ sieve and the animals filtered and were preserved in 5% formaldehyde (Strin, 1981). The identification of polychaetes by referring to field guide by Michael 1972.

Statistical analysis

The diversity of polychaetes was estimated by using the Shannon index of diversity, Shannon index of diversity -

(H'): $H' = - \Sigma n_i /N \ln (n_i /N)$ (Shannon and Weaver, 1949)

To understand the associations between the density of polychaete worm and the months General Linear Model (GLM) was applied by using MINITAB 15 (Ryan *et al*., 1992). Finally, Cluster analysis was applied for knowing the polychaetes' associations in the tidal flat. Statistical inferences were made by referring to Sokal and Rohlf (1995).

Results and Discussion

Totally 6 species of polychaete worms were identified (Table 1) and they are from five families. They are given below: *Paramphinome* jeffreysii, *Glycera dibranchiate*, *Notocirrus spiniferus*, *Sphaerodorum gracilis*, *Ceratonereis irritabilis* and *Nephtys ciliate.*

Highest abundance of *Paramphinome pulchella jeyffrii* was recorded during December 2008 and lowest during November 2008. This species showed more or less same trend during January 2009. But, the *Glycera dibranchiate* density showed maximum occurrence during March 2009 and minimum during February 2009 and same level density was recorded during November 2008 and January 2009 (Table 1).

In the case of *Notocirrus spiniferus*, maximum density

was noticed during January 2009 and minimum during February 2009, whereas the average density was found in November 2008 and in March 2009. But about *Shaerodorum gracilis*, highest density was recorded in January 2009 and lowest during November 2008.

In fact the *Ceratonereis irritabilis* was observed maximum during the month of January 2009 and minimum during the month of November 2008. However, *Nephtyus ciliate* species was found in maximum density during the month of January 2009 and minimum in the month of December 2008. But, during the months of November 2008 and February and March 2009 showed average density (Table 1).

Table.1. Abundance of Polychaete worms (No./m^2) recorded in the Thrangambadi tidal flat during the study periods from November 2008 March 2009.

S. No	Species Name	MONTHS				
		Nov. 2008	Dec. 2008	Jan. 2009	Feb. 2009	Mar. 2009
1	*Paramphinome pulchella*	9	26	25	18	11
2	*Glycera dibranchiate*	3	1	3	0	4
3	*Notocirrus spiniferus*	2	1	3	0	2
4	*Shaerodorum gracilis*	0	2	7	1	2
5	*Ceratonereis irritabilis*	3	8	13	10	8
6	*Nephtyus ciliate*	2	1	4	2	2

The overall results of the present study can be given as; the polychaete abundance and diversity were noted to be maximum during the month of January 2009 (winter month) and minimum during the month of November 2008 (pre winter month).

The study revealed that, polychaete abundance increased during the months of winter (Table 1). The benthic faunal density and diversity regulates the complicated food web and trophic structure in tidal zones and acts as dominant prey base for water birds (Nagarajan & Thiyagesan 1994, Pandiyan, 1999, 2000 and 2002 and Pandiyan et al., 2006). There was a significant relationship between months and polychaete abundance (Table 2).

Table.2. Analysis of variations showing the significant differences between thepolychaetes worm density and monthly variations in the Tharangambadi tidal flat during the study period from November 2008 to March 2009.

	Sum of Squares	df	Mean Square	F	Sig.
Between months	51.036	13	3.926	9.723	0.000
Within months	36.464	16	2.279		
Total	87.500	29			

However, most of the polychaete fauna remains to be correctly identified and there is no doubt that, they are a highly diverse group in biodiversity. Diversity of polychaetes in a wide variety of habitats and geographical regions is known (see Knox, 1977, for additional earlier studies). Comparing such sets of data is difficult for many reasons. Sampling techniques, mesh size used, and the size and number of replicates collected and over what time period greatly influence the number of species and individuals found. Mackie and Oliver (1996) discuss these problems in some details and the sampling strategy employed can obviously be determined by the questions being asked about the data as well as about funding and logistical restrictions.

Fig.2. Overall abundance (No/m^2) and diversity (H') of polychaetes recorded from the Tharangambadi, tidal flat, during November 2008 to March 2009.

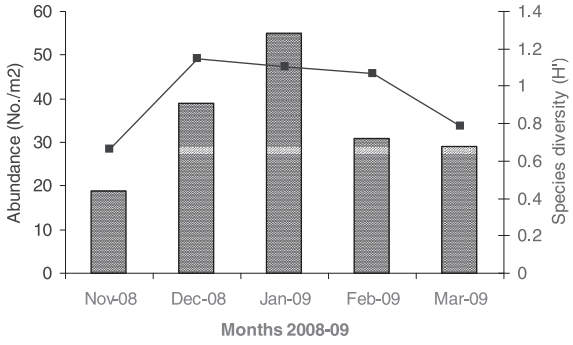
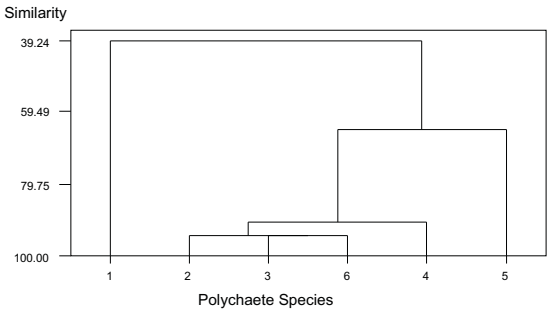


Fig. 3. Dendrogram showing the polychaetes assemblages recorded in the Tharangambadi tidal flat during the study period. (Mean values of polychaetes of fives months data were used) For Species name please refer table 1.



The results of the dendrogram show that, these six species were grouped into two major categories (Fig. 3). Among the six species the species *Paramphinome pulchella* forms a separate group than the other five species (Fig 3), it seems the *Paramphinome pulchella* could have significant behaviour and adaptatability than other species recorded in the tidal flat. The factors such as sediment type (Etter and Grassle, 1992), salinity regimes (Stephenson et al., 1979), historical disturbances (Gray, 1997), organic content, microbial associations and food availability (see review by Snelgrove and Butman, 1994) also greatly influence the total number of species and individuals present and the species composition. In most cases selection of habitat will occur at

the time of larval settlement (Butman and Grassle, 1992; Grassle et al., 1992; Wu and Shin, 1997).

Hence, the population of polychaetes depends on many environmental factors, which directly or indirectly influence the survival of polychaetes. Therefore, it is suggested that an intensive study involving the assessment of physico-chemical factors along with the population estimation of polychaetes would provide a clear picture of the interactions and survival strategies of polychaetes in this ecosystem tidal flat.

Conservation implications

The practice of wetland management for providing suitable habitat for waterbirds, it is necessary to develop effective tools of predicting the effects of wetland management on the dynamics of waterbirds and their habitats. This requires simplified decision supporting systems on the basis of complex multidisciplinary knowledge. The socioeconomic scenarios can also be involved in the systems to provide an integrated design for wetland management. Especially the coastal wetlands need to be saved for the sake of waterbirds and shorebirds these are the basic habitats suited for waterbirds and shorebirds during their life cycle. In addition, polychaetes are the major prey items for the shorebirds during their migratory season (Pandiyan *et al* 2010).

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Biochemical alterations in intertidal gastropod *Bursa tuberculata* exposed to Cadmium from Uran coast (West coast of India)

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Abstract : Uran and nearby coastal area is surrounded by many industrial plants. Under such circumstances coastal area of Uran is slowly becoming ground of chemical pollution. It is well known that by physiological and biochemical mechanisms of intertidal organisms play an important role to adapt the organism to variable environmental conditions. *Bursa tuberculata* was exposed to sub lethal concentrations of cadmium for 15 and 30 days. Control as well as experimental animal tissues was dissected out for analysis of glycogen, protein, lipid, lactic acid and pyruvic acid. A significant depletion in glycogen content was found in 15 and 30 days. Protein content in tissue of *Bursa tuberculata* was elevated significantly in 15 and 30 days. Lipid content of the tissue found declined after 15 and 30 days of exposure. A significant elevation in lactic acid was noticed in 15 days whereas after 30 days it was found depleted in the tissue. A significant reduction of pyruvic acid was noticed during 15 and 30 days. Sub lethal concentrations of cadmium do not kill the animals instantly but alter their overall metabolism. Among heavy metals cadmium is one of the most toxic pollutant because of its persistence, toxicity and potential for bioaccumulation.

Key word **:** Glycogen, Protein, Lipid, Lactic acid, pyruvic acid.

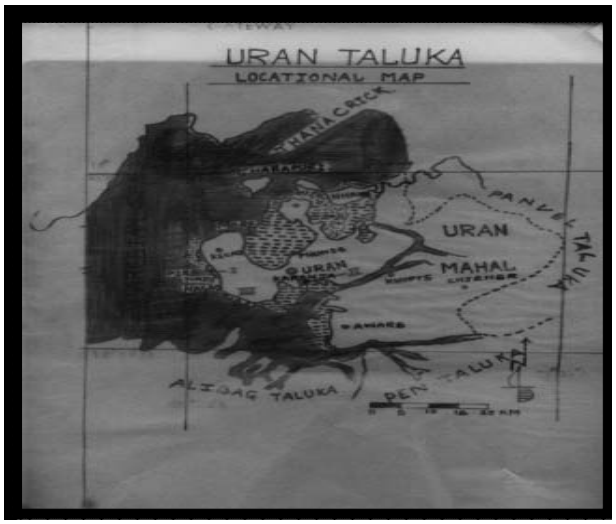
Introduction

Uran and nearby coastal area surrounded by industries of chemical production. Under such circumstances coastal area of Uran is slowly becoming a ground of chemical pollution. At the beginning of the investigation coast of Uran was surveyed for recording intertidal gastropod *Bursa tuberculata*. Animals for pursuing research were collected from rocky shore. Gastropods are among the most promising candidates used in biomonitoring studies focusing on heavy metals. Biochemical alterations occurring in the body give first indication of stress in the organism. Heavy metals are reported to induce many changes in biochemical and physiological dysfunctions of the organisms. Heavy metals like lead, mercury, cadmium and others contaminate water bodies when pass out into effluents **(**Everaarts and Fischer, 1992). This acts as toxicants for animals and cause health hazards knowingly and unknowingly in human beings and enters in food chain (El-Nady, 1996). Therefore, biochemical alterations act as a safety measures to overcome the altered conditions. In toxicological investigation also the change in the tissue metabolites proved to be a sensitive indicator of stress caused by toxicants **(**Gabbot, 1983). Therefore, many investigators have resorted to the assessment of tissue metabolites like glycogen, proteins, fats, lactic acid & pyruvic acid in fishes exposed to various pollutants under field and laboratory investigations (Venkatrama and Radhakrishniah, 1987). The studies have proved the utility of assessment of such metabolites in organisms to know the toxic mode of action of pollutants on fishes. Such methods have also been applied in assessment of the effects of various pollutants on metabolism like crustaceans & mollusks (Reddy et al, 1994; Roy, 1994). In India, considerable importance is given to the studies on ecophysiological aspects of marine bivalves (Deshmukh, 1998). Some of the investigators have also used intertidal bivalves as test organisms in toxicological research (Kulkarni & Kulkarni, 1988; Eapen & Patek, 1989; Kulkarni, 1983; Roy, 1994). However, the literature on biochemical responses with respect to tissue metabolites in intertidal gastropods is very scanty. Therefore the present investigation was conducted to assess Biochemical alterations in intertidal gastropod *Bursa tuberculata* exposed to Cadmium from Uran coast. It is well known that the efficient functioning of metabolis process in organisms is related to structural integrity of their tissues and organs. Sometimes intravenous and extraneous factors damage normal build up of tissue in organism which may go unnoticed before significant damage caused to the organism. Therefore toxicological investigations behavioral studies have gain prime importance. The behavioral modifications include changes in learning ability, chemically mediated behavior like reproductive activates, food findings and locomotion.

Materials and Methods

Study Area

In the beginning of the investigation coast of Uran was surveyed for recording intertidal gastropod. Uran coastline is a combination rocks, sand and mudflats. Gastropods were recorded from rocky part of the shore.



Map of Study Area

Plate No. 1.1

The intertidal gastropod *Bursa tuberculata* were exposed to sublethal concentrations (96 hrs LC50) of cadmium 50 µg/l and 100 µg/l for period of 15 and 30 days. At the end of experimental period of 15 days and 30 days and control, experimental gastropods were removed, tissues were dissected out for the analysis of glycogen, protein, lipid, lactic acid and pyruvic acid. The glycogen content was estimated by Anthrone method (Seifter et. al, 1950). The protein content was estimated by method of Lowry et al, 1951. While lipid contents were estimated by method of Bling and Dyer (1959) using chloroform menthol mixture of extract. A lactic acid level was determined according to the method of (Barker and Symmerson 1941) and pyruvic acid contained was determined by the method of (Friedmaan and Hawgen 1943).

Result and Discussion

The result of present investigation revealed that a significant depletion in glycogen content was noticed in tissues of gastropods, reduction in glycogen content was most significant after 30 days exposure (Table No 1.1). The protein content was found to be elevated after exposure of gastropod to cadmium for 15 and 30 days respectively. The elevation is more prominent after 30 days of exposure (Table No 1.2).The lipid content found to be depleted after 15 and 30 days of exposure .The decline was most significant after 30 days of exposure. (Table No 1.3) Significant elevation in lactic acid content was noticed in the tissue after 15 days, where as after 30 days exposure it was found depleted. (Table No 1.4). A general decreasing trend of pyruvic acid content was observed in gastropod exposed to 15 and 30 days (Table No 1.5).

Depletion in glycogen content in tissues of the marine clams under pollution stress was also reported (Dunning and Major, 1947).The maintenance of high reserve of glycogen is one of the adaptations in intertidal gastropod. Against anoxic conditions carbohydrates are the sole or main source of energy, such a depletion of glycogen reserves have also been observed in marine organisms, crustaceans under pollution stress. (Deshmukh, 1998; Kulkarni, 1983; Reddy et al, 1994). Protein forms one of the major fuels in marine gastropods. The observed increases in protein of the tissues of experimental animal also suggest that mobilization of protein which might have released in to the blood of gastropod during chronic exposure period. The presence of metallothionine and other low molecular weight protein in the clams has been suggest as indication in involvement in uptake ,storage ,transport and elimination of metals. The elevated level of protein in tissues of the cadmium treated gastropod suggests stimulation and synthesis of metallothionine which might be utilized to remove cadmium content via excretion **(**Chandravathy, 1994). An elevated level of protein under copper stress has been reported in the bivalve(Kattikaran et al,1995).The lipid content depleted in the tissues of gastropod *Bursa tuberculata.*It has been shown that lipids are utilized as a metabolic substrate in fishes under the stress of cadmium. (Gill and Pant, 1983).Furthermore lipid in mollusks acts as a external source of energy similar to that of other animals. The depletion in the lipid content in the tissues of gastropod may be due to utilization of stored lipid as metabolic structure under hyper metabolic state arises due to cadmium exposure. Significant elevation in lactic acid content was noticed in the tissue after 15 days cadmium treatment whereas after 30 days exposure it was found depleted. A general decreasing

trend of pyruvic acid content was observed in gastropod exposed to 15 and 30 days.

During environmental anoxia six end products of pyruvate metabolism have been identified in mollusks. Lactate is one of the six end products of anaerobic pyruvate metabolism in marine organisms. Furthermore, during environmental anoxia, marine bivalve accumulate a varieties of organic acids in addition to small amount of Co_2, opines and lactate (Katticaran, 1995; Goddard, 1966). Therefore observed changes in lactic acid and pyruvic acid content in tissues of gastropod suggest disturbed carbohydrate metabolism.

Conclusion

The contamination of heavy metals is serious threats because of their toxicity, long persistence, bioaccumulation and biomagnifications in the food chain. Sub lethal concentration of cadmium does not kill the gastropods instantly but affect their overall metabolism thereby reducing their chances to leave healthy life.

Table No. 1.1: Glycogen (mg/gm wet wt.) in tissues of *Bursa tuberculata* exposed to cadmium

Exposure Period (Days)	Control	Cadmium concentration (µg/l)	
		50	100
15	5.23 ± 1.23	6.33 ± 1.24	6.64 ± 0.53
30	7.10 ± 0.37	5.52 ± 0.34	56.73 ± 10.25

Table No. 1.2: Protein (µg/gm wet wt.) in tissues of *Bursa tuberculata* exposed to cadmium

Exposure Period (Days)	Control	Cadmium concentration (µg/l)	
		50	100
15	12.40 ± 1.43	9.83 ± 1.64	11.07 ± 0.69
30	9.16 ± 1.24	14.34 ± 1.67	13.73 ± 0.92

Table No. 1.3: Lipid (µg/gm wet wt.) in tissues of *Bursa tuberculata* exposed to cadmium

Exposure Period (Days)	Control	Cadmium concentration (µg/l)	
		50	100
15	30.65 ± 2.51	22.32 ± 1.52	22.35 ± 1.53
30	27.23 ± 5.30	21.53 ± 1.35	17.53 ± 4.39

Table No. 1.4: Lactic acid (µg/gm wet wt.) in tissues of *Bursa tuberculata* exposed to cadmium.

Exposure Period (Days)	Control	Cadmium concentration (µg/l)	
		50	100
15	27.75 ± 8.65	29.40 ± 0.01	42.03 ± 6.63
30	29.52 ± 5.31	26.21 ± 0.42	22.70 ± 4.47

Table No. 1.5: Pyruvic acid (µg/gm wet wt.) in tissues of *Bursa tuberculata* exposed to cadmium

Exposure Period (Days)	Control	Cadmium concentration (µg/l)	
		50	100
15	39.20 ± 3.30	29.60 ± 4.29	24.40 ± 6.14
30	37.80 ± 5.34	20.80 ± 2.68	18.40 ± 3.28

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Bioaccumulation of some heavy metals in indigenous fishes found in Vashi Creek and an insight on socioeconomic status of local fishermen

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Abstract : Fish constitutes an important and cheap source of animal protein to human beings and a large number of people depend on fish and fishing activities for their livelihood. Increasing human influences through heavy metal pollution have however, led to the depletion of our fish resources and substantial reduction in the nutritive values. The danger of these heavy metals is their persistent nature as they remain in the biota for long period of time when they are released into the environment. As a result of the heavy metal pollution several endemic fish species have become threatened. Realizing this, assessment of heavy metals in the tissues of fish species is increasingly gaining ground throughout the world.

Considering the above facts the current research was carried out at Vashi Creek. The creek is highly polluted and thus the fishes from this creek were selected which includes *Harpadon nehereus*, *Mugil* spp, *Terapon theraps*, *Mystus gulio*, *Macrobrachium idae*, *Clupeidae* and *Tilapia mossambica*. The fish muscle were tested for their nutritive value and presence of several metals like Hg, Pb, Cd, Cr, As, Ni and Fe.

Key words : Fish, Vashi creek, heavy metals, nutritive value.

Introduction

The pollution of the aquatic environment with heavy metals has become a world wide problem during recent years because they are indestructible and most of them have toxic effects on organisms. Among environmental pollutants, metals are of particular concern due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystems. The presence of heavy metals in aquatic ecosystems is the result of two main sources of contamination; natural processes or natural occurring deposits and anthropogenic activities. The main sources of heavy metal pollution to life forms are invariably the result of anthropogenic activities. In the fresh water environment, toxic metals are potentially accumulated in sediments and marine organisms and subsequently transferred to man through the food chain. Heavy metal concentration in aquatic ecosystems are usually monitored by measuring their concentrations in water, sediments and biota (Camusso *et al.*, 1995) which generally exist in low levels in water and attain considerable concentration in sediments and biota. Heavy metals including both essential and non essential elements have a particular significance in ecotoxicology, since they are highly persistent and all have the potential to be toxic to living organisms.

Essential heavy metals are absolutely required by an organism to grow and complete its life cycle, become toxic when its concentration levels exceed those required for correct nutritional response by factors varying between 40 and 200 folds (Venugopal *et al*., 1975). Meanwhile, some other metals such as Pb, Hg and Cd are toxic at quite low concentrations (Ogino and Yang, 1978;1980). Metal accumulation by marine organisms is influenced by a number of intrinsic factors such as size, age, sex, feeding behavior and growth rate and extrinsic factors as metal concentrations and speciation in surrounding waters, salinity, hardness and temperature (McCarty and Van Henry, 1978; Pastor *et al*., 1994). The main objective of this study was to evaluate the concentrations of heavy metals (Hg, Pb, Cd, Zn, Cr, As, Ni and Fe) in muscle tissues of seven fish species (*Harpadon nehereus*, *Mugil* spp, *Terapon theraps*, *Mystus gulio*, *Macrobrachium idae*, *Clupeidae* and *Tilapia mossambica*) collected from Vashi creek, Thane. The results obtained from this study would also provide information for background levels of metals in the water, sediments and fish species of the river contributing to the effective monitoring of both environmental quality and health of the organisms inhabiting the creek.

Materials and methods

Sampling

Sampling area was Vashi Creek. Seven samples of seven fish species were collected. The collection period was early post-monsoon. Fish samples were labelled, they were preserved using ice and transported to the main laboratory. Weighed muscle tissue was further pre-treated for estimation of heavy metals. The weighed wet tissue was also used for estimation of proteins and lipid.

Pre-treatment of Sample

Samples were thoroughly washed with sterile distilled water after removing the scales and muscle portion, which was taken for acid digestion.

Following methods were adopted for analysis of heavy metals and nutrients.

Table 1: Various parameters and methods of their analysis

Parameter	Method
Moisture Content	Evaporation
Protein	Follin Lowry
Total Lipids	Bligh and Dyer
Nickel	Atomic Absorption
Arsenic	Atomic Absorption
Chromium	Atomic Absorption
Iron	Atomic Absorption
Mercury	Atomic Absorption
Lead	Atomic Absorption
Cadmium	Atomic Absorption

Study of Socio-economic Status of Fishermen Staying in Vicinity of the Creek

A survey based on questionnaire was done to study the socioeconomic status of local fishermen staying in the vicinity of the creek.

Result and Discussion

While considering the heavy metals concentrations in fish species, the most important aspect is their toxicity to humans and their suitability for human consumption.

Nickel is found in all soils and is emitted from volcanoes. Nickel is used as an alloy in the steel industry, electroplating, Ni/Cd batteries, arc-welding, rods, pigments for paints and ceramics, surgical and dental prosthesis, moulds for ceramic and glass containers, computer components and catalysts (Bradi, 2005). At very trace levels, Nickel is considered as an essential trace element (Hussain, 1991 and Sivaperumal *et al.*,2007). It acts as an activator of some enzyme systems but its toxicity at higher levels is more prominent. High levels of Nickel can cause respiratory problems and it is carcinogenic (Sivaperumal *et al.*,2007; Ikema and Egieborb, 2005; ATSDR, 2005). According to WHO (1989), the maximum acceptable limit is 0.5-1.00 µg/g. The present study does not indicate any alarming concentration of Nickel (Table 3).

Arsenic has been recognized as a human poison for centuries. Ingestion of arsenic has been linked with skin, liver, bladder and prostate cancer. Humans are exposed to arsenic by eating food, drinking water and breathing air. Contaminated food is usually the largest source of arsenic. Marine organisms, especially shellfish, are known to contain relatively high concentrations of arsenic, while arsenic concentrations in freshwater organisms are much more variable (Cullen and Reimer, 1989). The present study indicates very low concentration of Arsenic (Table 3) in fish tissue and is safe to consume.

Chromium is a dietary requirement for a number of organisms. This however, only applies to trivalent chromium. Hexavalent chromium is very toxic to flora and fauna. The amount of dissolved Cr^{3+} ions is relatively low, because these form stable complexes. In natural waters trivalent chromium is most abundant. Hexavalent chromium is known for its negative health and environmental impact and its extreme toxicity. It is 1000 times more toxic than trivalent chromium. It is carcinogenic and causes allergic and asthmatic reactions. Health effects related to hexavalent chromium exposure include diarrhoea, stomach and intestinal bleedings, cramps and liver and kidney damage. Hexavalent chromium is mutagenic. Phytoplankton contains approximately 4 ppm chromium, sea fish contain between 0.03 and 2 ppm, and oyster tissue contains approximately 0.7 ppm (all values dry mass). Phytoplankton has a bio concentration factor of approximately 104 in seawater.

Table 2: Concentration of heavy metals in fish tissue in ppm

Name of Fish	Ni	As	Cr	Fe	Hg	Pb	Cd
Mugil spp.	4.3×10^{-5}	3.9×10^{-5}	6.7×10^{-5}	1×10^{-5}	1.7×10^{-5}	1.6×10^{-5}	1.2×10^{-5}
Harpadon nehereus	6×10^{-6}	4.2×10^{-5}	6×10^{-5}	3×10^{-4}	4×10^{-5}	4.5×10^{-5}	1.4×10^{-5}
Tilapia mossambica	2×10^{-5}	6×10^{-5}	8.2×10^{-5}	2×10^{-4}	7×10^{-5}	1.9×10^{-5}	6×10^{-6}
Macrobrachium idae	3.5×10^{-5}	3.1×10^{-5}	1.6×10^{-5}	3.2×10^{-3}	2×10^{-5}	4.2×10^{-5}	1.8×10^{-5}
Clupeidae spp	1.5×10^{-5}	2.2×10^{-5}	4.5×10^{-5}	2.1×10^{-3}	4×10^{-5}	5.6×10^{-5}	1.6×10^{-5}
Terapon theraps	1.8×10^{-5}	5.5×10^{-5}	2.1×10^{-5}	5×10^{-3}	1.5×10^{-5}	3.4×10^{-5}	$9.x 10^{-6}$
Mystus gulio	1.2×10^{-5}	4.5×10^{-5}	3.1×10^{-5}	2.1×10^{-3}	1×10^{-5}	4.8×10^{-5}	7×10^{-5}

In the present study the concentration of chromium was 0.06 ppm (Table 2) which is approximately near to the natural amounts present in the fishes. Therefore, it could be said that chromium concentrations did not indicate elevated exposure and uptake in fish.

Iron makes up about five percent of the earth's crust. It can be a soluble or relatively insoluble form found in water. Iron (Fe) is an indispensable element for the functioning of organs and tissues of higher animals, including fish, because of its vital role in oxygen transport and cellular respiration. Iron is also one of the most important micronutrients in terms of its effect on functioning of immune system and defense against various infections (Beisel, 1982; Bhaskaram, 1988). Fish can absorb soluble Iron from the water across the gill membrane and intestinal mucosa (Roedar and Roedar, 1968; Sealey *et al*., 1997). Iron plays a key physiological role in all aspects of animal's life; however, it causes deleterious effects on living organisms at supra-optimal concentrations (Davies, 1991; Misra and Mani, 1992). The present study reveals that the concentration of Iron is within supraoptimal levels (Table 2).

Most mercury contamination in human beings comes from eating contaminated fish. Mercury from the atmosphere deposits in water and a portion this is transformed into methylmercury which enters the aquatic food chain. Mercury is bioaccumulative and persistent in living organisms. It takes long time to decline. Methylmercury is highly toxic to mammals, including human and causes a number of adverse effects. Research and health studies claiming neurotoxicity of mercury; particularly in developing organisms are most abunbant. The mercury found in fish tissues during present study was very insignificant (Table 2) and fishes could be considered safe for consumption.

Lead is found in all parts of environment. However, excess amounts are released by human activities. The principal source of Lead in the marine environment appears to be the exhaust of vehicles run with leaded fuels that reaches the sea water by a way of rain and wind blown dust (Castro and Huber, 1997). When accumulates in the human body, it replaces calcium in bones. Lead exposure has been mainly related to retardation of neurobehavioral development (Lidsky and Schneider,2003; Castoldi *et al.* 2003). The European maximum residue limits permitted in fish is 0.3 µg/g for Lead, 0.1 to 0.3 µg/g for Cd (Herreros, 2008). From the present data, it is apparent that the Lead concentration in fish is also lower than permissible limits (Table 3) and safe for consumption.

Cadmium is rarely found in natural water (Hem, 1989). It is considered to be toxic if its concentration exceeds 0.01 mg/ L both in drinking and irrigation water (Taha, 2004). They are potentially toxic even at trace concentrations (Robert, 1991) and causes are high blood pressure, kidney damage, destruction of testicular tissue as well as destruction of red blood cells (Gupta and Mathur, 1983). The cadmium found in the fish tissue (Table 2) is still in a permissible value of Cadmium; 0.5 mg/ kg that was proposed by the Food and Agricultural Organizations (FAO, 1983) to be safe for human consumption.

Overall study indicates that though Vashi Creek is exposed to various sources of pollution from industries as well as road ways, the accumulation of metals in fishes is low. The reason could be the size of the fishes which indicates that they were young and smaller. As the samples were collected immediately after the monsoon, because of the dilution by the rain, the accumulation might have not been significant.

The nutrient analysis showed that *Clupidae* spp. has high protein content followed by *Mugil* spp. (Table 3). However, only 0.75 % was seen in *Harpadon neherius*. The proteins were also low in *Terapon theraps* and *Macrobrachium idae*. However, the reason for this could be the smaller size of fishes. The lipid content was very high in *Therapan theraps* and minimum lipids were found in *Macrobrachium idae*. The fishes like *Mugil*, *Tilapia*, *Clupeidae*, *Terapon theraps* are good in the calorific values.

Table 3: Proximate composition of fishes

Name of Fish	Length (cm)	Weight (gm)	Moisture %	Protein %	Lipid %	Calorie %
Mugil spp.	15.5	50	70	10	6.6	460.71
Harpadon nehereus	21.9	50	87	0.75	3	41.73
Tilapia mossambica	11.9	15	75	6.8	2.7	150.57
Macrobrachium idae	23.9	17.5	80	2.7	1	59.12
Clupeidae spp.	15	45	74	11	1.1	213.18
Terapon theraps	9.5	22.5	81	2.2	9.4	128.01
Mystus gulio	9.5	22.5	78	3.2	1.3	76.67

Socioeconomic Status

Generally the fishermen are characterized by low living standard and hence belong to the weaker sections of the society. They are mostly illiterate and unaware of the government policies regarding fisheries. The daily income they get is spent on liquor which has adverse effect on their livelihood. A preliminary survey was conducted on fishermen residing in around Vashi creek indicated that about 15% of the fishermen were involved only in fishing as their only source of income. 60% of them were less than SSC qualified with 33% earning less than rupees 5000 per month and 67% with more than rupees 5000 per month. 41% were found to be the only earning member in family. Going through such hardship with no government help the fishermen were also found to suffer with swelling, wounds and skin disease.

Conclusion

The results of this study revealed that consuming fish from the Vashi creek is still safe to consumers because observed values of heavy metals were within the permissible limits issued by FAO/WHO for human consumption. However, as the present study was for a limited period with small sample size, it cannot give exact scenario and hence more intensive study is needed in order to determine the bioaccumulation of heavy metals in fishes from the study area.

The fishermen are hard working but need special attention for the up-liftment of their socio-economic status. Some mitigation strategies must be made for the fishermen from such potential area as well as NGOs should take initiative to support them.

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Macro - Benthos of Tidal Ponds at Kandalvan along Eastern Suburb of Mumbai

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Abstract : The tidal ponds in the midst of mangrove forest at Kandalvan located along Thane creek forms a good breeding and feeding ground for various marine life and migratory birds like flamingos. The study of macro-benthic organisms play an important role in deciding the ecological status of any aquatic body. The benthic macro-fauna collected from two sites of study area for a year on monthly basis has been studied to understand its importance to maintain the ecological balance of the area forming prime food for marine life and resident as well as migratory birds.

Key words : Mangrove forest, Tidal ponds, Macro-Benthos, Flamingos

Introduction

In the last few decades the economic value and significance of wetland was recognized due to many direct and indirect benefits to the society. They support plant, animal, human life and preserve environmental balance. Still the wetlands are under constant threat. Environmentalists have begun showing their concern and have expressed anxieties about the damages being done to flora, fauna and the environment.

The Thane creek along eastern suburb coastline of Mumbai has a vast patch of diversified mangrove forest. The creek (Long. $72^0$55' to 73000' E, Lat. $19^0$00' to $19^0$15' N) is 26 km long, connected to Arabian Sea on its South. The regular inundation of tidal waters from the creek in mangrove forests for years led to the formation of ponds in the midst of the habitat with variety of flora and fauna, which are utilized for fishing activities by local fishermen. Such tidal ponds exist in the mangrove forest along the eastern coast of Mumbai and in neighboring parts of Mumbai viz. Mulund, Nahur, Bhandup, Kanjur and Vikhroli along eastern suburbs coastline and neighbouring places like Thane, Vitava, Airoli, Diva, Gothavali, Ghansoli, Koparkhairane, Vashi, Mahul, Turbhe, Uran, Alibag and Shabaz. The establishment of tidal ponds at various places along the mangrove patches mentioned has been a good source of income for fishermen in the area. Thus tidal ponds in mangrove ecosystems turned out to be integral part of local fishermen's life and also form structural and functional unit of the entire mangrove ecosystems.

Location

For the comprehensive study on fish farms located in the natural habitat of mangrove forest, the selected area is a part of the mangrove ecosystem, locally known as **"Kandalvan" at Mauze - Bhandup,** the Eastern suburb of Mumbai 400 042, lying along the Western bank of Thane creek. It covers almost 94.92 hectares of mangrove area. (Survey No.1049). The map of Mumbai (Fig. - Plate 1) also gives the exact location of study area. Two distinct sites are demarcated in the area. The Site 1 is about 0.5 km. away from the creek shore line and the Site 2 is about 2.5 km. away from the creek. The total area covered by 17 Ponds at Site 1 is about 42.6 hectares and that by 6 Ponds at Site 2 is about 11.5 hectares. Out of total 23 Ponds in the vicinity, two such ponds have been selected for detailed studies representing two sites .Pond 1 and Pond 2 represent site 1 and site 2 respectively

Kandalvan at Mauze Bhandup is a tidal forest located at the interphase between land and creek, represents a typical **"Mangrove ecosystem"** having a tidal water source from Thane creek. It is an ideal place for the establishment of mangrove vegetation as the area receives water every fortnight from Arabian Sea due to tidal actions and the fresh water flow from Ulhas river as it joins Thane creek. The study area is a vast expanse of mangrove habitat, selected from creek bank towards terrestrial land up to Eastern Express Highway covering a distance of nearly 3 km.

Benthos

Kandalvan produces large amount of litter in the form of falling leaves, branches, seeds etc. of mangrove trees. The decomposition of the fallen parts by the micro-organisms found in the muddy bottom contributes to the production of organic matter. The biomass of micro-organisms along with organic matter is known as **'detritus'**. Pond bottoms are thus enriched with detritus regularly brought in by the tidal water. During the process of formation of detritus the nutrients are regenerated and released which enrich the surrounding water and soil components of ponds.

Soil is a key factor regulating elementary cycles of an eco-system. Soil of this region is silty – clay type having good water retention capacity. The texture of soil at both

ponds was silty-clay, as it was more of silty nature. At Pond 1 the percentage of silt and clay was 61% and 35% respectively. But Pond 2 showed the 10% higher silt composition and lower clay composition than at Pond 1 may be due to its proximity to Express Highway.

Benthic organisms play an important role in regulating and maintaining the detritus food chain of pond eco system. Predominant species of macro benthos such as crustaceans, molluscs and annelids were studied in the area.

The green alga *Enteromorpha* growing in this region predominantly forms an important constituent of food for herbivores.

Materials and Methods

The collection of mud samples were done randomly from five different areas of ponds with the help of metal scoop 10 cm. x 10 cm. x 5 cm. The general procedure followed for the collection and processing of macro-benthos was as per the recommendations of Holmes (1971). All samples were pooled together and 10% $MgCl_2$ was sprinkled to narcotize the macro fauna. The sample was drained through the fine mesh sieve of 0.4 mm to collect macro fauna. The fauna collected was preserved in 10% formaldehyde isotonic solution. Other macro-benthic fauna was collected by hand net. The preserved fauna was then separated, identified and individual abundant species were counted and their density per m^2 was calculated. Identification of polychaetes was done from **"The Fauna of India including Pakistan, Ceylon, Burma and Malaya"** by **Pierre Fauvel**, Crabs from **"Marine Crabs of Bombay State"** by **B. F. Chhapgar** and Mollusks from **"Shells of Bombay**" by **Deepak Apte**.

Result

Macro-benthic fauna of ponds

Benthic community of ponds was analysed to establish ecological status. The macro faunal composition included mainly 4 forms i.e. polychaete worm *Nereis chingrighattensis*, bivalves *Sphenia sowerbyi* and two gastropods belonging to family Potamididae namely *Potamides (Cerithidium) cingulatus* and *Telescopium telescopium.* Their population density in numbers/m2 has been presented in Table 1.These species occur predominantly in the area throughout the year.

Table 1: POPULATION DENSITY (no. /m^2) OF MACRO-BENTHIC FAUNA AT POND 1 AND POND 2

Seasonal Collection	Nereis chingrighattensis		Sphenia sowerbyi		Potamides cingulatus		Telescopium telescopium	
	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2
Monsoon								
i	4	6	198	42	98	21	12	3
ii	3	5	210	58	122	19	15	5
Iii	5	8	264	62	148	25	17	6
Monsoon Avg.	4	6.3	224	54	122.7	21.7	14.7	4.7
Post-monsoon								
i	9	11	416	92	196	37	26	8
ii	10	13	482	116	224	51	30	10
iii	8	10	512	142	272	48	34	7
Post-monsoon Avg.	9	11.3	470	116.7	230.7	45.3	30	8
Pre–monsoon								
i	7	10	380	124	202	35	24	6
ii	8	9	342	92	164	32	20	4
iii	5	7	208	74	128	27	18	1
Pre-monsoon Avg.	6.7	8.7	310	96.7	164.7	31.3	20.7	3.7
Yearly average	6.5	8.8	334.7	89.1	172.7	32.7	21.7	5.5
Percent Composition	1.2	6.5	62.5	65.5	32.2	24.0	4.1	4.0

Macro-benthos of pond soil was typically represented by bivalves and gastropods. They reproduced extensively as their juveniles were plentifully spread out in the substratum which provided favourable environment to grow. The density of tiny bivalve *Sphenia sowerbyi* ranged from 198 to 512 /m2 at Pond 1 and 42 to 142/m2 at Pond 2, their number being more in Pond 1 area. Similarly gastropod like *Potamides cingulatus*, showed high density ranged from 98 to 272 /m^2 in Pond 1 and 31 to 62 /m^2 in Pond 2. Both the above mentioned species were spread out more or less uniformly on the surface of the bottom, whereas *Telescopium* species was distributed in patches and in very few numbers along the embankment of the ponds. Its presence in very few numbers around Pond 2 in summer indicated that it was sensitive to both higher salinities and temperature. The polychacte worm *Nereis chingrighattensis* were seen in muddy bottom as blood red colour worms but in very few numbers ranging from only 3 to 11 No. /m2 in both the representative ponds.

Occurrence of *Sphenia sowerbyi* in muddy shore line of Thane creek has been reported by Athalye (1988), *Potamides cingulatus* also occurred in high densities in these areas as reported by Deshmukh (1989). The occurrence of *Potamides* and *Telescopium* along West Coast of Mumbai has been recorded in mangroves of Versova where they were observed in large numbers (Pereira, *et al*, 2002). They have reported *Telescopium* species was particularly found in the areas where water content in the soil was high. Hence *Telescopium* was found in more numbers in Site 1 than Site 2 area because of proximity to the creek. As all these species are well adapted to both higher salinities, temperatures and available mangrove detritus, they grow in very high densities. In turn they form forage organisms for higher trophic level carnivores. *Sphaenia* measured from 6 to 8 mm. *Potamides* ranged from 9 to 17 mm. whereas *Telescopium* was seen as conical shells measuring 80 to 100 mms. The empty shells of these molluscs were seen scattered along the substratum and bunds where the water from ponds was drained out.

Other macro-benthic faunal composition in and around the ponds

Arthropods

Crabs – *Uca marionis, Scylla serrata, Sesarma quadrata*

Prawns – *Penaeus indicus, Penaeus monodon, Metapenaeus monoceros*

Molluscs

Pelecypods - *Katalysia opima, Arca granosa, Cardium species, Placenta placenta*

Gastropods - *Nerita sps., Natica sps.*

Pisces

Family Gobiidae *: Boleopthalmus dussumieri*

Fishery in the area

Among crustacean benthos three species form the major fishery in the area namely *Metapenaeus monoceros*, *Indomysis annandalei* and *Scylla serrata.*

Out of these three Opossum shrimps *Indomysis annandalei* forms the popular small scale prawn or mysid (kolim) fishery in the area. Fishermen harvest substantial biomass of mysids from the ponds using simple hand net during their peak period of occurrence from December till February. Kolim is the favorite sea food of fishing community and is consumed fresh and sun dried. Due to continuous exploitation the gradual reduction in the biomass of mysids has been noticed in this area since long.

It is very interesting to know why the migratory birds like flamingos regularly visit this green belt. They are selective in their diet and mangrove forest and the ponds provide them rich supply of food as well as shelter.

