"RECONNAISSANCE OF PLANKTON, MACROINVERTEBRATES, AVIAN FAUNA AND EVALUATION OF EUTROPHICATION OF A CRATER LAKE AT LONAR, MAHARASHTRA: AN ATTEMPT TO CONVINCE RAMSAR TREATY FOR ITS CONSERVATION"

A Major Research Project

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To
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Principle Investigator
Dr. Dilip Shaligram Dabhade
Professor & Head
Post Graduate and Research Department of Zoology,
R.A.Arts, Shri M.K. Commerce and Shri S.R. Rathi Science Mahavidhyalaya, Washim. 444505

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Principle Investigator

Dr. Dilip Shaligram Dabhade

Professor & Head
Post Graduate and Research
Department of Zoology,
R.A. Arts, Shri M.K. Commerce and
Shri S.R. Rathi Science Mahavidhyalaya,
Washim. 444505

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PREFACE

Only one well Known meteorites impact Crater of the India is Lonar Crater Lake. Present study is due to the fact of Crater which was evolved from its unique way. It provided special habitat for the large number of flora and fauna. Lonar Crater is also important for their high alkalinity and salinity then also numbers of algal species, planktonic community are survival in to it. Lonar Lake has high biodiversity due to that it is recommended to Ramsar Convection to conserved such lake. Otherwise it may loss. Lonar crater should be given a special status in order to protect and conserved it as natural and cultural heritage of extraordinary significance. It is necessary to compile the available data together, so that the remedy for the conservation of the Crater will be possible only through comprehensive conservative measures which will be conceived during this research work and to summarise the available knowledge and own observation the characteristics of the lake and anthropogenic impact on the lake and its surrounding is assessed and implications of need of study for future investigations are discussed.

GENERAL INTRODUCTION

1.1 INTRODUCTION

Lakes are inland bodies of water that lack any direct exchange with an ocean. Lake ecosystems are made up of the physical, chemical and biological properties contained within these water bodies. They may be shallow or deep, permanent or temporary. Lakes of all types share many ecological and biogeochemical processes and their study falls within the discipline of 'limnology'. It means world limnology also refers the lakes. The Lakes occupy a relatively small portion of the earth surface and majority of them are situated in temperate and subarctic regions. There are different types of the lakes on the basis of their origin and may classify on the basis of nutrients content, hardness of water, salinity, geographical locations etc. The types of lakes on the basis of their origin are,

1) Tectonic lakes. These lakes are created as a result of some kind of deformation in the earth crust associated with earth movements during earthquakes and faults. Faulting is a major result of tectonic activity and is responsible for the origin of lake basins Submarine structural basins or depressions may become lakes when uplifted above sea level, or isolated from the sea. Initial productivity is low in these lakes because of great depth and lack of nutrients, but as they age they accumulate nutrients and have richer substrates. Most of the tropical lakes are tectonic lakes.

2) Volcanic Lakes. They are formed when mouth of old volcanos is filled with water. In many respects the condition for the life in these lakes are much like those in tectonic lakes. The substrates are hard, coarse and inhospitable to most rooted plants. The lakes are deep with sleep sloping sides and have restricted biota. With the time, finer sediments and plants nutrients accumulate and these lakes become more productive. The lakes formed in craters are small, because these depressions are changed by explosions, giving birth to calderas.

3) Glacial lakes: They can also form lakes and ponds. Glaciers gouge out a deep basin as they advances and then to leave a natural dam across the mouth of the basin when they retreats. Most of the temperate lakes are glacial lakes. They are the outcome of erosion and accumulation processes.

4) Solution basins: These occur mostly in limestone-based depressions, but also on salt deposits. A special case is chemical suffusion, a process developing in loess deposits and generating small, shallow depressions on the ground, in which water gathers. They are usually productive because plants are able to utilized dissolved source of limestone as a carbon dioxide for photosynthesis.

5) Basin formed by streams: These are found in the floodplains of large rivers, in meanders and abandoned channels, wherever small tributaries become obstructed by the mainstream. Such lakes frequently occur on the lower course of lowland streams.

6) Lake formed by the impact of meteorites. These are crater - shaped depressions of various sizes,Such Lonar Crater lake.

7) Manmade Lakes: A pond may occasionally be digging a basin that intercepts the water table.

Then lakes are also classify on the basis of their nutrients present in it, these are,

1) Oligotrophic lakes: These type of lakes are, Steep shoreline and bottom gradient, Low nutrient enrichment, Little planktonic growth, Few aquatic plants, Sand or rock along most of shoreline, Coldwater fishery, High dissolved oxygen content etc.

2) Mesotrophic lakes: In this type of lakes there is Moderate nutrient enrichment, Moderate planktonic growth, some sediment accumulation over, Most of Lake Bottom, Usually supports warm water fish species etc.