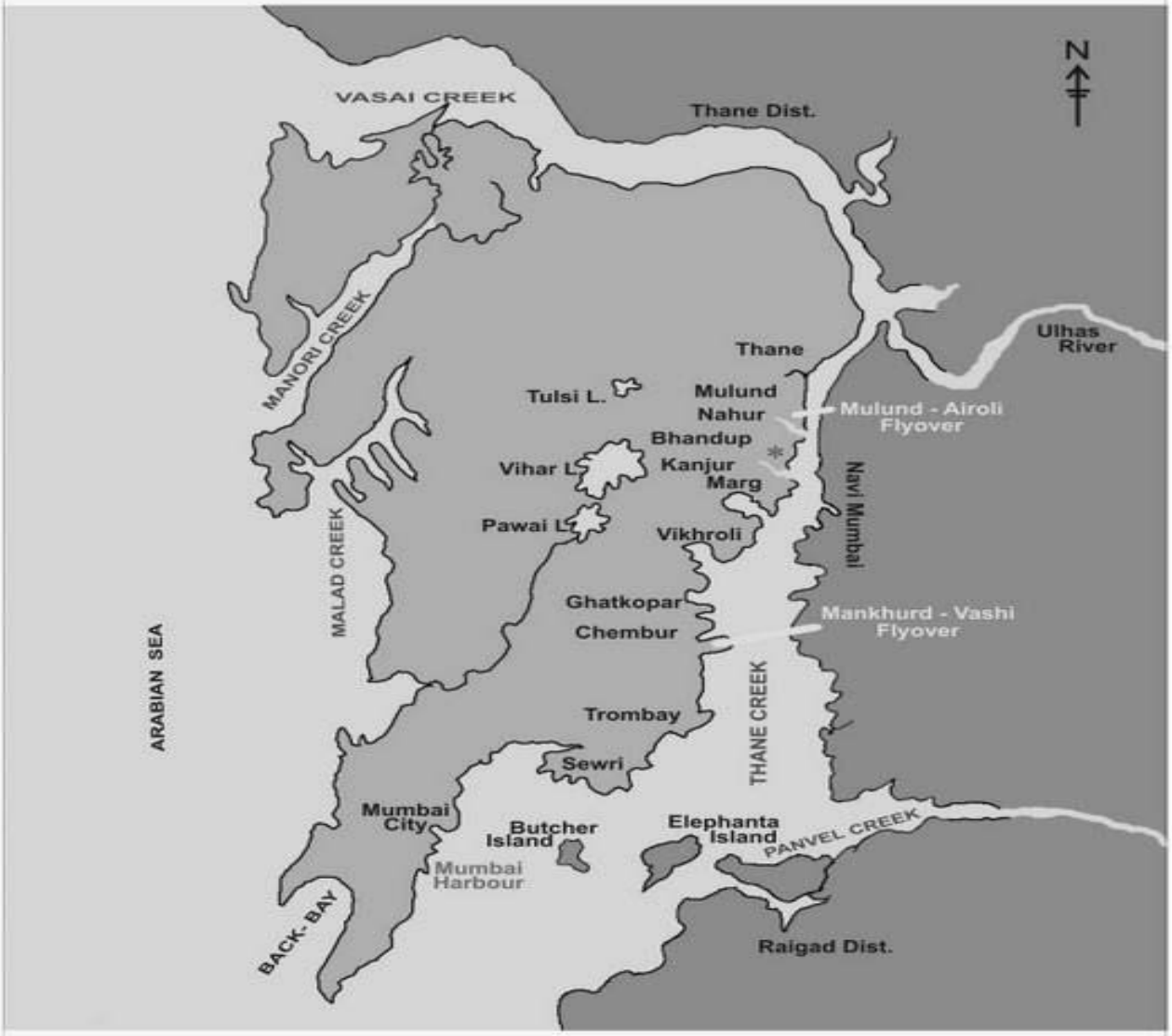
The appearance of mysid swarms of *Indomysis annandalei* in Thane creek and neighbouring tidal ponds particularly coincides with the presence of flamingos to visit these areas. Mysids undergo vertical migration in shallow pond waters during day time as they are sensitive to temperature so that their biomass is easily available for flamingos and other wading birds to strain through the muddy bottom. After the death and decay of mysids, they form an important part of organic ooze. In addition to rich organic ooze and green algae at the muddy bottom, the juveniles of gastropods like *Potamides cingulatus* and of bivalves like *Sphenia sowerbyi* are available in large numbers (Photo-plate).

Conclusion

The macro-benthic fauna of ponds were mainly contributed by the molluscan forms. Density of the bivalve *Sphenia sowerbyi* and that of gastropod *Potamides cingulatus* was the highest. The growing *Enteromorpha* on the substratum and the detritus of ponds was the suitable environment for these species to reproduce and grow. Hence both the species are proliferated in large numbers in this area forming a good food for resident as well as migratory birds. Particularly Opossum shrimps are also good attraction for migratory birds like flamingos. It is noteworthy to mention the number of nereid worms is minimal indicating good quality of water in ponds.

Fig. - Plate 1

LOCATION MAP ALONG THANE CREEK



* STUDY SITE - AT MAUZE BHANDUP

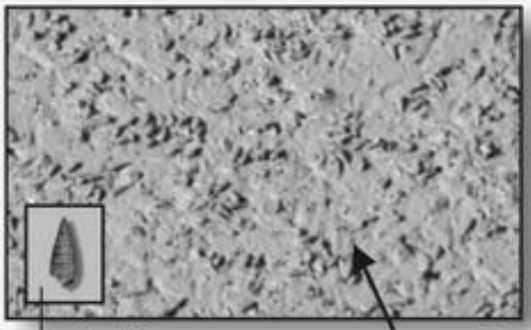
Photo - Plate

BENTHIC FAUNA OF PONDS

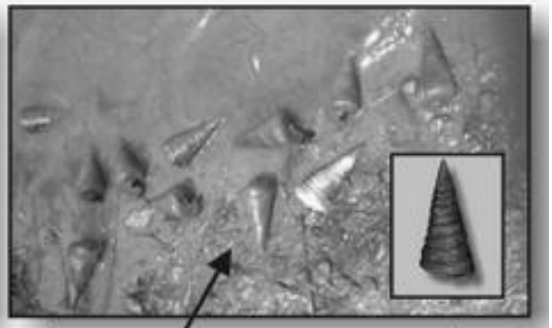
Polychaete worms – *Nereis chingrighattensis*

Boleopthalmus dussumieri

25mm



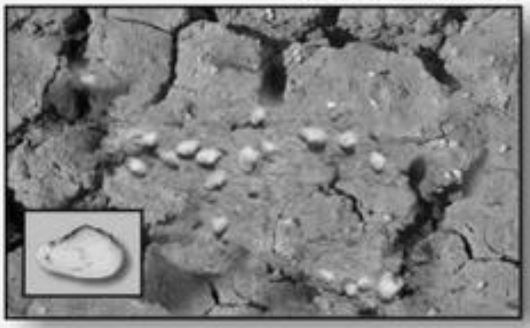
actual size



Gastropods

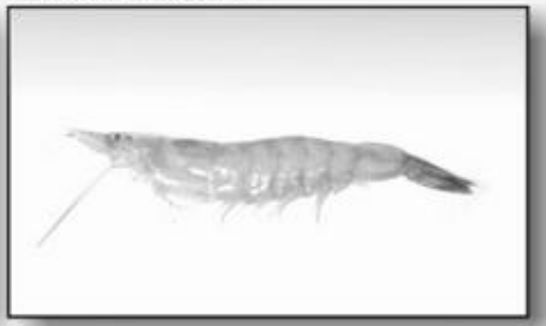
Spread of *Potamides* & *Telescopium* along pond 1

50mm



Pelecypode actual size

Sphenia sowerbyi (local name - Khubri)



Metapenaeus monoceros actual size

Scylla serrata

25mm

Iron bar used for collection of crabs

Scylla serrata collection

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Bivalve and Gastropod Diversity of Borli Coast, Dist. Raigad, Maharashtra

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Abstract : Borli, a small village in district Raigad dominated by fisherman community has about 2 km long rocky shore rich in Molluscan fauna. It is almost a virgin shore as there is little scope for tourism here. Fishermen's activity is found to some extent. Yet, conservation of molluscan fauna is essential and for this baseline data needs to be prepared. The current paper aims at highlighting abundance of various molluscan species season-wise. The year long study envisages recording of seasonal variation in occurrence of Bivalves and Gastropods. The results showed the inhabitance of 7 bivalves with dominance of *Crassostrea* spp. and 30 gastropods with maximum number of *Planaxis sulcatus*. Abundance of these two species was observed to be almost round the year.

Key words : Molluscan fauna, *Crassostrea, Planaxis*

Introduction

The long coastline of Peninsular India provides innumerable opportunities to study infinite aspects of marine biodiversity. The west coast of India has always augmented the research interests of scientists' fraternity as the varied topography supports diversity of life forms. Exploration of marine biodiversity has been focused on the coasts of Sindhudurg, Malwan and Ratnagiri in Maharashtra and Goa (*Apte, et. al.* 2012). Studies have also been carried out along the coast of Mumbai (*Datta, et. al*. 2010) however minimal studies have carried out along the Raigad coast.

Study Location

Borli (18° 30' N, 72° 50' E) a small coastal village in Murud Taluka about 20 kms from Alibaug has a 2 km long rocky coastline with few a sandy patches. A rocky shore being biologically rich niche, is ideal for studying inter tidal ecology. The phylum Mollusca is the largest of all phyla, inhabiting inter tidal zone. Borli coast is an ideal location to study the vast molluscan diversity owing to the superlative conditions for their survival.

The diversity and variation in molluscs of the shoreline between Alibaug and Murud need to be documented for the purpose of the conservation and education to quantify the impact of anthropogenic activities upon them.

Materials and Methods

Empty shells were collected for identification. Collected shells were brought to the laboratory and brushed to clean. Animals present in large numbers were collected and preserved in 6% formalin in glass bottles. Animals present in smaller number were photographed to avoid ecological damage. Identification of shells was done using identification keys.

The study location was visited once a month during low tide from June 2012 to May 2013. Water sample was collected and analyzed to assess the quality of water. The species abundance was studied by quadrant method ($1m^2$ quadrant). The diversity of the species was then assessed on a scale of 1 to 10 depending on their abundance. Scale 10 indicates abundance while scale 1 shows scarce presence. Other figures from 1 to 10 show minimum to maximum abundance.

Results and Discussions

Table 1: The seasonal variations in water parameters of Borli coast

Parameters	Monsoon	Early post-monsoon	Late post-monsoon	Pre-monsoon
	(June, July, Aug)	(Sept, Oct, Nov)	(Dec, Jan, Feb)	(Mar, Apr, May)
Temp °C.	24.8	25.2	22.6	28.5
Dissolved Oxygen	5.95	6.5	7.3	6.5
pH	8.3	7.79	8	8.5
Total Solids gm/L	19.02	17.03	16.85	18.4
Chlorides gm/L	17.49	17.94	17.49	19.084
Salinity ppt	31.59	32.42	31.59	34.47
Phosphates mg/L	3.2	0.75	0.9	3.2
Nitrates mg/L	19	1.12	14	2.9
Nitrites mg/L	6	9.1	11	2
Ammonia mg/L	4.71	3.6	3.49	5.04
Sulphates mg/L	1900	2499	2600	2750
Silicates mg/L	20.52	26.27	18	15.4

The quality of water remained almost stable and didn't show significant fluctuations during the study period. The sea water could sustain a healthy ecosystem throughout the study period and only nitrite and ammonia exceeded the prescribed limits.

Total 37 species of molluscs belonging to 30 genera, and 25 families were recorded. 7 species of Bivalvia and 30 species of Gastropoda were listed from the inter tidal zone during low tide.

Crassostrea spp. was the most abundant from class Bivalves while *Planaxis sulcatus* was the dominant Gastropod. *Crassostrea spp* are found to be dominant along the Indian coastline (*D. Mohan, et. al.* 2013) also *Crassostrea spp* are known to be highly adaptable and can survive even in waters polluted by heavy metals (*Baheerathi and Revathy*, 2013). *Planaxis sulcatus* is found to be abundant on most of the rocky beaches of Southeast Asia (*Rahman and Barkati*, 2004). Among other bivalves; *Pittar spp* and *Gafrarium spp* showed considerably large in number while other species were abundant only in late post-monsoon period. In remaining gastropods, *Nerita oryzarum* were numerous followed by *Astrea stellata* during almost all seasons but predominantly, in late post-monsoon and pre-monsoon periods. *Tibia spp* and *Torinia spp* represented in very small numbers in almost all the seasons but were negligibly small in number in early post-monsoon period. The overall finding states abundance of molluscs during late post-monsoon and pre-monsoon periods and meager presence during monsoon and early post-monsoon periods. The scarcity during monsoon could be attributed to vigorous tidal movements.

The abundance of Molluscan life forms was maximum during the Post-Monsoon period as the nutrients during that season were sufficient and also concentration of solids during the post monsoon period facilitates the propagation of filter feeders (*Beasley, et. al.* 2005).

Table 2: Seasonal variation of fauna at Borli Coast

Sr. No.	Fauna	Monsoon	Early post-monsoon	Late post-monsoon	Pre-monsoon
		(June, July, Aug)	(Sept, Oct, Nov)	(Dec, Jan, Feb)	(Mar, Apr, May)
	Bivalves				
1	*Arca torcusa*	2	1	2.3	1.8
2	*Crassostrea* spp.	8.7	6	6.6	7.1
3	*Gafrarium divaricata*	2.3	1	3.1	2.1
4	*Paphia* spp.	0.7	0	2.6	1.1
5	*Sunetta s*pp.	1	1.3	3.4	1.9
6	*Pittar s*pp.	1.3	2	4.1	2.5
7	*Gastrana s*pp.	0.3	2.3	4.2	2.3
	Gastropoda				
1	*Bursa tuberculata*	4	2.7	5.9	4.2
2	*Cantharus spiralis*	2.3	5.3	6.6	4.7
3	*Cantharus s*pp.	3	3.7	6.6	4.4
4	*Cyprea grayana*	3.3	4.7	7.3	5.1
5	*Cyprea maculifera*	2	2.3	6.4	3.6
6	*Cerithidium rubus*	3.3	4.3	7.9	5.2
7	*Cerithium morus*	3	5	8.3	5.4
8	*Astrea stellata*	6	6.7	9.2	7.6
9	*Deodora s*pp.	1.3	4	8.1	4.5
10	*Hemifusus pugilinus*	0.7	1	7.2	2.9
11	*Natica picta*	2	2	8.3	4.1
12	*Natica rufa*	3.7	2.3	9.3	5.1
13	*Natica albicilla*	2.7	2.3	9.3	4.8
14	*Nerita chamaeleon*	2.7	3.3	10	5.3
15	*Nerita oryzarum*	7	6.7	9.7	8
16	*Nerita* spp.	2.3	5.5	8.3	6.4
17	*Planaxis sulcatus*	9.3	7.7	9.9	8.9
18	*Potamedes* spp.	5.3	5.3	8.9	7.9
19	*Pyrene s*pp.	1.3	1	9.4	4.3
20	*Thais carnifera*	0.7	1	1.6	4.1
21	*Tibia* spp.	1	0.7	0.9	4.2
22	*Torinia doruosa*	1	0.3	1.1	4.2
23	*Trochus radiates*	1.7	2	2.2	5.3
24	*Turbo brunneus*	3.3	1.7	1.3	6
25	*Turris* spp.	1.3	0.7	2.3	4.8
26	*Nassarius* spp.	1	0.3	4.4	4.6
27	*Conus* spp.	1.3	1	3.1	5.2
28	*Clavus javana*	1.7	1	3.6	5.4
29	*Celina radiate*	1.3	1	3.8	5.4
30	*Surcula javana*	2	0.3	4.1	5.5
	Total	97.8	99.4	211.3	175.9

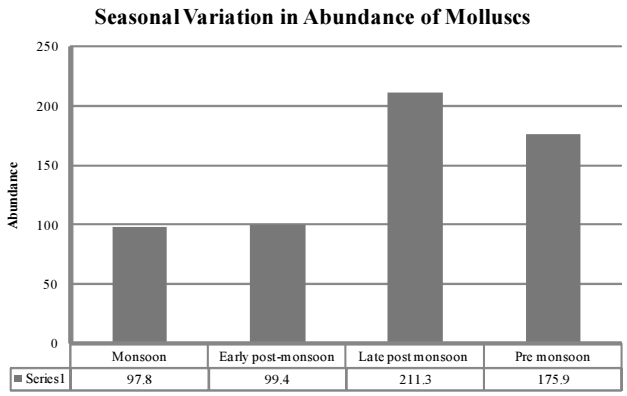

Fig.2: Seasonal variation in Abundance of Molluscs

Conclusion

Year long study of Borli Coast showed 7 species of Bivalves and 30 species of Gastropods. The increasing tourist activity at nearby beaches and rapid urbanization along the coast emphasizes the need for conservation by application of stringent laws and regulations. To invite tourists or to accommodate them, resorts and hotels are being constructed along the coast. This construction activity is likely to pose threat to the biodiversity of Borli coast. Strict implementation of the provisions of Coastal Regulation Zone should be considered to prevent any impact of the anthropogenic activities on the coastal ecosystem.

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Pollution Status in Mangrove Ecosystem of Mahi and Dadhar River Estuaries

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Abstract : Mangrove forests are extremely important coastal resources, which are vital to our socioeconomic development. However, they are often considered as uncreative land and used as discharge ground for pollutants. The Gulf of Khambhat and coast of south Gujarat had reasonably good mangrove cover in the past but the ecosystem has degraded due to development activities. The present study was carried out in four mangrove sites located along the Mahi and Dadhar river estuaries; Sarod, Neja, Asarsa and Dahej. Due to estuarine and gulf hydrodynamics and sediment composition mangrove forests have high organic load, both suspended and dissolved. The organic matter in the form of industrial effluent add to the total organic load of the mangrove ecosystem in this region. In present study COD of water ranges from 768 to 18.12 mg/l while sediment COD ranges from 233 to 15 mg/l. Level of phenolic compound ranges from 10.26 to 0 mg/l in water and sediment from 4.7 to 0 mg/l in sediments. Mangrove litter degradation add to natural phenolics in water and sediments, however, in present studies higher phenolic levels were due to pollution discharges in the gulf. Heavy metals like Cu, Zn, Cr, Ni, Pb, Hg, Cd, Co and Mn were recorded from the water and sediment samples of the studied mangrove ecosystems. Heavy metals like Cu, Zn, S, Si, Sr, Ti and Br were recorded from the root, stem and leaves of *Avicennia marina* samples also while, Cu, Zn, K, Fe, Sr and Br were recorded from samples of crab tissue. The status of over all pollution and its effect on crab population is discussed.

Key words **:** Metal pollution, Mangrove, Brachyuran Crab, Mahi-Dhadhar Estuary

Introduction

Mangrove forests are extremely important coastal resources, which are vital to our socio-economic development. Extraordinary capacity of the mangrove habitat sediments to accumulate large amount of pollutant make them a favorable ground for the effluent disposal by industries. Although mangrove ecosystems can act as sinks for pollutants, they can also become pollution source. Various kinds of the pollutants, from the industries and sewage, are accumulated in the mangrove swamps changing bio-physical environment of the habitat and consequently the floral and the faunal diversity change at the faster rate. Gujarat always had good and flourished mangrove cover along the coast but during past two decades this extensive and diverse ecosystem had degraded due to one or other developmental activities. Mangrove were considered as 'Economically Unproductive Areas' and suffered massive loss (Hirway and Goswami, 2007). Benthic systems are enriched by the deposition of organic matter and the primary production at the water-sediment interface. So importance of COD in sediment is more for mangrove (Wang et al., 2010; Gandaseca et al., 2011; Deshkar et al., 2012). Mangrove water, having low penetration of light, high salinity, high turbidity and high microbial activities, has high concentration of phenolic compound, like tannin, that leaches from mangrove's litter, but the problem arises when artificial phenolic compound are introduced in the water through pollution discharge (Labunska et al., 1999; Sebastian 2002; Deshkar et al., 2012). Mangrove roots often act as barrier, retain most of the heavy metals and reduce the translocation of heavy metals to other plant parts. Heavy metal level can also act as indicator to other pollution in the mangrove ecosystem (Mateu et al., 1996; Labunska et al., 1999, Kathirasen, 2002, Machado et al., 2002; Mermi and Machiwa, 2002; MacFarlane et al., 2003; Agoramoorty et al., 2008; Kumar et al., 2010; Ahemad et al., 2011; Kumar et al., 2011; Kamaruzzaman et al., 2012).

Present study sites are located in Gulf of Khambhat which is trumpet shaped gulf of the Arabian Sea, projecting northward the coast of Gujarat state, western India, between Mumbai and the Saurashtra Peninsula. The Gulf is characterized by a number of large and small estuaries. Many rivers, like Sabarmati, Mahi, Narmada and Tapti, have their river mouth in the Gulf of Khambhat. The Golden Chemical Corridor of Gujarat is located along the Gulf of Khambhat and thus poses environmental hazards. Over the past three decades the Gulf ecosystem has been conspicuously influenced by developmental activities, therefore, this area was selected to evaluate the pollution status of mangrove ecosystem.

Material and Methods

Study Sites: Sarod (22°10'31.12"N & 72°45'18.49"E) and Neja (22° 9'2.00"N & 72°33'3.10"E) are situated in Mahi river estuary while Asarsa (21°53'53.75"N & 72°34'56.43"E) and Dahej (21°43'13.50"N & 72°31'42.90"E) are situated in Dhadhar river estuary. Sarod, Neja and Asarsa falls in Jambusar taluka while Dahej falls in Vaghra taluka of Bharuch district.

Methodology selected and the studies carried out are divided in to field surveys, sampling and data collection

and laboratory analysis for abiotic and biotic components. The site entry point was taken as middle point and workable area was extended to 500 meter on both sides. Sediment, water and biotic data were collected in July, December and April for two years to have complete idea of structure and pollution stress in the ecosystem. For heavy metal analysis sediment, water, mangrove and crab samples were collected once in study period. Determination of chemical oxygen demand and phenolic compounds in sediment leachet and water were carried out by APHA (1999) standard methods. Heavy metals in water, sediments, mangrove and associated fauna were measured by Energy Dispersive X-Ray Florescence Spectrometer (EDXRF Spectrometer).

Random quadrate of 5 m^2 were laid in the study area to assess mangrove density while quadrates of 0.25 m^2 size were laid to assess crab burrow density. Statistical analysis was carried out by Spearmen Correlation of Biotic and Pollution Components in Microsoft Office Excel program. One way ANNOVA was carried out to know whether there is any correlation of biotic and pollutant components between sites. Bray-Curtis similarity analysis was carried out to find out similarity of diversity of associated fauna among the sites. This analysis was done in PAST software.

Results and Discussion

The description of study sites is presented in Table 1. An overall analysis suggests that there is a high level of pollution and lowest mangrove density at Sarod as compared to other sites.

Chemical Oxygen Demand (Figs. 1.1, 1.2)**:** The chemical oxygen demand is based on the chemical decomposition of organic and inorganic contaminants, dissolved or suspended in water. Many scientists have worked on the aspects of chemical oxygen demand (COD) of water of mangrove ecosystems. Gandaseca et al. (2011) studied water quality in Sibuti Mangrove (Malaysia) and reported COD ranging from 7.5 to 2.5 mg/L. Wanga et al., (2010) studied water quality of mangrove of Zhangjiang Estuary (China) and reported variation of COD in March (2.0 mg/l), June (1.25 mg/l), September (0.50 mg/l) and December (0.60 mg/l). In present study COD of water ranges from 768 mg/l (Sarod site, July'10) to 18.12 mg/l (Asarsa site, April'12) with cumulative average of 265.55 mg/l of all sites. Mean COD value (Fig.1.1) was observed to be higher at Sarod, 624.74 mg/l, as compared to other sites but the mean variation between the sites was not significant (ANOVA F=132.34 , Fcrit = 3.09 P> 0.5). At the value of COD 768 mg/l average mangrove density and burrow density at Sarod were observed to be 0.33 mangroves/ m^2 and 1.2 burrows/ m^2 respectively. While at the value of COD in water 18.12 mg/l average mangrove density and burrow density at Asarsa were observed 4.20 mangroves/ m^2 and 32.70 burrows/ m^2 respectively. Mangrove density showed significant negative correlation with COD at Sarod (r= 0.75) while non significant negative correlation was observed at Dahej (-0.18). Mangrove density showed non significant positive correlation with COD at different sites like Neja (r= 0.06) and Asarsa (r= 0.12). Average burrow density showed significant negative correlation with COD at sites Sarod (r= 0.83) and Dahej (r= 0.61) while Average burrow density of Neja(r= 0.56) and Asarsa (r= 0.88) showed positive correlation with COD.

Table 1: Description of study sites and their qualitative status

No	Parameter	Sarod	Neja	Asarsa	Dahej
A	**Location**				
1	N	22°10'31.12"	22°8'52.57"	21°57'10.28"	21°42'51.39"
2	E	72°45'18.49"	72°33'54.19"	72°35'32.55"	72°34'57.98"
3	Estuary	Mahi	Mahi	Dadhar	Dadhar
4	Taluka	Jambusar	Jambusar	Jambusar	Bharuch
B	**Mangrove Patch**				
5	Type	Sparse	Open	Open/Dense	Dense
C	**Mangrove Status**				
6	Avg. Density (m2)	1.94	19.83	25.11	18.00
D	**Associated Faunal Status**				
7	Avg. Burrow Density in LZ (m2)	0.87	22.35	32.77	17.20
8	Avg. Burrow Density in UZ (m2)	0.82	34.57	52.07	32.72
9	Total number of Faunal Species	2	30	40	36

E	**Sediment Pollution Status**				
10	Avg. Chemical Oxygen Demand (mg/l)	207.70	43.20	21.83	2
11	Avg. Phenolic Compounds (mg/l)	3.78	0.48	0.02	0.16
12	Total Heavy Metals (mg/l)	3.69	0.42	0.03	0.34
F	**Water Pollution Status**				
13	Chemical Oxygen Demand (mg/l)	624.74	289.49	28.53	23
14	Phenolic Compounds (mg/l)	7.37	1.31	0.03	0.31
15	Total Heavy Metals (mg/l)	7.87	1.72	0.2	0.7
G	**Heavy Metal Status in Biotic Components**				
16	Mangrove Root (%)	2.82	1.24	1.72	1.84
17	Mangrove Stem (%)	1.11	2.76	1.64	2.63
18	Mangrove Leaf (%)	4.83	4.08	3.64	3.23
19	Crab (%)	1.44	0.83	0.50	0.83

In present study COD of sediment, ranges from 233 mg/l (Sarod site, December'11) to 15 mg/l (Asarsa site, July'10) with cumulative average of 89.25 mg/l of all sites. Mean COD value of sediement (Fig. 1.2) was observed higher at Sarod, 207.70 mg/l, as compared to other sites but the mean variation between the sites was not significant (ANOVA F=257.30, Fcrit= 3.09 P>3.86). At the value of COD of sediment 233 mg/l, average mangrove density and burrow density at Sarod were observed to be 0.47 mangroves/ m^2 and 1.2 burrows/ m^2 respectively. While the value of COD in water was 15 mg/l, average mangrove density and burrow density at Asarsa were observed to be 4.60 mangroves/ m^2 and 51.55 burrows/ m^2 respectively. Mangrove density showed significant negative correlation with COD at Sarod (r = 0.63) while non significant negative correlation was observed at Asarsa (r = 0.04). Mangrove density showed significant positive correlation with COD at Dahej (r = 0.81) while non significant positive correlation was observed at Neja (r = 0.01). Average burrow density showed non significant negative correlation with COD at Sarod (r = 0.35) and Asarsa (r = 0.03) while Average burrow density showed significant positive correlation with COD at Neja (r = 0.63) and Dahej (r = 0.81).

Phenolic Compounds (Figs. 1.3, 1.4): Mangrove water, which having low penetration of light, high salinity, high turbidity and high microbial activities, has high concentration of phenolic compound that has leached from mangrove's litter. This concentration of natural phenolic compound is good, as scientists suggested but the problem arises when artificial phenolic compounds are introduced in the water through pollution discharge. Labunska et al. (1999) found Alkyl phenol derivatives in samples collected at Sarod. Deshkar et al. (2012) studied three estuaries in Gujarat and found that in Mahi estuary the level of phenolic compound ranges from 2.61 to 6.21ug/l with an average of 3.63 ug/l. Sebastian (2002) studied biogenic compounds in mangroves of Kerela and found that there was pre-monsoon (4.80 to 1.80 mg/g), monsoon (4.50-2.0 mg/g) and post-monsoon (4.0 to 2.0 mg/g), fluctuation in concentration of phenolic compound.

In present study water phenolic compound, ranges from 10.26 mg/l (Sarod site, July'10) to 0 (Asarsa site) with cumulative average of 1.25 mg/l. Mean water phenolic compound value (Fig. 1.3), was observed higher at Sarod, 7.37, as compared to other sites but the mean variation between the sites was not significant (ANOVA F=46.43, Fcrit = 3.09 P> 0.5). At the value of phenolic compound in water 7.37 mg/l, average mangrove density and burrow density at Sarod were observed to be 0.33 mangroves/ m^2 and 1.2 burrows/ m2 respectively. While where the value of COD in water was 0 mg/l, average mangrove density and burrow density at Asarsa were observed to be 5.02 mangroves/ m2 and 40.59 burrows/ m^2 respectively. Mangrove density showed significant negative correlation with concentration of phenolic compound at Sarod (r = 0.60), Neja (r =0.55) while non significant negative correlation was observed at Asarsa (r = 0.01) and Dahej (r = 0.38). Average Burrow density showed non significant negative correlation with phenolic compound at Sarod (r= 0.35) while significant positive correlation observed at Asarsa (r = 0.57) and non significant positive correlation observed at Neja (r = 0.40) and Dahej (r = 0.41).

In present study, sediment phenolic compound ranges from 4.7 mg/l (Sarod site, December'10) to 0 mg/l (Asarsa site) with cumulative average of 1.11 mg/l. Mean sediment phenolic compound value (Fig. 1.4), was observed to be higher at Sarod, 3.78 mg/l, as compared to other sites but

the mean variation between the sites was not significant (ANOVA F=127.76, Fcrit= 3.09 P> 0.5). At the value of phenolic compound in sediment 7.37 mg/l, average mangrove density and burrow density at Sarod were observed to be 0.60 mangroves/ m2 and 1.2 burrows/ m2 respectively. At the value of COD in water 0 mg/l, average mangrove density and burrow density at Asarsa were observed to be 5.02 mangroves/m2 and 40.59 burrows/ m2 respectively. Mangrove density showed significant negative correlation with concentration of phenolic compound at Sarod (r = 0.79) while non significant negative correlation was observed at Neja (r = 0.11), Asarsa (r = 0.01) and Dahej (r =0.40). Average Burrow density showed significant negative correlation with phenolic compound in sediment at Sarod (r =0.66). Average Burrow density showed significant positive correlation with phenolic compound in sediment at Neja (r =0.81), Asarsa (r = 0.57) while it has showed non significant positive correlation at Dahej (0.46).

Heavy Metals (Figs. 1.5 to 1.10): Heavy metals, accumulated in primary producer, i.e. mangrove, finds its way to human population through the various primary and secondary consumers like crabs and fishes. Heavy metals not only affect the flora or fauna but ecosystems as a whole. Heavy metal level can also act as indicator to other pollution in the ecosystem (Mateu et al., 1996). Labunska et al. (1999) studied heavy metal, released by Nandesari Industrial Estate, Vadodara and its concentration in Mahi estuary. This estate has more than 300 units out of which 82% are dye manufactures and rest 13% are of pharmacy based industries (CPCB, 1996). Samples collected from Sarod (IT9053) showed presence of Cadmium (Cd), Cromium (Cr) and Cobalt (Co) <10 ug/l, Copper (Cu) 10 ug/l, Lead (Pb) 40 ug/l, Mercury (Hg) <2 µg/l, Nickel (Ni) 60 ug/l and Zinc (Zn) 50 ug/l. Another study conducted by Lotfinasabasl et al. (2013) on metal pollution in water at Alibag (Maharashtra) mangrove showed Cu (0.64 mg/l), Cd (0.67 mg/l), Co (1.53 mg/l) and Cr (BDL) in water samples collected from 18 stations. Kathirasen (2002) has reported heavy metals like Copper (7.85±3.7 ppm), Cobalt (4.84±1.7 ppm), Lead (2.05±0.9 ppm) etc. in the degraded mangrove of Pichavaram. Kumar et al. (2008) also studied the changes in heavy metal concentration in Cochin estuary and found heavy metal like Mn (210.5-315.35µg/g), Zn (101.3-455.68 ìg/g), Cr (53.30- 90.22µg/g), Ni (30.60 69.35 µg/g), Pb (19.5-39.50 µg/g), Cu (23.97- 39.12 ìg/g), Co (12.82-23.08 µg/g) and Cd (0.062-0.223 ìg/g). Agoramoorty et al. (2008) studied heavy metal pollution in Pichavaram mangrove and found Pb (8 µg/l). MacFarlane et al., (2003) have reported concentration of Pb (5 µg/g) in the *Avicennia marina* of Australia. Nirmal Kumar et al., (2011) studied accumulation of heavy metals in various parts of Avicennia marina, at Valmeshwer mangrove (Gujarat) and found mean accumulation of heavy metal in pattern of Root>Leaf>Stem. In present study presence of heavy metals was found in pattern of Leaf>Stem>Root. Shazili et al., (2012) studied bio-accumulation in *Scylla serrata* in Malaysia and reported that heavy metal accumulation in *Scylla serrata* followed Zn > Cu > Pb > Cd order. Ahemad et al., (2011) studied heavy metal accumulation in macro benthic fauna of Sundarban mangrove and found accumulation of heavy metals like Cu (3.66 ± 0.89 to 7.55 ± 1.29 µg/g), Zn (76.8 ± 8.55 to 98.5 ± 6.49 µg/g), Cd (0.46 ± 0.11 to 0.859 ± 0.2 µg/g) and Pb (4.66 ± 1.17 to 6.77 ± 1.1 µg/g).

In present study, heavy metals like Cu, Zn, Cr, Ni, Pb, Hg, Cd, Co and Mn were recorded from the water samples, Copper (Cu), with average of 0.73, recorded highest at Sarod, (1.21 mg/l) and lowest at Asarsa (0.10 mg/l). Zinc (Zn), with average of 0.76, recorded highest at Sarod, (1.19 mg/l) and lowest at Asarsa (0.10 mg/l). Cromium (Cr), with average of 0.45, recorded highest at Sarod, (1.20 mg/l) and lowest at Asarsa and Dahej (0 mg/l). Nickel (Ni), with average of 0.22, recorded highest at Sarod, (0.78 mg/l) and lowest at Asarsa and Dahej (0 mg/l). Lead (Pb), with average of 0.27, recorded highest at Sarod, (0.67 mg/l) and lowest at Asarsa (0 mg/l). Mercury (Hg), with average of 0.15, recorded highest at Sarod, (0.59 mg/l) and lowest at Asarsa and Dahej (0 mg/l). Cadmium (Cd), with average of 0.05, recorded highest at Sarod, (0.20 mg/l) and lowest at Neja, Asarsa and Dahej (0 mg/l). Cobalt (Co), with average of 0.01, recorded highest at Sarod, (0.02 mg/l) and lowest at Neja, Asarsa and Dahej (0 mg/l). Magnesium (Mn) were absent from the sample. Mean heavy metal value (Fig. 1.5) was observed higher at Sarod, 0.87 mg/l, as compared to other sites and the mean variation between the sites was significant (ANOVA F =7.14, Fcrit = 2.90 P< 0.01). At high concentration site, Sarod, average mangrove and burrow density was observed as 0.39 mangroves/ m^2 and 0.84 burrows/ m2 respectively. At the lowest concentration of heavy metal site, Asarsa, average mangrove and burrow density was observed as 5.02 mangroves/ m^2 and 42.42 burrows/ m2 respectively. Mean Mangrove density and mean heavy metal concentration shows significant negative correlation (r = 0.97) at all sites. Mean burrow density and mean heavy metal concentration also shows significant negative correlation (r = 0.93) at all sites.

In present study heavy metals like Cu, Zn, Cr, Ni, Pb, Hg, Cd, Co and Mn were recorded from the sediment samples. Copper (Cu), with average of 0.32 mg/l, recorded highest at Sarod, (1.15 mg/l) and lowest at Dahej (0.01 mg/l). Zinc (Zn), with average of 0.36 mg/l, recorded highest at Sarod, (1.12 mg/l) and lowest at Asarsa (0.01 mg/l). Chromium (Cr), with average of 0.17 mg/l, recorded highest at Sarod (0.57 mg/l) and lowest at Asarsa and Dahej (0 mg/l). Nickel (Ni), with average of 0.12 mg/l, recorded highest at Sarod (0.44 mg/l) and lowest at Asarsa and Dahej (0 mg/l). Lead (Pb), with average of 0.13 mg/l, recorded highest at Sarod (0.31 mg/l) and lowest at Asarsa (0 mg/l). Mercury (Hg), with average of 0.03 mg/l, recorded highest at Sarod (0.10

mg/l) and lowest at Neja, Asarsa and Dahej (0 mg/l). Cadmium (Cd), Cobalt (Co) and Magnesium (Mn) were absent from the sample. Mean heavy metal value (Fig.1.6) was observed higher at Sarod, 0.41 mg/l, as compared to other sites and the mean variation between the sites was significant (ANOVA F=5.98, Fcrit = 2.90 P<0.01). At high concentration site, Sarod, average mangrove and burrow density was observed as 0.39mangroves/ m^2 and 0.84 burrows/ m^2 respectively. At the lowest concentration of heavy metal site, Asarsa, average mangrove and burrow density was observed as 5.02 mangroves/ m^2 and 42.42 burrows/ m^2 respectively. Mean Mangrove density and mean heavy metal concentration showed significant negative correlation (r = 0.97) at all sites. Mean burrow density and mean heavy metal concentration also shows significant negative correlation (r = 0.93) at all sites.

In present study, heavy metals like Cu, Zn, S, Si, Sr, Ti and Br were recorded from the root, stem and leaves of *Avicennia marina* samples. Mean heavy metal value(Fig. 1.7) in root was observed higher at Sarod, 2.82 %, as compared to other sites and the mean variation between the sites was significant (ANOVA F=0.30, Fcrit = 3.00 P< 0.5). In roots, Copper (Cu), with average of 0.31 %, was recorded highest at Sarod (1.23 %) and lowest at Neja, Asarsa and Dahej (0.00 %). In roots, Zinc (Zn), with average of 0.18 %, was recorded highest at Sarod, (0.32 %) and lowest at Neja, Asarsa and Dahej (0.00 %). Mean heavy metal value (Fig. 1.8) in stem was observed to be higher at Dahej, 2.63 %, as compared to other sites and the mean variation between the sites was significant (ANOVA F=0.23, Fcrit = 3.00 P< 0.5). In stem, Copper (Cu), with average of 0.18 %, was recorded highest at Sarod, (0.70 %) and lowest at Neja, Asarsa and Dahej (0.00 %). In stem, Zinc (Zn), with average of 0.05 %, was recorded highest at Sarod, (0.21 %) and lowest at Neja, Asarsa and Dahej (0.00 %). Mean heavy metal value (Fig 1.9) in leaves was observed to be higher at Dahej, 4.83 %, as compared to other sites and the mean variation between the sites was not significant (ANOVA F=0.09, Fcrit = 3.00 P>0.5). In leaves, Copper (Cu), with average of 0.11 %, was recorded highest at Sarod, (0.45 %) and lowest at Neja, Asarsa and Dahej (0.00 %). In leaves, Zinc (Zn), with average of 0.04 %, was recorded to be highest at Sarod, (0.16 %) and lowest at Neja, Asarsa and Dahej (0.00 %).

In present study, heavy metals like Cu, Zn, K, Fe, Sr and Br were recorded from tissue of crab samples, Mean heavy metal value (Fig. 1.10) in crab was observed higher at Sarod, 1.44 %, as compared to other sites and the mean variation between the sites was significant (ANOVA F=0.67, Fcrit = 3.09 P<0.5). Copper (Cu), with average of 0.04 %, recorded highest at Sarod (0.16 %) and lowest at Neja, Asarsa and Dahej (0 %). Zinc (Zn), with average of 0.06 %, recorded highest at Sarod (0.14 %) and lowest at Asarsa and Dahej (0 %).

Mangrove Density (Figs. 1.11): Mangrove is the primary producer in the mangrove ecosystem and by evaluating its density one can have a fair idea about healthiness of the ecosystem. Many scientists have worked on mangrove ecosystem and produced valuable information on the forest structure of mangrove. But there are only few studies focusing on the density of mangrove. Kairo et al., (2002) studied mangrove of Watamu Marine National Reserve (Kenya) and reported relative density of A. marina 11.59 to11.57 mangroves/m^2.

In present study, maximum mangrove density was observed 32.67 mangroves/m^2 (Asarsa site, December'10) while lowest density was observed 1.0 mangroves/ m^2 (Sarod site, April'11) with overall average of 16.22 mangrove/m2. Mean mangrove density (Fig. 1.11), was observed higher at Asarsa, 25.11 mangrove/m2, as compared to other sites but the mean variation between the sites was not significant (ANOVA F =20.69, Fcrit = 3.09 P>0.5). Asarsa with highest mangrove density 5.02 mangroves/ m^2 showed burrow densirty of 44.55 burrows while with the lowest density of mangrove of 0.39 mangroves/ m^2 Sarod showed burrow density of 0.60 burrow/m^2. Average mangrove density showed non significant postive correlation with burrow density at different sites like Sarod (r = 0.34), Neja (r = 0.46), Asarsa (r = 0.49) and Dahej (r = 0.46).

Crab Density (Figs. 1.12, 1.13)

Associated macro benthic fauna plays an important role in mangrove ecosystem. They act as primary consumer (crabs), secondary consumer (fish) and decomposer (gastropods) in healthy mangrove ecosystem.
Prosser (2004) studied burrow density in mangrove of Moreton Bay (Australia) and reported mean density of 294 ± 29 burrows/ m^2.

In present study highest average burrow density in lower zone was observed as 44 burrow/m^2 (Asarsa Site, July'11) and lowest average burrow density in lower zone was observed as 0.50 burrows/ m^2 (Sarod, April'12) with overall average burrow density in lower zone of 18.30 burrows/ m^2. Mean burrow density (Fig. 1.12) in lower zone (32.77 burrows/ m^2) was observed higher at Asarsa, as compared to other sites and the mean variation between the sites was not significant (ANOVA F = 27.02, Fcrit = 3.09 P>0.5). Highest burrow density (44 burrows/ m2) in the lower zone was observed Asarsa with average mangrove density of 25 mangroves while lowest burrow density (0.55 burrows/ m2) in the lower zone was observed at Sarod with average mangrove density of 1.67 mangroves/ m^2. Average burrow density in lower zone showed significant positive correlation with mangrove density at sites like Neja (r = 0.57), Asarsa (r = 0.55) and Dahej (r = 0.58) while non significant positive correlation was observed at Sarod (r = 0.13).

In present study, highest average burrow density in upper zone was observed as 59.10 burrow/m2 (Asarsa Site, July'11) and lowest average burrow density in upper zone was observed as 0.40 burrows/ m2 (Sarod, April'11) with an overall average burrow density in uper zone of 30.04 burrows/m2. Mean burrow density (Fig.1.13) in upper zone (52.07 burrows/ m2) was observed to be higher at Asarsa, as compared to other sites and the mean variation between the sites was not significant (ANOVA F=293.36 , Fcrit= 3.09 P>0.5). Maximum burrow density (59.10 burrows/ m2) in upper zone was observed at Asarsa with an average mangrove density was 5.02 mangroves/ m2 while lowest burrow density (0.40 burrows/ m2) in upper zone was observed at Sarod with an average mangrove density was 0.39 mangroves/ m2. Average burrow density in upper zone showed non significant positive correlation with mangrove density at different sites like Sarod (r= 0.49), Neja (r= 0.19), Asarsa (r= 0.26) and Dahej (r= 0.20). Significant positive correlation was observed between lower zone and upper zone burrow density at different sites like Sarod (r= 0.66), Neja (r= 0.69), Asarsa (r= 0.92) and Dahej (r= 0.60).