3) Eutrophic lakes: About these types of lakes High nutrient enrichment that may due to increasing the concentration of phosphates, nitrates etc., Much planktonic growth (high productivity) development of algal blooms due to which increasing the biological oxygen demand, Extensive aquatic plant beds, Much sediment accumulation on bottom, Low dissolved oxygen on bottom, supports only warm water fish species

In India different eutrophic lakes observed due to enrichment of nutrients one of them is Lonar crater, which was due to the increasing primary nutrients as phosphates and nitrates, now such Crater Lake has attracted the attention of world different scientists for the investigation of its origin and source of salinity, alkalinity of lake water. Such saline lake has marshy areas around it, freshwater streams, natural and manmade plantations, crop fields and the remnants of the original forest and scrub, all provide special niches for plants, animals and it brine, the microbial flora and fauna of the lake basin is still more important hence it has great important about biodiversity. The Lonar crater was formed by the impact of a meteorite which was complex process and depending on the material properties of the target and projectile, parameters of impact, atmospheric effects and on gravity. For the same energy of impact, the greater the height of the ejecta, smaller is the depth of the crater.

The Physics and chemistry of meteorites was studied by Ghosh (2009), according to him Meteorites are extra-terrestrial fragments that may arrive any time at the earth's surface from different parent bodies belonging to the Solar System. Barring these gifts as natural fall attempt has also been made to collect meteorite samples through the planetary missions spending millions of dollars. Research in Meteorite was started after the launching of a series of Apollo missions and first landing of Man on Moon. The meteoritic community is exploring the different subjects of meteorites from the available samples on the earth. In consequence the concepts on the origin of the Solar System and its members are continuously changing to a new dimension. The starting point of the meteorite origin may be considered from Laws of Planetary Motion and Laws of Planetary Distance. A continuous struggle between the Ejection Velocity related to impact mechanics caused by other extra-terrestrial bodies and the Escape Velocity related to gravitational force of the parent

body ultimately places the meteorite to its own elliptic orbit in the interplanetary space with an acquired speed. Meteorite during its residence in the parent body bears isotopic signatures of a set of complex physico-chemical processes that involve nucleo-synthesis, first isotopic equilibration, accretion, static meta-morphism, major break-up and associated shock-event and finally major mass isotope fractionation.

Thermal event related to cooling history gives rise to differentiated silicate-rich meteorites with primary melt-textures and differentiated metal- rich meteorites with subsolidus Widmansttaten pattern of growth in Fe-Ni system. Chondrites, the undifferentiated member of the meteorite, being the most largely documented population, provide a wide scope to the deeper probe of the Solar system and its precursors. In this context, first discovery of a refractory inclusion, called Calcium Aluminum Inclusions in Allende carbonaceous meteorite in 1973 is a milestone in the history of Space Science. Micron-sized Calcium Aluminum Inclusions within Allende carbonaceous chondrite indicated the presence of pre-solar grains. This discovery not only ruled out the existing concepts of a perfectly homogenized solar nebula with no isotopic difference between lunar, terrestrial and meteorite samples but also proved that the signature of pre-solar memory is not erased out but may survive the formation of the Sun and its planetary members.

The carbonaceous first group having quasi-solar nonvolatile composition represents the most primitive carbonaceous chondrite and is indicative of its alteration in an aqueous environment. Hydrous mineral assemblages like serpentine, amphibole, epsomite, gypsum, calcite and presence of carbon in the form of inorganic and complex organic compounds bear testimony to such aqueous alteration. In course of movement when meteorite appears at the intersection of meteorite- orbit and earth-orbit it is easily captured by the earth's gravitational field and starts its journey through the earth's atmosphere which is largely inhomogeneous with two major discontinuities - one in between troposphere and stratosphere and the other between stratosphere and mesosphere. Flight of meteorite through the atmospheric passage generates light, heat, sound and mechanical stress all of which are witnessed by the sky watchers. In the upper atmosphere friction with the air causes rise of surface temperature to several thousand degrees and a brilliant light effect. This light effect

may be either Shooting Star in case of a meteor or a Fireball in case of a large meteorite fragment. Due to rise of temperature surface material of meteorite melts, vaporizes and the meteorite mass continuously decreases due to atmospheric ablation. Quick chilling simultaneously with melting generates a thin solid fusion crust on different surfaces of the meteorite.

The falling meteorite with a cosmic speed comes across dust particles that impinge and produce fingerprint-like depressions or, Regmaglypts. Mechanical stress due to different pressure and density at the Stratopause and at Tropopause causes repeated fragmentations and formation of large number of faces covered with regmaglypts and fusion crusts of different generations. Whirling movement of the meteorite at this stage is generally indicated by a large variety of surface features viz., flow lines, radiating ribs, stagnation zone and different surface textures viz., smooth, close texture, scoriaceous and knobby. Simultaneously, various kinds of thundering, roaring and hissing sounds are produced due to the shock waves in front of the fireball and due to air turbulence caused due to subsequent fragmentation.

Morphological study of the meteoritic fragment helps to unravel its flight history if the morphological parameters like its size, completeness of the fragment in regard to face, fusion crust and textures are well preserved. Flight history interprets basically the last stage of its flight in terms of the number of repeated fragmentation, chronology of development of faces, constancy or change in orientation. It also ascertains the front, rear and lateral part of the fragment, degree of ablation and the pre- fall or, post fall fragmentation.

Our planet Earth is increasing its weight continuously due to influx of these extra-terrestrial bodies. It is also known as cosmic dust or Interplanetary Dust Particles that strip off from the surface of meteorites, survive the frictional heat due to large surface- mass ratio and reach to the earth's surface as unaltered cosmic dust. It has been estimated that our planet since its birth (that is, during last 4.6 b.y.) has accrued 5,00,000 billion tons of extra-terrestrial matter out of which a large proportion was accumulated in its first 0.5 billion years due to intense meteoritic bombardment on the planet. Recovery and estimate of these dust particles is

conducted through the Airborne sampling in the stratosphere using artificial satellites, U-2 spy aircraft and rockets, Surface sampling avoiding contami-nation by sedimentary, volcanic and industrial particles, Deep sea sediment sampling of cosmic spherules associated with deep-sea clay present in the deeper part of oceanic beds.

In recent years, more rapid technique for identification of cosmic dust is the analysis of Spherules of silicates or black magnetite, Ni- bearing magnetite, Iridium anomaly and Cosmic-ray produced 26Al influx. Radio technique is also used to estimate the flux of material entering the atmosphere from space. Journey of meteorite finally ends in a single fall or meteorite shower with or without formation of impact pit/impact crater and occasionally in explosion crater.

In India, more than 300 fragments have been recorded in Dhajala Shower of Gujarat and the 'Ellipse of scattering' so formed thus helped one to search and recover more fragments of that particular shower. Formation of impact crater entirely depends on the kinetic energy of the bolide and the nature of the surface impacted on. Bolide coming with hypervelocity may create explosion crater and in such crater the impacting mass may completely evaporate due to severe rise of temperature. Present study is on Lonar crater in Buldana District, Maharashtra, India which is one such example of explosion crater. It may so happen that the fall of meteorite goes unnoticed and may remain unidentified on the ground and subsequently it may be recognized by chance and recovered as 'Find'. Since meteorite requires good preservation immediately after its fall in a suitable inert, dry and humidity-free environment therefore natural terrestrial weathering may partially/ completely destroy it in no time. In order to know the antiquity of meteorite find, especially those of well-preserved Antarctica samples Thermoluminiscence or, TL dating is conducted to determine the terrestrial age (residence period on earth's surface since its fall) of meteoritic finds with a maximum limit of 100 years of residence period.

These studies led to very significant results that include discovery of ancient solar flare records in meteorites and constancy of solar and galactic cosmic ray fluxes over long (million year) time scales. Several research groups in India studied fossil records of nuclear track, noble gas, nitrogen, trace element and radioactivity in

returned Apollo and Luna samples to understand both the nature of long-term solar wind, solar energetic particle and galactic cosmic ray fluxes as well as chemistry of lunar rocks and soils and their evolution on the lunar surface.

The identification of meteorites of martian origin has also led to studies of such meteorites to understand the evolution of martian atmosphere over time. Analysis of diagnostic trace elements in samples of Cretaceous-Tertiary (K/T) boundary and chronology of Deccan volcanism supported asteroid impact as the cause of extinction of life ~65 million years ago. Studies of impact craters records in the Indian shield have also been pursued and led to the identification of new impact structures. The realization that some primitive meteorites host refractory oxides and silicates that are some of the first solids to form in the solar system has opened a new window to study the events and time scales leading to the origin and early evolution of the solar system. Meticulous studies of isotope records in early solar system solids using secondary ion and noble gas mass spectrometry techniques, primarily done at the Physical Research Laboratory, Ahmedabad led to the identification of fossil records of short-lived nuclides of stellar origin in early solar system solids. Studies of these records provided a chronological framework for the origin and early evolution of the solar system, led to the identification of the short-lived nuclide 26Al as the heat source for early melting of planetesimals and bolstered the proposal for a supernova triggered origin of our solar system.