Associated Fauna (Figs. 1.14): Health of mangrove ecosystem is reflected by the presence of associated fauna that are primary and secondary consumer and decomposers. It has been observed that diversity of associated fauna is more where the mangrove patch is relatively undisturbed then the mangrove patch which is disturbed, either by local population or by pollution. Many scientists studied mangrove associated fauna. Rao (1997) has reported different faunal groups like fishes (397 sp), crab (259 sp.), mollusca (256 sp), insect (450 sp.) and mammals (250 sp.) dwell the in mangrove ecosystem of the world. In present study, total 51 species belonging different groups like mollusca (7 sp.), arthopoda (13 sp) and cordata (31 sp.) were recorded.

Sarod has its own kind of diversity and didn't show any kind of similarity with other group. Neja has 60% similarity in species composition with the group of Asarsa and Dahej (Fig. 1.14). Asarsa and Dahej have 80% similarity in species composition. Maximum mangrove associated faunal diversity was observed at Asarsa (40 species) followed by Dahej (36 species) Neja (30 species) and Sarod (2 species). Amongst the mangrove associated species observed in the area, maximum species were reported form class Aves (25 species,11 families) followed by class Malacostraca (9 species,7 families),class Gastropoda (6 species, 6 families), class Insecta (4 species, 2 families), class pisces (3 species, 2 families), class Reptila (2 species,1 family) and Class Bivalve (1 species,1 family).

Conclusion

Though Chemical Oxygen Demand is good up to certain level, GPCB limits of COD in water is >4.0 mg/l (Deshkar et al., 2012). All the sites showed high COD in the water and sediments. As predicted Sarod had the highest COD of water and very low mangrove and burrow density per meter square. Although naturally occurring phenolic compound are good for mangrove, as they act as an antioxidant but artificial phenolic compound found in the water and sediments are cause of worry. As revealed in the results that although they didn't have significant effect of the associated fauna, further study is needed on the effect of phenolic compound on the density of crab and mangrove along with other factor. Heavy Metal recorded from the study showed that anthropogenic activities have considerable pressure on the mangrove ecosystem of the study site. Heavy metal in water and sediment shows negative correlation with mangrove and burrow density. The most striking results have been observed at Sarod where average mangrove and burrow density were 0.39 mangrove/ m^2 and 0.84 burrows/ m^2 respectively. This shows that the ecosystem is under tremendous pressure. Presence of heavy metal in mangrove also shows that there are defiantly chances of heavy metals to pass to human as mangroves of this area are utilized for fodder and also the seed consumption in form of food. Associated fauna also found contaminated with heavy metal which creates high risk of bio-accumulation in human as these fauna is an important part of the diet of the local people. Present status of mangrove, density, height and diameter, suggested that there are possibility that Sarod had relatively good patch of mangrove in past as Sarod has highest diameter of mangrove. But due to increasing pressure from the various anthropogenic activities that patch is now reduced to almost zero in case of mangrove density. As stated earlier burrow density can be an indicator of healthy mangrove ecosystem, Sarod being most polluted site had very low burrow density in both zone as compare to other site. Composition of associated fauna clearly reflects the fact that status of physiochemical parameters and degree of pollutant affect the diversity of associated fauna in the mangrove forest. Sarod being most pollutant site had very less diversity of associated fauna while on other hand Asarsa, relatively free from pollution, had high diversity. But the high diversity of associated fauna at Asarasa, Neja and Dahej is facing pressure anthropogenic activity, i.e. fishing.

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Map 1: Location of study sites

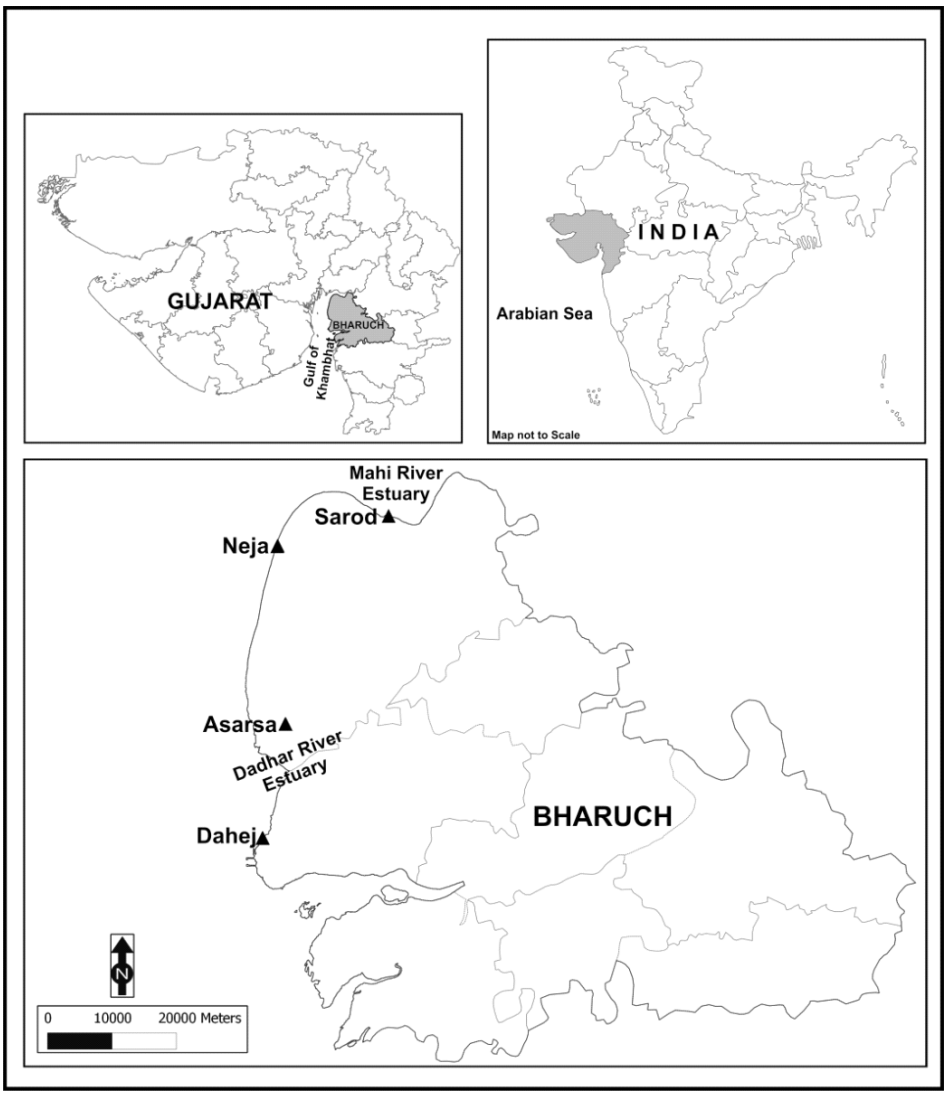

Fig. 1.1: Analysis of COD (mg/l) of Water at all Sites

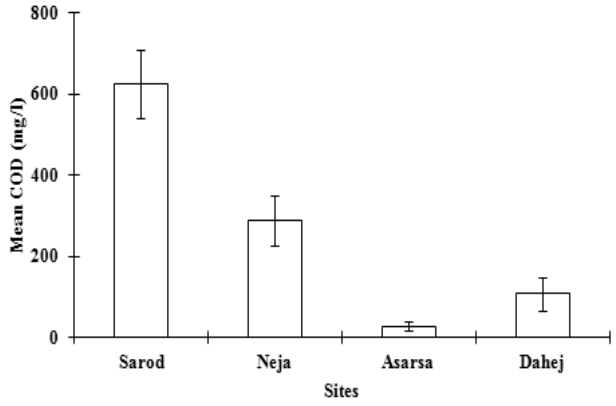

Fig. 1.2: Analysis of COD (mg/l) of Sediment at all Sites

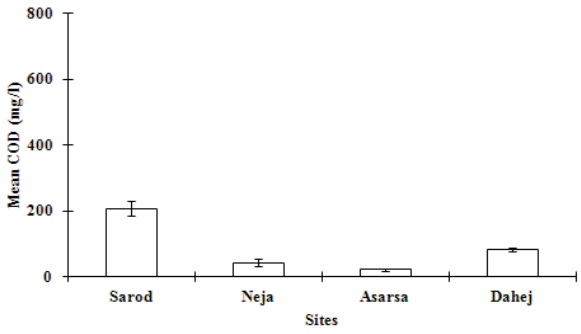

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Fig. 1.3: Analysis of Phenolic Compounds (mg/l) of Water at all Sites

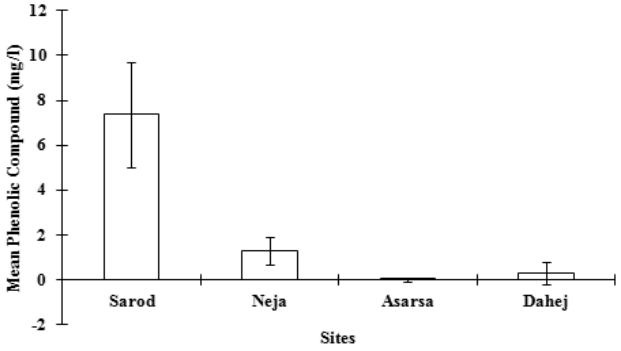


Fig. 1.4: Analysis of Phenolic Compounds (mg/l) of Sediment at all Sites

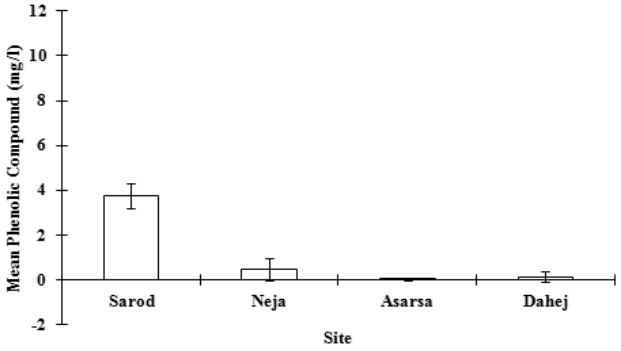


Fig. 1.5: Analysis of Heavy Metal (mg/l) of Water at all Sites

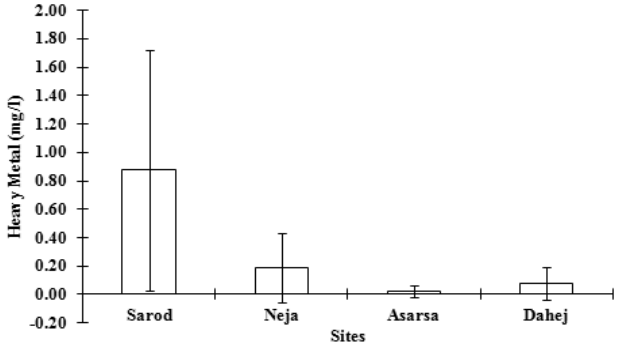


Fig. 1.6: Analysis of Heavy Metal (mg/l) of Sediment at all Sites

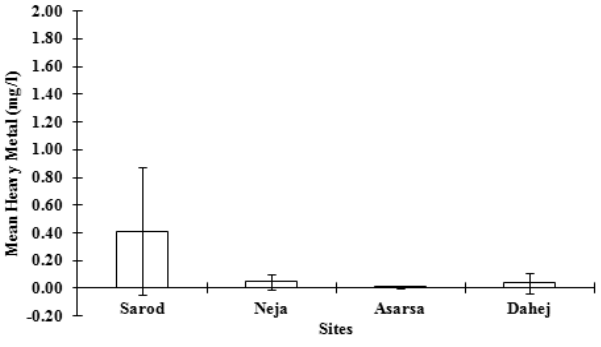


Fig. 1.7: Analysis of Heavy Metal (%) presence in *A. marina* Root at all Sites

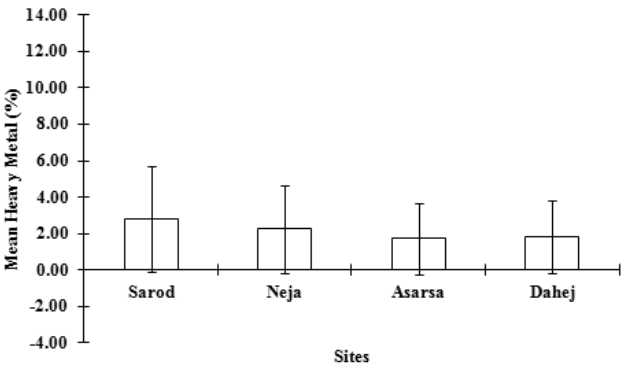


Fig. 1.8: Analysis of Heavy Metal (%) presence in *A. marina* Stem at all Sites

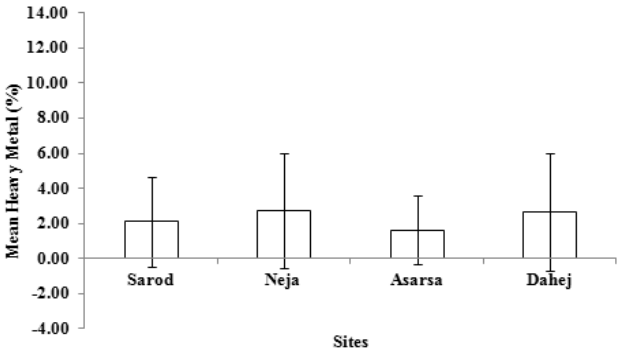


Fig. 1.9: Analysis of Heavy Metal (%) presence in *A. marina* Leaves at all Sites

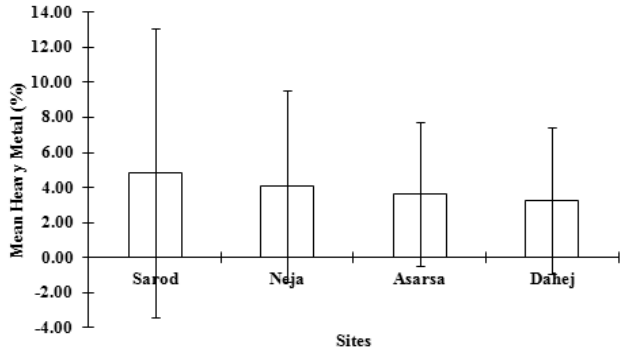


Fig. 1.10: Analysis of Heavy Metal (%) presence in Crab at all Sites

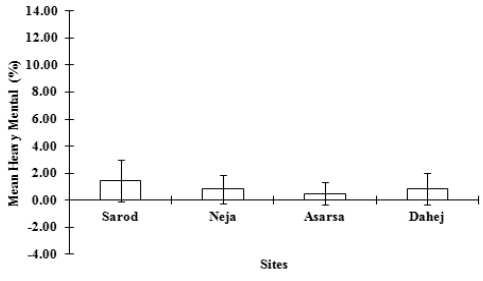


Fig. 1.11: Analysis of Mangrove Density (m2) at all Sites

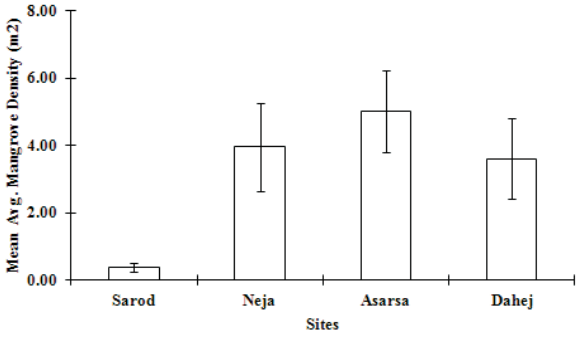


Fig. 1.12: Analysis of Lower Zone Burrow Density (m2) at all Sites

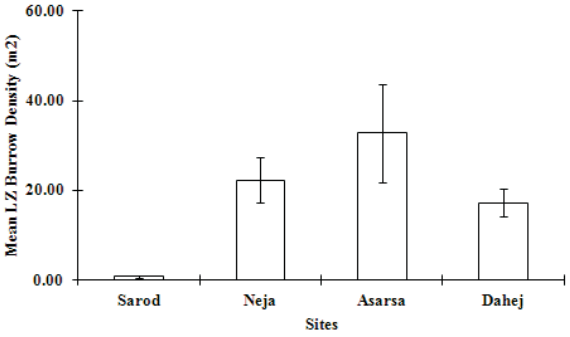


Fig. 1.13: Analysis of Upper Zone Burrow Density (m2) at all Sites

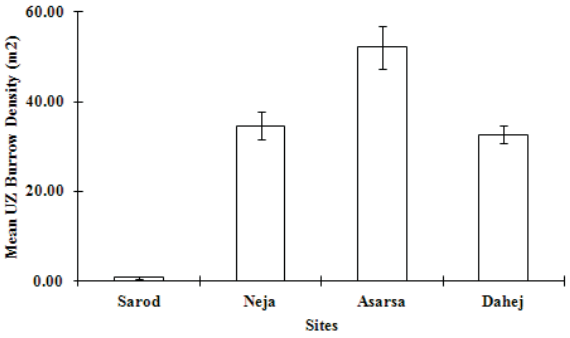
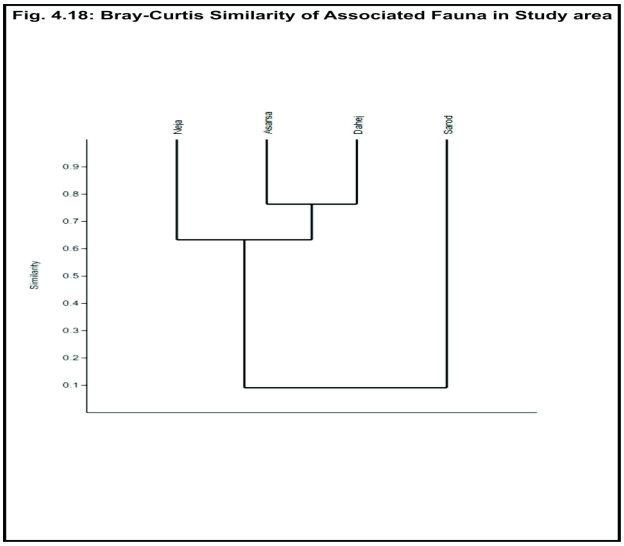


Fig. 1.14: Bray-Curtis Analysis of presence of associated fauna at all Sites



Phytoplankton enumeration with respect to water parameters of Kurul lake-Alibagh, dist. Raigad, Maharashtra.

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Abstract: The growth of phytoplankton is governed by many environmental factors like sunlight, chlorides, phosphates and nitrate content, etc. The present study deals with the investigation of phytoplankton population at Kurul Lake with respect to physicochemical parameters. The water sample was collected in all the three seasons and analysed for various limnological parameters. Phytoplankton analysis was done by Sedgwick Rafter Counting Cell and number of phytoplankton per liter was estimated.

Present study reveals high density of phytoplankton during monsoon season with increasing concentration of nitrate. pH of the water was found to be about neutral but phosphates were always present beyond the permissible limit. Though total solids were higher during monsoon, maximum phytoplankton density was observed. It necessitates studying the diversity of phytoplankton to identify the phytoplankton species as a bio-indicator.

Key words: Physicochemical parameters, Sedgwick Rafter Counting, Seasonal variation.

Introduction:

Lake water study is extremely important to interpret the fresh water ecosystem. Alibaug is a small town in Raigad district of Maharashtra undergoing tremendous urbanization. The ecosystem in and around is undergoing rapid changes. Peculiarity of Alibaug and nearby villages is the temples and lakes next to it. The present study is carried out in Kurul lake (18° 41' 38.42" N and 72° 57' 19.83" E) located in Raigad District of Maharashtra situated at a distance of about 100 kms from Mumbai. The lake also called as Lotus Point Lake is divided into two parts by a mud barrier of approximately 3 m width. There is a temple near the eastern end of the lake which justifies the human interference in the lake ecosystem as it is used for holistic purposes. The western part of the lake has undergone complete eutrophication and is completely covered by *Eichornia* spp.

The eastern end has however been cleaned and is partially covered with *Lotus* and *Hydrilla* spp. The water in this western end is used for washing linen, bathing and cleaning cattle.

Washing activities tend to release large amount of organic matter and macronutrients like phosphorus in the aquifer (CEEP). The release of these nutrients and organic matter facilitate the growth of algae and phytoplankton in presence of ample sunlight (Kauppila, 2007). Phytoplankton are microscopic organisms that play a crucial role in the food chain as they are a source of carbon (Kathi et *al*). Phytoplankton help maintain a healthy food chain in the aquatic ecosystem however they may create an imbalance if they exceed in number and some phytoplankton have a toxic effect as well (ref). However, phytoplankton serve as good pollution indicators (Kauppila, 2007) and should be monitored to assess the levels of pollution in the aquifer.

Phytoplanktons are not only important as a basic link of food chain but also ecologically significant as pollution indicators helping assessing environmental condition of the ecosystem (Dalal *et.al,* 2012).

Materials And Methods:

The study was carried out from November 2012 to October 2013. 1000ml of surface water sample was collected on a monthly basis separately in glass jars from Kurul Lake for studying the seasonal variations in physicochemical parameters of water and diversity of phytoplankton. The collected sample was analyzed immediately for physicochemical parameters on a portable bench photometer for Environmental Testing - Hanna HI 83206 instruments.

For preservation of phytoplankton the sample water was instantly fixed using 4% formaldehyde in Lugol's Iodine solution. The sample was left undisturbed for 24 hours to allow the settling of phytoplankton and then the settled part of the solution was transferred in other capped glass jar.

The subsample was then observed under high power microscope, quantitative analysis of phytoplankton species was done by Sedgwick Rafter Counting Cell. The number of phyto-planktons per liter was estimated.

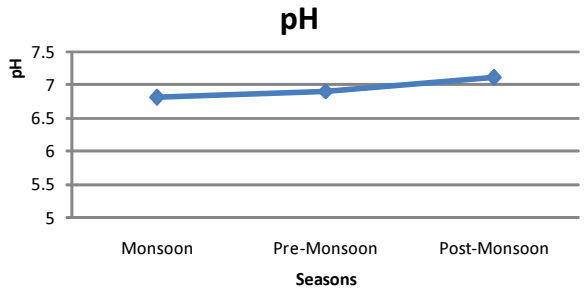
Results And Discussion:

Table1. Seasonal Variation in Water Parameters of Kurul Lake

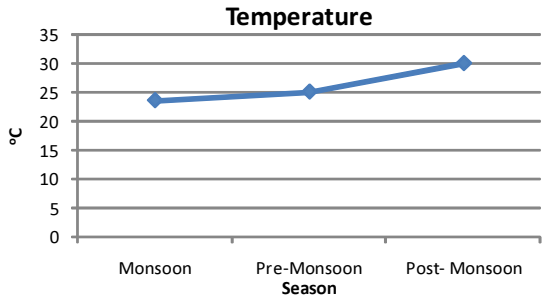
Seasons	Post-Monsoon	Pre-Monsoon	Monsoon
Parameters			
pH	7.1	6.9	6.8
Temperature ° C	30	25	23.5
D.O. (mg/l)	3.25	1.6	5.8
Chlorides (mg/l)	20.2	59.55	19.88
Phosphates (mg/l)	1.3	2.15	1.65
Nitrates (mg/l)	6.2	4.2	8.6
Nitrites (mg/l)	0.1	0.8	0.2
Ammonia (mg/l)	0.385	3	1.3
Total Solids (mg/l)	380	160	385
LP (cms)	52	63	42
Phtyoplankton Density (ind/l)	4,49,000	5,16,267	7,26,000

The limnological characters of the water body are mentioned in Table 1. The water quality was monitored on a monthly basis and pooled season wise. The pooled data was then interpreted for results and discussions.

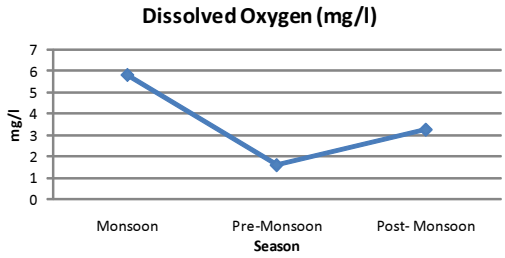
pH: The pH of an ideal fresh water ecosystem should be in the range of 6.5 for the sustenance of life (Muralidhar *et al*). The pH of the water body under study was in the range 6.8 to 7.1. In the present investigation the pH of the water body was near neutral throughout the study period. The highest pH was recorded during the post monsoon period while slight change in pH is due to the increased photosynthetic activity of the planktons and aquatic plants (Bhandarkar *et al,* 2013).



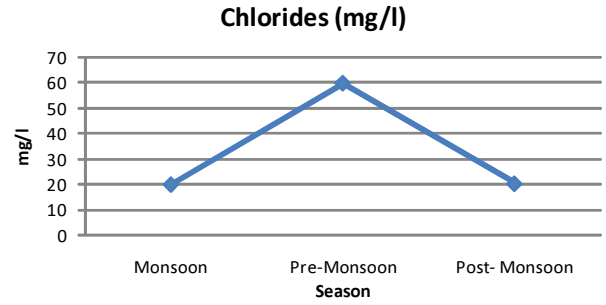
Temperature: The temperature variation was between 23.5 to 30°C with the highest temperature in the post-monsoon period and minimum in the monsoon season. The temperatures increased during the post monsoon period owing to increased atmospheric temperatures in the post monsoon month of October.



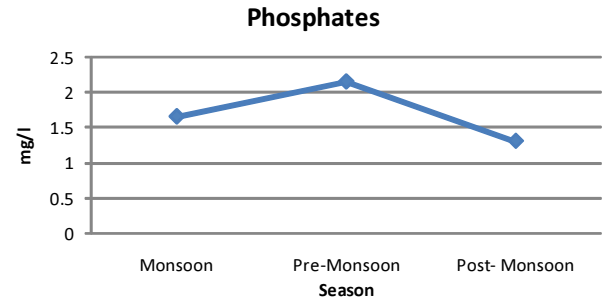
Dissolved Oxygen: The dissolved oxygen levels were in the range of 1.6 to 5.8 mg/l. The maximum dissolved oxygen levels were observed during monsoon owing to the maximum turbulence in the water caused by precipitation as rainfall. The oxygen levels in water required to sustain life is 3.0 mg/l as per WHO standards. Accordingly the oxygen levels in water were reduced below this limit only during the pre-monsoon period due to the reduced exchange of gases (Verma and Singh, 2010).



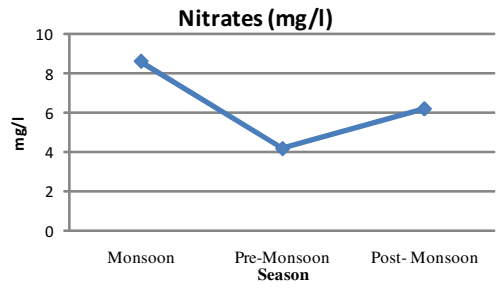
Chlorides: The chlorides ranged from 59.6 to 19.88 mg/l with the highest concentration in post monsoon period and the minimum was seen during the monsoon period owing to the constant dilution by rainwater. The concentration of chlorides was always under the permissible limit of 250 mg/l.



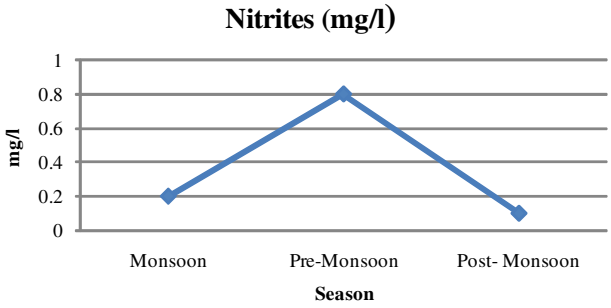
Phosphates: Phosphates were in the range of 1.4 to 2.15 mg/l. Maximum concentration of phosphates was seen during the pre- monsoon periods when the evaporation rates are high causing saturation of salts in the water body. The levels of phosphates were always above the permissible limits of 0.1 mg/l (WHO) for drinking water however, the phosphate levels were below the permissible limit if 5mg/l as per the Pollution Discharge Standards.



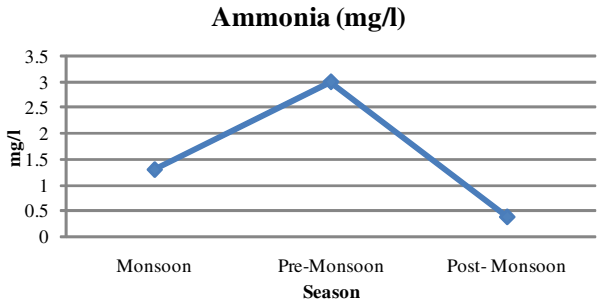
Nitrates: The nitrates were in the range of 2.5 to 8.6 mg/l. The levels of nitrates were high during monsoon. The nitrate levels were however within the permissible levels of 50 mg/l as prescribed by ISO and WHO. The high levels of nitrates during the monsoon due to the wastes of the animals washed in the pond and surface run off from the nearby areas



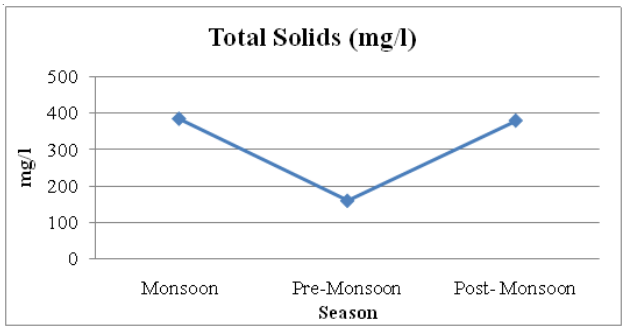
Nitrites: The nitrite levels during the study period were in the range of 0.2 to 0.8 mg/l. The nitrites levels were fluctuating around the permissible limits of 0.3 mg/l (USEPA). But the mean values were above the permissible limit of 0.3 mg/l. Highest concentration of nitrites were seen during the pre-monsoon period due to the concentration of salts by increased levels of evaporation. Also, as the lake is used for holistic purposes; organic matter is emitted into it.



Ammonia: The ammonia levels were in the range of 0.3 to 3 mg/l. The maximum concentration of ammonia was seen during pre-monsoon period when the evaporation rate is high and ammonia exceeded the permissible limit of 1.5mg/l (WHO). The levels of ammonia were below the permissible limit during monsoon and post monsoon periods.



Total Solids: The total solids in the water varied from 160 mg/l to 385 mg/l. The maximum levels of total solids were seen during the monsoon due to the extreme turbulence caused by the rainfall and also due to the flow of sediments with the rain water.



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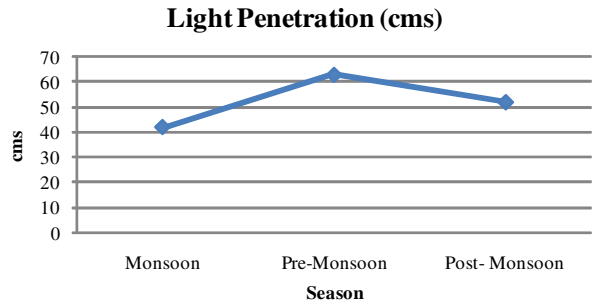
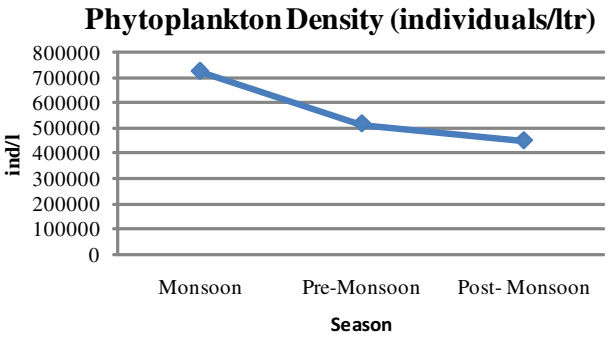
Light Penetration: The light penetration varied with the seasons from 42 cm to 63 cm and maximum light penetration was seen during the pre monsoon period owing to the reduced presence of total solids in the water. Also, the light penetration was low during monsoon owing to the high total solid content.



Biological Analysis: The phytoplankton enumeration showed results ranging from 4, 49,000 to 7,26,000 ind/l. The maximum density of phytoplankton was seen during the monsoon period due to the animal wastes liberated in to the waters. These animal wastes and anthropogenic activities like holistic rituals and offerings, etc carried out on the periphery of the lake result in release of nitrates in the lake water. Nitrates being a macro-nutrient help in increasing the population density of the phytoplankton. The post-monsoon season showed minimal phytoplankton density as the lake water was completely covered by *Lotus* and *Eichornia* spp. Phytoplankton require stable water for propagation and require sunlight to flourish but *Lotus* and *Eichornia* spp. block sunlight thereby reducing phytoplankton growth. The number of phytoplankton was found to be higher during pre-monsoon period than post monsoon as availability of sunlight was maximum.



Conclusion:

The analysis indicated that the water though not extremely polluted shows impact of anthropogenic interference in the lake ecosystem which is further indicated by presence of highest amount of nitrates during the monsoon season when the water should be most diluted. Also, in depth analysis of the phytoplankton diversity needs to be carried out to identify bio-indicator phytoplankton if any.

Acknowledgement:

Authors are grateful to Principal Dr. Mrs. M. K. Pejaver for her constant support and encouragement. We also wish to thank Dr. Nirmalkumar Kurve for the help and support whenever needed. We are thankful to Dr Ketan Thatte and colleagues for their valuable suggestions during the study.

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Comparative study on variation of plankton of macrophyte infested and non infested lakes from Thane city, Maharashtra.

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Abstract : Life on earth is quite vivid. Every living being appears to be different with respect to appearance and mode of life and maintains its own identity. This leads to diversity and known as "Biodiversity". Aquatic macrophytes may contribute considerably to the productivity of lakes and play an important role in regulation of metabolism of aquatic ecosystem (Marshall and Westlake, 1978; Best 1982). Macrophyte infested Lake Ambeghosale (infested mainly with *Pistia stratiotes*) and noninfested lake Upvan were studied. These two lakes showed variation in observations. pH was alkaline in Lake Ambeghosale while Light penetration was more in non-infested lake Upavan, high nutrient values of PO_4-P (0.069-1.0052 mg/L), NO_3-N (0.1359 – 0.4500 mg/L) in Lake Ambeghosale compare to Lake Upavan PO_4 – P (0.0 – 0.196 mg/L), NO_3 – N (0.1070 – 0.2050 mg/L). Similarly difference in number of species of phytoplankton was observed in Lake Upavan and Lake Ambeghosale. Monthly variation of zooplankton showed maximum variation. Cladocera, Ostracoda showed variation in number while phytoplankton and zooplankton showed negative correlation with light penetration. Thus it can be seen that the infestation of Macrophytes bring changes in biodiversity of Lake.

Key words : Macrophyte, Plankton, Pollution.

Introduction

Water is one of the natural resource available in abundant in nature which man has exploited more than any other resources for the sustenance of Life. (Sultana and Sharief, 2004).

The water quality is of paramount importance in the distribution and abundance of organisms present in the water body. The fast deteriorating water quality world over, has put forth a serious problem for the existence of life in and outside water.

Aquatic weeds referred to, as macrophytes constitute an important component of an aquatic ecosystem. Macrophytes though providing a food source and refuge for aquatic animals may also increase diurnal variability of ecologically important physicochemical variables and inhibit mixing process that might improve habitat quality (Wilcock *et.al.,* 1999). According to Abubakar (2012) aquatic macrophytes when present in large abundance have the power of modifying the composition, abundance and distribution of other organisms in water body.

Among the two lakes studied one was infested with macrophytes while other was not. Hence these two lakes were undertaken for study.

Materials and Method

The two lakes namely Ambeghosale which was macrophyte infested and Upavan which was macrophyte non infested lake were selected.

The water samples, from these lakes were collected fortnightly; during the period of one year from October 2000 to September 2003, the data was pooled together and was represented annually. The physicochemical analysis of water samples was performed as per the procedures described in the Standard Methods APHA, (1981) and Trivedi and Goel (1984). The samples for phytoplankton and zooplankton were collected fortnightly and preserved in 4% Lugol's Iodine for further analysis. Macrophytes from Lake Ambeghosale were also collected fortnightly.

Results and Discussion

Aquatic macrophytes may contribute considerably to the productivity of lakes and play an important role in regulation of the metabolism of aquatic ecosystems. (Pieczynska, 1976).

During the present study Air temperature, water temperature, light penetration was more and pH was towards alkaline side in Lake Ambeghosale than Lake Upavan.

According to Wilcock *et.al.,* (1998) the weed chocked streams typically show wide diurnal variation in temperature and pH, extreme values of which can influence habitat suitability. The essential nutrients for algal growth are nitrates and phosphates. The nutrient concentration normally limits the growth and production of phytoplankton. (Bhaskar *et.al.*, 2009).

During the present study nutrients like silicates, phosphates and nitrates also showed variation in these two lakes. Higher range of Phosphates (0.069 – 1.0052 mg/l) and nitrates (0.1359 – 0.4500 mg/l) were recorded in Lake Ambeghosale while in Lake Upavan phosphates (0.0 – 0.196 mg/l) and nitrates (0.1070 – 0.2050 mg/l) were recorded. The presence of high concentration of phosphates in water may lead to pollution as it may accelerate plant growth. However Silicates showed higher range (16.67 – 82.17 mg/l) in Lake

Upavan compared to Lake Ambeghosale.

Productivity of lakes depends on the presence of plankton biomass. Enrichment of nutrients and dissolved matter in the water bodies affects diversity of plankton and also physico-chemical properties of water (Sawant and Telave, 2009). Macrophytes compete with phytoplankton for nutrient requirement and thus the presence of macrophytes may result in change in phytoplankton community.

During the present study macrophytes were reported in Lake Ambeghosale namely *Ipomoea acquatica, Lemna minor, Pistia stratiotes* which were also reported by Manipur and Sitre (2013) in Ghotnimbala Reservoir, Chandrapur.

During the present study 36 species of phytoplankton were identified belonging to 6 classes in Lake Ambeghosale while 32 species of 6 classes were recorded in Lake Upavan. Thus total species of phytoplankton were found more in macrophyte infested Lake Ambeghosale than non infested Lake Upavan. Due to pollution of infested lake is more compared to non infested lake. Plurosigma was observed only in Lake Upavan while Anabena. Euglena, Ulothrix, Zygnema, Amphora, Diatoma and Volvox colony were seen only in Lake Ambeghosale. The presence of phytoplankton in freshwater bodies is a widely accepted indicator of water quality (Sudeep *et.al.*, 2008).

Monthly variation of zooplankton is showing maximum variation. Cladocera was dominant in Lake Upavan while Ostracoda was in Lake Ambeghosale. Ganai *et.al.*, (2010) and Sukhija (2010) also reported presence of Protozoa, Rotifera, Cladocera, Copepoda in Wular Lake, Kashmir and Foy Sagar Lake, Ajmer respectively. Zooplankton showed negative correlation with light penetration in Lake Ambeghosale and with total solids with Lake Upavan. The species composition and abundance of zooplankton group varied from time to time and season and depends on limnological characteristics of the water body (Sukhija, 2010). Which was also observed in present study.

Thus, it can be seen that the phytoplankton and zooplankton vary in the macrophyte infested and non infested lakes.

Table - 1. Nutrients of Macrophyte infested and non infested lakes of Thane City.

		AT(^{0}C)	WT(^{0}C)	Salinity (mg/L)	PO_4-P (mg/L)	No_3-N (mg/L)	SiO_2-Si (mg/L)
Ambeghosale	Annual Average	26.6	24.8	0.054	0.662	0.0400	37.04
	Minimum	22.0	21.5	0.043	0.069	0.1359	7.92
	Maximum	33.5	28.0	0.064	1.005	0.4500	63.53
Upavan	Annual Average	27.6	25.0	0.033	0.058	0.0350	55.23
	Minimum	23.5	19.5	0.019	0.000	0.1070	16.67
	Maximum	33.5	31.5	0.052	0.196	0.2050	82.17

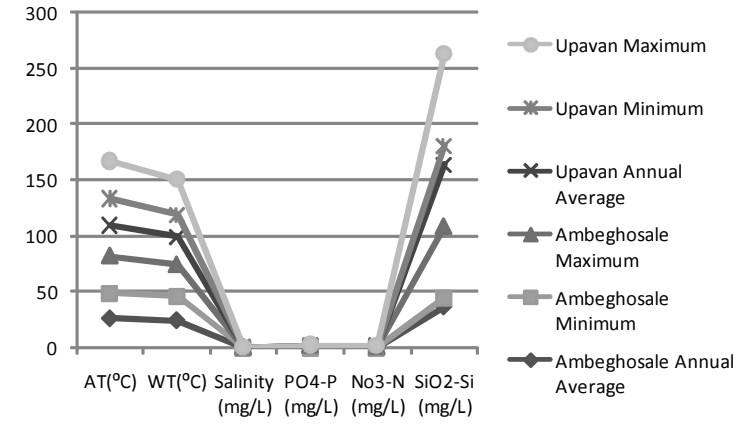

Fig. – 1. Nutrients of Macrophyte infested and non infested lakes of Thane City.

Table - 2. List of Phytoplankton

Class	Genus	Lake Ambeghosale	Lake Upavan
Chlorophyceae	*Chlamydomonas spp.*	P	P
	Chlorella spp.	P	P
	Coelastrum spp.	P	P
	Cosmarium spp.	P	P
	Crucigenia spp.	P	P
	Kirchinenilla spp.	P	P
	Koliella spp.	P	P
	Monoraphidium spp.	P	P
	Pediastrum spp.	P	P
	Scenedesmus spp.	P	P
	Spirogyra spp.	P	P
	Tetraedon spp.	P	P
	Tetrastrum spp.	P	P
	Ulothrix zonata	P	A
	Zygnema spp.	P	A
Cyanophyceae	*Chroococcus spp.*	A	P
	Gleocapside spp.	A	P
	Anabeana spiroides	P	A
	Gomphospria spp.	P	P
	Merismopedia spp.	P	P
	Microcystis spp	P	P
	Oscilatroia spp.	P	P
Bacillariophyceae	*Amphora holsatrical*	P	A
	Cocconeis spp.	P	P
	Cyclotella spp.	P	P
	Diatoma spp.	P	P
	Fragilaria spp.	P	P
	Melosira spp.	P	P
	Navicula spp.	P	P
	Nitzschia spp.	P	P
	Pinnularia spp.	P	P
	Plurosigma spp.	A	P
	Synedra ulna	P	P
	Thalassiosira spp.	P	P
	Triceratium spp.	P	P
Euglenophyceae	*Euglena viridis*	P	A
	Phacus longicauda	P	P
Cryptophyceae	*Cryptomonas spp.*	P	P
Dinophyceae	*Glenodinium spp.*	P	P
	Volvox Colony	A	P

P = Present , A = Absent

Table -3. List of Zooplankton

Class	Lake Ambeghosale	Lake Upavan
Rotifera	P	P
Copepoda	P	P
Ostracoda	P	P
Caldocera	P	P
Nauplius	P	P
Bivalve	P	P
Eggs	P	P
Eggmass	P	P
Aqu. Insect	P	P
Polychate	P	A

Table – 4. Macrophytes present in Lake Ambeghosale

Plant's name	Habitat	Family
Ipomoea acquatica	Floating	Convolvulanceae
Lemna minor	Floating	Lemnaceae
Pistia stratiotes	Floating	Araceae

Acknowledgement

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Phytoplanktonic Community of Aarey Lake, Mumbai

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Abstract : Limnological investigations were carried out during June, 2012 to May, 2013 in Aarey Lake. Fluctuations were noted in air and water temperature, transparency, dissolved oxygen, pH, alkalinity, phosphates, Nitrates, Chlorides total solids, conductivity and total plankton. The water body sustains heavy phytoplankton biomass throughout the year except for the rainy season. The phytoplankton population was dominated by Bacillariophytes despite eutrophication occurring in the lake.

Keywords: Aarey Lake, Phytoplankton, Zooplankton.

Introduction

Water is one of the most important compounds that profoundly influence life. It is widely believed that life itself originated in some quiet corner of the primordial oceans in the remote part. Water is aptly called the " Liquid of life" or the " Elixir of life" or the "Universal solvent" from the point of view of plant life every substance is dependent on water. Water which is regarded as the soul of nature, its pollution will mainly affect entire biotic community. Pollution of lakes first affects its physico-chemical quality and then systematically destroys the microbial and plankton communities. Thus, unbalancing the delicate microbial food web which in turn affect the food chain of ecosystem.

The study was conducted from June, 2012 to May, 2013 in Aarey Lake situated at Aarey Colony, Lat. 19.1612 ° N and Long. 72.8716°E in Mumbai, Maharashtra. Phytoplankton, being the primary producer, forms the lowest trophic level in the food chain of fresh water ecosystem and plays a key role in pisciculture. Moreover, number and species of phytoplankton Serves to determine the quality of a water body. With this in view, present work was undertaken which deals with phytoplanktonic community of Aarey Lake.

Material and method

Limnological investigations were carried out during June, 2012 to May, 2013. Selected physico-chemical parameters of water (temperature, transparency, salinity, dissolved oxygen and pH) were estimated using standard analytical methods (APHA, 1995). Fortnightly samples were taken from the surface from two different stations during early morning hours or late evening hours of the day, using a plankton net made up of bolten silk with a mesh of 100µm. The phytoplankton samples were preserved in Lugol's iodine. The zooplankton samples were preserved in 5% formalin. Identification was done with the help of key given by Prescott (1969), Adoni (1985), Edmondson (1965), APHA-AWWA-WPCF (1975), Chapman and Chapman (1975), Round(1975), Needham and Needham (1978).

Results and Discussion

Results are presented as average of two stations. Trend of phytoplankton standing crop and different phytoplankton groups over the study period are depicted. Period of occurrence and degree of maximum of various phytoplanktons are shown in Table 1.

Phytoplankton community comprised of algal groups; Bacillariophyta and Chlorophyta represented by total 22 genera. Somani and Pejaver (2003) reported 14 genera of Chlorophyceae, in the lake Masunda, Thane, Maharashtra. Cyanophyta was represented by the highest numbers of genera (10), whereas other two algal groups were represented by 6 genera each (Table 1). The phytoplankton standing crop (average of 2 stations) ranged from 15786.665x 10^3/1 (early April) to 15711.65x10^3 /1 (late May). The standing crop showed a marked increasing trend from March to May followed by decline by June.

During early months of study, when the temperature was moderate to some extent, blue green algae and green algae dominated, while as the summer advanced and temperature increased the diatoms became dominant and replaced the two other algal groups. Saad and Abbas (1985) also observed the highest number of diatoms during the period of highest temperatures in the Nile. Thus, the peaks of Cyanophyta and Chlorophyta were recorded during early period of study and that of Bacillariophyta during late summer presenting a clear succession among algal groups.

A comparison of the highest population size of the planktonic algal groups reveals that Bacillariophyta (95.40%) were the most dominant alga to be followed by Cyanophyta (45.94%) and Chlorophyta (28.47%). Although blue greens from the conspicious part of the phytoplankton community in most of the eutropical waters (Wetzel, 1975). During

present study, despite of the fact that present tropical tank is highly eutrophic, cyanophytes are placed only second.

Among Bacillariophyta, *Coscinodiscus, Gomphonema* and *Nitzschia*; among Cyanophyta, *Microcystis* and *Synechoeystics* and among Chlorphyta, *Closeterium* and *Scenedesimus* showed their occurrence throughout the study period. The maximum dominant genera (as ascertained on the basis of their highest numbers and as such prescribed by Cisneros *et al*., 1979) belonged to Bacillariophyta as out of total 6 genera, 5 enjoyed a dominant status; 3 of Cyanophyta and 2 of Chlorophyta were dominant. The phytoplankton peak which coincides with highest of Bacillariophyta was found to be dominated by *Nitzschia*, linking diatom bloom with phytoplankton population maxima. Details pertaining to occurrence and abundance of different are summarised in Table 1. The occurrence of *Microcystis,* the toxin producing blue green (Harris and James, 1974) in blooms, is a significant feature of tropical waters (Wetzel, 1975). In the present study also this alga appeared as a dominant taxon during most part of the study.

Table no: 1
Monthly variations of phytoplankton during the period of June 2012 – May 2013

Sr. No.	Phytoplankton Genera	Jun,12	Jul	Aug	Sept	Oct	Nov	Dec	Jan, 13	Feb	Mar	April	May	Mean
	CYANOPHYTA													
1	*Anabaena*	10	5	0	15	20	5	10	0	15	20	15	25	11.7
2	*Aphanocapsa*	0	0	5	5	10	0	0	5	10	5	0	15	4.6
3	*Merismopedia*	5	15	15	5	20	15	5	5	0	10	15	25	11.3
4	*Microcystis*	25	35	30	15	35	20	25	15	10	25	35	55	27.1
5	*Oscillatoria*	10	15	10	5	15	25	20	15	35	30	35	25	20
6	*Spirulina*	0	5	0	0	0	5	10	0	0	5	15	10	4.2
	Total	**50**	**75**	**60**	**45**	**100**	**70**	**70**	**40**	**70**	**95**	**115**	**155**	**78.8**
	CHLOROPHYTA													
1	*Scenedesmus*	5	20	15	15	25	10	15	35	30	15	10	25	18.3
2	*Pediastrum*	35	55	45	35	25	60	65	45	50	65	15	35	44.2
3	*Ankistrodesmus*	5	10	0	0	15	20	0	5	15	10	5	15	8.3
4	*Closterium*	0	0	0	5	0	15	5	10	0	0	5	5	3.8
	Total	**45**	**85**	**60**	**55**	**65**	**105**	**85**	**95**	**95**	**90**	**35**	**80**	**74.6**
	BACILLARIOPHYTA													
1	*Navicula*	15	25	20	5	15	30	35	20	15	35	45	30	24.2
2	*Nitzschia*	20	30	25	10	35	20	15	5	10	5	15	25	17.9
3	*Fragillaria*	5	10	15	10	15	20	25	35	10	5	15	25	15.8
4	*Gomphonema*	0	15	0	0	0	5	15	0	0	5	10	5	5
5	*Melosira*	15	25	25	20	15	5	5	15	10	5	5	15	13.3
	Total	**55**	**105**	**85**	**45**	**80**	**80**	**95**	**75**	**45**	**55**	**90**	**100**	**76.3**

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Mushrooms And Macrofungi From Jnanadweepa, College Campus in Thane, Maharashtra

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Abstract : Fungi and mushrooms; their wide variations in range of colours, shapes, sizes and other characteristics and the secretive status attached to their way of life have always intrigued and fascinated botanists, mycologists and laymen alike. Mushrooms and toadstools have been associated with several animals, fictious creatures, mysterious entities, super natural beings and happenings, mythological associations which unsurprisingly and appropriately are reflected in their common and vernacular names. These small and relatively insignificant entities today continue to play important roles in feeding the populace, as dietary supplements, as medicines and sources of drugs and pharmaceuticals, sources of novel compounds, in modern research and in agriculture.

In the present investigation biodiversity studies employing the survey method were carried out to record mushrooms and other macrofungi from Jnanadweepa, Vidya Prasarak Mandal's college campus, popularly known as Thane college campus. The study recorded 22 different types of macrofungi inclusive of several mushrooms; prominent among them being the genera *Auricularia*, *Daldinea*, *Ganoderma*, *Laccaria*, *Mycena*, *Schizophyllum*, *Polyporus*, *Xylaria* among several others, details of which, as well as the ecological significance and economic importance of the types recorded, are mentioned in the research paper.

Key Words: biodiversity, mushrooms, macrofungi, polyporaceae, Thane college campus

Introduction

The word fungus by itself denotes mushrooms and its colloquial usage has grown to include other related organisms such as molds, polypores, puff balls, rusts, smuts, yeasts and many other similar groups. The wide range of variations in colours, shades, sizes, shapes and other characteristics exhibited by fungi, particularly mushrooms, accompanied with the mysterious and secretive status attached to their way of life; while fine mycelial threads maintain an invisible presence in the soil, the mystifying appearance and disappearance of fruiting bodies above the ground, have always fascinated botanists, mycologists, naturalists and also laymen; many of whom have evolved into amateur mycologists and mushroom hunters. Another prominent group of macrofungi; namely, members of the polyporaceae family, inhabit wood; growing on trees, timber and decaying wood, although there are also instances of soil inhabitation.

It is equally interesting to trace the origins of vernacular names of mushrooms. While some, such as amethyst tallowgill, chestnut bolete, saffron milkcap, scarlet hood and yellow morel have names referring to their colours; those like slippery jack, waxycap, velvety psathyrella and smooth volvariella have reference to textures, those such as bitter bolete, and pungent fiber head refer to tastes; while honey mushroom, shell fish scented russula, soap scented trich and sweet bread mushroom bear reference to aroma and flavor; the likes of black trumpet, pear shaped puffball, common funnel cap, jew's ear and stag's horn denote shapes among many other connotations. Indian literature refers to mushrooms as *bhuchhatri*, *kavaka*, *ksumpa*, *kukurmutta*, *kumbhi* among other colloquial names. The intoxicating drink *soma* or *somarasa*, mentioned in the *Rig veda* also has reference to mushrooms (Wasson, 1969).

On the dietary frontier, no other food is so wrapped in mystery as the mushrooms (Bahl, 1998). Their food value is well acclaimed (Shukla, 1991; Patil, 2013), however distinguishing between the poisonous and edible ones is a matter of expertise (Khaund and Joshi, 2013). Cultivation of edible mushrooms is a science in itself that has been in the limelight of research (Ram, 2007; Sharma and Thakur, 2010) and the trend is catching up even in remote areas as an answer to dietary deficiencies (Dayaram, 2009; Dorugade *et al*., 2009). Amongst the several other uses of mushrooms and macro fungi are their applications in agriculture and horticulture (Tibuwah, 2012; Sendi *et al*., 2013), dying, as exhibition articles, as hallucinogens (Kolet and Sonparate, 2011), therapeutic agents (Villares *et al*., 2012), neutraceuticals, as sources of novel bioactive compounds (Sengar, 2006; Tripathi and Tiwary, 2013), tinder, writing material and several others (Nair and Balakrishnan, 1995). In spite of the aspects mentioned above, literature on macrofungi from Mumbai region is scarce and scattered and there are practically no reports of this important component of biodiversity from Thane region, adjoining the metro city of Mumbai. Hence the current investigation was undertaken to study and document mushrooms and macrofungi from V.P.M.'s Jnanadweepa campus in Thane city.

The area of study viz. Jnanadweepa, popular amongst locals as Thane college campus is a large 13.5 acre island campus situated in the Chendani area of Thane city, alongside the Thane creek, near Thane railway station (Central Railway) on the outskirts of Mumbai, the commercial capital of India. Apart from housing some of the best educational institutes in the region, the world class campus also sports a huge biodiversity of vegetation, both natural and cultivated. Various mushrooms and macrofungi appear on the educational campus, especially during the monsoon season, which prompted the present study.

Materials And Methods

The study was carried out by employing the survey method for collection and documentation of data during the monsoon and post-monsoon season from June to November 2013; wherein a survey of all specimens of macrofungi was carried out in the area of study. The specimens were identified in the field and in the department of botany, B.N Bandodkar College of Science, a NAAC reaccreditated A Grade institution from amongst the VPM Group of Institutes, situated on the campus, using standard literature (Bakshi, 1971; Keizer, 1997; Polese, 2000) and techniques suggested by Buczacki (1992) and Kaul (1999).

Results And Discussion

A total of 22 types of macrofungi, comprising 18 genera, were recorded during the investigation. Amongst the fungi recorded, 5 forms comprising 3 genera belonged to Ascomycetes, while 17 forms comprising 15 genera were members of Basidiomycetes. The results of the survey are presented in Table 1. Forms such as *Auricularia auricula*, *Daldinea concentrica*, *Schizophyllum commune* and *Xylaria* sp. (1) were not uncommon and prominently represented. The findings are in agreement with Deshmukh (2004) and Todawat and Papdiwal (2012). Most of the forms recorded in the current investigation had remarkable wood rotting activities that are considered indispensible for maintenance of carbon cycle in the biosphere (Ichinose, 2013).

From amongst the macrofungi reported, *Daldinia concentrica* has been reported as a wood decay fungus (Shary *et al*., 2007) and also has applications in the form of tinder as well as in traditional medicine (Benie *et al*., 2008). The 2 species of genus *Xylaria* recorded in the current study exhibited significant differences in the heights of fruiting bodies, while species of *Hypoxylon* showed differences in colours, one being bright orange and the other, black in appearance. Species of the genus *Xylaria* have been used for isolation of novel metabolites (Shiono *et al*., 2009) and enzyme (Liers *et al*., 2007) whereas *Hypoxylon* has been successfully exploited for metabolites exhibiting anti-fungal activity (Qing and Yan, 2009). Apart from yielding metabolites, the fairly common macrofungus *Auricularia* was recently tapped as a source of novel enzyme (Aschoff *et al*., 2013) while *Schizophyllum commune* was implicated as a common and harmful human respiratory allergen (Singh *et al*., 2013). *Polyporus*, *Poria* and *Trametes,* notorious for their wood rotting activity, also have great therapeutic values (Cheng *et al*., 2013; Zhao, 2013). The wood rot fungus *Daedalea* and *Marasmius* were reported as important sources of laccase (Dedeyan *et al*., 2000; Baldrian, 2004). *Ganoderma lucidum* has had a long and effective tradition in the science of medicine and therapy (Sliva, 2003). Apart from its food value, *Sparassis crispa* was reported as a source of novel metabolites having therapeutic properties (Kimura, 2013). Lawrence and Harniess (1991) reported *Mycena* as a fairly common and inedible mushroom. While the culinary aspects of *Agaricus* are well known, its medicinal value (Wang *et al*., 2013) also inspires awe. Pushpa and Purushothama (2012) reported *Chlorophyllum* from Bangalore city while Gulati *et al*., (2011) assessed the food value of genus *Lentinus*. The current study revealed a rich biodiversity of macrofungi on Jnanadweepa, VPM's Thane College Campus.

Conclusion

A survey of mushrooms and macrofungi was conducted during monsoon and immediate post monsoon months in the current year 2013 on Jnanadweepa, VPM's College Campus, Thane, Maharashtra, India. A total of 22 types of mushrooms and macrofungi, belonging to 18 genera, were recorded during the study. Amongst the fungi recorded, 5 forms comprising 3 genera belonged to Ascomycetes, while 17 forms comprising 15 genera were members of Basidiomycetes. All the macrofungi found growing in the area of study were economically important. Most of the forms documented, were reported to exhibit wood rotting activities which are indispensible for carbon cycle in the biosphere.

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Table 1: Macrofungi and mushrooms recorded on Jnanadweepa, Thane

S. No.	Botanical Name	Common Name	Habitat
Ascomycetes			
1	*Daldinia concentrica* (Bolton) Cesati & de Notaris	King Alfred's cakes, carbon balls	On decaying wood/ logs
2	*Xylaria sp.* (1)		On decaying logs
3	*Xylaria sp.* (2)		On decaying logs
4	*Hypoxylon sp.*(1)	Strawberry hypoxylon	On decaying wood
5	*Hypoxylon sp.*(2)		
Basidiomycetes			
6	*Auricularia auricula* (Bull.) J. Schrot	Jelly ear, tree ear	On decaying wood stumps
7	*Schizophyllum commune* Fries	Split-gill	On decaying wood stumps
8	*Polyporus rubidus* Berk.	Bracket fungus	On tree stump
9	*Polyporus sp.*	Bracket fungus	On tree stump
10	*Poria sp.*		On decaying wood, twigs
11	*Trametes sp.*	Many zoned polypore	On decaying logs
12	*Daedalea sp.*	Maze gill	On decaying wood and logs
13	*Daedaleopsis sp.*	Blushing bracket	On dead wood stump
14	*Ganoderma lucidum* (Curtis) P. Karst	Reishi/ Lingzhi	On decaying wood stump
15	*Sparassis crispa* Fr.	Cauliflower fungus /Brain fungus	On decaying wood stump
16	*Cantharellus sp.*	Chanterelle	On soil near bamboo clumps
17	*Marasmius sp.*		Common in large groups on coconut trees
18	*Mycena sp.*(1)	Common mycena	On leaf litter and rotting wood
19	*Mycena sp.*(2)	Common mycena	On leaf litter and rotting wood
20	*Agaricus sp.*		On humus rich soil among decaying organic matter
21	*Chlorophyllum sp.*	Chlorophyllum	On decaying leaf litter
22	*Lentinus sp.*		On decaying logs

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Lawsonia inermis L.: A rainfed ratoon crop

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Abstract: *Lawsonia inermis* L. is a leaf based perennial dye crop commonly called henna or mehndi. Cosmetic and pharmaceutical companies largely depend upon materials procured from naturally occurring stands. Though abundantly found earlier, today concerns are about the possible extinction of the plant. Since it is a rain-fed ratoon crop, it should be cultivated by farmers for its good regeneration ability. The plants procured from Jodhpur and Kalyan, showed morphological differences strongly influenced by environmental factors and geographical distribution. The quantitative estimation of Lawsone in plants procured from Jodhpur and Kalyan showed variation.

Key words **:** *Lawsonia inermis* L., ratooncrop, lawsone.

Introduction

Lawsonia inermis is a leaf based perennial dye crop belonging to the family Lytheracae. It is commonly called as henna or mehndi. The plant is self-pollinated woody shrub. In India, Henna is mostly grown in the states of Rajasthan, Gujarat, Madhya Pradesh and Punjab. Rajasthan henna farms normally produce body art quality henna (Khandelwal, 2002). Leaves of henna contain Lawsone, the active ingredient responsible for its dye properties. Physical conditions influence the dye properties and percentage of Lawsone in henna. Normally the concentration of Lawsone found in leaves is between 0.5 to 1.5% (Simon *et al*, 1984). Henna can be grown on wide variety of soil and climatic conditions. However deep, fine sandy soil is good for henna cultivation. The plant thrives well under arid to tropical and warm temperate climatic conditions. It need moderate rainfall of around 40 mm and temperature of about 30^0-40^0C. Climate plays a dominant role in the production of quality leaf crop. The rainfall distribution is important and Henna requires dry sunny periods along with cool nights for proper growth. Rains at harvesting (Sept-Oct) stage or just after harvest spoils the produce and lower the market value (Shukla *et al*., 2012).

In the present investigation effect of geographical distribution on morphological characteristics and Lawsone content of *Lawsonia inermis* L. was studied. Henna plants growing in Jodhpur and Pilani (Rajasthan); Kalyan, Thane and Badlapur (Maharashtra) were investigated.

The climate of Rajasthan is hot and arid with low and erratic rainfall, high evapo-transpiration and poor soil physical and fertility conditions. The average daily maximum temperature in summer is 45^0C and in winter average mean daily minimum temperature is 9.9^0C. The average annual rainfall in the district is 41 mm. In such conditions cultivation of henna provides some assured income to the farmers because of its drought hardness and deep root system (http://www.cazri.res.in/) (Table 1).

In Maharashtra, the climate of Thane district is characterized by an oppressive summer, dampness in the atmosphere nearly throughout the year and heavy south – west monsoon rainfall from June to September. The average daily maximum temperature in summer is 32.9°C and in winter average mean daily minimum temperature is 16.8°C. But in the interior parts of the district, the average daily minimum temperature is slightly lower in the winter season and the average daily maximum temperature is higher in the summer. The average annual rainfall in the district is 2293.4 mm. Two types of soils have been observed in the district viz., medium to deep black and reddish colored soil (Gupta, 2009) (Table 1).

Materials and Methods

Henna plants growing in Jodhpur and Pilani (Rajasthan); Kalyan, Thane and Badlapur (Maharashtra) were collected. Morphological study was done for plants from both the regions.

Leaves of *Lawsonia inermis* L. from field grown plants from Kalyan (MS) and Jodhpur (Rajasthan) were collected (February-May and October-January) separately and dried, powdered and stored in air tight containers separately.

Authentication of the plant (S.H.-1533) was done at Blatter Herberium, St. Xavier's College, Mumbai. The specimen voucher was deposited in the Blatter Herberium, St. Xavier's College, Mumbai.

Moisture content was calculated for leaves of *Lawsonia inermis* L. procured from Jodhpur and Kalyan. Dried leaf powder from Kalyan (MS) and Jodhpur (Rajasthan) were used separately for analysis. 1 gm of powder was weighed and placed in a test tube and 10 ml of 50% methanol was added. Samples were vortexed for 10 minutes and left to stand overnight at room temperature (28 ± 2^0C). The extracts were filtered through Whatmann No. 41 paper (E. Merck, Mumbai, India) and the filtrate was used for experimental work. Standard solution of lawsone (1mg/ 1ml) was prepared in 50% methanol.

HPTLC was performed on silica gel 60 F_{254} HPTLC per-coated plate (10 cm X 10 cm) of 0.2 mm thickness, for the quantification of lawsone in samples of *Lawsonia inermis* L. 8mm bands of sample and standard were applied with an automatic Camag Linomat V sample applicator. The chromatogram developed inpre-saturated Camag twin through chamber with mobile phase, toluene: ethyl acetate: acetic acid (5: 4: 1 v/v/v), for 20 minutes, at room temperature (28°C±2°C). After drying HPTLC plate scanning profiling was carried out with a Camag TLC scanner III at a single wavelength 254 nm. Determination of lawsone amount was calculated by comparison of area measured for the sample to that of the standard. Each sample was analyzed in triplicate.

Results and Discussion

The lawsone content is the principal quality parameter of henna which is significantly influenced by weather and its geographical distribution. In the present study non-significant variation was found in the morphological characteristics and lawsone content due to location within the state (Kalyan, Thane and Badlapur of Maharashtra; Jodhpur and Pilani of Rajasthan). Therefore further studies were restricted to Kalyan (Maharashtra) and Jodhpur (Rajasthan).

The morphological difference between leaves of *Lawsonia inermis* L. procured from Kalyan and Jodhpur is shown in Table 2 and Table 3. The work carried out here has led to the development of HPTLC fingerprint patterns for leaf powder of *Lawsoni inermis*L. procured from Kalyan and Jodhpur. The marker lawsone was detected and quantified (Plate 2). The developed fingerprints showed distinct variation in lawsone content and was found to be maximum in leaf powder procured from Jodhpur (0.061µg/mg) than leaf powder procured from Kalyan (0.043µg/mg) (Table 4 and Plate 3 and 4).

The study revealed that colour, number and leaf size showed morphological variation in the *Lawsonia inermis* L. procured from Jodhpur and Kalyan. These differences were strongly influenced by environmental factors (soil texture, soil chemical characteristics and annual rainfall) and geographical distribution. The quantitative estimation of Lawsone in plants procured from Jodhpur and Kalyan showed variation. This quantification data can be used as a diagnostic tool to identity and determine the quality and purity of the plant material. However, cosmetic and pharmaceutical companies largely depend upon materials procured from naturally occurring stands.

Abundantly found earlier, today concerns are about the possible extinction of the plant. It is an important export oriented dye crop, but it is also a ratoon crop. It can be cultivated by farmers for its good regeneration ability in dense plantation, mainly as rain-fed crops. Henna cultivation has been found an economically viable agri-enterprise. If planted as short rotation forestry plantation, it maintains continuous soil cover through foliage and also helps in building a cleaner environment. Henna based agro-forestry system may also help farmers in drought proofing strategy.

Table 1: Climatic conditions in different regions

Rajasthan:		
Period	**Temperature**	**Rainfall**
January to March	10^0C - 27^0C	4mm – 7mm
April to June	24^0C - 45^0C	11mm - 30mm
July to September	21^0C - 35^0C	100mm - 165mm
Octoberto December	13^0C - 30^0C	3mm - 8mm
Kalyan:		
January to March	16^0C - 30^0C	NA
April to June	32.9°C - 40^0C	250 mm - 320mm
July to September	20^0C - 25^0C	1730.5 mm -2588.7 mm
Octoberto December	16.8^0C - 25^0C	91mm-103mm

Table 2: Morphological study of leaves of *Lawsonia inermis L.* (Kalyan)

Sr. no.	Leaves	Length (cm)
	Young leaves	2.0-2.5 ± 2.57
	Old leaves	3.0-3.5 ± 2.89
	No. of leaves/branch	40-50 ± 3.10
	Attachment of leaves	2 leaves/internode
	Colour of leaves	Dark green
	Branch length	16-25 ± 2.43
	pH	7.1-8.0
	Moisture content	63.6% ± 0.03

Table 3: Morphological study of leaves of *Lawsonia inermis L.* (Jodhpur)

Sr. no.	Leaves	Length (cm)
	Young leaves	2.2-2.8 ± 2.45
	Old leaves	3.5-4.5 ± 3.34
	No. of leaves/branch	50-60 ± 3.38
	Attachment of leaves	2 leaves/internode
	Colour of leaves	Light yellow green
	Branch length	25-35 ± 2.97
	pH	8.6-8.9
	Moisture content	71.9% ± 0.01

Table 4: Amount of Lawsone in field grown plants (Kalyan and Jodhpur) of *Lawsonia inermis* L. by HPTLC

Sr. No.	Sample	Concentration (µg/mg)±S.D.
1.	Leaf powder (Kalyan)	0.043 ± 3.33
2.	Leaf powder (Jodhpur)	0.061 ± 1.87

Plate 1: Plant of *Lawsoniainermis* L.
1. Kalyan (Maharashtra)
2. Thane (Maharashtra)
3. Badalapur (Maharashtra)
4. Jodhpur (Rajasthan)
5. Pilani (Rajasthan)

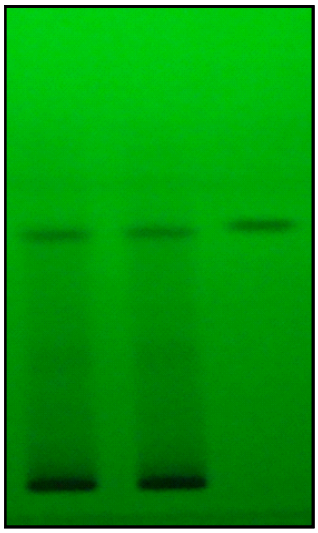

Plate 2:Chromatographic plate of *Laswoniainermis* L

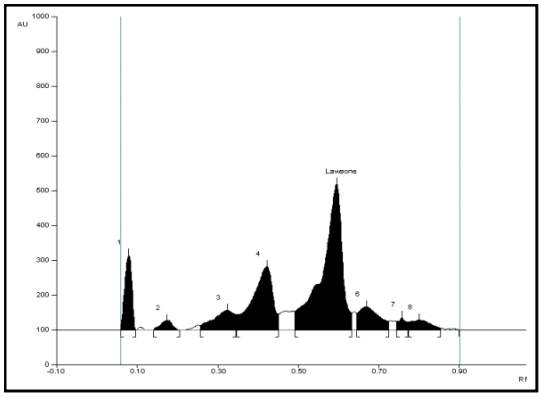

Plate3:Densitogram of leaf powder of *Laswoniainermis* L. procured from Jodhpur

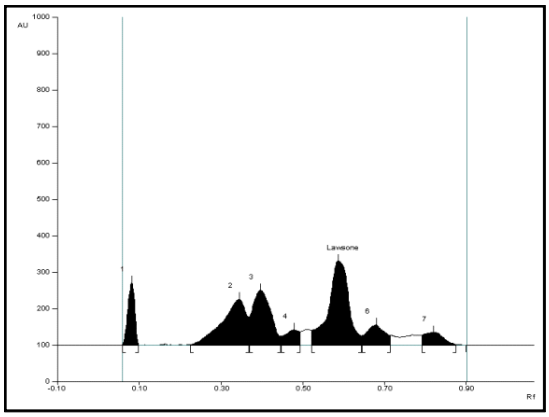

Plate 4: Densitogram of leaf powder of *Laswoniainermis* L procured from Kalyan

Acknowledgments:

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Comparative study of Flora of three Plateaus in Western Maharashtra

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Abstract: The current study aimed at comparing the flora of Bhavale, Kaas and Velneshwar plateaus. Data was collected by check list method . The comparative study revealed similarities between all the three study stations in the monsoon. While floral diversity of Bhavale was distinctly varying in the summer season, as Bhavale was otherwise a barren land taken up for plantation and reforestation by an NGO Hariyali. The study also highlights that conservation education and measures are required to preserve the flora to maintain the ecological balance of Velneshwar which is currently undergoing rapid development.

Key words : Velneshwar, Kaas, Bhavale, floral diversity.

The Western Ghats is one of the major biodiversity hot spots in India. It shows vast diversity in flora and fauna with high degree of endemism. The floral diversity in various parts of the Western Ghats of Maharashtra is well documented owing to ecologically sensitive flora. Geographically the Western Ghats is distributed as coastal region and plateau region which shows variations in the flora. Geographical and climatic conditions govern the native flora. There are various reports which document the native flora of Maharashtra but up till now very few attempts have been made to study the comparative floral diversity in various regions of Maharashtra. In present study, comparative documentation of the native flora present at plateaus of Bhavale, Velneshwar and Kaas was carried out.

The three plateaus are geographically very distinct and are expected to have diverse plant populations. There is urgent need to document such diverse floral population to conserve and maintain the ecosystem. Therefore this study was undertaken to study scientifically and document the plants growing in the plateau regions of Maharashtra and to propose strategies for conservation of ecosystem.

Study area

Bhavale (18°42'N, 75°45'E) is the small village in Thane district of Maharashtra and adopted by NGO, Hariyali for restoration of the depleting forest cover.

Velneshwar (17°082N', 73°162E,) is situated on the western coast of Maharashtra is mainly known for the Velneshwar temple and picturesque Velneshwar beach. The habitat is now claimed by various industries and infra-structural projects as a promising area. Anthropological activities are still not well spread in Velneshwar region but they are slowly progressing to threaten the existing floral diversity.

Kaas (17°43'N, 73 ° 49'E) is situated in the central portion of Deccan plateau of Maharashtra. It is well known tourist destination and serious damage to the ecosystem has been observed due to increased tourist activity, major collection by the botanists and many other reasons like climate change. The flora on the plateaus comprises mainly of ephemeral and seasonal herbaceous elements and hence gets neglected by the botanists (Watve, 2013). The constant threat to the floral diversity of Kas is seen due to the lack of conservational activities in the earlier years. Presently many NGOs have taken up the initiative to conserve the severely damaged Kas ecosystem.

Materials And Methods

The study area of Bhavale covers 10 hectares of land given to Hariyali for restoration of forest cover, while in Velneshwar the study area is of 35 acres involving the area in and around Vidya Prasarak Mandal's Maharshi Parshuram College of Engineering. The data was collected by taking the photographs of the habit and floral morphology of the plant species. The data of Kaas plateau was collected chiefly during the monsoon when it becomes the valley of flowers comprising mainly of ephemerals .

The data of the three plateaus was compared for similarities and IUCN Red data book for determining the ecological importance.

Results And Discussion

Table 1: List of Trees at Bhavale, Kaas and Velneshwar

Genus	Species	Family	Bhavale	Kaas	Velneshwar
Acacia	*arabica*	Mimosae	+	-	-
Adenanthera	*pavonia*	Mimosae	+	-	-
Aglaia	*lawii*	Meliaceae	-	+	-
Anacardium	*occidentale*	Anacardiaceae	+	+	+
Annona	*squamosa*	Annonaceae	+	-	-
Azadirachta	*Indica*	Meliaceae	+	-	-
Bauhinia	*tomentosa*	Caesalpinae	+	-	-
Bombax	*salmalia*	Bombacaceae	+	-	-
Butea	*monosperma*	Fabaceae	+	-	-
Cassia	*fistula*	Caesalpinae	+	-	+
Dalbergia	*latifolia*	Fabaceae	+	-	-
Delonix	*regia*	Caesalpinae	+	-	-
Dolichondron	*Falcate*	Bignoniaceae	-	-	+
Fermiana	*colorata*	Sterculiaceae	-	-	+
Ficus	*bengalensis*	Moraceae	+	+	+
Ficus	*rumphii*	Moraceae	+	-	+
Ficus	*ernotiana*	Moraceae	-	-	+
Ficus	*pallid*	Moraceae	-	-	+
Flacourtia	*montana*	Flacourtiaceae	+		+
Gmelina	*arborea*	Verbenaceae	+	-	-
Gymnosporia	*montana*	Celastraceae	-	-	+
Hardwickia	*binata*	Caesalpinae	-	-	+
Heterophragma	*quadriloculare*	Bignoniaceae	-	-	+
Khaya	*senegalensis*	Euphorbiaceae	+	-	-
Kigelia	*pinnata*	Bignoniaceae	+	-	-
Macaranga	*peltata*	Euphorbiaceae	+	-	-
Mangifera	*indica*	Anacardiaceae	+	+	+
Melia	*azadirach*	Meliaceae	+	-	-
Memecylon	*umbellatum*	Melastomataceae	-	-	+
Peltoforum	*ferruginum*	Caesalpinae	+	-	-
Phoenix	*sylvestris*	Palmae	+	-	-
Phyllanthus	*emblica*	Euphorbiaceae	+	-	+
Pithecolobium	*dulce*	Mimosae	+	-	-
Pongamia	*pinnata*	Leguminosae	+	-	+
Sapium	*insigne*	Euphorbiaceae	-	-	+
Syzigium	*rubicunda*	Myrtaceae	-	-	+
Syzigium	*jambolana*	Myrtaceae	+	-	-
Tabebuia	*pentaphylla*	Bignoniaceae	-	-	+
Tabernaemontana	*alternifolia*	Apocyanaceae	-	+	-
Tamarindus	*indicus*	Leguminosae	+	-	+
Tectona	*grandis*	Verbenaceae	+	-	-
Terminalia	*elliptica*	Combretaceae	-	-	+
Terminalia	*paniculata*	Combretaceae	-	-	+
Terminalia	*arjuna*	Combretaceae	-	-	+
Thevetia	*peruviana*	Apocyanaceae	+	-	-
Trewia	*nudiflora*	Euphorbiaceae	+	-	+
Vitex	*negundo*	Verbenaceae	+	-	-
Xanthoxyllum	*rhetsa*	Rutaceae	-	-	+

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Table 2: Shrubs of Bhavale, Kaas and Velneshwar.

Genus	Species	Family	Bhavale	Kaas	Velneshwar
Abelmoschus	*tetraphyllus*	Malvaceae	+	-	-
Adhatoda	*zeylanica*	Acanthaceae	+	-	-
Alternanthera	*sessilis*	Amaranthaceae	+	-	-
Argyreia	*boseana*	Convolvulaceae	-	+	-
Argyreia	*cuneata*	Convolvulaceae	-	+	-
Argyreia	*sericea*	Convolvulaceae	-	+	-
Azanza	*lampas*	Malvaceae	+	-	-
Blumea	*camphora*	Asteraceae	+	-	-
Calotropis	*gigantea*	Asclepiadaceae	+	-	-
Calycopteris	*floribunda*	Combretaceae	+	-	-
Capparis	*spinosis*	*Capparaceae*	-	-	+
Carissa	*carandus*	Apocyanaceae	+	-	-
Crotalaria	*leptostachya*	Fabaceae	-	+	-
Dalbergia	*trigona*	Fabaceae	-	-	+
Dendropthoe	*trigona*	*Loranthaceae*	-	-	+
Dracaena	*terniflora*	Dracaenaceae	-	+	-
Eupatorium	*adenophorum*	Asteraceae	-	-	+
Hamelia	*patens*	Rubiaceae	-	-	+
Helecteris	*isora*	Sterculiaceae	+	-	-
Holarrhena	*antidysentrica*	Apocyanaceae	+	-	-
Hyptis	*suaveoloens*		+	-	-
Indigofera	*tinctoria*	Fabaceae	+	-	-
Ixora	*coccinea*	Rubiaceae	-	-	+
Lavandula	*lawii*	Lamiaceae	-	+	-
Leea	*macrophylla*	Leeaceae	+	-	-
Lepidagahtis	*bandraensis*		+	-	-
Malachra	*capitata*	Malvaceae	+	-	-
Mimosa	*pudica*	Mimosae	+	-	-
Phyllanthaceae	*reticulatus*	*Phyllanthaceae*	-	-	+
Psychotria	*truncata*	Rubiaceae	-	+	-
Scurulina	*feruginea*	*Rhamnaceae*	-	-	+
Scutia	*myrtina*	*Rhamnaceae*	-	-	+
Strobilanthes	*callosa*	Acanthaceae	-	+	-
Tephrosia	*purpurea*	Fabaceae	+	-	-
Trimpfeta	*rhomboidea*	Tiliaceae	+	-	-
Urena	*lobata*	Malvaceae	+	-	-
Zizyphus	*oenoplea*	*Rhamnaceae*	-	-	+
Zizyphus	*rugosa*	*Rhamnaceae*	-	-	+

Table 3: Herbs of Bhavale, Kaas and Velneshwar

Genus	Species	Family	Bhavale	Kaas	Veneshwar
Achyranthes	*aspera*	Amaranthaceae	+	-	-
Adelocaryum	*coelestinum*	Begoniaceae	-	+	-
Adelocaryum	*malabaricum*	Boraginaceae	-	+	-
Adenoon	*indicum*	Asteraceae	-	+	-
Adhathoda	*zeylanica*	Acanthaceae	-	-	+
Aerides	*crispa*	Orchideacea	-	+	-
Aerides	*maculosa Lindl*	Orchideacea	-	+	-
Amaranthus	*viridis*	Amaranthaceae	+	-	-
Ammania	*baccifera*	Lythraceae	+	-	-
Argyreia	*strigosa*	Convolvulaceae	-	-	+
Arisaema	*caudatum*	Araceae	-	+	-
Arisaema	*ghaticum*	Araceae	-	+	-
Arisaema	*murrayi*	Araceae	-	+	-
Barleria	*gibsoni*	Acanthaceae	-	+	-
Begonia	*crenata*	Begoniaceae	-	+	-
Bulbophyllum	*fimbriatum*	Orchideacea	-	+	-
Canscora	*diffusa*	Gentianaceae	+	-	-
Cassia	*tora*	Caesalpinae	+	-	-
Celosia	*argentea*	Amaranthaceae	+	-	-
Ceropegia	*lawii*	Asclepiadaceae	-		+
Cleome	*chelidonii*	Capparidaceae	+	-	-
Cleome	*viscose*	Capparidaceae	+	-	-
Colebrookia	*oppositefolia*	Lamiaceae	-	-	+
Commelina	*benghalensis*	Commelinaceae	+	-	-
Corchoru	*capsularis*	Tiliaceae	+	-	-
Crinum	*brachynema*	Amaryllidaceae	-	+	-
Crotolaria	*pumila*	Fabaceae	-	-	+
Cyanotis	*fasciculata*	Commelinaceae	-	-	+
Delphinium	*malabaricum*	Ranunculaceae	-	+	-
Dendrobium	*microbulbon*	Orchideacea	-	-	+
Drosera	*indica*	Droseraceae	+	-	+
Ensete	*superbum*	Musaceae	-	+	-
Eriocaulon	*sedgewickii*	Ericaulaceae	-	-	+
Eupatorium	*spp.*	Asteraceae	+	-	-
Euphorbia	*hirta*	Euphorbiaceae	+	-	-
Euphorbia	*panchganiensis*	Euphorbiaceae	-	+	-
Exacum	*pumillum*	Gentianaceae	+	-	-
Exacum	*lawii*	Gentianaceae	-	+	-
Exacum	*pumilum*	Gentianaceae	-	+	-
Flemingia	*nilgheriensis*	Leguminosae	-	+	-
Gloriosa	*superba*	Liliaceae	+	+	+
Haplanthodes	*verticillatus*	Acanthaceae	-	+	-
Heracleum	*grande*	Apiaceae	-	+	-
Impatience	*balsaminae*	Balsaminaceae	+	+	-
Impatiens	*dalzellii*	Balsaminaceae	-	+	-

Impatiens	*dalzellii*	Balsaminaceae	-	+	-
Impatiens	*lawii*	Balsaminaceae	-	+	-
Impatiens	*minor*	Balsaminaceae	-	+	-
Impatiens	*oppositifolia*	Balsaminaceae	-	+	-
Impatiens	*pulcherrima*	Balsaminaceae	-	+	-
Impatiens	*tomentosa*	Balsaminaceae	-	+	-
Justicia	*trinervia*	Acanthaceae	-	+	-
Kalanchoe	*olivacea*	Crassulaceae	-	+	-
Lepidagathis	*lutea*	Acanthaceae	-	-	+
Leucas	*ciliate*	Lamiaceae	-	-	+
Martynia	*annua*	Pedaliaceae	+	-	-
Murdania	*simplex*	Commelinaceae	-	-	+
Murdannia	*wightii*	Commelinaceae	+	-	-
Murdannia	*lanuginosa*	Commelinaceae	-	+	-
Murdannia	*vaginata*	Commelinaceae	-	+	-
Murdannia	*versicolor*	Commelinaceae	-	+	-
Neanotis	*lancifolia*	Rubiaceae	+	+	-
Neanotis	*subtilis*	Rubiaceae	-	+	-
Neuracanthus	*sphaerostachyus*	Acanthaceae	-	+	-
Pimpinella	*wallichiana*	Apiaceae	-	+	-
Pinda	*concanensis*	Apiaceae	-	+	-
Plectranthus	*mollis*	Lamiaceae	-	+	+
Pogostemon .	*spp.*	Acanthaceae	-	-	+
Polygonum	*glabrum*	Polygonaceae	-	-	+
Pseuderanthemum	*malabaricum*	Acanthaceae	-	+	-
Ramphicarpa	*longifolia*	Scrophulariaceae	+	-	-
Rotala	*fimbriata*	Lythraceae	-	+	-
Rungia	*pectinata*	Acanthaceae	-	-	+
Scenecio	*edgeworthi*	Asteraceae	-	-	+
Senecio	*arachnoidea*	Asteraceae	-	+	-
Sesamum	*orientale*	Pedaliaceae	+	-	-
Smithia	*sensitiva*	Fabaceae	+	+	+
Smithia	*bigemina*	Fabaceae	-	+	+
Smithia	*agharkarii*	Fabaceae	-	+	-
Smithia	*hirsute*	Fabaceae	-	+	-
Smithia	*salsuginea*	Fabaceae	-	+	-
Smithia	*setulosa*	Fabaceae	-	+	-
Sonchus	*oleraceus*	Asteraceae	-	-	+
Spermacoce	*pusilla*	Rubiaceae	+	-	-
Striga	*gesnerioides*	Scrophulariaceae		-	+
Swertia	*densifolia*	Gentianaceae	-	+	-
Trichodesma	*indica*	Boraginaceae	+	-	-
Tricholepis	*glaberrima*	Asteraceae	-	-	+
Utricularia	*reticulate*	Lentibulariaceae	-	-	+
Utricularia	*praeterita*	Lentibulariaceae	-	+	-
Utricularia	*purpurascens*	Lentibulariaceae	-	+	-
Utricularia	*albo-caerulea*	Lentibulariaceae	-	+	-

Table 4: List of Climbers of Bhavale, Kaas and Velneshwar

Genus	Species	Family	Bhavale	Kaas	Veneshwar
Arnicratea	grahamii	Celastraceae	-	+	-
Canavalia	lineate	Leguminoseae	+	-	-
Ceropegia	jainii	Apocynaceae	-	+	-
Ceropegia	vincaefolia	Apocynaceae	-	+	-
Cissampelos	pareiera	Menispermaceae	-	-	-
Ipomoea	pes tigris	Convolvulaceae	+	-	-
Mucuna	pruriens	Leguminoseae	+	-	-
Piper	trichostachyon	Piperaceae	-	+	-
Trichosanthes	cucumerina	Cucurbitaceae	+	-	-
Vigna	capensis	Fabaceae	+	-	-

The trees and shrubs of Velneshwar and Bhavale were the prominent flora during the pre-monsoon period with very scanty under growth vegetation. The monsoon season showed an immense change in the floral landscape which was dominated by season herbs and grasses.

The tree species of Velneshwar mainly belonged to the Moraceae family. The plant species of this family are adaptable to the conditions of heavy rainfall during the monsoons and a dry season for the remaining part of the year. Bhavale flora mainly consisted of tree species belonging to the families Fabaceae, Verbenaceae and Bignoniaceae.

The shrubs in Velneshwar were dominated by species of the family Rhamnaceae while Bhavale was dominated by the species of the family Malvaceae.

The monsoon flora mainly consisted of herbs and grasses. Maximum species of herbs in Velneshwar belong to family Acanthaceae while that in Bhavale belong to the family Amaranthaceae. The difference in flora is mainly seen due to the difference in altitude of both the plateaus and their respective proximities from the sea.

Also during monsoon insectivorous plants like *Drosera indica* and *Utricularia reticulate* were seen in Velneshwar and Kaas while no insectivorous plants were seen at Bhavale. The flora of Bhavale and Velneshwar when compared to that of Kaas it was seen that plant population at Velneshwar is parallel to Kaas floral population.

Very few plants species at Bhavale are observed to be similar to Kaas flora. The flora of Kaas is dominated by seasonal herbs of family Acanthaceae, Balsaminaceae and Fabaceae. The plant species commonly observed in Velneshwar and Kaas were *Impatiens* spp., *Smithia* spp. and *Utricularia* spp. whereas those common to Kaas and Bhavale were *Smithia* spp. and *Murdannia* spp.

The similarities in flora of Velneshwar and Kaas were mainly due to the presence of a rocky substratum whereas Bhavale exhibits a hilly terrain. Kaas landscape is more supportive to herbs because of lesser density of shrubs and trees. Hariyali has carried out dense afforestation in Bhavale facilitating tree growth. Also the rainfall in Kaas and Velneshwar is much higher than that in Bhavale which impacts the growth of monsoon herbs.

38 endangered species are listed from Kaas, 4 from Velneshwar but none are found in Bhavale as Bhavale is basically a barren hillock undertaken for plantation.

Flora of Kaas is becoming endangered mainly due to the anthropogenic activities like tourism and other human interferences. Velneshwar on the other hand is being slowly developed for industrial and infrastructural facilities which will eventually have a direct impact on the ecosystem of the place. Bhavale is already under reforestation. Maximum numbers of endemics (41) were reported from Kaas (Satara). The family Poaceae has largest number of endemic species (22 species), followed by Fabaceae with 5 species and Apiaceae, Apocynaceae and Asteraceae with 4 species each. (Lekhak and Yadav, 2012). 4 from Velneshwar and none from Bhavale are endemic. The endemic ecosystem of Kaas has already been declared as under threat and needs utmost protection but the same threat should be averted in Velneshwar. Endemic species exhibit very less diversity so the natural rate of conservation is very slow thereby

stressing the need of conservation *in-situ*.

Plant communities at plateau regions are edaphically controlled and show an adaptation for water accumulation, such as succulence and poikilohydry, carnivory in response to the lack of nutrients (N, P and S) in the soil and the presence of subterranean organs (bulbs, corms, tubers and rhizomes) to overcome extreme temperature during summer.

Harsh environmental conditions on the plateaus have given rise to plants with certain traits that allow them to overcome environmental adversities. These traits help the plants to overcome major environmental stresses such as drought, high temperature and light intensities and nutrient deficiency. A detailed account on the adaptation/ ecophysiology of vasular plants of rock outcrops is provided by Kluge and Brulfert (2000). Some well-known adaptive traits that have been observed in the vascular plants on plateaus are mentioned below (modified after Biedinger *et al.,* 2000).

Carnivory: It is a means to overcome the scarcity of soil nutrients. Carnivorous plants are extremely calcifuge and need acidic and wet soils (Kluge and Brulfert, 2000). This kind of microhabitat is provided by plateaus. *Drosera burmannii, D. indica*, *Utricularia* species are the common carnivores on the plateaus. These species comprise ephemeral vegetation where soil deposition is negligible.

Soil varied from sandy to sandy loam type with good water holding capacity and normal EC. It was highly acidic (4.5–6), rich in organic carbon, available nitrogen and available potassium. Lekhak and Yadav (2012) relate the presence of carnivorous plants on the plateau to the poor nitrogen, phosphorous and potassium (N,P,K) values. However, the soil is poor only in available phosphorus. In addition to the carnivorous plants, many other plant species are able to survive in the habitat. Hence, the abundance of carnivorous species on rocky plateaus might be mainly because of reduced competition from other generalist species as a result of harsh physical environment, acidic soils and low levels of available phosphates. Presence and dominance of other plant adaptive strategies such as poikilohydry, geophytic, therophytic, hydrophytic species seen on rocky plateaus (Watve 2007, 2010; Lekhak & Yadav 2012) is also a result of extreme seasonality in climate. (Watve, 2013)

Conclusion

The study shows that there is similarity in the flora of Kaas and Velneshwar while Bhavale shows totally different floral pattern. The plateau of Kaas is already declared a UNESCO World Heritage Site and major conservation projects are already underway there. Bhavale has been adopted by the NGO Hariyali for afforestation however through this study an attempt is made to document the flora of Velneshwar and state its ecological significance. The study also aims to emphasize the ecological importance of the three plateaus and the need for their flora to conserve so as to study the environmental relationships between the various strata of life and the inter dependence of abiotic and biotic factors of nature.

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A Survey of Palms from Jnanadweepa Campus and Studies on their status of conservation

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Abstract : Members of the plant family Palmae, also known as Palmaceae, or more recently rechristened as Arecaceae are mostly found in hot tropical, subtropical and warm temperate regions of the world. Apart from exhibiting enormous diversity in their morphological features, palms are known to inhabit almost all types of habitats ranging from tropical rainforests to desert habitats. They feature amongst the most extensively cultivated botanical families and have been very close to mankind since the origin of civilizations. Whilst various historical accounts depict palms as symbols of fertility, peace, wellbeing and victory, in recent times the palm tree has come to symbolize vacations at exotic locations and also, their significance in all the major religions of the world continues unquestioned. Besides being sources of ethno-medicines, foods, oils and various other products of utility, palms are also widely used in landscaping, horticulture and gardening. The popularity of palms has increased with times.

The biodiversity of palms occurring on Jnanadweepa, Vidya Prasarak Mandal's college campus, popularly known as Thane college campus was studied in the current investigation. Different varieties of palms were recorded, dominant among them, on the college campus, being *Cocos nucifera* (coconut palm), *Areca catechu* (areca palm) and *Chrysalidocarpus lutescens* (golden cane palm). *Caryota urens*, with its majestic appearance and multi faceted utility potential, and *Rhapis* spp. (lady palm) were also recorded in the study. *Ravenala madagascariensis*, popularly referred to as traveller's palm; but not actually a true palm, was also observed and included in the findings as a special listing. The economic importance and status of conservation of the listed palms is also mentioned.

Key words : Biodiversity, palmae, arecaceae, palms, Thane college campus, Cocos nucifera

Introduction

The majestic palms prominently feature amongst the best known and most extensively cultivated plants in the world today. These members of the botanical family Arecaceae, previously known as Palmae, are generally found in hot tropical, sub tropical and warm temperate regions. Further north or south, they are prized as popular indoor, conservatory, glass house or hot house specimens. Palms exhibit an enormous diversity in their morphological features and are also known to inhabit almost all types of habitats ranging from tropical rainforests to desert habitats (Leaser, 2005). Acknowledged amongst plants for their imposing appearance, heights, dimensions of leaves, seeds and inflorescence; palms hold undisputed records for the tallest monocotyledonous plant in the world, largest leaves, largest seeds, largest flower clusters and largest inflorescence in the plant kingdom. As sheer numbers would testify, some palms bear up to 15 million flowers on a single plant (Riffle, 2008).

Palm trees have been intimately associated with human civilizations throughout the history of mankind (Dekhane, 2003); having being quoted in ancient Indian literature (Bedekar, 1993; Nene, 1997a), acknowledged from excavation sites of ancient civilizations (Mehra, 1997; Tamboli and Nene, 2005), mentioned in mythological legends and folklore (Gandhi and Singh, 1989), historical memoirs and records (Nene, 1997b; Kumar, 2008), religious texts inclusive of both Old and New testaments of the Bible and writings associated with the major religions of the world wherein they have been attributed with symbolic significance (Kadari, 2009; Schulze, 2012) as well as classics (Doyle, 1981). Various civilizations have associated them with symbolism depicting aspiration, fertility, honour, life, peace, resurrection, truth, value, victory, vitality and warmth, to name a few and their usage in religious rites and rituals of all major religions has continued since ancient times. In recent times, palms have come to symbolize leisurely vacations at exotic tropical seaside locations.

Members of the palm family have been supplying all the basic necessities of life to human civilizations in the tropics since times immemorial; providing them with livelihood and sustenance, and, subtly entering their lives by becoming a part of socio- religious functions and rituals. In acknowledgement of their contribution and anthropological importance, the renowned botanist Carolus Linnaeus referred to them as 'princes of the plant kingdom'. Currently, while over 200 genera with around 2600 species of palms are known all over the world (Wikipedia), around 63 palms are reported indigenous to India and an equal number introduced from other countries, collectively putting the numerical diversity of palms in India at over 125 types (Mahabale, 1982). In spite of this rich and impressive background, information available on Indian palms is scattered and relatively scanty. Hence, to create awareness on this rich natural heritage, it was planned to carry out a survey of members of the family arecaceae (palmae) on Jnanadweepa, Vidya Prasarak Mandal, Thane's college

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campus, popularly known as Thane college campus as part of an exercise for documentation of palm flora on the campus.

The area of study viz. Jnanadweepa, popular amongst locals as Thane college campus is a spacious 13.5 acre island campus situated in the Chendani area of Thane city, alongside the Thane creek, near Thane railway station (Central Railway) on the outskirts of Mumbai, the commercial capital of India. Apart from housing some of the best educational institutes in the region (VPM, 1996, 2013), the world class campus also sports a huge biodiversity of micro and macro flora, both natural and cultivated. The avenues in the campus and the carefully laid out jnanapath viz. the walking track along the circumference of the campus are for a major part lined with coconut and other palms. The overwhelming majority of palms, especially the coconut palm (*Cocos nucifera* Linn.), on the campus prompted the current investigation.

Materials And Methods

The study was carried out by employing the survey method for collection and compilation of data over a period of 12 months, from November 2012 to October 2013; wherein a physical count and survey of all specimens belonging to the family Arecaceae (Palmae/ Palmaceae) was carried out in the area of study. Specimens planted at permanent locations in the ground, potted specimens as well as transplanted saplings were considered for documentation and recording in the study. The specimens were identified in the field and in the department of botany, B.N Bandodkar College of Science, a NAAC reaccreditated A Grade institute from amongst the VPM Group of Institutes, situated on the campus, using standard literature. The related facts presented in the section of results and discussion, were compiled from various sources, duly cited in the references section.

Results And Discussion

The study revealed an impressive 279 single specimens of palms and a further 31 number of clumps of the golden cane palm (*Chrysalidocarpus lutescens*) exhibited both, as potted specimens as well as in the ground at permanent locations in the area of study. This was in addition to 2 clusters comprising collectively 10 specimens of the 'palm like' member of the botanical family Musaceae, more recently classified under the bird-of-paradise family Strelitziaceae.viz. Traveller's palm (*Ravenala madagascariensis* Sonn.). The 279 single palm specimens recorded, belonged to 5 different genera; the majority of the recorded specimens belonged to genus *Cocos* viz. the coconut palm (*Cocos nucifera* Linn.) followed by genus *Areca* viz. Areca nut palm (*Areca catechu* Linn.). The genera recorded in lesser numbers, but nevertheless of value from the biodiversity point of view were genus *Livistona* viz. Fan palm (*Livistona chinensis* R. Br.), genus *Caryota* viz. Fish tail palm (*Caryota urens* L.) and genus *Rhapis* viz. lady palm (*Rhapis* spp.). All the specimens recorded were cultivated, having being planted or introduced in the area of study at different times since establishment of the educational campus in late 1960s. The results are depicted in Table 1.

The coconut palm (*Cocos nucifera* L.) is of common occurrence in the Konkan area under which the area of study falls; growing best near the sea coast (Pfleiderer, 1990) and results are in agreement with the same. This palm has been cultivated in India since ancient times. All parts of this tree being useful to mankind, has earned it the name 'kalpavriksha', one among the 5 legendary devavrikshas, the 'all giving trees' (Markrose, 2008). The roots, trunk, leaves, flowers, fruits, seeds, kernel, pulp, coconut milk, coconut water, oil, oil cake, mature coconut shell, coir, wood and pith are valuable assets yielded by this tree which can be put to a vast multitude of uses in various fields of utility inclusive of their reputed medicinal uses (Chopra *et al*., 1969; Agarwal, 1986; Tiwari and Pande, 2005; NISCAIR, 2010). The entire tree is of importance in horticulture and landscaping (Gopalaswamiengar, 1991), considered as sacred, the nuts being part of socio religious functions and rituals (Bhatla *et al*., 1984) and is also a valuable source of pollen and nectar for honey bees (Alexander and Daniel, 2012). An impressive total of 187 coconut palms were recorded in the area of study during the investigation; some were newly transplanted, some well settled and showing excellent growth, while many were the original specimens planted soon after establishment of the campus, in late 1960s and early 1970s.

The betel-nut palm (*Areca catechu* L.), common in the coastal regions from Maharashtra to Kerala and Tamil Nadu, is almost equally useful; its roots, young shoots, leaves, nuts, juice of nuts, burnt nuts, green kernel, husk are put to several uses which also includes several medicinal uses (CSIR, 1948; Pullaiah and Naidu, 2003; Kirtikar and Basu, 2006). These nuts are also a part of socio religious functions. The chewing of betel-nuts is believed to induce oral cancer and unripe fruits are believed to harm the eyesight (Parrotta, 2001; Chen *et al*., 2013). A total of 79 areca-nut palms were recorded on the campus during the study. Most of the specimens surveyed were young specimens in large pots, exhibited at vantage points for ornamental purposes and landscaping.

The cane palm (*Chrysalidocarpus lutescens*) is essentially an ornamental palm introduced from Madagascar (Mahabale, 1982), equally suitable for indoor, semi-outdoor as well as outdoor locations. The clumping habit adds beauty to this palm. Thirty one clumps of this palm were

recorded, each clump comprising few to several individual specimens; both, plants at permanent locations as well as potted specimens were recorded during the study.

Seven specimens of the Chinese fan palm (*Livistona chinensis R. Br.*) at permanent locations in the campus as well as in pots were recorded during the study. This versatile palm is capable of growth indoors, to a certain extent, as well as outdoors and is exhibited as an impressive ornamental palm.

The fish tail palm (*Caryota urens L.*) is commonly seen in evergreen forests of peninsular India (Santapau, 1967) and is also renowned as an ornamental tree (Swarup, 1997) planted in gardens for its distinctive looks and silhouette. The tree has several other uses viz. its yield of strong kitul fibre, food value for large animals such as elephants, timber value, source of sweet toddy, palm jiggery, sago and medicinal value (CSIR, 1992; Parrotta, 2001;Sahni, 2005). All parts of this palm are useful. Four specimens of this handsome palm were recorded during the current investigation.

The lady palm (*Rhapis spp*.) has been reported as a slow growing ornamental plant, suitable for indoor as well as outdoor locations, preferably in shade (Beri, 1987). Two potted specimens of this beautiful palm were observed and recorded during the study.

The palm-like member of plant family Musaceae, or recently Strelitziaceae, viz. Traveller's palm (*Ravenala madagascariensis* Sonn.) has its own charming beauty. Its large woody trunk resembles that of palms, while the leaves are more like those of banana, to which botanical family it belongs. Ten specimens of the palm were recorded from two locations, one location showing a cluster of 9 plants, most of which had arisen from the sides of the parent plant as is the case with banana. This is not actually a true palm and has been included in the study as a special listing due to its resemblance to palms.

Conclusion

The investigation revealed an overwhelming, healthy and vigourous population of palm specimens thriving on Jnanadweepa, VPM's college campus, popularly known as Thane college campus. All the specimens recorded were healthy, free from diseases and actively growing; many also showed flowering and fruiting, indicating a natural, healthy and undisturbed environment suited for growth and development. The best of the conservation efforts were observed to be carried out by the support staff under instructions from authorities to maintain the healthy and thriving population of palms on the campus. There is no doubt that the palms investigated in the current study, along with the rich flora on the Jnanadweepa educational campus housing VPM's group of institutions, serve as green lungs for all the surrounding areas in the viscinity.

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Table 1: Palms recorded on VPM's Jnanadweepa campus, Thane, India

S. No	Botanical name	Common Names (English, hindi, Marathi,Sanskrit)	Specimens Recorded (*Nos./ **clumps)
1	*Cocos nucifera* L.	coconut palm, nariel, nariyal, narikela	187*
2	*Areca catechu* L.	areca palm, areca-nut palm, betel-nut palm, supari, pophali, gubak, guvaka, kramuka, puga, tantusara	79*
3	*Chrysalidocarpus lutescens* syn. *Areca lutescens*, *Dypsis lutescens* (H. Wendl.)	bamboo palm, butterfly palm, cane palm, golden cane palm, golden feather palm, madagascar palm,	31**
4	*Livistona chinensis* R. Br.	chinese fan palm, fan palm, fountain palm	7*
5	*Caryota urens* L.	fish tail palm,horse tail palm, Indian sago palm, kitul palm, Malabar palm, wine palm, bankhajur, berli, berlimad, dirgha, dhoajavriksha,	4*
6	*Rhapis* spp.	lady palm, little lady palm, broadleaf lady palm, ground rattan palm	2*

(In addition to the above palms, 10 specimens of the palm akin Traveller's palm (*Ravenala madagascarensis* Sonn.) in two clusters comprising 9+1 specimens were also recorded)

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Studies on the Biodiversity of Weeds from V.P.M.'s College Campus and Adjoining Areas in Thane, India

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Abstract : Weeds are commonly considered as unwanted or undesirable plants in areas of specified human activities such as agricultural fields, horticultural cultivations, gardens, parks, lawns and landscaped areas. This mixed group of unrelated plants is adapted to grow aggressively and reproduce at phenomenal rates so as to spread far and wide and capture all available land within its reach. Weeds are known to occur in all natural habitats, cultivated lands, disturbed land habitats, degraded lands and also on roadsides and sites with human constructions. Generally considered a menace, weeds are also useful in several respects. Besides their use in traditional systems of medicine, they have applications in ethno-, tribal and veterinary medicines and have also been exploited by modern research in drugs as sources of novel phyto-compounds.

The biodiversity of winter weeds in Jnanadweepa, Vidya Prasarak Mandal's college campus, locally popular as 'Thane college' campus, and its adjoining areas, was studied in the present investigation. Ten locations within the college campus were earmarked for study which was carried out by the list quadrant method. Over forty five different broad and narrow leaved plants were recorded as weeds during the study; prominent amongst them were *Alternanthera sessilis*, *Amaranthus viridis*, *Cynodon dactylon*, *Euphorbia hirta*, *Cyperus* sps. and *Oxalis* spp.

Key Words: biodiversity, weeds, Thane college campus, grasses, sedges

Introduction

Weeds are best described as unwanted and undesirable plants that interfere with and hamper optimum usage of land, water, space and nutrients, and thus negatively affect crop yields and human interests in the long run. Many a times they are referred to as plants growing where they should not be; or, plants growing in the wrong places. Other than cultivated lands and orchards, weeds are known to occur practically everywhere. They are found on degraded lands, fallow lands, waste lands, disturbed land habitats, along road sides, along railway tracks, airfields, construction sites, at industrial locations, in and around human settlements, water channels, irrigation canals, water tanks, alongside ponds, lakes and water bodies inclusive of waste water nullahs and bunds. Their aggressive growth coupled with phenomenal rates of reproduction and capability to survive in challenging circumstances ensure their spread far and wide and result in capture of all available land within their reach by the notorious weeds. Weeds thus are much dreaded by farmers and horticulturists alike.

The harmful effects of weeds are greatest felt in agriculture where the unwanted weeds compete with crops for space, soil, water, nutrients, light and inputs; block irrigation channels with their prolific growth and ultimately reduce the yields of crops and their quality (ICAR, 2000). Weeds are also known to harbor insects, pests and harmful microorganisms, release poisonous toxins and growth inhibitory substances in the soil, thereby affecting surrounding cultivated plants (CSIR, 1992), live stock and human beings. Weeds are notorious because they increase the expenditure by involving the cumbersome process of weeding which has been described as one of the most labourous operations in agriculture (Puttoo, 2008). They are known to hamper harvesting operations. The losses caused by weeds in agriculture far exceed losses from all other categories taken together (Subramanian *et al*., 1995). Besides bringing about reduction in crop yield, weeds reduce land value, affect the quality of produce, affect human efficiency, and block water bodies resulting in impediments and death of fish. Several empowering factors bestowed by nature such as early germination of seeds, faster growth of seedlings, early maturity, early flowering, production of seeds in great profusion, extreme endurance, durability and physiological capabilities ensure superiority and wide distribution of weeds. The intense crop-weed competition is a science in itself. One of the significant developments in agricultural technology in recent times has been the usage of chemical means viz. herbicides for weed control and this is a cost effective and less laborious option (Shinde *et al*., 2013); while some prefer integrated weed management (Ghadage *et al*., 2013) however manual weeding practices are still considered the best option by many Indian farmers. In case of parks, lawns and gardens, weeds give an untidy appearance to the entire landscape and spoil the beauty.

As stated earlier, not all weeds are that much a menace as they are projected to be. Many weeds are actually useful and extremely beneficial to mankind in many respects. Most of the weeds are known to have medicinal attributes (Parrotta, 2001), traditional, ethno- and tribal-medicinal usages (Siddalinga Murthy and Vidyasagar, 2013), value as remedies against snake bites (Naidu *et al*., 2013), food value (CSIR, 1948; Singh and Shrivastava, 2013), fodder value (Relwani, 1979, Kulkarni and Kumbhojkar, 2003), traditional and local

veterinary medicinal usages (Tiwari and Tiwari, 2003), manurial and green manurial value (Padmaiah, 1999, Naikwade *et al*., 2011) and religious or sacred importance attached to them (Jasrai and Chaplot, 2003). Some weeds are commercially valuable (Kalbande, 2009) and some have, believe it or not, ornamental value (Courtier and Clarke, 1997). Useful and effective formulations for controlling termites (Ahmed, 2008), nematodes (Joshi *et al*., 2012) have been indigenously developed from weeds and many of these unwanted plants are gainfully looked upon as sources of anti microbial and anti fungal compounds (Rathore, 2009) as well as novel life saving phytochemicals (Yogesh *et al*., 2013). Marginal farmers consider weeds as an asset with food, fodder, socio-economic and soil conservation values (Singh and Tulachan, 2002). With this background, the current investigation was undertaken to create awareness about weeds and to study the diversity of weeds in the college campus.

The area of study viz. Jnanadweepa, popular amongst locals as Thane college campus is a spacious 13.5 acre island campus situated in the Chendani area of Thane city, alongside the Thane creek, near Thane railway station (Central Railway) on the outskirts of Mumbai, the commercial capital of India. Apart from housing some of the best educational institutes in the region, the world class campus also sports a huge biodiversity of micro and macro flora, both natural and cultivated. The well laid out gardens, lawns, landscaped grounds and open land for sports are a haven for growth of weeds in the monsoon season. The current study was undertaken after monsoon, to study and document winter weeds in the campus.

Materials and Methods

The study was carried out by employing the survey and quadrat methods for collection and compilation of data over a period of 3 months, from December 2012 to February 2013; wherein a physical survey of all weeds was carried out in the area of study. 1m X 1m quadrats were laid out at 12 locations of which location nos. 1-10 were within the campus and the remaining quadrats were outside and to the left and right sides of the main gate of the campus. The 10 locations within the college campus were as mentioned below:

Location 1: Area in front of the college cafeteria building

Location 2: Area to the left of the cafeteria building, inclusive of the sports ground

Location 3: Area behind the cafeteria

Location 4: Area to the right of the cafeteria building, inclusive of the NCC obstacle course

Location 5: Area behind the science college building.

Location 6: Area flanking the science college building

Location 7: Area in front of the student's gate and in between science, commerce and arts college buildings

Location 8: Area in front of the main gate, security cabin and fountain; law college flanks

Location9: Area around polytechnic building and shade net areas

Location 10: Area covering open air theatre in front of science college

The methodology recommended by Subramanian *et al*., (1991) was followed during the investigation.

The specimens were identified in the field and in the department of Botany, B.N. Bandodkar College of Science, a NAAC reaccreditated A Grade institute from amongst the VPM Group of Institutes, situated on the campus, using standard literature. The related facts presented in the section of results and discussion, were compiled from various sources, duly cited in the references section.

Results and Discussion

Weeding operations have been carried out since historical times in India and our farmers understood the ill effects (Tamboli, 2008) as well as the plus points of weeds (Watt, 1999). The importance and wisdom of weeding has been explained through historical maxims (Ahuja, *et al*., 2005) and *abhangas* (Patil, 2002).

A total of 51 weeds belonging to 24 families were recorded during the study. Plant families Amaranthaceae, Asteraceae, Malvaceae and Poaceae were represented by 5 specimens each; Euphorbiaceae and Fabaceae by 4 specimens, Solanaceae by 3 specimens, Capparidaceae, Commelinaceae, Cucurbitaceae, Cyperaceae and Tiliaceae by 2 specimens each and the rest had 1 representative each. The results are presented in Table 1. The results are in aggrement with lists of weeds released by ICAR, 2000.

Alternanthera sessilis (family Amaranthaceae) was the most abundant weed, recorded from all the 12 locations of study, followed by *Cynodon dactylon* (family Poaceae) which was recorded from 11 locations. Several weeds were located at only 1 location, but were nevertheless important from biodiversity point of view. The total number of specimens recorded at each location showed that locations within the college campus had a richer composition of weeds in comparison with locations outside. Locations outside the campus demonstrated heavy disturbance owing to excessive human activities, vehicular movements, animal and poultry related disturbances, which may all probably be responsible for the reduced flora. The abundant supply of water, favourable growth conditions and relatively less disturbance inside the educational campus probably are factors boosting development of flora in the area. The weeds were much more prolific and abundant during monsoon and lesser in the period of study, mainly due to the grass cutting

and weeding operations undertaken after monsoon on the campus.

Most of the weeds recorded were medicinally important and also had several other reported uses. *Calotropis gigantea* has been widely reported for its medicinal (Parrotta, 2001), ethnomedicinal (Ladda., *et al*., 2013), ethnoveterinary (Dwivedi and Singh, 2002) and green manure usage (Padmaiah, 1999). Vijigiri *et al*., 2013 reported usage of *Cynodon dactylon* and *Celosia argentea* for treatment of kidney stones. Lantana camara was reported to yield manure of excellent quality (Ghadge and Jadhav, 2013) and Riccinus communis, for its crop protective and manorial role (Reddy, 1998).

Conclusion

An impressive total of 51 weeds belonging to 47 genera were documented in the current investigation. Most of the weeds recorded were broad leaved.The rich biodiversity of weeds recorded on the Jnanadweepa campus calls for further studies.

Future Plans

It is planned to carry out a systematic season wise study of weeds all round the year for better understanding and awareness on the subject.

Acknowledgements

The authors gratefully acknowledge the co-operation, encouragement and inspiration received from Vidya Prasarak Mandal, Thane, the Principal, B. N. Bandodkar College of Science, Head of the Department of Botany, Department of Library and Information Science, Science Square, and help received from the gardeners and garden labour on the campus for completion of this project.

Table 1: Winter weeds recorded on VPM's Jnanadweepa campus and adjoining areas, Thane, India

S.No	Name of Plant/ Weed	Family	Location												
			1	2	3	4	5	6	7	8	9	10	11	12	% abundance
1	*Achyranthes aspera*	Amaranthaceae						+							8.3
2	*Alternanthera sessilis*	Amaranthaceae	+	+	+	+	+	+	+	+	+	+	+	+	100
3	*Amaranthus spinosus*	Amaranthaceae								+	+				16.6
4	*A. viridis*	Amaranthaceae	+	+		+		+	+	+	+	+		+	74.9
5	*Celosia argentea*	Amaranthaceae			+	+									16.6
6	*Centella asiatica*	Apiaceae			+										8.3
7	*Calotropis gigantea*	Asclepiadaceae		+	+										16.6
8	*Ageratum conyzoides*	Asteraceae			+	+	+		+					+	41.6
9	*Blumea lacera*	Asteraceae	+		+	+	+				+			+	50
10	*Eclipta prostrata*	Asteraceae		+	+	+	+		+		+				50
11	*Tridax procumbens*	Asteraceae					+		+		+	+			33.3
12	*Vernonia cinerea*	Asteraceae					+		+						16.6
13	*Cleome viscosa*	Capparidaceae	+		+		+	+	+						41.6
14	*Gynandropsis pentaphylla*	Capparidaceae	+				+	+	+	+	+	+			58.3
15	*Commelina benghalensis*	Commelinaceae									+				8.3
16	*Cyanotis axillaris*	Commelinaceae								+					8.3
17	*Coccinia indica*	Cucurbitaceae					+	+							16.6
18	*Diplocyclos palmatus*	Cucurbitaceae			+										8.3
19	*Cyperus rotundus*	Cyperaceae			+	+	+				+				33.3
20	*Cyperus* spp.	Cyperaceae	+				+								16.6
21	*Euphorbia hirta*	Euphorbiaceae	+				+	+		+	+	+	+		58.3
22	*Phyllanthus fraternus*	Euphorbiacea	+	+	+		+	+		+	+	+		+	75
23	*Phyllanthus* spp.	Euphorbiacea						+	+						16.6
24	*Riccinus communis*	Euphorbiacea			+						+				16.6
25	*Cassia tora*	Fabaceae-Caesalpinoideae	+	+							+			+	33.3
26	*Mimosa pudica*	Fabaceae-mimosoideae									+				8.3
27	*Mucuna pruriens*	Fabaceae-Papilionoideae		+											8.3

28	*Smithia spp.*	Fabaceae-Papilionoideae	+				+		+						25
29	*Ammannia baccifera*	Lythraceae						+	+			+			25
30	*Abelmoschus moschatus*	Malvaceae			+										8.3
31	*Malachra capitata*	Malvaceae			+	+		+							25
32	*Sida cordata*	Malvaceae		+	+	+		+							33.3
33	*Urena lobata*	Malvaceae		+	+			+	+		+				41.6
34	*U. sinuata*	Malvaceae						+							8.3
35	*Cocculus hirsutus*	Menispermaceae				+	+				+				25
36	*Oxalis corniculata*	Oxalidaceae	+	+			+	+	+	+	+				58.3
37	*Coix* spp.	Poaceae		+							+				16.6
38	*Cynodon dactylon*	Poaceae	+	+	+	+	+	+	+	+	+	+	+		91.6
39	*Cenchrus granularis*	Poaceae		+							+				16.6
40	*Paspalum spp.*	Poaceae			+		+	+	+	+	+				50
41	*Zea mays*	Poaceae							+						8.3
42	*Pteris* spp.	Polypodiaceae-Pteridaceae						+		+					16.6
43	*Portulaca oleracea*	Portulaceae					+					+	+	+	33.3
44	*Oldenlandia corymbosa*	Rubiaceae		+	+	+	+	+	+	+	+	+			75
45	*Scoparia dulcis*	Scrophulariaceae					+		+			+			25
46	*Datura metel*	Solanaceae			+										8.3
47	*Lycopersicon esculentum*	Solanaceae							+						8.3
48	*Physalis minima*	Solanaceae	+						+		+				25
49	*Corchorus capsularis*	Tiliaceae				+									8.3
50	*Triumfetta rhomboidea*	Tiliaceae				+		+							16.6
51	*Lantana camara*	Verbenaceae									+				8.3
			13	14	20	14	21	20	20	12	24	11	4	7	

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Treatability Study of Waste Water Using Activated Carbon, Sand Filter and Dual Media Filter

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Abstract: A treatability study was carried out at Common Effluent Treatment Plant (CETP), Koperkhairne, Navi Mumbai, Maharashtra by setting up a pilot plant using filters like Activated Carbon, Dual Media and Sand Filter. CETP receives effluent from approximately 3056 industries which include Large scale industries, Medium scale industries and Small scale industries. It includes a variety of industries like textiles, leather, paints, pharmaceuticals and many others whose effluents have a high load of COD, TSS, TDS etc. The aim of the research project was to check out which of the above mentioned filters give maximum colour and odour removal, COD reduction and TSS removal. After carrying out the study for seven days each on using effluent from clari-floculator it was found that Activated Carbon gives maximum colour and odour removal and maximum COD reduction.

Keywords: CETP, effluent, clarifloculator

Introduction:

The main objective of CETP is to make project feasible, techno-economical treatment cost which is to be borne by individual member unit to minimum while protecting the environment to a maximum.

CETP receives industrial waste water from industries of varying magnitude containing high load of Total Solids (TS), Total Suspended Solids (TSS), Mixed Liquor Volatile Suspended Solids (MLVSS), Mixed Liquor Suspended Solids (MLSS), Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), pH (varies from industry to industry). Treatment of such heavily polluted water is very essential before discharging it into the receiving water body. If such water is discharged in the receiving body, it will affect the flora and fauna of the water body and lead to its pollution.

At CETP preliminary, primary and secondary treatment is given to the effluent without significant change in color and odour. The preliminary treatment includes physical treatment; followed by primary treatment, which includes addition of chemicals and neutralization of the effluent. Further effluent is sent for secondary treatment which includes biological treatments, such as Activated Sludge Process. After all treatment processes, the parameters such as COD, TSS, TDS etc gets reduced within the permissible limits as prescribed by Maharashtra Pollution Control Board. But this treatment process is not sufficient to remove the colour and odor of the waste water.

In the present study, a pilot plant was set up at CETP using different filters like Activated Carbon, Sand Filter and Dual Media Filter to compare their efficiency in reducing the colour and odour component of waste water. The filters were changed after every 7 days. Various water parameters like COD, TSS, TDS, DO, BOD, MLSS, MLVSS etc were monitored. The color and odor were also visually checked regularly.

Sand Filter was selected because; it had been traditionally used as the filter medium in conventional water treatment plants owing to its wide availability, low cost and the satisfactory results. (Al-Rawi S. M., 2009).

Research also shows that, activated carbon filters are extremely effective as primary filters and have the added benefit of organic load reduction resulting in cost savings with reduced chlorine demand and safer water (Peta Thiel, 2006).

Materials and methods:

Waste water sources:

The effluent was taken from 12 MLD clarifloculator, quantity 12lit/day. The effluent at CETP is high in TS, COD, BOD and TSS.

Materials Used: To treat this heavily polluted water a pilot plant set up was made wherein three different filters were used to check which of the filters give maximum color and odor reduction, maximum COD and TS reduction etc. The filters used where Activated Carbon, Sand Filter and Dual Media Filter.

The set up was as followed: the effluent from clarifloculator was connected to the aeration tank wherein 24hrs aeration was supplied followed by the filter i.e Activated Carbon, Sand Filter and Dual media filter alternately. The flow rate was adjusted to 11.25ml/min.

Fig 1. Pilot plant set up

Result and Discussion

Each filter was analyzed for 7 days and parameters were assessed on daily basis.

Table1. Plant performance of Activated Carbon

DATE	CLF				ACTIVATED CARBON				AERATION TANK			% REDUCTION IN COD
	pH	COD	TSS	TDS	pH	COD	TSS	TDS	MLSS	MLVSS	DO	
24th May	7.30	1464	108	97	7.1	260	49	95	3961	1902	2.8	82.24%
25th May	7.32	1426	122	95	7.3	256	46	89	3957	1865	2.9	82.04%
26th May	7.8	1532	105	98	7.2	304	43	91	3869	1184	2.6	80.15%
27th May	7.2	1248	98	87	7.1	247	41	82	3752	1747	2.6	80.20%
28th May	7.1	1392	107	95	7.1	254	50	93	3652	1673	2.8	81.75%
29th May	7.3	1200	95	83	7.3	238	39	79	3450	1554	2.7	80.16%
30th May	7.3	1528	119	100	7.1	264	47	96	3261	1468	2.6	82.72%

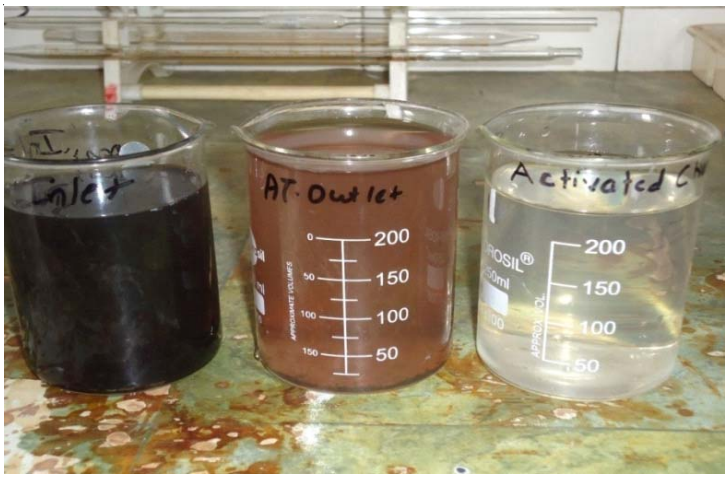

Fig 2 : Colour reduction on using activated carbon

Table 2. Plant performance of Dual Media Filter

DATE	CLF				DUAL MEDIA				AERATION TANK			% REDUCTION
	pH	COD	TSS	TDS	pH	COD	TSS	TDS	MLSS	MLVSS	DO	
1st JUNE	7.3	1532	112	98	7.2	356	58	97	3961	1435	2.8	76.76%
2nd JUNE	7.4	1248	109	97	7.2	304	54	95	4026	1255	2.6	75.64%
3rd JUNE	7.3	1392	105	87	7.1	287	52	84	4050	1740	2.8	79.38%
4th JUNE	7.3	1256	98	95	7.1	298	58	90	4027	1695	2.7	76.27%
5th JUNE	7.4	1528	120	101	7.3	348	67	118	3869	1597	2.9	77.22%
6th JUNE	7.3	1458	116	84	7.1	324	59	82	3359	1438	2.0	77.77%

Table 3 . Plant performance of Sand Filter

DATE	CLF				SAND FILTER				AERATION TANK			% REDUCTION IN COD
	pH	COD	TSS	TDS	pH	COD	TSS	TDS	MLSS	MLVSS	DO	
17th May	7.30	1464	150	430	7.1	260	112	301	3250	1607	2.5	82.24%
18th May	7.32	952	380	790	7.3	256	250	523	3977	1694	2.3	73.10%
19th May	7.8	796	300	370	7.2	304	198	178	4039	1703	2.6	61.80%
21nd May	7.2	1256	280	500	7.1	445	156	345	4021	1609	2.7	64.57%
22rd May	7.1	1392	135	365	7.1	304	86	193	4119	1740	2.0	78.16%
23th May	7.3	1200	277	355	7.3	248	132	175	4027	1695	2.8	79.33%

Sand filter can remove turbidity of water and also reduce the microbial load (Al.Rawi S.M., 2009). After pilot plant study using sand filter the results obtained were on the similar lines. The effluent was efficiently treated to reduce the turbidity of water and also give good COD reduction.

On completing the treatability study using different filters each for seven day study, it was found that Activated Carbon is the best adsorbent. It gives maximum reductions in colour and odor (Thiel P., 2006), in his pilot plant study also found the similar results. The effluent from approximately 3056 industries was treated using Activated carbon which gave 80-85% COD reductions and treated the water to drinking water quality.

There should also be organisms present in the aeration tank so that there is maximum treatment of water. Presence of *Sphaerotilus* (sewage fungus), *Beggiatoa species, Diatoms, Paramecium spp, Vorticella spp,* Nematodes, *Trypanosomes* etc. indicates that the aeration tank is functioning properly.

The observed results of the pilot plant after carrying out 7 days study for each are as follows:

PARAMETERS (% reduction)	ACTIVATED CARBON	SAND FILTER	DUAL MEDIA FILTER
COD	80-85	75-80	70-75
TSS	55-60	35-40	40-45
TDS	45-50	40-45	45-50

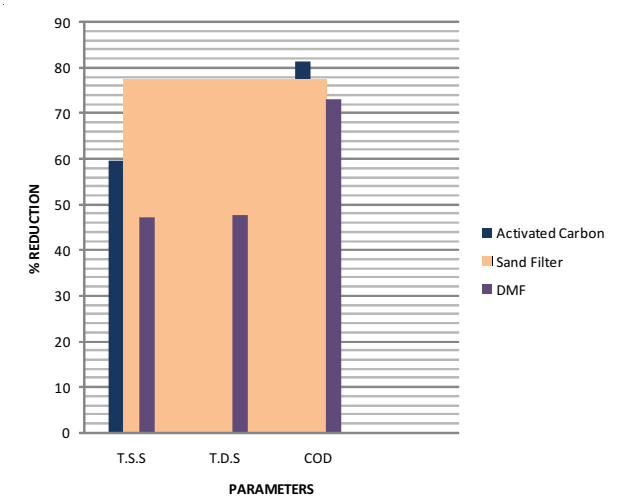

Fig 3: Graphical Representation Of The Plant Performance

Conclusion

The study showed that Activated carbon filter was the most efficient in reducing COD, colour and odor of the effluent sample.

The treatment of such heavily polluted water is essential because the untreated effluent will affect the biota severely by significantly reducing dissolved oxygen and light penetration capacity of the receiving water body i.e. Trans Thane Creek.

The iodine content in the activated carbon is responsible for treatment of water. The efficiency of the filter reduces as the iodine content decreases with time. Further research can be carried out to increase durability and efficiency of the filters.

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Characterization and Identification of Microflora in Activated Sludge Process.

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Abstract: The study was carried out for identifying microorganisms present in the extended aeration activated sludge process at Common Effluent Treatment Plant (CETP), Thane. The stabilization of biological foams results from production of extra cellular materials like lipids, peptides, proteins and carbohydrates which have the properties of surface active agents and bulking phenomenon has been recognized for a long time and is known to be caused by at least 14 types of filamentous microorganisms.

The microbial population from treated sludge was isolated on nutrient medium, MacConkey's agar and Sabauroud's agar using streak plate method. The isolated colonies were then Gram stained and isolates were used further for biochemical tests to confirm the organism upto probable genus level.

Diverse microflora was observed in the water sample collected from aeration tank at CETP. The microscopic examination of water samples showed the presence of *Diatoms* (Bacillariophycophyta), *Paramoecium species, Vorticella species, Nematodes, Trypanosomes,* and motile filamentous algae. The activated sludge at CETP showed the presence of various types of bacterial and fungal species *viz., Pseudomonas, Klebsiella, Alcaligenes, Sphaerotilus natans, Beggiatoa species, Escherichia coli, Staphylococcus aureus* and *Aspergillus*.

***Keywords**:* CETP, Activated sludge, Streak plate method, Biochemical tests.

Introduction:

Wastewater is defined as the water carrying wastes collected from residences, institutions and various industries. Wastewater released in the natural water bodies without any treatment, leads to cause diseases. The wastewater is treated by primary, secondary and tertiary treatments which include physical, chemical and biological processes. In primary treatment, the solids from wastewater are removed by sedimentation and filtration as physical process. Secondary treatment involves the use of trickling filters, activated sludge, lagoons and anaerobic digesters to remove the organic decomposable matter. Activated sludge or extended aeration treatment involves a continuous system where aerobic microorganisms are mixed with waste water and then separated in a gravity clarifier. Therefore, waste treatment system such as the activated sludge system depends on the activities of communities of living organism (Sharifi *et al*., 2001). In this process, the sewage or industrial waste water is aerated in an aeration tank in which microbial floc is suspended. The bacterial flora grows and remains suspended in the form of floc, which is called as activated sludge.

In the aeration tank, there is a chain of microorganisms which actually degrade the organic matter. These microorganisms are highly active in degradation of xenobiotics which are otherwise non biodegradable thus reducing the chemical oxygen demand (COD) value of water. It also helps to reduce the biological oxygen demand (BOD) value. Microbial population developing in the form of biofilm is closely linked with each other with respect to their metabolism. Generally these are decaying, facultative anaerobic and aerobic organisms.

The microbial floc formed in this process is zoogleal mass of living organisms embedded with their food and slime material which act as centers for biological oxidation. Hence, it is called as activated sludge. The microorganisms should be provided with essential nutrients such as Nitrogen, Phosphorus which are supplied in the form of urea and mono-or di- ammonium hydrogen phosphate. Other nutrients such as Potassium, Magnesium, and Calcium are generally present in the waste. Other important factors which determine the efficiency of activated sludge are pH, temperature and oxidation reduction potential. The optimum pH range for process is 6.5 to 9.0. The extended activation process can be assessed with the help of microbial indicators as observed by regular microscopic examination of activated sludge. A good activated sludge contains a relatively high number of free swimming and stalked ciliates apart from rotifers. The presence of such diverse microflora in activated sludge makes its use inevitable in the wastewater treatment to increase the efficiency of treatment plant.

Therefore, use of this activated sludge is more common in treatment of effluent generated in large scale or small scale industries. As per guideline given by Maharashtra Pollution Control Board (MPCB) and subsequent reference of Memorandum of article and Tripartite agreement, all medium and large scale units have to give full-fledged treatment involving primary, secondary and detoxification treatment to the effluent and small scale units are supposed to give primary and detoxification treatment, before it is discharged to sewer system leading to Common Effluent Treatment Plant (CETP). CETP unit collectively treats the wastewater receiving from various industries. Such effluent

consists of varied organic and inorganic components which in turn regulate the development of zoogleal film.

In the present study, attempts have been made to study the microbial diversity present in activated sludge used at CETP, Thane, Maharashtra, which treats the wastewater from varied industries *viz.,* chemical, pharmaceuticals, dyes, pigment manufacturing, petrochemical, electronics, textile processing, engineering etc.

Materials and Methods: The effluent generated from different zones of industrial area is being collected in to three different collection pumps provided at Rabale, Pawane and Sanpada. The effluent collected at Rabale and Sanpada is pumped to the Pawane (KoparKhairane) pump. The ultimate equalisation of entire waste water takes place at Pawane and equalized wastewater is then further treated by adopting extended aeration activated sludge process. The effluent is disposed to Vashi creek and solid waste generated is sent to Trans Thane Creek for secured land filling. The existing treatment facility having capacity of 12 Million Liters per Day (MLD) and 15 MLD is divided in two plots namely Plot P-18 and P-60. They are about 750 meter away from each other. In CETP, the effluent is treated for 36hours. The aeration tank is divided in 3 bays at 12 MLD plant where each bay consists of 5 aerators. Whereas aeration tanks in 15 MLD are divided in 4 bays where each bay consisting of 4 aerators.

The sample for analysis was collected from outlet of 12 MLD aeration tanks from all the three bays. Also, the splashing liquid from each aerator as well as sludge sample from side walls of each aerator of each bay was collected for microbiological analysis. The sludge was analyzed by wet mount method to determine the presence of microflora. Collected water sample from aeration tank was centrifuged at 3000 revolution per minutes for 15 minutes. The supernatant was discarded and the precipitate was resuspended in sterile distilled water. This sample was then examined microscopically under 40X magnification.

After the wet mount analysis the sludge samples were used to culture the microflora present in it. Each sludge sample was diluted 1 : 10 with sterile distilled water, and loopful suspension of each was streaked on sterile plates of Nutrient agar and MacConkey's agar using T-streak or side streak technique and the plates were incubated at room temperature for 24hours. Colony characteristics were recorded for each isolate and it was characterized by various biochemical tests *viz.,* Indol, Methyl red, Voges-Proskauer, Triple Sugar Iron butt (TSI), Citrate utilization, production of certain enzymes like catalase, urease and oxidase. These tests were performed to identify the organism upto genus.

The fungal strains were cultivated on sterile Sabaurouds agar plates. The plates were incubated at room temperature for about 3 days. The tentative genus identification was carried out by lactophenol blue wet mount method. The fungal species were identified based on the specific types of spores they formed.

Results and Discussion: The wet mount of all the different sludge samples revealed the presence of different microorganism likes protozoans, rotifers, bacteria, algal filaments and fungal mycelia. Different types of protozoa and rotifers observed were *Vorticella, Neviculata, Trypanosoma* and *Paramoecium*.

The agar plates after incubation of 24 hours at room temperature showed number of well isolated colonies. Table 1 gives the comparative colony characteristics of certain isolates on Nutrient agar plates and table 2 represents the colony characteristics of certain isolates on MacConkeys agar plates which are species representative.

The fungal strains were grown on sabaurouds agar plate after 3 days of incubation. The plates were continued to incubate for spores to form. Depending on the mycelial and spore characteristics it was confirmed that the growing fungi was of *Aspergillus species* and *Geotrichum species*.

Table.1: Comparative colony characteristics of isolates on Nutrient agar plate

Colony characteristics	BAY 1			BAY 2		BAY 3	
	colony 1	colony 2	colony 3	colony 1	Colony2	colony 1	colony 2
Size	1 mm	>1 mm	1 mm	1 mm	1 mm	1 mm	>1 mm
Shape	Circular	Pin Point	Circular	Circular	Circular	Circular	Pin Point
Colour	Bluish Green Pigment	Colourless	White	Bluish Green	Golden Yellow	Bluish Green	White
Elevation	Concave	Concave	Concave	Flat	Flat	Flat	Flat
Consistency	Smooth	Smooth	Mucoid	Smooth	Smooth	Smooth	Smooth
Opacity	Opaque	Opaque	Translucent	Transparent	Opaque	Transparent	Transparent
Margin	Entire	Entire	Entire	Entire	Entire	Entire	Entire
Gram Nature	Gram Negative Bacilli	Gram Positive Cocci In Cluster	Gram Negative Bacilli	Gram Negative Bacilli	Gram Positive Cocci In Cluster	Gram Negative Rods	Gram Negative Bacilli

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Table.2: Comparative colony characteristics of isolates on MacConkey's agar plate

Colony characteristics	Bay 1		Bay 2		Bay 3	
	Colony 1	**Colony 2**	**Colony 1**	**Colony 2**	**Colony 1**	**Colony 2**
Size	1mm	1mm	1 mm	1 mm	1 mm	1 mm
Shape	Circular	Circular	Circular	Circular	Circular	Circular
Colour	Pink (Mucoid)	Pink (Dry)	Pink (Dry)	Pink (Mucoid)	Pink	Coloueless
Elevation	Entire	Entire	Concave	Concave	Concave	Flat
Consistency	Smooth	Rough	Smooth	Smooth	Smooth	Smooth
Opacity	Translucent	Translucent	Opaque	Opaque	Opaque	Transparent
Margin	Entire	Entire	Entire	Entire	Entire	Entire
Gram Nature	Gram Negative Bacilli	Gram Negative Bacilli	Gram Negative Bacilli	Gram Negative Bacilli	Gram Negative Rods	Gram Negative Rods

The isolated colonies were further analysed for various biochemical tests to determine the possible genus of the isolate. Table 3 represents the comparative analysis of different biochemical tests performed to characterize the isolates from Nutrient agar and MacConkeys agar plates. Table 4 gives the presence of various microorganisms in activated sludge and they were identified on the basis of colony characteristics, Gram nature and biochemical tests.

Table. 3 : Biochemical tests for detection of microorganisms.

Biochemical test	1st Colony	2nd Colony	3rd Colony	4th Colony	5th Colony
Indole	+	-	-	-	-
Methyl Red	+	-	-	-	-
Voges-Proskauer	-	-	+	+	-
Citrate	-	-	+	+	-
Urease	-	-	+	+	-
TSI : BUTT **: SLANT** **: GAS** **: H_2S**	A A + -	- - - -	A A + -	ALK ALK - -	N ALK - -
Oxidase	-	-	+	+	+
Catalase	+	+	+	+	+
Possible Organism	***E. coli***	***S. aureus***	***Klebsiella***	***Pseudomonas***	***Alcaligenes***

Key: +: Positive test, -: Negative test, A: Acid production, A & G: Acid and Gas production.

Table.4 Different types of microorganisms present in activated sludge.

Protozoa and Rotifers	Bacteria	Fungi
Diatoms (Bacillariophycophyta)	*Pseudomonas spp*	*Aspergillus spp*
Paramecium spp	*Escherichia coli*	*Geotrichum spp*
Vorticella spp	*Staphylococcus aureus*	
Nematodes	*Klebsiella spp*	
Trypanosomes	*Alcaligenes spp*	
Motile algal filaments	*Sphaerotilus natans*	
	Beggiatoa spp	

Protozoa are important micro-organisms taking part to the ecosystem balance in wastewater treatment plants. A procedure for their semi-automated identification and counting based on image analysis is proposed. The main difficulty is the segmentation of the protozoa as most of them are in contact with the sludge. The protozoa are characterized by the size of their silhouette (area and length) and three shape factors (elongation, circularity and eccentricity). Table 5 represents the relationship between commonly occurring protozoans with the efficacy of treatment plant.

Table.5: Some relations between protozoa and plant efficiency

Predominant group Efficiency	Possible cause
Small flagellates very low	Bad oxygenation of the sludge, too high loading, presence of fermenting substances
Large swimming ciliates (> 50 µm) low	Too high loading
Crawling ciliates	Good condition
Crawling + attached ciliates	Good condition
Amoebae with shell	good Low loading, diluted mixed liquor, good nitrification

It was observed that if the oxygen supply in relation to the demand becomes inadequate, sphaerotilus and other filamentous organisms attain the ascendency and the sludge becomes bulking. Biochemical activities of these organisms would bring about the purification in a way similar to the desirable sludge organisms except with lower and more efficient oxygen utilization at lower tensions. In other words when the sludge is diffuse and filamentous, it exposes more surface which might enable the sludge to obtain the limited amount of oxygen present in the medium immediately surrounding it. This type of sludge however, usually produces a sparkling effluent.

Two major types of bacteria were observed during the 24 hours of aeration. They were dispersed, short, thick, round ended rods; approx size 2-2.5 microns x 1 micron. Some of these organisms appeared as finger like capsules. As the aeration period progressed there was an apparent increase in the no. of slime- enmeshed bacteria. *Sphaerotilus* like organisms often as unsheathed forms; these were more abundant after 6 hours of aeration and reached an apparent maximum after 24 hours.

Alcaligenes species which has heterotrophic nitrification and aerobic denitrification abilities was used to treat actual wastewater containing high-strength ammonium under aerobic conditions.

Aerobic bacteria live in colonial structures called floc and are kept in suspension by the mechanical action used to introduce oxygen into the wastewater. This mechanical action exposes the floc to the organic material while treatment takes place. Following digestion, a gravity clarifier separates and settles out the floc.

The total aerobic bacterial counts in standard activated sludge are in the order of 10^8 colony forming units/ mg of sludge. When culture based techniques are used, it was found that the major genera in the flocs are *Zooglea, Pseudomonas, Alcaligenes, Enterobacter, Bacillus species* etc. These microorganisms decompose the organic matter as a part of their metabolism. Biological degradation of organic wastes generates the simple sugars, inorganic salts like nitrates, phosphates, sulphates and carbon dioxide which is used by the growing organisms to enrich the sludge. Decomposed organic matter can then be used as biofertilizer.

Majority of filamentous organisms are bacteria, although some of them are classified as algae, fungi or other life forms. There are a number of types of filamentous bacteria which proliferate in the activated sludge process. Filamentous organisms perform several different roles in the process, some of which are beneficial and some of which are detrimental. When filamentous organisms are in low concentrations in the process, they serve to strengthen the floc particles. This effect reduces the amount of shearing in the mechanical action of the aeration tank and allows the floc particles to increase in size. Larger floc particles are more readily settled in a clarifier. Larger floc particles settling in the clarifier also tend to accumulate smaller particulates (surface adsorption) as they settle, producing an even higher quality effluent.

e.g. *Sphaerotilus* (sheathed bacteria), *Beggiatoa* (gliding bacteria) Moderately polluted water may carry cells or spores of three types; however it has fewer true aquatic fungi and aquatic hyphomycetes, soil fungi are more numerous. Heavily polluted water has large no. of soil fungi. The group - designated as soil fungi includes yeast like fungi, many species of which have been isolated from polluted waters.

The association between fungal densities and organic loading suggests that fungi may be useful indicators of pollution. Because fungi possess broad enzymatic capabilities, they can degrade actively most complex natural substances and certain synthetic compounds, including some pesticides.

Conclusion:

The waste water collected in CETP is heavily polluted as it contains effluents of many industries. The treatment of such water is a tedious job. The Activated sludge process or the Extended Aeration system employed in CETP gives reduction in COD. This is the result of presence of wide variety of microorganisms in activated sludge. Thus, after identifying different microorganisms such as bacteria, protozoa and rotifers, fungi and studying the role played by each microorganism in degradation of organic matter, it can be concluded that the treatment unit is working efficiently.

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A Study of Maharashtra Nature Park for its role in Environmental Education

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Abstract : As human beings, we continue to have significant impacts on the environment and its resources. Environmental education seems to be the best tool for providing the public with an understanding of the ramifications of their actions and behavior patterns in order to increase sensitivity and concern surrounding environmental issues. This can be done by taking aid of nature parks and other environmental education centers. Nature Parks are now viewed as places which offer much more than just recreation and leisure. These parks influence visitors at a much deeper level and help them realize the importance of the environment and the need for conservation and one such park is Maharashtra Nature Park, Mumbai.

This research was aimed at studying Maharashtra Nature Park and its role in environmental education using a questionnaire survey method. Around 160 individuals were interviewed. These individuals belonged to the age group of 18 and above. The questions were based on their awareness about the park and their experiences after visiting the park. According to the data collected, most individuals agree that Maharashtra Nature park has indeed helped them to become environmentally aware and sensitive. There was also a consensus to the fact that more centers like Maharashtra Nature Park should be set up to help increase environmental awareness amongst the public.

Keywords: Maharashtra Nature Park, Environmental Education, Awareness, Attitude

Introduction :

Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address the challenges, and fosters attitudes, motivations and commitments to make informed decisions and take responsible action (UNESCO, Tbilisi Declaration, 1978). The natural environment encompasses all living and non-living things occurring naturally on Earth or some region thereof, and also the interaction within all living and non-living species. Each passing year as the population on the planet increases, we exert additional pressure on the natural world. Till we realized the need to stabilize the population of the country, we added a population of approximately one Australia to India every year. With about 16% of the world's population and a little over 2% of its land, there is already enormous pressure on our resources (Sarabhai K.V., 2000). However, there are those that think we as a whole are doing nothing wrong to the environment and that the pollution and the extinction of animals is all a cycle of life and everything is balanced. This situation has started to degrade the environment in which we live. This overall environmental threat, according to K.V. Sarabhai (2000) ; has initiated a movement in both the formal and non-formal education system, which has lead specialists to consider providing environmental education (EE) in schools. Our nation's future relies on a well-educated public to be wise wardens of the very environment that sustains us, our families and communities, and future generations. All education departments in India recognize EE as an essential part of education.

Studies carried out in the field of environmental education have confirmed the fact that students, tend to learn better and comprehend to a situation, when taught with a practical approach. This is possibly why environmental education techniques work best outdoors or outside the classroom. In cities like Mumbai, open spaces are on a rapid decline. This brings us to think about the detachment between the fast paced people of Mumbai and their natural environment. Nature parks like are not only hubs of biodiversity, but also allow visitors to be 'one on one' with nature. A study was carried out by Armstrong H.G., (2005) in Tobago's schools which supports this statement. This was the key motivation behind carrying out this study, to explore the role of nature parks in environmental education. Maharashtra Nature Park (MNP), located on the southern bank of Mithi river, and at Bandra-Sion Link Road is not just a green getaway in this concrete jungle we call Mumbai, but also is a center for promoting environmental awareness. One of the major aims of the park is to create environmental awareness and to educate children especially, about ecology and Nature conservation. While interacting with Deputy Director, Mr. Avinash Kubal, it was brought to light that since his joining MNP in October 2000, the number of visitors in the park had increased from 11,000 to a massive 1.5 Lakh per year, as the number of activities conducted at MNP have increased. He also claims that now a large section of people are aware about the park, since the activities at MNP do not only cover different age groups, but also different segments of the society. Since the park reaches out to so many people from different strata of the society, it is an exceptional aid in creating environmental awareness.

A questionnaire survey method was used to document the attitudes of the public towards Maharashtra Nature Park. Its popularity in Mumbai, history and large scale socio-environmental awareness oriented activities, is the reason behind choosing Mahim Nature Park as the study area.

Methodology

The idea of a nature park was conceived by the World Wide Fund for Nature- India (WWF-India) in the late 1970s, an area of about 37 acres in the "H" Block of Bandra-Kurla Complex, which was earlier a garbage dump or land fill, was decided to be ecologically restored and developed as a Nature Park by MMRDA. Over a period of time, tons of harmful garbage was scraped into, soil spread over, by enthusiastic student volunteers and a team of workers. Over the next three years several thousand saplings were planted, including five more by Dr Salim Ali in 1987. On Earth Day, 22nd April 1994, Mahim Nature Park (now known as Maharashtra Nature Park) was declared open to people. Today experts from around the world visit the MNP to study the flora that grows on a dumping ground used for decades by the Municipal Corporation of Mumbai. MNP plays host to about 100 species of butterflies and more than 80 species of birds. Also, as many as 350 tree species have been listed, many naturally planted by birds and insects.

The study was carried out using survey questionnaire method. The analysis of the data was carried out using both qualitative and quantitative analysis methods. For this study, a random sample of 40 participants of the age group of 25 years and above was taken (referred to as 'adult' group). Moreover, 40 students each from 3 different colleges were asked to fill in the questionnaire. The three colleges selected viz., The Institute of Science, Ramnarain Ruia College and Mithibai College are situated at different areas in the city. The questionnaire was designed keeping in mind that it was to be filled by the general public. Thus, the language used was simple and not scientific and the questions were very basic. Furthermore, only a few explanatory questions were added so that the person answering it would not lose interest or spend too much time filling the questionnaire. The questions asked were based on the respondent's awareness about the park, visits, its location, importance, experiences during visits and so on. The data received was analyzed using MS Excel 2007.

Observations

Out of the 160 questionnaires handed over, 151 filled questionnaires were received. Thus only the 151 questionnaires were considered during analysis. According to the data, **83.4%** of the participants interviewed are aware about MNP and **16.6%** are not. The answers of the 83.4% of the survey takers were taken into account during further analysis.

It was observed that out of all the participants who were aware about Maharashtra Nature Park (MNP), **84.1%** knew the location. On being asked, if the location of MNP is ideal; **80.4%** agree. However, only **64%** have actually visited the park. This brings to light the fact that there should be more centers like MNP around Mumbai, that are accessible to all people, so as to help increase the public's interest about the environment.

When asked the purpose of them visiting MNP, the answers of **57%** of the participants was related to academics. Since a large percentage of participants answering the questionnaire were students that were taken for study visits. (FIG 1)

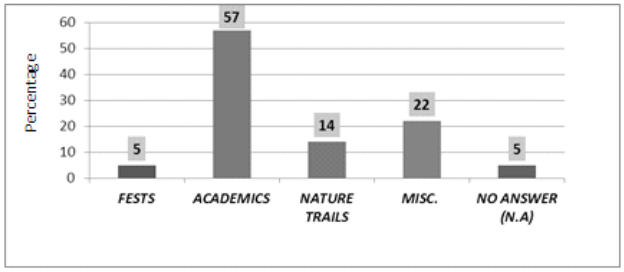

FIG:1Purpose of visiting MNP (Values in %)

89.3% the survey takers, aware about MNP, feel that MNP has some kind of importance in society (FIG 2), environment or education; whereas **7.9%** disagree. Since these 7.9% people are aware about MNP and its location, we can say that the purpose of MNP has not been fulfilled and its potential has been overlooked. Majority of the survey takers who have given this answer are students.

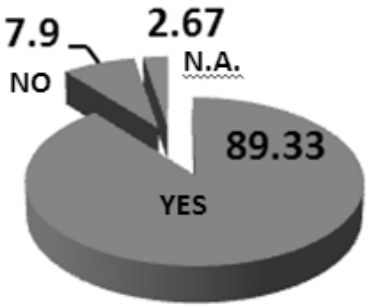

FIG:2 Importance of MNP (Values in %)

When asked in what way they feel MNP is important (FIG 3), **48.9%** of the survey takers, who answered positively in the previous question, felt that MNP is important for plant and animals- with relation to studies and conservation. From all three colleges, students mostly feel MNP is important as it harbors plants and animals in a concrete jungle like Mumbai. The one dimensional focus of

environmental education in colleges today is clearly reflected in these answers.

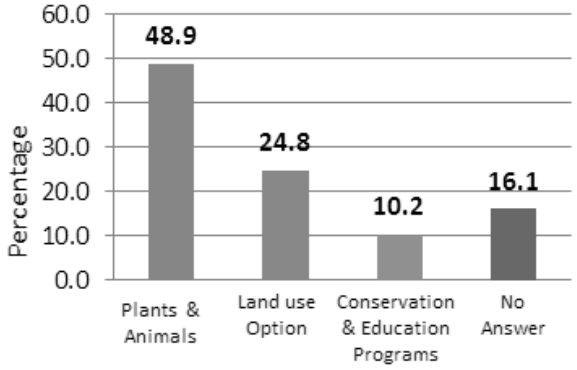

FIG: 3 Why MNP is Important (Values in %)

90% of the survey takers believed that MNP plays a role in environmental education. And the following table (FIG 4) shows what kind of role MNP seems to play in environmental education.

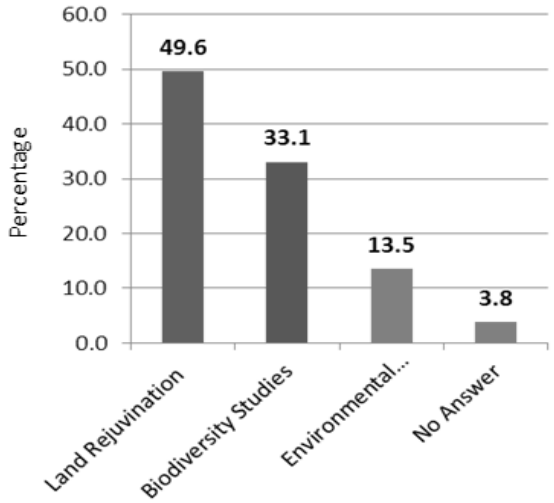

FIG: 4 Role of MNP in environmental education (Values in %)

49.6% of the participants feel that since MNP was once a dumping ground, the process of rejuvenation of the land and its associated ecological studies helps creating awareness about the environment and also increases interest. **33.1%** feel MNP aids in environmental education by promoting studies about its biodiversity. **13.5%** people feel that since MNP helps in creating environmental awareness, it plays an important role in Environmental education. The answers of most participants were close to or with reference to land use and land rejuvenation. It inspires people to study about nature and how it works. Few students believe that MNP helps creating environmental awareness and thus aids in environmental education.

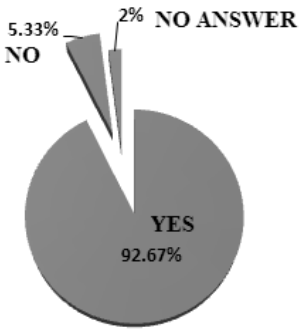

FIG: 5 Should there be more centers like MNP?

Most of the survey participants were positive about wanting more centers like MNP in Mumbai. 92.7% of the participants agreed while 5.3% did not. The 5.3% may have not visited the park or may have not been oriented well on their visit. (FIG 5)

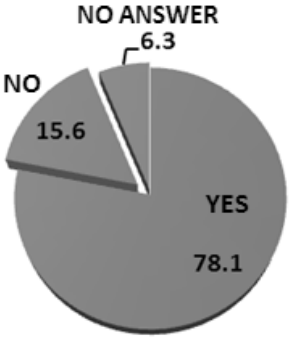

FIG: 6 Change After Visiting MNP (Values In %)

Of all the people who were aware about MNP and had visited MNP, **78.1%** felt a change or growth in them. **15.6%** people were unaffected after the visit and **6.3%** did not answer the question. (FIG 6)

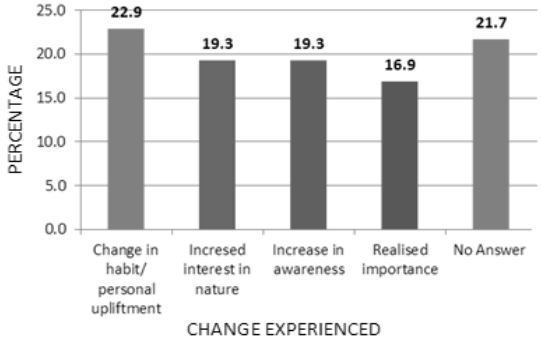

Fig: 7 Kinds of change after visiting MNP (values in %)

On the basis of the answers received, they were segregated into 4 major response heads. In the overall data, the answers were pretty much equally distributed under all four heads.

19.3% found themselves to be more interested in nature after visiting MNP. **19.3%** found themselves to be more aware about issues related to the environment. **16.7%** realized the importance of the environment and were more sensitive towards it. **22.9%** felt a change in habit or some other personal change. (FIG 7)

Results

Maharashtra Nature Park is well known amongst students and people of the higher age group, however the essence of setting up an establishment of this sort, is being overlooked.

For students, the purpose of visiting MNP is academic, where they study only one or two aspects of the environment- plants and animals. Thus their awareness about the environment is restricted to these factors only. More importance is being given to the 'floral-faunal conservation' aspect of the environment. Biodiversity studies are only a tip of the iceberg that we call the environment; there are many more aspects that should be given equal importance especially where education is concerned. The percentage of participants, who find MNP to have no importance or no role in environmental education, highlights the fact that MNP is not being used to its potential. Even though 7.9% is a small number, its value amplifies in terms of environmental awareness. This indicates a lack of or limited orientation to the park visitors during visits emphasizing on the inadequate teaching methodology as discussed earlier. A noteworthy percentage of survey participants feel that there should be more centers like MNP in Mumbai. This is supported by the fact that a considerable number of people who took the survey experienced a change in them after visiting MNP. During an interview, Mr. Kubal stated that MNP has the potential of changing people's outlook not only towards the environment, but to life as well.

Conclusion

The questionnaire was so designed so that the environmental awareness, the attitude of the participants towards environment and the role of MNP in creating this awareness could be assessed.

The answers that received from the questionnaire raise a concern about environmental education in colleges today. Answering environmental related questions was a chore for most students- which is why many students may left the explanatory questions blank. Even though environmental science is taught in most schools and colleges across India, students are not instinctive about their thoughts about the environment. This is clearly seen in the answers obtained in the survey. As the survey progressed, the answers of most participants became more environmentally inclined and sensitive.

In the beginning of the questionnaire, a lot of answers were related to biodiversity, but later in the questionnaire the answers seemed to have changed. This clearly supports the fact that we need to reform the way environment education is being taught in educational institutes, not only in the city but also in the country and Nature Parks like MNP can help enhance this experience. This is clearly seen in the results of a certain question that inquires the respondent about the change or growth they felt after visiting the park. Not only is MNP important to a city like Mumbai, but it also plays an important role in creating environmental awareness. We all may be educated with respect to the environment, but only a few of us are environmentally conscious. Environmental awareness is important to sensitize oneself to nature and to respect all forms of life around us, as all aspects of the environment are important for is optimal functioning. And what better example of optimal functioning may there be other than Maharashtra Nature Park what was once a landfill site, is now a heaven for plant and animal life in Mumbai, the commercial capital of India.

Mumbai needs more centers like MNP. A few suggestions while setting up such centers would be to keep in mind that MNP is much more than just a garden. It is a result of natural selection over a period of many years. The trees planted should be those which can survive harsh conditions and help rejuvenate the land. Most trees in MNP exist as a result of natural propagation by insects, birds and mammals. The main idea of setting up a similar center should not be beautification, but to create a natural habitat within the city.

Parks like MNP have the potential of changing the way people think. And changing people's thought process towards a better and secure future is what education and awareness are about.

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Bridging gaps: Open Source geospatial technology as a public participatory tool for landscape assessment

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Abstract : Geospatial tools assist in landscape assessment and open source geospatial tools could enable participation of a wider community beyond trained professionals. In this study a public domain model for landscape assessment was designed and executed to document the landscape at a small scale in the Sanjay Gandhi National Park (SGNP). Further, landscape changes in and around the SGNP were monitored at a larger scale using the GLOBE protocol. The SGNP faces management challenges due to the changing land use and land cover patterns (LULC) within and adjacent the park boundaries. For the large scale LULC change detectigon, Landsat imagery from 2000 and 2010, and Google Earth were used. The result show increase of urban land along the park's boundaries and some parts within the national park. It also highlights the pressure of anthropogenic activities on the fringes of the park. Over the same time period, vegetation also shows an increase. This increase could be a false positive because of seasonal variationdue to difference in imagery months. The results of both the small scale and large scale landscape assessments demonstrate that the internet, open source public participatory landscape assessment method, though not without limitations, can be effective in landscape assessment.

Keywords: open source; geospatial; public; participation; landscape

Introduction

Land use and land cover change assessments are important for monitoring and evaluating the health of the environment. Changes in land use and land cover impact various ecosystem goods and services including impacts on biodiversity worldwide (Sala et al., 2000), soil degradation (Trimble and Crosson, 2000), climate (Sagan, Toon, and Pollack, 1979), ability of biological systems to support human needs (Vitousek, Mooney, Lubchenco, and Melillo, 1997)and also, to an extent, determining the vulnerability(Kasperson and Kasperson, 1995) of places and people to climatic, economic, or sociopolitical disturbance (Lambin, Geist, and Lepers, 2003). Anthropogenic changes and vegetation succession are recognized factors causing LULC change scenarios (Bray, Ellis, Armijo-Canto, and Beck, 2004; Flamm and Turner, 1994; García-Frapolli, Ayala-Orozco, Bonilla-Moheno, Espadas-Manrique, and Ramos-Fernández, 2007, Goetz et al., 2003; Nagendra and Utkarsh, 2003).

Remote sensing and geographic information system (GIS) are considered to be effective tools for LULC change analysis (Mas, 1999; Sarma et al., 2008) with their potential for timely and cost effective assessment of natural resources. Both the techniques have been used extensively for generating valuable information on forest cover, vegetation type and landscape changes. Also, open source GIS, remotely sensed imagery and virtual globes like Google Earth (GE) with GIS-like capabilities that are freely available have reduced the financial challenges that were a limitation for such studies especially to monitor tropics (Dorais and Cardille, 2011; Ploton et al., 2012).

GE has found numerous applications, including climate change (Sun et al., 2012), weather forecasting (Travis &Valliappa,2006), natural disasters (Nourbakhsh et al., 2006; Parks, 2009) and many more. Dorais and Cardille (2011) utilized the high resolution GE database to understand deforestation in Borneo, whereas (Ploton et al. 2012) discussed the potential of free GE canopy images for forest monitoring and tests the advantages of GE imagery compared to that of commercial IKONOS. The GE Outreach (a Google initiative) has documented how nonprofits are taking advantage of GE's presence in engaging with the public to document causes including wildlife, forest, and land use (Butler, 2009; Mishra, 2012; Tracking, 2012).

The prospect of public participation in using geospatial technology depends on if the public find the tools and techniques simple and can possibly use them independently. For LULC monitoring this means designing and promoting models, platforms and protocols that are user-friendly.

In this paper, we present the landscape assessment of the Sanjay Gandhi National Park at a small scale for a pilot site in the park using a public domain model and further, we investigate the park's landscape changes at a larger scale. First, we design the model and demonstrate its use for identifying specic aspects of land for interested individuals to monitor and document changes in their immediate landscape. Second, we monitor the park using the established Global Learning and Observation to Benefit the Environment (GLOBE) change detection protocol and document the landscape changes at a larger scale.

Materials and Methods

Study Area

The study was conducted in Sanjay Gandhi National Park which is located partly in Mumbai and partly in Thane district (19°8' N 72°53'' E to 19°21''N 72°58'' E) in Maharashtra, India and is spread over 103.09 sq. km. The mean annual temperature is 27 °C and the mean annual rainfall of about 2600mm, concentrates itself from middle of June to end of September. The park area is rich in biodiversity and encompasses a varietyof forest types including southern moist deciduous forest, tropical moist deciduous mixed forest, pockets of semi-evergreen forest, western tropical hill forest and mangrove scrub forest (Paranjpye, 1997). Increase in population and industrialization on the park's fringes has resulted in pressure on forests causing alteration in the forest's extent, structure, composition and wildlife habitat conditions (Jadhav, 1995; Paranjpye, 1997; Ze´rah, 2007). Also, Illegal encroachment of the forest land is a serious problem faced by the SGNP.

Google Earth Land Resource Monitoring Model: A Public Domain Model

Google Earth (GE), a free, virtual globe, provides the capability of integrating satellite imagery, aerial photography, and digital map data into a three-dimensional interactive virtual image of the world. A GE user would be able to recognize land cover types, disturbance events and additional features from imagery observations. This makes GE a potential tool for landscape assessment. Its potential applications beyond image visualization, its user friendly interface, high resolution (<2.5 m for some locations) and free distribution were the reasons for choosing it for the current model.

To design the model for landscape assessment at a small scale the factors considered include possible simple and user friendly steps, efficiency, cost-effectiveness and potential users. The potential users include public and non-governmental organizations. The conceptual model was formulated after extensive relevant literature survey on GE applications and open source softwares. The model (Fig. 4) was than verified on the pilot site in the SGNPand calibrated accordingly.

The GE imagery of 25 January, 2010 of the SGNP was used for the initial GE survey (Fig. 1). For the initial GE image survey, this imagery was surveyed based on spectral characteristics and ancillary data including prior field knowledge and available literature. This authenticated the visual accuracy of the GE image. Next, the pilot site was selected and several landscape features were marked based on visual cues (Fig. 2). These features were to be identified on field during ground truthing when the field data was documented and verified. The ground truthing was conducted along the pilot site using Garmin GPS; which can be substituted by mobile GPS by the public. Further steps, include data transfer to GE (Fig. 3), this transferred data along with the image under scrutiny is interpreted by the user. The individual can then share the data using GE or advanced users can carry out the more technical steps using open source data conversion tools and QGIS independently or in collaboration with scientists or experts to monitor or document more details of the landscape.

Figure 1. Initial Google Earth Survey (Step 1)

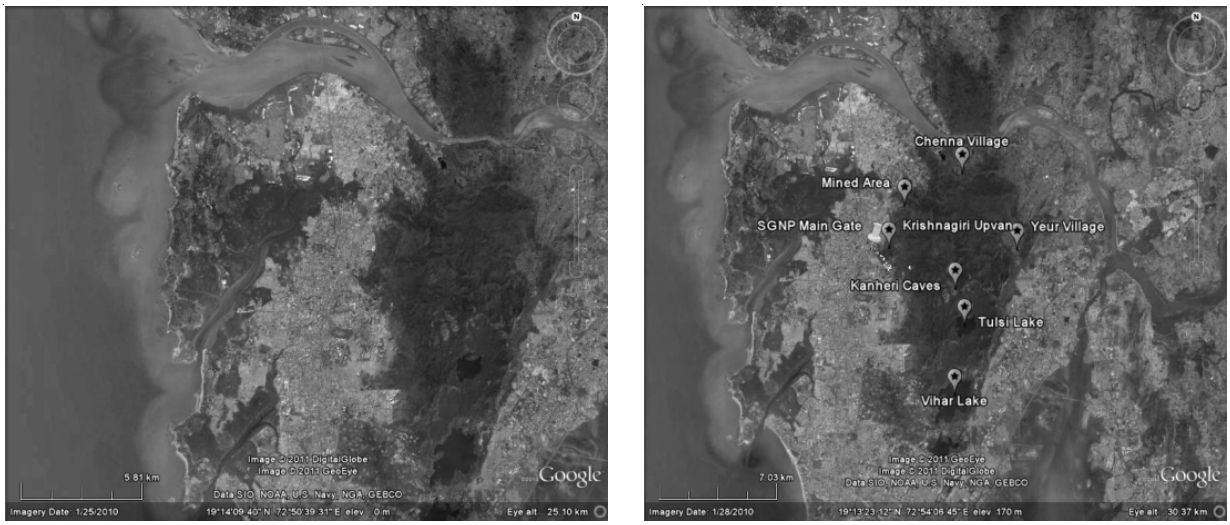
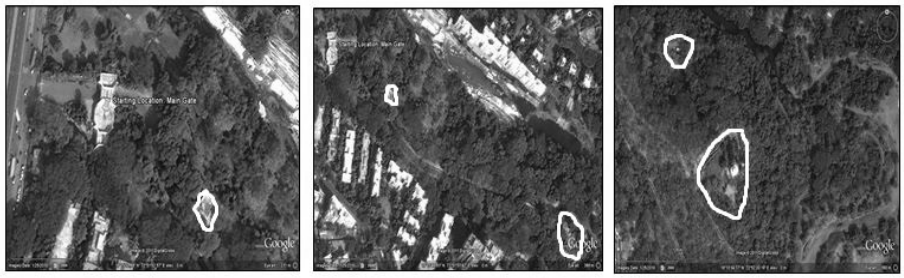
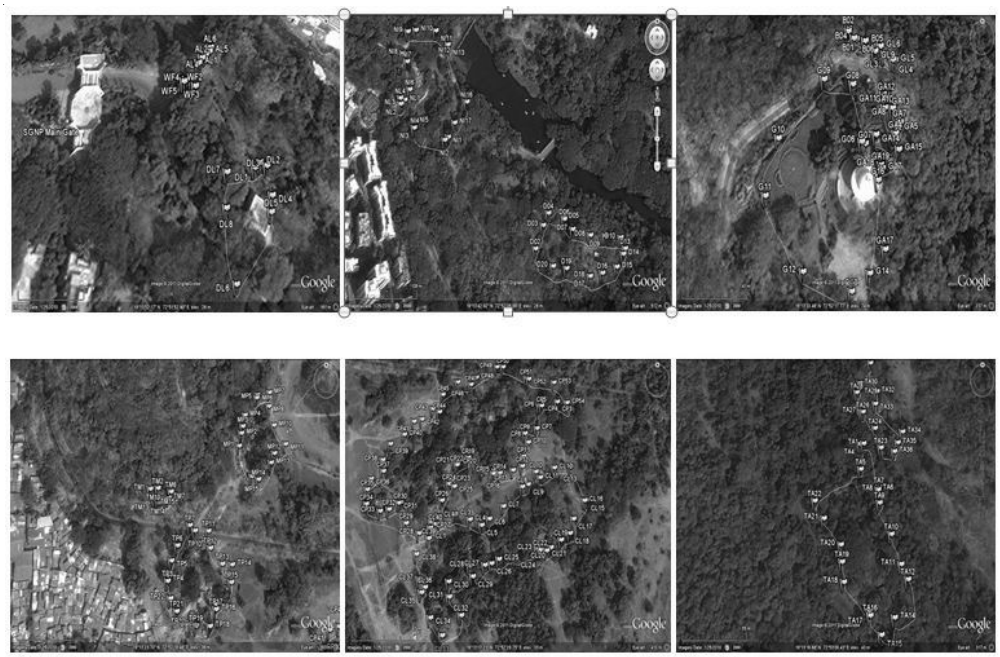


Figure 2. GE showing marked landscape features on the sample study area in the SGNP (Model: Step 1)



Sample Study Area: Initial Google Earth Survey

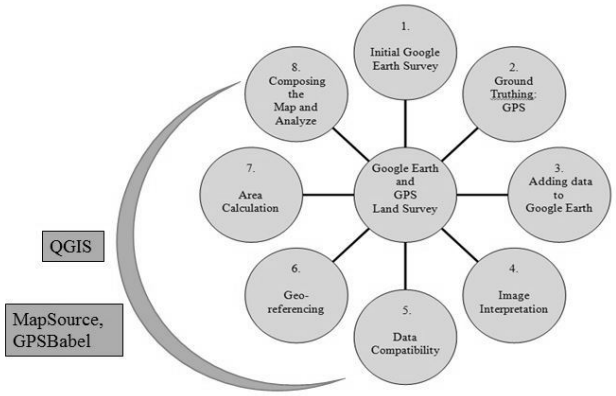
Figure 3. GE showing data obtained from ground truthing of the survey area (Model: Step 2-4)



Landscape changedetection at a larger scale

The freely available remotely sensed cloud-free satellite data obtained from the United States Geological Survey were used in the Landscape change detection study for the SGNP: Landsat-5 TM of 23 November, 2000 and Landsat-7 ETM+ of October 26, 2010. Since the obtained images have the same source and were available as orthorectified images with sufficient product processing, for the current use no further processing was required.The Global Learning and Observations to Benefit the Environment (GLOBE) program's land cover change detection protocol(GLOBE at the University of New Hampshire, n.d.,Finarelli 1998; Becker et al. 1998) was then run on the acquired Landsat images of the SGNP for the whole area using the open source Multispec software. Google Earth was used for ancillary data when required.

Figure 4. The public domain model including the model components; enclosed within the arc are steps required for advanced processing.



Results

Google Earth Land Resource Monitoring Model: A Public Domain Model

The designed model (Fig 4) was tested. Steps 1 to 4 are user friendly and can be easily executed to document land resource. Steps 5 to 8 require some technical assistance with data conversion and Quantum GIS processing and map composition.All the areas marked in the initial survey to be checked for their presence/ absence could be traced on the study site. Also, additional features along the survey route that were marked in field could be traced on GE. Minor blank brown patches in GE were identified during ground truthing to denote areas of land use for instance, Deer Park. Due to dense vegetation a tribal settlement could not be clearly identified on GE but easily marked by ground truthing.

Steps 5- 8 were executed and represented as a map for sharing of information (Fig.5).Smaller polygons could not bemeasured.The measurements of larger polygons are given in Table 1.

Figure 5. Map showing the assessed landscape features and their area

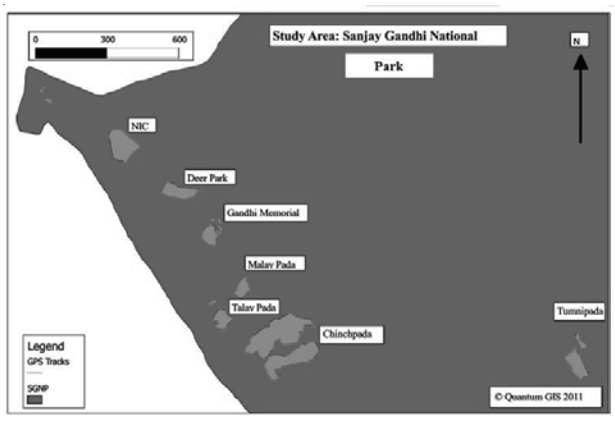


Table 1. Landscape features assessed and their determined area

Sl.No	Name of the landscape feature	Area measurement (in km^2)
1	Nature Information Centre	0.0116
2	Deer Park	0.00542
3	Gandhi Memorial	0.00382
4	Malay Pada	0.00342
5	TalayPada	0.00414
6	Chinchpada	0.0355
7	Tumnipada	0.00683

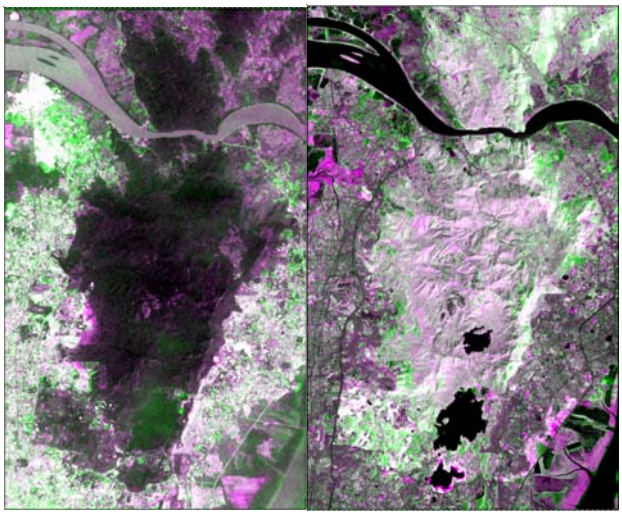
Of these, Malaypada, Talaypada, Chinchpada and Tumnipada are tribal settlements while others are land use by the forest department. In terms of area (Table 1), Chinchpada is the largest tribal settlement with an area of 35500 m^2 while the Nature Information Centre covering an area of 11600 m^2 is the largest land use by the forest department in the pilot site.

Landscape change detection at a larger scale

Landscape change detection was carried out for the SGNP with the satellite images of Landsat-5 TM of November, 2000 and Landsat-7 ETM+ of October 26, 2010. The change detection for urban areas and vegetation change can be seen in the Fig. 5.

Figure 6. Change detection for:

A) Urban Areas B) Vegetation



Change detection for urban areas (Fig 6A): The green areas represent an increase in reflectance in Channel 1 (Blue Visible Band) in 2010 image compared to that of 2000. This strong visible reflectance is often associated with exposed

urban development, rocks, bare ground. It was inferred that these dense green areas have undergone an increase. Verification using GE confirmed these to be the change areas of increased urban development in the national park.

Change detection for vegetation (Fig 6B):

The green areas represent an increase in reflectance in Channel 4 (Near Infrared) in 2010 compared to 2000. This strong visible reflectance is associated here with exposed vegetation, it is inferred that these green areas have undergone an increase. Verification using GE confirmed these to be areas showing increase in vegetation.

Discussion and Conclusion

The GE land resource monitoring model for landscape assessment at a small scale was designed and effectively implemented on the pilot site in the SGNP. The result of the application of the model for the park highlights the effective use of GE and users ground-based and image-based observations for identifying specific landscape features by interested individuals to monitor and document landscape changes in their vicinity. Such a combined use of imagery, individual land observations and further image interpretation aid in understanding the local land use of the concerned area. There are limitations to the use of GE; GE does not have the same level of high resolution and cloud free imagery for every location. This makes it essential to do the initial GE survey described in the model before using GE imagery 'as is' to note landscape features.

The use of virtual globes for landscapes is also emphasized by Sheppard and Cizek, (2009) who states the benefits of the virtual globe to include accessibility, interactivity and engagement in landscape visualization and that this technology has the potential application for participatory GIS but its limitations should be acknowledged.

Further, the landscape change detection conducted at a larger scale highlights the need for greater protection of the park's fringes. The results show an increase of urban land along the park's boundaries and some parts within the national park for the change detection of 2000 and 2010. It also highlights the pressure of anthropogenic activities on the fringes of the park. Our findings are in support of Jadhav (1995) who indicates increase in population and industrialization on the park's fringes to be causing pressure on the park and showcases the encroachments areas in the SGNP. Further, this is also in accord with Tiwari (2007) who presents points of encroachment areas in the park; many of which are along the fringes.

Over the same time period, the park's vegetation also shows an increase in the LULC change detection but is not entirely due to true increase in vegetation growth, this is because the imageries are of two different months: October, 2010 and Novemeber, 2000.This accounts for seasonal variation in terms of change detection. To conclude about the actual vegetation increase in the national park; same month image would give correct estimates.

Our study shows that open source geospatial technology can contribute significantly towards enhancing public participation in landscape monitoring and demonstrates that the internet, open source public participatory landscape assessment method, though not without limitations, can be effective in landscape assessment.

Acknowledgements

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Section III
Research Articles and Short Communications

Screening of Edible Fish Pathogens

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Abstract : A microbial study of organisms associated with fresh fish samples was carried out. Samples from the fish skin, gills and ice water were cultured in five different media; Nutrient agar, Baird parker's agar, Xylose Lysine Deoxycholate agar, Thiosulphate-citrate-bile salts-sucrose agar, Violet red bile agar media for the examination of *Salmonella*, *Vibrio*, *Staphylococcus*, *Coliforms*. The highest colony count was obtained from the skin samples in all the media. It is recommended that better handling and processing methods should be adopted to reduce or eliminate health risk to fresh fish consumers.

Keywords : Organisms, media

Introduction

The last two decades have seen appreciable increase in global fish trade and the need to enforce safety standards and regulations on imported consignment especially from developing nations fraught with unacceptable levels of microbiological contamination.

Contamination concern has been on high loads of unsuspected spoilage by microorganisms like *Salmonella sp., Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli* (Bramsnacs, 1999 and Gram *et al.,* 2000).Fish possess a neutral to slightly acidic pH and high moisture content which favor growth of a wide range of microbes coupled with their poikilothermic nature (Herbert *et al.*, 1997). Fish spoilage essentially can be attributed to three main factors namely; microbial, enzymatic or autolytic and chemical spoilage (oxidative rancidity) of which microbiological contamination has been noted as the main cause of fish deterioration.

Methods and Materials

(a) Sample Information

(1) Location – Vitawa goan, (Latitude19°18'60", Longitude 72°99'12"8919) Thane, Maharashtra.

(2) Samples used – Mackerel (*Rastrelliger kanagurta*)

Bombay duck (*Harpadon nehereus*)

Prawns (*Penaus monodon*)

Ice water (in which the fishes are kept before selling)

(3) Season - Monsoon"

(b) Collection of sample – Sample was collected from the street vendors from the fish market.

(c) Isolation and Enumeration

(1) Serial dilution - The fresh fish species were killed and macerated in a mortar and pestle,

1 gm of fish tissue was dissolved in test tube containing 9ml of sterilized distilled water to obtain a solution of 10ml.Serial dilution up to 10^{-5} was carried out on extracts from the skin and gill.

(2) Spread plate – It is the method of distributing bacteria evenly over the surface of the agar plate. 0.1 ml is spread aseptically by the sterile glass spreader until the plate is dry.

(3) Total bacterial count – Quadrant method was used to enumerate the colonies formed. Here the plate is divided into 4 parts by drawing a vertical and horizontal line. Colonies of 1 quadrant are counted and are multiplied by 4. And result is the total bacterial count of that plate.

(d) Mediums used

(1) Nutrient agar (NA) – It is the complete media used for the cultivation of non-fastidious bacteria.

(2) Baird Parker's agar – Selective media used for growing *Staphylococcus* colonies showing a clear zone.

(3) Xylose Lysine Deoxycholate agar (XLD) – Selective growth medium for *Salmonella* and *Shigella* species.

(4) Thiosulphate-citrate-bile salts-sucrose agar (TCBS) – Selective media used to isolate *Vibrio* species.

(5) Violet red bile agar (VRBA) – Selective medium used for the isolation of *coliforms*.

Result and Discussion

Table 1: Table represents the number of colony forming units (cfu)/0.1ml for the water sample in which the fish are kept during marketing. Water sample is diluted in 1:1 ratio and the plates were incubated at 37°C.

Media	Water sample	
	Undiluted water sample	Diluted water sample
Nutrient agar	300	200
Baird Parker's agar	150	60
TCBS agar	54	25
XLD agar	78	25
VRBA agar	150	115

Table 2: Table represents cfu/0.1ml for the samples of body and gill from Bombay duck. Plates were incubated at 37°C for 24 hrs.

Media	BOMBAY DUCK				
	Body surface			Gills	
	10^{-1}	10^{-2}	10^{-3}	10^{-1}	10^{-2}
Nutrient agar	65	--	--	43	28
Baird Parker's agar	32	--	--	--	--
TCBS agar	--	--	--	--	--
XLD agar	--	--	--	--	--
VRBA agar	220	150	93	13	5

Table 3: Table represents cfu/0.1ml the samples of body and gill from Prawns. Plates were incubated at 37°C for 24 hrs.

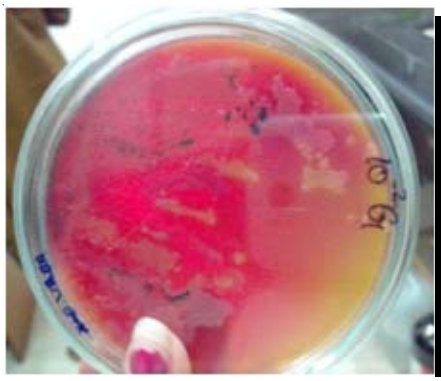
Media	PRAWNS				
	Body surface			Gills	
	10^{-1}	10^{-2}	10^{-3}	10^{-1}	10^{-2}
Nutrient agar	289	53	33	66	49
Baird Parker's agar	--	--	--	--	--
TCBS agar	58	--	--	--	--
XLD agar	38	--	--	--	--
VRBA agar	116	--	4	32	--

Table 4: Table represents cfu/0.1ml the samples of body and gill from Mackerel. Plates were incubated at 37°C for 24 hrs.

Media	MACKEREL				
	Body surface			Gills	
	10^{-1}	10^{-2}	10^{-3}	10^{-1}	10^{-2}
Nutrient agar	28	2	--	Matte	139
Baird Parker's agar	22	2	--	Matte	202
TCBS agar	42	1	--	Matte	Matte
XLD agar	--	--	--	Matte	29
VRBA agar	--	--	--	Matte	Matte

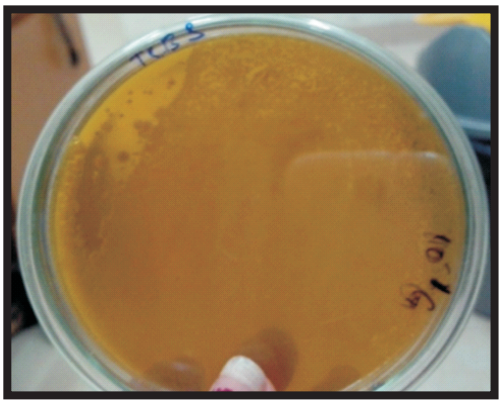
Mediums showed various changes related to their colour. TCBS agar turned its colour from green to yellow showing black colonies. Sucrose fermentation was the cause for colour change. The non Vibrio spp produced H_2S and hence the colonies appeared black; XLD agar changed its colour from red to yellow due to the degradation of xylose, lactose and sucrose. It also showed black pigmentation which are due to H_2S producing spp. It is generally accepted that fish with microbial load of >106cfu/0.1ml is unacceptable from the microbiological point of view and unfit for human consumption (Cheesbroughl, 2000).

Images of media after incubation period of 24 hrs.

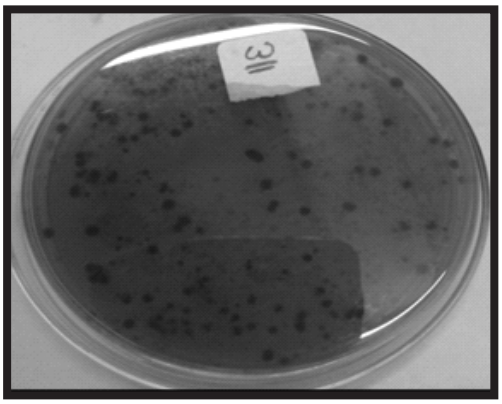


XLD agar (Black Pigmentation

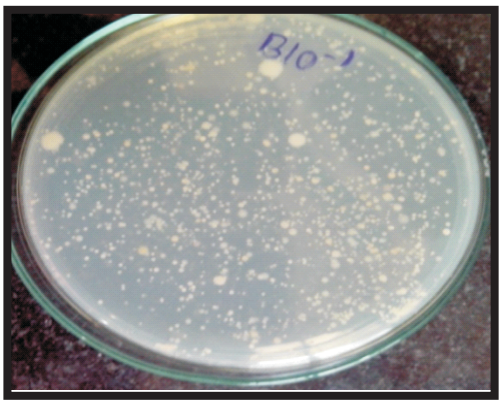
VRBA agar (Red to Yellow)



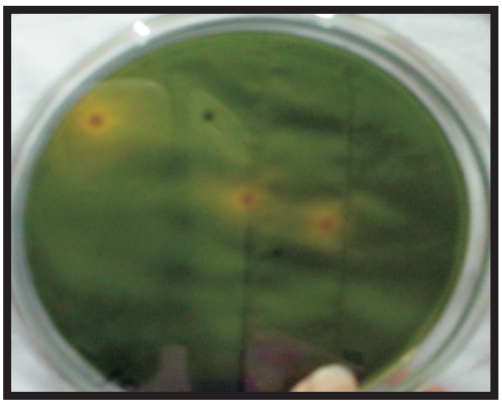
VRBA agar (isolated colonies



TCBS agar (Green to Yellow)



TCBS agar(Yellow colonies)



Nutrient agar (isolated colonies)

Conclusion

The study has revealed a moderate level of bacterial contamination of fish sold in supermarkets and by street vendors. Lack of knowledge regarding sanitary handling of food and poor processing conditions on the streets contributed to the high bacteria levels in the fish. The cutting of fish by street vendors in the absence of freely flowing water introduced more pathogens to the fish. The lack of infrastructure and use of ice at street sale point may have allowed for the growth of bacteria on the fish. These circumstances therefore, represent a potential health risk to fish eating society in the country if left unmonitored. Stringent regulations and monitoring activities coupled with food safety training of suppliers (fishermen and traders) and consumers on various aspects of Good Hygiene Practice (GHP), Good Manufacturing Practice (GMP) and Hazard Analysis and Critical Hazard points (HACCP) is strongly recommended. In view of the findings of this research work it is therefore recommended that good hygienic conditions and use of clean and free flowing water during processing should be strictly adhered to. After fishing activity, optimum storage conditions should be made available such as fresh fish should be stored at low temperatures so as to inhibit the growth of bacteria.

Future research

Based on these findings, it is important to broaden the scope of future research studies in this area like inhibition of these microorganisms by using antibiotics. According to the research paper the microbes like *Salmonella, Pseudomonas* as sensitive to antibiotics like amoxicillin, gentamycin and tetracycline (Thrower, 2000). So these antibiotics can be spread over the ice in which the fishes are stored. Different antibiotics with differing concentrations are to be tested further by using Agar cup method or Disc diffusion method. Synergistic effect of antibiotics n also be studied for better results.

Acknowledgements

We are greatful to Vidya Prasarak Mandal for providing us with infrastructural facilities. I would like to express my gratitude towards Dr.Mrs N.Patil for her valuable guidance. Also I would like to thank Miss R.Radhakrishnan, Dr.Mrs P.N.Kurve and Miss G.Syed for finalizing my research work. Secondly I would like to thank everyone who helped me during my research work.

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Cheesbroughl, 2000; A.E. Ghaly, D. Dave, S. Budge and M.S. Brooks; Fish Spoilage Mechanisms and Preservation Techniques: Review; American Journal of Applied Sciences 7 (7):PP 18.

Herbert *et al.*, 1997; WOGU, M.D. and MADUAKOR, C.C.; Evaluation of Microbial Spoilage of Some Aqua cultured Fresh Fish in Benin City Nigeria; Ethiopian Journal of Environmental Studies and Management(3) PP 09.

Thrower, 2000; WOGU, M.D. and MADUAKOR, C.C.; Evaluation of Microbial Spoilage of Some Aqua cultured Fresh Fish in Benin City Nigeria; Ethiopian Journal of Environmental Studies and Management(3) PP 15.

Study of the sponge spicules from the coastline of Raigad district, Maharashtra, India

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Introduction

Phylum Porifera includes multicellular, pore bearing invertebrate animals commonly known as sponges. These animals lack definite tissues and thus are considered as primitive multicellular animals as per cellular grade of organization. They show presence of spicules which provide structural support and deter predators. Large spicules are referred to as megascleres, while smaller, are termed microscleres.

Structure of spicules

Spicules are made up of silica or Calcium carbonate and are found in different symmetry. Monaxons form simple cylinders with pointed ends. Monactical monaxons always have one pointed end; they are termed styles if the other end is blunt, tylostyles if their blunt end forms a knob; and acanthostyles if they are covered in spines. Diactinal monaxons are classified by the nature of their ends: oxea have pointed ends, and strongyles are rounded. Spine-covered oxea and strongyles are termed acanthoxea and acanthostrongyles, respectively.

Triaxons have three axes; in triods, each axis bears a similar ray; in pentacts, the triaxon has five rays, four of which lie in a single plane; and pinnules are pentacts with large spines on the non-planar ray.

Tetraxons have four axes, and polyaxons. Sigma-C spicules have the shape of a "C".

Dendroclones might be unique to extinct sponges and are branching spicules that may take irregular forms, or may form structures with an I, Y or X shape.

For the present study, the sampling was carried out at the coastline of Raigad district, Maharashtra. A variety of sponge samples were collected and sponge spicules were studied.

Materials And Methods

The fresh samples of sponges with different colours were collected from the coastline of Raigad district. A piece of sample was boiled with 10% KOH and was allowed to settle for 10 minutes. After cooling, upper part of the solution containing KOH was carefully extracted out using dropper and distilled water was added. A drop of this solution was taken on the slide and the sponge spicules were observed under a light microscope.

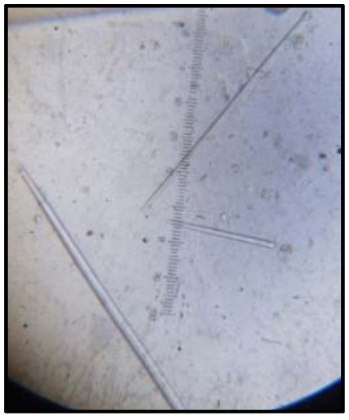
Result and Discussion

The study of sponge spicules of various types of sponges with different pigmentation such as orange yellow, red golden, yellow green was carried out. .For all the 3 samples, the sponge spicules found out to be monaxon spicules of tylostyle type with one end knobbed and other pointed end.

Microscopic observation of spicules: (Magnification 450x)

Spicules of Orange Yellow pigmented sponge

Spicules of red golden pigmented sponge



Spicules of yellow green pigmented sponge

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Conclusion

All the samples sponge spicules observed during the study were of monoaxons type subtype tylostyle.

Acknowledgement

We are thankful to Vidya Prasarak Mandal and Principal Dr. (Mrs.) M. K. Pejavar for providing infrastructural facilities. We are greatful to our guiding teacher Dr. (Mrs.) Poonam N. Kurve. We are also thankful to Ms. Gayatri Oak for her help.

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Study of phytoplankton diversity and physico-chemical parameters of Upvan-lake, Thane, Maharashtra, India

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Introduction

Thane is known as 'City of lakes'as there are around 35 lakes of which Upvan Lake is well known for its recreational activities. Upvan Lake (19°13'21''N 72°57'22''E) is located at foothills of Yeoor, in Thane, Maharashtra. It extends over an area of about 6 hectares.

Thane Municipal Corporation (TMC) had undertaken conservation of 13 lakes including Upvan Lake in 2002. In their study it was observed that water in all these lakes was highly polluted, turbid, greenish black in colour. The lakes were also infested with dense growth of aquatic plants water hyacinth, salvinia and algae. Considering the need for recreation and improving the aesthetics of region, de-weeding, clearing of garbage and bioremediation of lakes were undertaken by TMC with support from NLCP (National Lake Conservation Plan).

The Upvan lake is getting polluted by the sewage entering from the surrounding settlements, religious practices and human activities like washing, bathing, etc. The restored lakes have to be kept free from pollution to maintain their ecosystem.

Material and Methods

In the present study the phytoplankton diversity and the physico-chemical properties of the lake water were studied for monsoon and postmonsoon season. The physico-chemical parameters such as temperature, pH, Dissolved oxygen, chlorinity, salinity, nitrates, nitrites, phosphates, were studied. pH, temperature and DO were estimated onsite and DO was estimated using a portable DO kit. Chlorinity and Salinity was done by Argentometric method, Nitrates and Nitrites by colorimetric and Phosphates by spectrophotometric method.

The collection of sample for phytoplankton

The samples were collected from the surface using one litre glass jar and fixed immediately using 4% formaldehyde in Lugol's Iodine solution. The sample was left undisturbed for 24 hours to allow the settling of phytoplanktons and then the settled part of the solution was transferred in other capped glass jar.

The subsamples were observed under high power of microscope. The checklist of the phytoplankton species was prepared. The identification key given by Caljon (1983) and Sanet Janse van Vuuren et al (2006) were used.

Results and Discussion

Physico-chemical properties of water

Sr no.	Water parameters	August	September	Average
1	pH	7-7.5	7.5	7.5
2	Dissolved Oxygen	5.85	5.85	5.85
3	Chlorinity	0.021gm/l	0.042gm/l	0.031gm/l
4	Salinity	0.038gm/l	0.076gm/l	0.057gm/l
5	Nitrates	0.3mg/l	0.01mg/l	0.15mg/l
6	Nitrites	0.21mg/l	0.21mg/l	0.21mg/l
7	Phosphates	0.3mg/l	0.8mg/l	0.55mg/l
8	Hardness	90mg/l	80mg/l	85mg/l

pH: The pH of the sample was found to be near neutral. The pH was neither highly acidic nor alkaline. It was within the range described by IS0 2003 which is 6.5-8.5. It can be said to be suitable for the life.

Dissolved Oxygen: The dissolved oxygen in the water was found to be 5.85 mg/l. According to WHO standards, the dissolved oxygen required to sustain life is 3mg/l. The DO was found to be in the range described by WHO.

Chlorinity: The chlorinity was found to be 31.5 mg/l. The chlorinity was within the limits of 200mg/l given by WHO(1971)

Nitrates: The nitrates were found to be 0.155 mg/l. The discharge standards described by WHO for nitrates is 50 mg/l. The nitrates were found to be within the given limits.

Nitrites: The concentration of Nitrites was found to be 0.21mg/l which was within the permissible limits of 0.3 mg/l described by USEPA.

Phosphates: The concentration of Phosphates was found to be 0.55 mg/l. This level was above the permissible limit of 0.1mg/l given by WHO.

Hardness: The total hardness of water was found to be 85 mg/l. It is within the permissible limit of 200 mg/l given by WHO (1984).

After comparing water parameters with study by Raut N. S., (2006), the difference was not significant except phosphates which were found to be greatly reduced due to the dilution by rain water. As this study was conducted during the monsoon season, there is a possibility of dilution in nutrient concentrations and thus phytoplankton diversity.

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Phytoplankton Diversity

20 genera of phytoplankton belonging to three divisions were observed. The checklist of the Species from each division has been given in the Table No.:2

Table No. 2 : List of Phytoplankton

Sr. No.	Chlorophyta	Bacillariophyta	Cyanophyta
1	*Tetrastrum* Spp	*Synedra* Spp	*Microcystis* Spp
2	*Cosmarium* Spp	*Nitzschia* Spp	*Merismopedia* Spp
3	*Crucigenia* Spp	*Gomphonema* Spp	-
4	*Pediastrum simplex*	*Aulacoseira granulate*	-
5	*Pandorina* Spp	*Pinnularia* Spp	-
6	*Koliella* Spp	-	-
7	*Monoraphidium* Spp	-	-
8	*Tetraedron mediocris*	-	-
9	*Tetraedron minimum*	-	-
10	*Tetraedron trigonum*	-	-
11	*Scenedesmus* Spp	-	-
12	*Oocystis* spp	-	-
13	*Chlorogonium euchlorum*	-	-

In the previous study, by Raut N. S. (2006), had studied the phytoplankton diversity of Upvan lake. Table no. 2 shows a comparison between (Raut N. S., 2006) and present study.

Table No 3: Comparison between the studies of 2006 and 2013

Sr. No.	Divisions	No. of Species	
		Studies in 2002-03 (Raut N., 2006)	Present study 2013
1	Chlorophyta	13	13
2	Bacillariophyta	11	5
3	Cyanophyta	6	2
4	Euglenophyta	2	-
5	Cryptophyta	1	-
6	Dinophyta	2	-
	Total	**35**	**20**

Studies in 2006 revealed 35 species from 6 different divisions. While in the present study 20 species were found from 3 divisions. Division Chlorophyta was represented by 13 species, division Bacillariophyta by 5 species and division Cyanophyta by 2. The study also shows that the diversity of species from Bacillariophyta has reduced by 54% and that of Cyanophyta by almost 67%. Species from divisions Euglenophyta, Cryptophyta and Dinophyta were not found in present study.

The present study was carried out during monsoon. Decrease in the number of species in 2013 can be attributed to dilution by rain water.

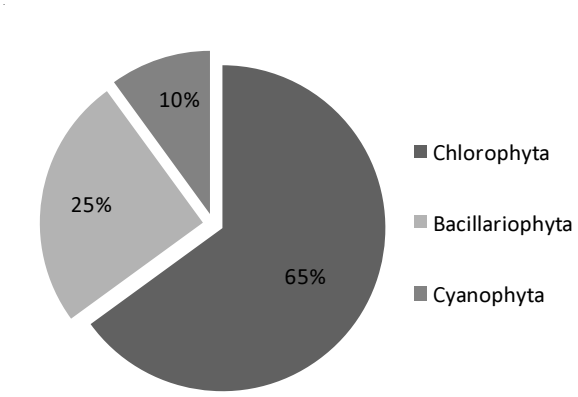
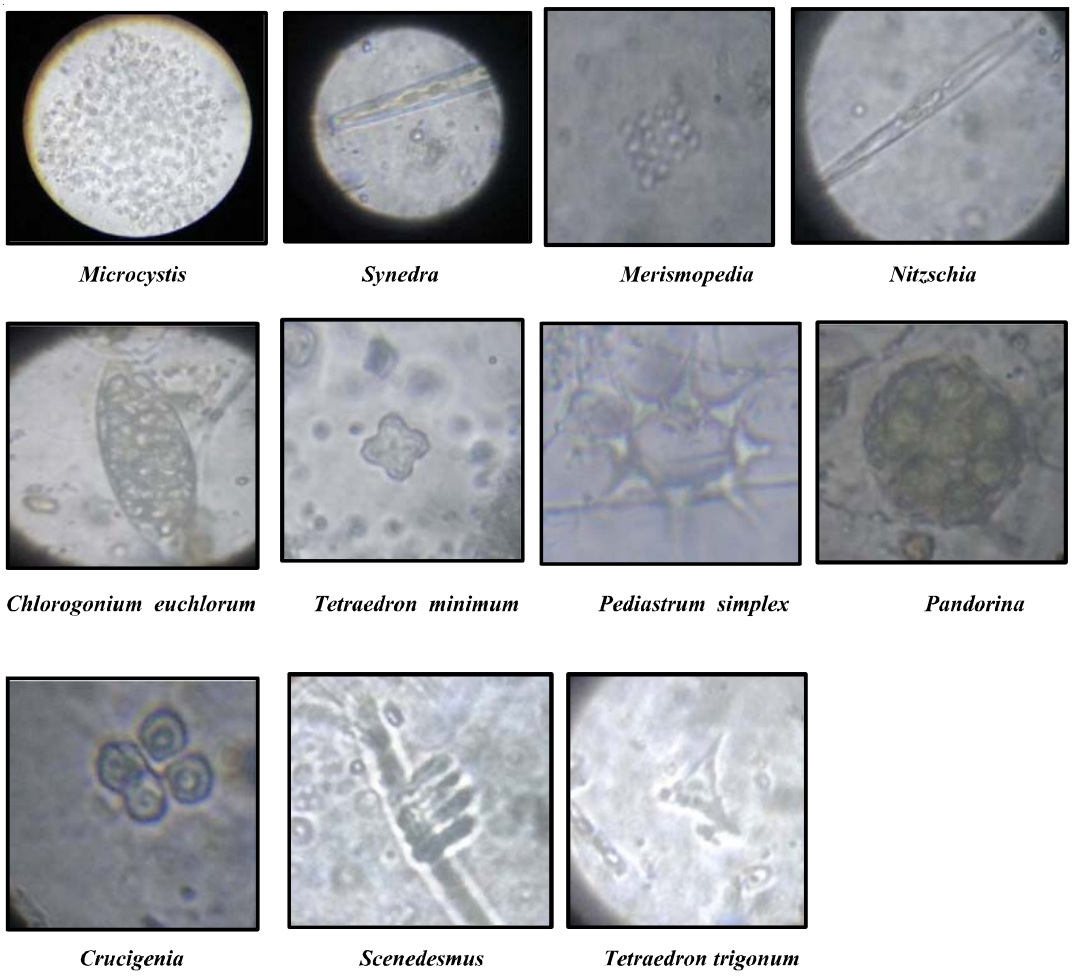


Fig.1 Division wise distribution of Phytoplankton

Images of Phytoplankton species



Conclusion:

The present study shows that anthropogenic activities have a profound impact on Lake ecosystem. A detailed study of limnological characters and phytoplanktonic activities in the lake should be carried out to get an elaborate estimate of the quality of the lake ecosystem.

Acknowledgements:

We are greatful to Vidya Prasarak Mandal for providing us with infrastructural facilities. We are grateful to our guiding teacher Dr. Mrs. Poonam N. Kurve for her constant support and guidance. We wish to thank Ms. Gayatri Oak, Ms. Sneha Joshi and Mr. Dilip Shenai for their help.

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The Study of Physico-Chemical Parameters And Plankton Diversity of the ponds in The V.P.M. Campus, Thane, Maharashtra, India.

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Introduction

The study of phytoplanktons was done in ponds present in V.P.M. campus, Thane. Various ponds have been made in the college campus for aesthetic value. The ponds showed growth of various aquatic plants such as *Pistia*, *Hydrilla* and small fishes. The study was done to find out the presence growth of phytoplankton and zooplanktons in these ponds.

Phytoplankton are small microscopic, photosynthetic organisms. They are among the primary producers in the aquatic ecosystems. They are vital parts of food chain in the aquatic ecosystems. The abnormal increase in their number indicates pollution.

Materials And Methods

Collection of water was done using plastic bottle. There were 7 ponds labeled as 1 to7.

The physico-chemical parameters such as Dissolved oxygen, Temperature, pH, Chlorides, Nitrates and Nitrites were studied. The book referred for estimations was Chemical And Biological methods For Water Pollution Studies by R.K.Trivedi and P.K.Goel.

The collection of sample for phytoplankton

The samples were collected from the surface using one liter glass jar. The samples were immediately fixed using 4% Formaldehyde in Lugol's Iodine solution. The sample was left undisturbed for 24 hours to allow the settling of phytoplankton and then the settled part of solution was transferred in other capped plastic container.

The subsamples were observed under high power of microscope. The checklist of the phytoplankton species was prepared

The identification key given by Caljon (1983) was used.

Result and Discussions

Physico-chemical properties of water:

The water parameters are shown in table no1.

Table 1: Physico-chemical parameters of water of 7 ponds

WATER PARAMETERS	Temperature ^{0}C	pH	Dissolved oxygen (mg/l)	Nitrates (mg/l)	Nitrites (mg/l)	Chlorides (mg/l)
POND 1	27°C	7.5	3.6	0.266	0.011	17.04
POND 2	27°C	7.25	3.8	0.077	0	18.46
POND 3	28°C	7.25	3.2	0.033	0.022	8.52
POND 4	29°C	7	3.4	0	0.135	49.7
POND 5	27°C	7.5	3.4	0.022	0.011	8.52
POND 6	27°C	7.5	4.6	0	0.566	19.88
POND 7	29°C	7.5	4.2	0.022	0	24.14

pH: The pH of the sample was found to be near neutral. The pH was not highly acidic or alkaline. It can be said to be suitable for the life.

Nitrites: Nitrites were in the range of 0-0.566mg/l. pond 6 had the highest concentration of nitrites, while pond 2 and 7 showed absence of nitrites.

Nitrates: Nitrates were in the range of 0-0.266mg/l. Pond 4 and Pond 6 showed absence of nitrates while pond 1 showed the highest concentration of nitrates.

Chlorides: Chlorides were in the range of 8-25 mg/l. Pond 4 had highest concentration of Chlorides (49.7mg/l) while lowest concentration was recorded in pond 6 and Pond 3 (8.52 mg/l)

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Dissolved Oxygen: Dissolved oxygen of all the ponds was found to be above 3mg/l which is above the limit given by WHO.

The plankton diversity

The plankton diversity was found to be very poor. Among the phytoplankton species, Chlorella spp, Navicula spp, Diatoms were found. Pond 4, 6 and 7 showed high density of phytoplankton. Pond 1 and 3 showed least density of phytoplankton. Ponds 2, 4, 5, 6 showed the presence of zooplankton as well. Pond 2 and 4 showed presence of Rotifers. Pond 6 showed presence of zooplankton from class Cladocera. Zooplankton from Cyclopoda, and the larvae of zooplankton were also found.

Table2: Plankton diversity in all the ponds

POND	Phytoplankton	Zooplankton
1	Chlorella spp.	-
2	Chlorella spp.	Rotifer
3	Chlorella spp.	-
4	Navicula spp., chlorella spps.	Rotifer
5	Chlorella spp.	-
6	Naviculla spp.,Chlorella spp.	Cyclopoda
7	Chlorella spp., diatom	Cladoceran

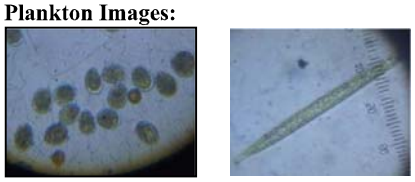
Conclusion

Very poor phytoplankton diversity was observed in these ponds and may be caused by several factors. Light penetration was low. Numerous plants were growing on the surface of the water like lotus, hydrilla, Water hyacinth, *Pistia*, etc. Water was highly turbid. Dissolved oxygen levels were low at the area below the plant community covering. Poor quality of water contributed to low phytoplankton diversity. Ponds with more depth showed higher density of phytoplankton and zooplanktons were observed compared to the ones with less depth. The ponds showing more covering of plants showed less number of both phytoplankton and zooplanktons.

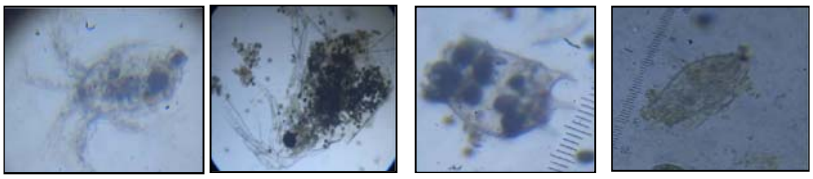
Pond 1 Pond 2 Pond 3 Pond 4

Pond 5 Pond 6 Pond7

Plankton Images:



Chlorella spp. Diatom



Zooplankton larva Zooplankton (Cladoceran) Rotifer Rotifer

Acknowledgements

We are thankful to Vidya Prasarak Mandal and Principal Dr.(Mrs.) M. K. Pejaver for providing us with infrastructural facilities. We are thankful to Dr. (Mrs.) Poonam N. Kurve for her guidance and support. We also thank Ms. Gayatri Oak for her help.

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Comparative Study of Microbial population in Vermicompost and Biocompost in Relation with Physicochemical Parameters

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Abstract: The study was focused on quantitative estimation of microorganisms in vermicompost and biocompost and if earthworm presence has any impact on microbial growth. The physicochemical parameters such as pH, Temperature, Organic matter, Nitrogen(N), Phosphate (P), Potassium (K) were also analyzed to determine the effect of microbial activity. There is extensive evidence in the literature that earthworms and other soil invertebrates feeding on microorganisms enhance microbial activity in the first instance. As a result of it, earthworms reduce the availability of these resources for the microbial communities and consequently their activity, in later stage.

Many authors have recorded higher microbial populations in the partially decomposed vermicompost than completely formed vermicompost. This may be due to the temperature and pH conditions in the partially decomposed raw material. Compared to conventional thermophilic composts, vermicompost is much richer in microbial diversity, populations and activities (Subler *et al*. 1998).

***Keywords**:* Vermicompost, Biocompost, Microbial activity, Earthworms, Organic wastes.

Introduction

Vermicomposting is a mesophilic bio-oxidative process in which detritivorous earthworms interact intensively with microorganisms and soil invertebrates within the decomposer community, strongly affecting decomposition processes, accelerating the stabilization of organic matter and greatly modifying its physical and biochemical properties. Vermicomposting systems sustain a complex microbial and invertebrate food web that results in the recycling of organic matter and release of nutrients. Biotic interactions between decomposers(i.e. bacteria and fungi) and the soil fauna include competition, mutualism, predation and facilitation and the rapid changes that occur in both functional diversity and substrate quality are the main properties of these systems(Sampedro and Domínguez, 2008). The most numerous and diverse members of this food web are microorganisms, although there are also abundant protozoa and many invertebrates of varying sizes, including nematodes, microarthropods and large populations of earthworms(Monroy 2006; Sampedro and Domínguez 2008). These invertebrates cover a range of trophic levels-some feed primarily on microbes (bacteriovores and fungivores), on organic waste (detri-tivores) or on a mixture of organic matter and microbes (microbio-detritivores), whereas others feed on animals (carnivores) or across different trophic levels (omnivores); (Sampedro and Domínguez 2008).

The primary consumers of the vermicomposting food web are the microorganisms (mainly bacteria, fungi and ciliates) that break down and mineralize organic residues. Microorganisms are the most numerically abundant and diverse members of the vermicomposting food web and include many thousands of different organisms. Secondary and higher-level consumers, that is, the soil invertebrates, including earthworms, exist together with microbes, feeding on and dispersing them throughout the organic matter. Endosymbiotic microbes produce extracellular enzymes that degrade cellulose and phenolic compounds, enhancing the degradation of ingested material and the degraded organic matter passes out of the earthworm's body in the form of casts. As decomposers die, more food is added to the food web for other decomposers. Earthworms accelerate decomposition processes during vermicomposting (Aira *et al*. 2006, 2007).

The effect of earthworms on the decomposition of organic waste during the vermicomposting process is, in the first instance, due to gut-associated processes (GAPs). These processes include all the modifications including the addition of sugars and other substances, modification of the microbial diversity and activity, homogenization and the intrinsic processes of digestion, assimilation and production of mucus and excretory substances such as urea and ammonia, which constitute a readily assimilable pool of nutrients for microorganisms. The proximate activities of earthworms enhance the mineralization of both carbon and nitrogen in the substrate significantly and such effects are in proportion to the earthworm population densities (Aira *et al*. 2008).

In addition, carbon availability is a limiting factor for earthworm growth and it has been reported that earthworms and microorganisms may compete for carbon resources (Tiunov and Scheu 2004); thus earthworm activity may have reduced the quantity of resources available for microbial communities and consequently the bacterial growth rates.

Materials and Methods

Vermicompost and Biocompost Bed

Two plastic bins were taken and covered with nylon mesh for proper aeration. The contents in both the bins were same except vermiculture (1 & ½ kg) and *Eisenia fetida* worms (12 worms of around 7 to 10 cm size) were added in vemicompost bin. Brick pieces of around 2 cm size formed the first layer (500 gm) of both bins. Around 1 & ½ kg baggase was added as second layer followed by dry hay layer (500 gm) and Cabbage waste of around 2 kg. Small pieces of dry cowdung (1 Kg) were added. Between all these layers soil was sprinkled in both bins, again around 50 gm of soil was spread at top of both bins. Watering was done daily to maintain moisture content.

Physicochemical analysis: The physiochemical parameters of vermicompost and biocompost bins were also analyzed after 15 days time interval including initial parameters of soil. Table 1 gives methods used for analysis of chemical parameters.

Table 1: Methods used for analysis of chemical parameters

Sr. No.	Parameters analyzed	Method used
1.	Organic contents	Walkey and black method.(Trivedi R.K & Goel 1986)
2.	Nitrogen(N)	Kjeldahl method (Trivedi R.K & Goel 1986).
3.	Phosphorus(P)	Olsens method (Trivedi R.K & Goel 1986).
4.	Potassium(K)	A flame photometry (Trivedi R.K & Goel 1986).

Microbial analysis: First Sample was collected for analysis 15 days after the set up of vermicompost and biocompost, second and third samples were also taken by keeping 15 days gap between them, to complete 60 days study (i.e. initial setup to 3rd sample). For observing microbial growth Sterile Nutrient agar plates were used. 1 gm of sample was dissolved in 9 ml of sterile saline. The Serial dilution (10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}) up to 10^{-6} was carried out. Then 0.1 ml of sample from the 10^{-4}, 10^{-5} and 10^{-6} was taken and spread by Spread plate method over the sterile Nutrient Agar plate and Incubated at R.T. for 24 hours and microbial count was done.

Result and Discussion:

The sterile nutrient agar plates after an incubation period of 24 hours at room temperature showed a crowded plate on first sampling i.e. during initial stages of formation of vermicompost and biocompost. Table2. shows the total count of Colony Forming Unit (CFU) per gram of vermicompost samples for 10^{-4}, 10^{-5}, 10^{-6} dilutions.

The CFU count was higher at initial stages while it was getting decreased further. Thus the microbial population was found higher at initial stages, which may be because after digestion of organic material the vermicasts formed; providing large quantity of material to decompose and large surface area for microbes to adhere to the substrate; microbes from earthworm's gut i.e. enteric microflora also get added to the microbial population. After the formation of vermicompost and degradation of organic matter, the food chain in vermicompost and biocompost starts working i.e. the microbes and other soil invertebrates compete for available resources (i.e. C, N, P, O) to sustain their lives, thus the microbial population starts decreasing. The total CFU counts of biocompost were determined. Table 2. represents the total CFU/g count of vermicompost and biocompost for 45 days with 15 days time interval in each sampling.

Table 2: Total CFU/g count for vermicompost and biocompost

Dilution used	10^{-4}		10^{-5}		10^{-6}		Average	
	Vc	Bc	Vc	Bc	Vc	Bc	Vc	Bc
Sample 1 CFU/g	1.64×10^6	3.1×10^6	10×10^6	4.5×10^6	80×10^6	24×10^6	30.54×10^6	10.53×10^6
Sample 2 CFU/g	1.45×10^6	2.7×10^6	9×10^6	4×10^6	68×10^6	20×10^6	26.15×10^6	8.9×10^6
Sample 3 CFU/g	1.38×10^6	2.4×10^6	7.7×10^6	3.2×10^6	61×10^6	18×10^6	23.36×10^6	7.86×10^6

The comparative study showed that microbial population in biocompost was much lower as compared to vermicompost. This may be due to the presence of earthworms in vermicompost, as they act a good supporters for microbial growth i.e. by providing, a large pool of resources such as N, P, K, provide larger surface area by digesting organic material and degrade it into smaller pieces; also the earthworm activity or movement through vermin bin provides proper aeration. Thus a favorable medium was provided for microorganisms to grow. Fig.1 represents the

comparative account of microbial populations in vermicompost and biocompost.

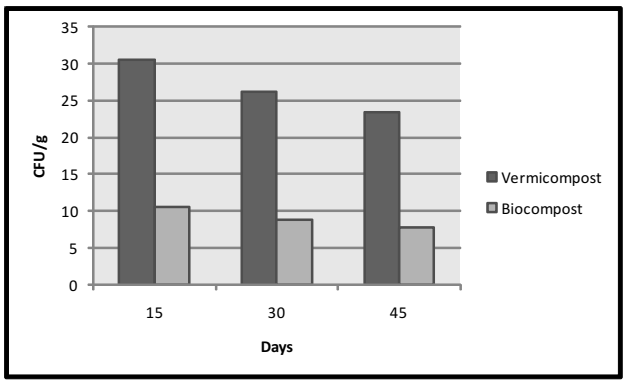

Fig.1: comparison between CFU/g counts of vermicompost and biocompost

The physiochemical parameters such as pH, Temperature, N, P, K contents and Organic matter were also analyzed. Initial parameters of soil were analyzed to determine the impact of compost formation on soil on both vermicompost and biocompost. The pH of both vermicompost and biocompost was found to be in the range of 5 – 7 and 4 – 7 respectively during the process. The Slight change in pH from slightly acidic to neutral is due to increase in NPK content or Organic matter content. The temperature in both the bins showed an increase from 15°C to 25°C which may be due to the heat generated during decomposition, digestion and respiration of microorganisms and earthworms. Table3. showed the physiochemical parameters in both vermicompost and biocompost

Table 3.: The Physicochemical parameters of Vermicompost and Biocompost

Analysis	1		2		3		4	
	Vc	Bc	Vc	Bc	Vc	Bc	Vc	Bc
pH	5 – 6	4 – 5	5 – 6	4 – 5	6 – 7	5 – 6	6 – 7	6 – 7
Temperature	15°C– 25°C	18°C– 27° C	15°C– 23°C	18°C- 25°C	18°C – 24°C	16°C – 23°C	16°C – 24°C	15°C – 25°C
Organic contents %	9.8	6.5	10.1	8.9	11.2	10.3	11.5	10.52
N %	0.51	0.32	0.75	0.43	1.25	0.68	1.45	1.8
P %	0.91	0.67	1.24	0.83	1.63	1.3	2.12	1.4
K %	0.15	0.1	0.27	0.12	0.39	0.21	0.46	0.32

The organic matter content of both the Bins was found to be increased from initial concentration of 6.5% to 11.5% and 10.52% for vermicompost and biocompost respectively. Fig 2 showed comparison between Organic matter contents of vermicompost and biocompost.

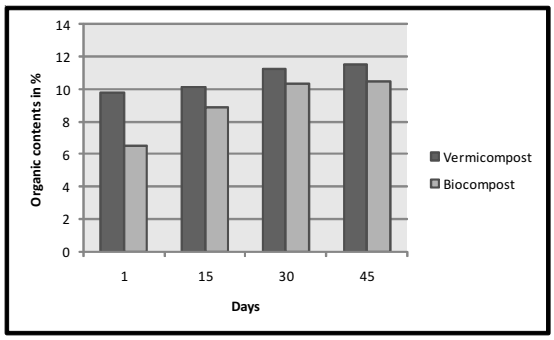

Fig 2: Comparison between Organic matter contents of vermicompost and biocompost

The N, P, K content in both vermicompost and biocompost were found to be increased from initial concentration of 0.51% to 1.8% in Vermicompost and 0.32% to 1.45% in biocompost respectively. It has followed an increasing trend for all the phases in development of Vermicompost and biocompost. In vermicompost the NPK content was found higher as compared to biocompost. Higher 'N' content may be due to the presence of earthworms, as, the Nephridial secretions of earthworms produce Nitrogenous compounds in their digestive tract which finally get mixed up with vermicomposting material, increasing the 'N' content. P and K content also followed an rising trend in all phases. Again it is found higher in vermicompost compared to biocompost. Fig 3 represents comparison of N, P, K contents in % of vermicompost and biocompost.

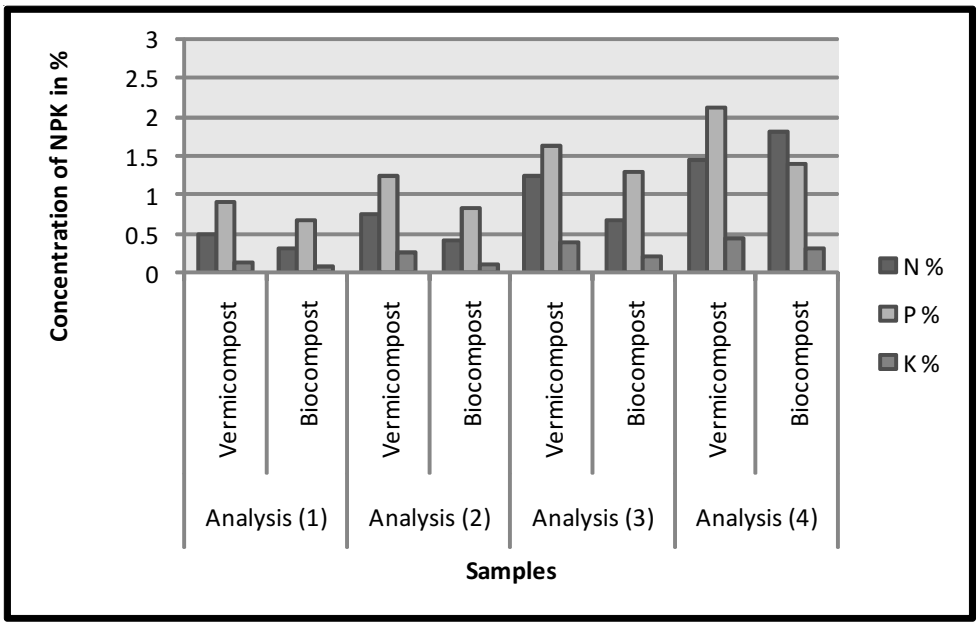

Fig 2: Comparison of NPK contents in % of vermicompost and biocompost

Conclusion: The study proves that, earthworms act as crucial drivers of the process and are involved in the indirect stimulation of microbial population, Earthworms activity helps microbial communities to use available energy more efficiently, thus enhancing the quality of final product i.e. vermicompost which can be used as best biofertilizer.

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Traditional Concepts of Bio-conservation

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Key Words : Bio-conservation, Tradition

All the biotic and abiotic components of this globe are interlinked and complement each other's existence. The biotic component that includes living organisms right from microbes to huge trees or gigantic animals show significant levels of interdependence. This interdependence (also called as food chain or food web) is easily hampered on destruction of any of the floral or faunal group. On the backdrop of exploding population, this kind of interdependence amounts to a deciding factor in continuation or existence of any plant or animal race.

The management of the human use of the biosphere (the part of the earth's surface and atmosphere inhabited by living things) so that it may yield the greatest sustainable benefit to current generations while maintaining its potential to meet the needs and aspirations of future generations is bioconservation.

Conservation of biodiversity has of late become very popular but the fact that the concept of conservation has been handed to us by our ancestors cannot be ignored. From time immemorial our ancestors respected nature and this very fact has proved very crucial in minimal use of the resources and restoring back the bounties taken from mother earth. Slowly with changing civilizations, man's greed increased and he, with his quest for becoming powerful started taking more than what could be replaced. Now after years rolled by, he has realised that he has to implement conservation of biodiversity on a war footing.

This paper has made an attempt to bring forth that, though the terms biodiversity and bioconservation may be coined by naturalists, this very concept of limited use of nature and conserving as well as respecting nature has been an age old tradition followed throughout the world.

Going back to historic time period, the tradition of conservation was quite evident in every continent as represented in the culture, religion and social norms of traditional societies.

Forest patches preserved in the name or culture is reported from many countries extending from Asia, Africa, Europe and America but present occurrence is mostly restricted in Africa and Asia.

Expansion of agriculture and human settlement destroyed vast tracts of forest land which resulted into gradual erosion of fertile soil, hence adverse consequences of these led people to realize the importance of forest ecosystem in soil and water conservation as well as livelihood security which ultimately manifested in the form of protection of remaining forest patches under various socio-economic norms. Sacred grooves are perhaps the first democratic approach by the rural people to protect the nature from overexploitation.

Atharva veda (12.1.11) hymn believed to have been composed sometime at around 800 B.C. somewhere amidst deep forests reads- "O Earth! Pleasant be thy hills, snowclad mountains and forests, O numerous coloured firm and protected earth!, on this earth I stand undefeated, unslain, unhurt".

Another hymm from Atharva veda (12.1.35) reads: "Whatever I dig out from you, O earth! May that have quick regeneration again, may we not damage thy vital habitat and heart".

Nature worship is a form of tribal belief and the faith of these laymen has helped to conserve many natural ecosystems in India. They have preserved many pristine forests called 'sacred groves' in their original forms. Indian sacred grooves have prevedic origin. Sacred groves are rich in biodiversity. They are the last refuge of the rare flora and fauna which have otherwise disappeared from the modern world. Sacred groves have become part of the 'biosphere reserves' of India. The basic elements of nature in the form of Prithvi (Earth), Agni (Fire), Jal (Water), Vayu (Air) and Akash (Space) were always worshipped or revered in one or the other form from the ancient times as per the Hindu mythology (Anthwal *et al*. 2006).

Specific local knowledge, skills and strategies, concern for well being of future generations, reliance on local resources, restraint in resource exploitation, an attitude of gratitude and respect for nature, management conservation and sustainable use of biodiversity outside formal protected areas and transfer of useful species across villages and larger landscape, all has painted a bigger picture of bioconservation. These are some of the useful attribute of local knowledge systems. (Pandey 2009). Over thousands of years local people have developed a variety of vegetation

management practices that continue to exist in tropical Asia. (Pandey 1998), South America (Atran et. al, Gomez Pompa and Kaus 1999), Africa (Getz et. Al. 1999, Infield 2001) and other parts of the world. (Brosius 1997, Berkes 1999).

Various religious traditions like temple forests, monasteries, sanctified and deified trees, tribal traditions like sacred forests, sacred grooves and sacred trees helped in conservation. The various royal traditions maintained by kings like royal gardens and elephant forests also helped in conservation. Various livelihood traditions like forests and grooves serving as cultural and social space as well as source of livelihood products also did help in conservation.

Tanks have been the most important source of irrigation in India. Some tanks may date as far back as the Rig vedic period around 1500 BC. Reference to the tanks is also found in the Arthashastra of Kautiliya written around 300 BC. (Rangarajan 1987).

The use of plants in mural painting as found in the Ajanta mural art speaks volumes of the traditions adopted by people in those days to create awareness about the importance of nature. The practice spanned a whole millennium from the second century BC to the eight century A.D. The tradition continued up to the nineteenth century under the support of different dynasties in India.

For meditation Hindu, Buddhist and Jain monks and saints sought a natural and peaceful environment, the highest expression of which is the forest. Thus traditionally temples were often built in forests, hence the surrounding forest became sacred space to be preserved rather than exploited. Traditionally this would tend to promote the conservation of all the species diversity within the surrounding ecosystem. Buddhism encouraged individuals to limit their resource consumption to the optimal satisfaction of the four basic needs of food, clothing, shelter, and medicine. This vantage point renders ecology a very concrete and personal matter.

Religion played a major role in protecting species. The temple walls of the sacred complex of the Shiva temple at Panchami village in Birbhum district of West Bengal, were ruined by the growth of a banyan tree. The demolition of the temple by the growing tree over decades was withstood by the worshippers, a new temple was erected close by, and the sacred trees, occupying the previous temple site are still given full protection by the local community (Deb and Malhotra 2001).

Protection of natural habitats (forest patches, stretches of river, ponds and lakes) in indigenous cultures is typically achieved by declaring it as sacred, by associating it with ancestral sprits or a local deity. Fishing is prohibited in the Ganga from Gangotri to Hardwar, as this stretch of the river is considered sacred. Similar stretches of other rivers like Mahanadi, Narmada and Godavari are also deemed sacred, hence no fishing is permitted. These stretches serve as important refugia for fish in these rivers. Also, religious restrictions on fishing and hunting at certain time of the year are traditionally observed by many communities.

Khecheopalri lake (Sikkim)

There are mythological links associated with the origin of all lakes in Sikkim which makes them sacred. One among them is the Khecheopalri lake (wish fulfilling lake). The lake is situated amidst pristine forest at an altitude of 1,700 mts. The depression where the lake is situated was formed by the scooping action of a glacier. The Lepchas are the inhabitants of the place. The sanctity of the lake is exemplified by a legend which says that the shape of the lake in the form of a foot that represents the foot of Lord Buddha. There is another legend that a Lepcha couple were peeling of the bark of the nettle when they saw a pair of conch shells falling from the air on the ground. This was followed by severe shaking of the ground and spring water emerged from below and thus the lake was formed. These myths have definitely gone a long way in preserving the ecosystem.

In India, since ancient times, several members of the flora and fauna have been identified with particular personalities of the Hindu pantheon and are worshipped. Many wild animals, such as tigers, lions and elephants, and birds such as the peacock, owl and swan have been revered as the vehicles of Gods and Goddesses and worshipped. Several trees, such as mango, coconut, khejri, emblica, tamarind, ashoka, madhuca and wood apple, and herbs such as basil are considered highly sacred and worshipped. This belief and these practices continue in one form or another even today in certain sections of Indian society, particularly the rural folk. Nature worship is a form of tribal belief and the faith of these laymen has helped to conserve many

natural ecosystems in India. They have preserved many pristine forests in the form of 'sacred groves'. Sacred groves are rich in biodiversity. They are the last refuge of the rare flora and fauna which have otherwise disappeared from the modern world. Thus sacred groves have become part of the 'biosphere reserves' of India.

The whole universe together with its creatures belongs to the Lord (Nature). No creature is superior to any other and the human being should not have absolute power over nature. Let no species encroach upon the rights and privileges of other species. However one can enjoy the bounties of nature by giving up greed." (Ieshaupanished, Verse-1). Obviously, all narrations in every religion preached conservation.

The whole rescue process of the biodiversity during the time of dissolution (Pralaya) was according to divine wish as narrated in both the epics, Manusamhita and Bible. In Manusamhita, God advised King Satyabrata to carry plant and animal species with him in a ship to a safer place when Pralaya began. Lord Vishnu guided the ship in form of a giant whale which was tied to with the ship by a large serpent Vaasuki. These species were taken through the period of deluge (Pralaya) and recreated the living world later.

For Noah as Bible says, "he walked with God", a sense of direct communication. Noah and his family might have struggled hard to protect the animals and save the ship from the flood waters for a long time of one year. In both the instances, if the metaphysical factor 'God' is looked in obscurity, the intension of Satyabrata (Hindu mythology) and Noah was a clear expression of their attitude for the conservation of biodiversity at the time of dissolution. This shows that, it is eternally a human responsibility to take care of the nature, either in ancient days or modern times.

Sacred groves in Nigeria promised alternative sources of high quality germplasm for conservation. Taboos worked as dependable instruments for conserving biodiversity in sacred groves in the country. Traditional belief systems created fears on the people not to violate regulations on groves because of negative repercussions; taboos failed as instrument of conservation in community forests where the traditional belief system was not recognised by heterogeneous members of the community. Forests outside the protected system are managed by rural communities to meet their desires and needs. Taboos are social prohibitions regulating or restraining individuals, families and communities from using biotic resources. They are based on mutual agreements collectively made by members of land holding communities to aid conservation of biodiversity. Taboos regulate access to biodiversity in terms of species protection, harvest and utilization. They also involve protection of water surface: wetlands, rivers and lakes; and terrestrial habitats in specific areas or locations. Taboos apply to all spheres of people: young, old, males and females (Osemeobo 1992).

Taboos are influenced by cultural beliefs, religion, social status and richness of biodiversity in terms of species availability, distribution, population, diversity and use intensity by members of the community. According to Khan et al (2008) taboos are used to establish most sacred groves. Each grove carries its specific myths, lore and legends which link owners with their spiritual guardians. The rules or regulations are often different and are often based on their historical past. Taboos in Nigeria exist in different forms (Osemeobo 1992; Osemeobo and Omeni, 2008): (i) Taboos are being observed due to nature of birth. Twins in Yoruba (Nigeria) are made to observe some taboos prohibiting them from eating monkey and some plants. (ii) Pregnant mothers are made to observe some taboos for safe delivery and for the protection of the unborn from evil spirits. (iii) Taboos are imposed on people that patronize traditional African medicine when they are cured of illness or when they acquire some magical powers. (iv) Taboos are attached to various traditional offices such as priests. People did not want to offend guardian spirits as they were invisible members of families. The invisible members were believed to be spiritually powerful which can despoil when taboos were flouted and bless individuals in a family when not offended. It has been said that respect or adherence to taboos is primarily based of fear of supernatural retribution (Casagrande 2008) if they fail to respect the taboos. Neglecting ancestral sprits could cause disasters to families (childlessness, pandemics, psychotic breaks and suicides). Strong traditional beliefs existed among groups of families living in harmony with culture, folk stories and myths surrounding ancestors and individuals. In Madagascar (Jones et. al. 2008) found taboos as a practice used to effectively protect endangered species (Propithecus edwardsi and Cryptoprocta ferox) thereby reducing pressure on endangered species often harvested for income generation. Outside protected areas, enforcement of conservation rules through taboos are breaking down due to of lack of capacity. Ineffective monitoring and law enforcement on the part of government has made access to biodiversity uncontrollable in protected forests. This is why species and habitat have played significant role in biotic conservation but with positive implications. In Konkan region, small lake (Pokharan) in front of a temple is a routine view. Many aquatic forms inhabit these lakes. Formation and removal of silt in these lakes is also a routing phenomenon. These lakes are said to be meant for immersion of floral offering to God and also cleaning oneself before entering the temple in order to maintain the sanctity of the temple.

Results And Discussions

There is clear evidence about awareness regarding conservation of biodiversity. Right from the ancient vedic times till date need for conservation has been sensed by rulers and concerned authorities. Successful attempts have been made to conserve various forms of life in natural conditions. To achieve this, emotional, spiritual or even devotional beliefs of the people were invoked. Satyabrata's ship, Noah's ark, Sacred groves, and many more have been proved to be successful means of creating awareness about conservation among laymen.

Yet, these ideas are proving to be obsolete now. In many places, the infrastructure for conservation no longer exists. Exponential growth of human population and consequent stress upon various resources has posed a serious threat to natural habitats. Mushrooming infrastructure facilities in the area has been an important reason for deteriorating the proper functioning of social institutions, which reflect that sacred groves are no longer getting the privilege they had in the past. Human interference needs to be regulated by defining various indigenous practices along with scientific implications rather than only old religious prescriptions and proscriptions. Proper legislative support and specific policies must be provided. Difference government and non-government bodies have to synergistically contribute towards creating consciousness about deteriorating status of nature and the need for its conservation.

Man has to realize, he has to live in harmony with nature and not allow greed to overpower him. From the above review one can understand that all the traditions, myths and taboos handed down to us from generations ultimately had the aim of conservation of biodiversity. Even our forefathers strongly vouched on conservation of biodiversity. The nature that we are exposed to and are experiencing its thankless offerings has to be conserved appropriately for the future generations. Legal restrictions are not the ultimate solution but emotional or devotional feelings have to be invoked for achieving this. The task is beyond capacity of any governing body. It is the wholehearted individual contribution that can bring about a change. This is just a humble attempt to put fourth past and present scenario of conservation.

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Coastal tourism in Alibaug, Raigad District: A menace or a bonus?

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Introduction:

Coastal area protection has become matter of concern all over the world because this zone is under enormous stress of anthropogenic activities like land exploitation, sand dredging, over exploitation of natural resources and also the tourism. Tourism is a fast growing industry affecting marine biodiversity directly or indirectly (Croall 1995).

It is well known that India has 7500 km coast line with coastal areas as west coast comprising Gujarat, Konkan region of Maharashtra and Malabar Coast and east coast comprising Coromondal coast and Orissa-West Bengal coast line.

Konkan coast comprises Thane, Mumbai, Raigad, Ratnagiri and Sindhudurg. Though Mumbai has a long coast line it has undergone complete urbanization. It is highly commercialized and has lost its calmness. Ratnagiri, Sindhudurg and Goa (about 350 to 600 km from Mumbai, Pune) are far from these cities. Therefore, these places are not preferred by day trippers and weekend picnickers who are more interested in stress relief.

The study area i.e. Alibaug (latitude 18^0 $38^{'}$ $28^{"}$ longitude 72^0 $52^{'}$ $45^{"}$) is a part of Konkan region of Maharashtra state. On all the three sides it is surrounded by Arabian Sea. Its bordering villages are popular for beaches with shimmering sand and fresh air. It is an astonishingly beautiful place with eye soothing greenery of coconut trees. This attracts people from nearby cities like Mumbai and Pune (located at about 110 km and 200 km respectively).

In the vicinity of Alibaug, Kashid, Murud, Kihim are popular as choicest seashores for these visitors. Nagaon beach is almost established as weekend picnickers' paradise while a nearby village Akshi is an upcoming tourist spot. The natives are neither aware of the rich biodiversity other than edible fish nor are they conscious about negative impact of excessive tourism. Present work focuses upon marine life and effect of tourism on the same.

Material and Methods

The paper focuses upon richness of Biodiversity around Alibaug and increasing trend of upcoming tourism there.

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The study period is from November 2008 till date. The data collected is based on the field visits made twice a month. Interviews of local people and picnickers were conducted to know the level of awareness and their idea of tourism.

The data related to biodiversity was collected mainly in form of photographs and video clips so as to avoid disturbing the flora and fauna. Few empty mollusk shells were collected as samples. The molluscans available in large numbers were also collected as samples and were preserved in formalin solution. Few samples of algae (available in ample) were collected and preserved in form of herbarium sheets.

Line-transect method and quadrant methods were applied for studying population density. Sediment and water samples were collected for analysis.

While working on a project sanctioned by University of Mumbai, conditions of different shores were observed and the adverse effect of tourism was realized.

Observation

The study location is mainly dominated by sandy beaches with intermittent rocky patches. These beaches are very safe and secure for visitors to enjoy. The fort built by King Shivaji and his warriors and Mughal emperors add to its historic value. Thus, it has become a perfect picnic spot.

Alibaug is a small town and has shed its age old appearance years back. It has emerged as the main place of tourism and many high end resorts and hotels have come up here. These are places of interest for those interested in modern amenities.

Kihim village has a sandy coastline extending to over three kilometers with a small rocky patch. This shore is preferred only for roaming around or for swimming. There are no recreational activities like water sports, paragliding. Though, this place is a tourist spot the molluscan diversity has still sustained itself (Kurve and Sinha, 2011). Over 73 different molluscan shells were observed on this coast.

The locals are also quite aware in Kihim. Some social groups have been formed here which undertake regular cleaning of beach and also propagating the movement. Though the houses have been converted into resorts, they have been taking due care of the nature. There are resorts in Kihim which are ideal eco-friendly resort. Separate dustbins are provided for segregation of dry and wet waste which is made into manure and used for growing plants. Waste water is used for watering plants. Hot water is provided by solar heater. Kitchens work on fuel from Biogas plant.

Kaashid located about 25 km from Alibaug is another place of attraction. The approach road also flaunts scenic beauty with open Arabian Sea on one side and hills on the other. A long coastline measuring about 3km has sandy shore and plantation along the shore. Shady shore and open sea are the plus points of this area. Ample parking space and many small food vending stalls add to the facilities. Local villagers have gone a step ahead and provided changing cabins for the tourists. Hammocks are tied to the trees and attract younger generation. Not only snacks but also lunch and dinner are served at cheaper costs by small hotels around this place. Though better resorts and hotels are available, visitors prefer these country side hotels which serve homely food of good quality and also cheap. Tourism has been a major factor in bringing economic progress and prosperity in these villages. The beach is not so badly polluted because local governments (Grampanchayats) have taken initiatives in cleaning it regularly. Pay and park facility is provided by grampanchayat and the amount collected as parking charges is used for this purpose.

Few other beaches which are coming up as recently developed beaches seem to be facing the problems of pollution. Leftover food, plastic carry bags and other factors are causing pollution on these beaches. Grampanchayat at Nagaon has appointed staff for collecting entry toll from car owners. Around 150 to 200 cars visit this beach every week. This money is utilized for cleaning beach at least once a week. This takes care of the problem of littering and pollution. The villagers have taken to selling of household products like Tamarind, Onions, and Rice flakes. Almost every house has got modified for greeting tourists. Swings and dining tables are set in the gardens next to houses. Parking facility is also available. This has become an attraction for visitors. Cheap yet tasty food is served almost everywhere. Thus, tourism has caused a transfer scene in Nagaon. The financial status of villagers has been elevated drastically. They are leading a better life.

Looking at this drastic change, nearby villages have started thinking about tourism as a lucrative source of income. As such, this beach is very rich in marine life. Exotic marine forms like colourful Sponges, corals (like Gorgonia), aplysia, Sabella, sea-anemones, brittle stars are sighted on this beach (Kurve and Kurve 2011). The villagers unfortunately, are not aware of this richness of marine fauna. They are trying to follow the footsteps of Nagaon natives. Gradually, they are also preparing to welcome visitors. The villagers and grampanchayat authorities have shown interest in developing Akshi beach also as a tourist spot. They are also about to invite water sports and various such activities to attract the tourists.

Discussion and conclusion

10-15 years back, coastal tourism in India was restricted to Goa, Kerala and Peninsular region for domestic and foreign tourists. Konkan coast as a potential tourist hub was considered thereafter. Yet, in this short span of about 10-15 years, it has been undergoing a fast development as a major tourist attraction in Maharashtra state. To bring the demands and suppliers together, private landlords have taken to developing infra-structure. There is a boon in construction business consequently, causing land exploitation, coastal encroachment leading to pollution and waste generation.

Indian beaches at Goa, Kerala, Tamilnadu have undergone revolutionary development as tourists attractions even for foreign tourists. These places have been commercialized to a notable extent and have established themselves as popular tourist beaches. In addition to having sun, sand and sea these places are approachable even for foreign nationals as the airports are comparatively closer from these cities. These places are totally developed for inviting tourists from India and abroad. Social and economic development of these is also influenced by tourism.

In Maharashtra, only Mumbai has the airport at a communicable distance from seashore. Yet, it is established as business hub. This has led to excessive strain on resources and infrastructure in Mumbai. There is crowding in Mumbai. Globalization movement and IT boon have elevated the financial status of middle class families. Other side of this picture is the rise in mental stress. To overcome this stress, they keep looking for some places of relief and respite. These people have started looking for places of serenity. Weekend picnics become the most suitable solution to this problem. Environment happens to be a good option as holiday destination. Alibaug shore being about 100km from Mumbai, it is the choice of people for spending weekends.

So, the workforce goes for weekend outings at nearby places like Alibaug which is also known as mini Goa. The clean and virgin beaches near Alibaug are the relieving spots during weekends. The beaches like Kihim, Kaashid, Murud are frequented by picnickers. These have been established as tourist spots.

Yet, there is not so much of commercialization as that in Goa or other coastal States of India. Affordable staying, food, easy commuting and scenic sea views are the main assets of these places. These cater to the taste of both middle class and higher class populations. Kihim, Kaashid and Murud have already established themselves as places of tourists' interest.

Other nearby shores are on similar lines preparing to invite visitors. Among these, Nagaon has taken a leap by creating various facilities to invite guests. Water sports, affordable lodging and boarding and ample parking place attract the tourists. Water sports operated in the intertidal zone disturb the shallow water and generate threat to marine flora and fauna. Because of their driving force and oil and grease degrade the water quality (Sawkar *et.al*.). Driving vehicles on exposed part of sandy beach during low tides crush molluscs and other sand dwelling animals. The sandy beach of Nagaon is a classic example of this phenomenon.

There are several places in Konkan region identified by Government of India as tourist area (Mangal Padhye 2011). In some places, ecotourism is also implemented for protection of marine environment. But there are many unprotected coasts like Alibaug, vulnerable to anthropogenic activities such as construction on beaches, water sports, driving vehicles, beach littering. Tremendous tourist response and eagerness of villagers to welcome them are the key factors in causing this change.

Further, there are no means by which these beaches can be conserved like sanctuaries. Nobody has a control over what an individual takes away from the seashore (shells or any other form of living being). This is likely to lead to habitat loss and challenge the survival of marine life.

There are many beaches that are not known to tourists. The local fishermen community has conserved their culture. But if the same rate of development continues in few years from now there is quite a possibility of these coasts losing their importance as spots of marine biodiversity.

A location becomes tourists' spot because of healthy environment. But if there is excessive tourism without awareness, the environment will deteriorate. This will spoil the environment. Consequently, the place will not only lose its value as a tourist place but also biodiversity. Considering the current state of Alibaug, it appears mandatory to make people aware of the environment and the need for its conservation.

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Coastal Environment Overview in Raigad District, Post Chitra Khalijia Collision

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India with the shoreline of over 7500 km. is rich in marine wealth in form of varied sea flora and fauna. The faunal diversity has been satisfying the requirement of human being about food (Protein rich diet), aesthetics (Shells and other sea forms), recreation (Coastal tourism) and many others. The main advantage of this coastline is international logistics. Freight worth lacs of tones is transported through sea from one country to another. Cruising of these huge ships is controlled by various cruise control agencies. A minor mistake or slightest negligence on part of these agencies can cause hefty losses to the shipping companies and also the countries involved.

One such incident that happened in Indian sea was the collision between Panamian cargo ship MSC Chitra and Gulf cargo ship MV Khalijia on 7th August 2010. It has been the most catastrophic happening near Mumbai. When Khalijia collided with Chitra, the latter one was carrying over 500 cargo containers with diesel, hazardous chemicals, lubricating oil and much more. After the collision, Chitra sank partially on one side and hence, it was decided to sink it completely with all its contents. With the help of people from a company specialized in this, the ship was sunk 350 nautical miles (around 680km) from Mumbai port.

On collision, a lot of oil (around 700 tonnes) spilled from the ships and polluted sea water seriously. Further, the containers (over 500) on MSC Chitra were also sunk with the ship and they carried deadly pollutants. All the contents of these containers got released into water causing serious damage to the water and marine life in Mumbai and nearby shores. Over 300 hectares of mangrove was destroyed by this oil spill (Deepak Apte 2010). It has a long lasting effect on marine flora and fauna as it prevents light penetration into water (Deepak Apte 2010). Oil spill and effects of sinking of ship worsened this problem. The crisis did not end there. Other containers sunk to the bottom which will corrode gradually and over a period of time, release chemicals and other material which are still more toxic. In future, after corrosion of the containers there is likely to be another shock for the marine life.

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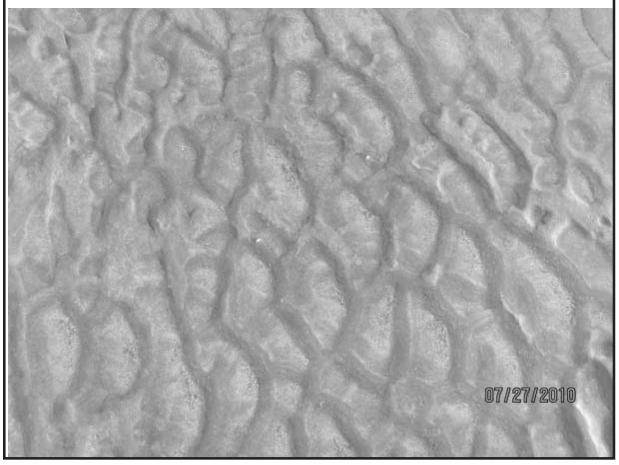
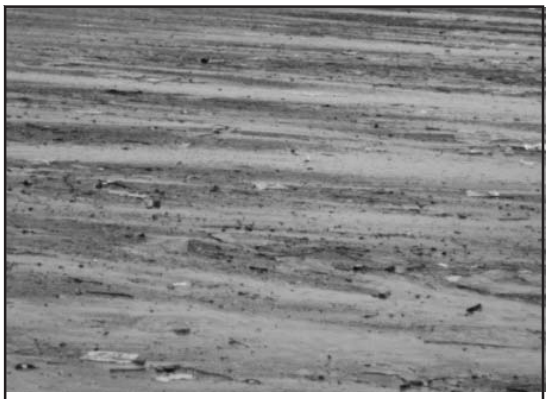
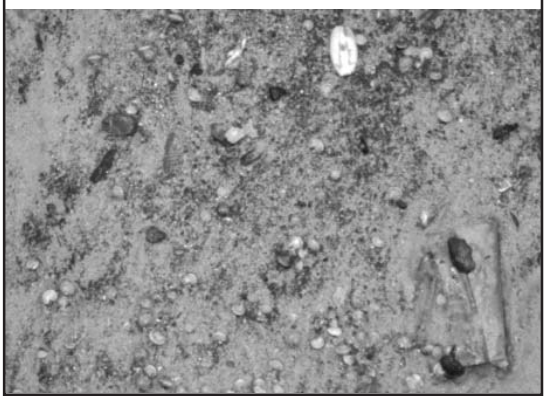
Clean shore before the effect of collision of ships

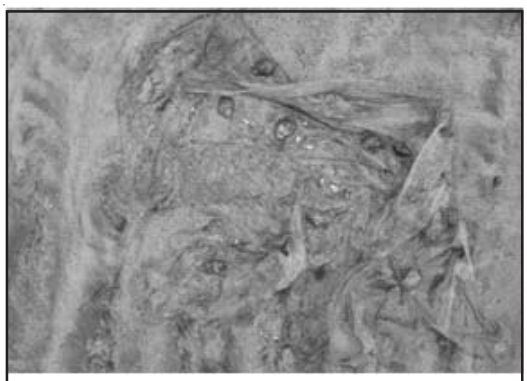


As such, main focus of the organized efforts to treat the hazards of this collision and its side effects was Mumbai and nearby coastline. But actually the scenario after this collision was quite alarming at coastline of Alibaug, and nearby villages in Dist. Raigad located about 100km from Mumbai. The oil and grease content of sand was found to be 234gm/kg. The detrimental effect was lot of oil deposits, thick tar-ball deposits, wrappers of hazardous chemicals scattered along the shores, long sheets of non-degradable plastic, empty syringes, needles and much more. Many molluscan shells were observed to be coated with thick layer of carbon or oil. Numerous molluscans were found dead along the mid and infra-littoral zones. Thick black oil deposits were observed in the supra-littoral region. Exotic marine fauna like sponges, gorgonia were found dead whereas, *Thias lacera* were abundant in comparison to records in earlier years.

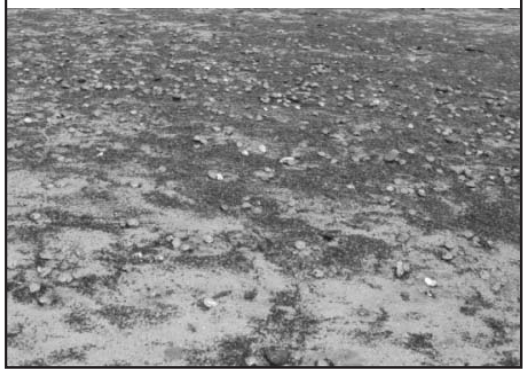


Carbon and tar deposits in mid-littoral zone

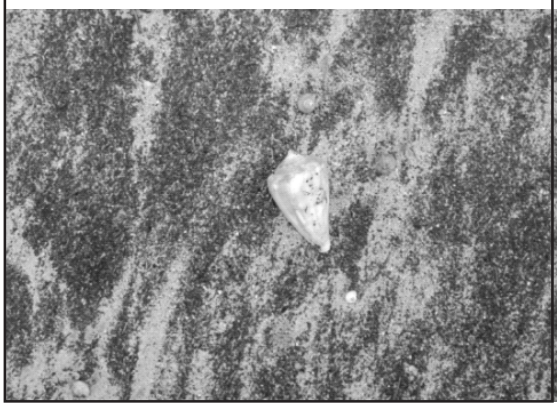




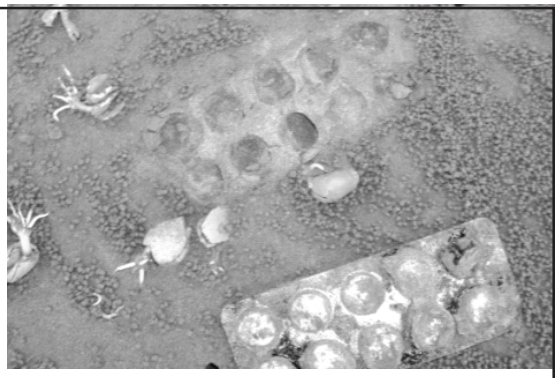
Molluscan shells trapped in plastic and tarballs



Dead molluscans in thick carbon deposits



Plastic sheets washed ashore



Hazardous material washed ashore

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Local people carrying these plastic sheets for their own utilization

Beach cleaning by students and, teachers of Bandodkar college, Thane & senior citizens

The entire coast was almost covered with tar deposits. sand was also found to be dark probably due to carbon pollutants. Plastic sheets found lying in the intertidal region got gradually covered by sand and the hazardous articles were washed ashore. The local villagers were found carrying plastic sheets for covering their houses without paying any attention to probable threat to their health.

The coastline was reported to have many molluscan, crustacean species in the intertidal region. After the pollution due to the said collision, this fauna is prone to depletion. In view of this, students and some faculty members of Bandodkar college of Science, Thane participated in the beach cleaning program alongwith the members of senior citizens club, Revdanda.

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