Studies of planetary astronomy carried out in India have also led to significant results that include the discovery of the rings of Uranus and of new asteroids. Observations of cometary dust and emission of X-rays from planets as well as analytical modelling of martian ionosphere and aerosols and cometary atmosphere have also yielded important results. A new chapter in planetary science research in India was scripted with the successful launch of Chandrayaan-1 on 22 October, 2008. The data obtained by instruments onboard Chandrayaan-1 has already yielded significant new results and the Chandrayaan-2 mission is being planned with a targeted launch in 2012. Future planetary exploration plans are being formulated with Mars and comets/asteroids as plausible targets. This review provides a brief outline of planetary research activities in India from the very beginning, a broad outline of

important contributions made during the last two decades and a future perspective, including those for planetary exploration.

Hagerty and Newsom (2011) they suggest that alteration could have only taken place after the impact event had occurred. Electron microprobe and X-ray diffraction results suggest that the majority of the clays in the Lonar samples are saponite with minor occurrences of celadonite. Geochemical modeling and data from terrestrial geothermal systems indicate that saponite and minor celadonite are produced during the hydrothermal alteration of basalt, typically at temperatures of 130–200°C, while a different assemblage will form under ambient conditions. The presence of hydrothermal alteration clays at the Lonar crater compared with data for other small terrestrial impact craters shows that the lower size limit for impact craters that can produce and sustain a significant hydrothermal system resulting in the formation of alteration clays is probably somewhat less than 1.8 km in diameter. A similar limit should apply to Mars, although similar impacts on Mars produce slightly larger craters due to the reduced gravity. The comparable compositions of Lonar basalts and martian basalts suggest that similar alteration products should have been produced on Mars due to impact-induced hydrothermal activity. Because impact craters, especially small ones similar to Lonar, are largely surficial in nature, they have the potential to contribute to the physical and chemical evolution of the near surface environment on Mars, including the uppermost crust and the martian soil.

These processes include the possibility of transporting mobile elements to the surface and trapping water in hydrated minerals. Over the course of martian history, hydrothermal alteration in small craters in the 2–11 km diameter range on Mars could conservatively trap as much as 0.7 m of water in alteration minerals near the surface. Some of these alteration phases could also contribute material to the martian soil. In fact, preferential erosion of the Fe-rich martian alteration products observed in this study could provide a component of the martian soil that would help explain the Fe-enrichments, in martian soils compared to basaltic martian meteorites. Their results suggest that the Lonar crater has great potential as a laboratory to further study geochemical and hydrothermal processes that may be important on the surface of Mars.

Geologically, the area of Lonar Crater belongs to Deccan Basalts of late Cretaceous to early Eocene period the rocks observed in the lake are compact, vesicular and amygdaloidal basalt. At places the red bole beds separated the two lava flows. The basalt flows dip away from the depression. No appreciable fracturing or shattering is noticeable in the rocks. Compact basalt rocks are highly jointed and weathered around the joints. The Lonar Lake water has its unique properties that are their salinity and observing the pH was much alkaline. The fascinating physical setup of Lonar crater, its relative isolation and the, morphometry, hydrography, Limnological, Ecological status evolve in a unique way due to the unusual geographical and hydrological and climatic isolation. Unfortunately, deteriorating changes in hydrology of the lake due to input of sewage of Lonar town and agriculture inside the crater on alluvium it is leading towards Eutrophication consequently, reduction of macrophytes and phytoplankton diversity and increase in pathogenic organisms. If appropriate steps are not followed in near future for the conservation and protection of this unique ecosystem, it will be lost forever Dabhade (2006).

India's freshwater resources comprise the single most important class of natural endowments enabling its economy and its human settlement patterns. The fresh water resources comprise the river systems, groundwater and wetlands. Each of these has a unique role, and characteristic linkages to other environmental entities, Wetlands, natural and manmade, freshwater or brackish, provide numerous ecological services. They provide habitat to aquatic flora and fauna, as well as numerous species of birds, including migratory species', a holistic view of Wetlands is necessary which looks at each identified Wetlands in terms of its causal linkages with other natural entities, human needs, and its own attributes. National Environment Policy (2006).

The Lakes, Reservoirs and Rivers are the rich source of inland water in India. In which reservoirs are constructed for the effective utilization of water as irrigation, power generation and flood control. Reservoirs constitute the prime fishery resources of our country in terms of their vast area and enormous production propensity. These open water system not only allow quick , yield enhancement at low capital environment cost, but also fisheries development of these big water

bodies directly benefits some of the weakest sections of our society. These benefits are accrued through increase in and there by improve the quality and living standards of poor fishermen/women. Unlike culture fishery, where income is shared between limited investors, in reservoir fishery.

Fresh water habitats are located in different parts of the country especially in rural areas, and are mainly used as a source of drinking water, irrigation and for fish production by the local fisherman communities. However, tropical climate of the region create an environment conducive for fast growth of fish. Fish is most important bio-product of fresh, marine and brackish water ecosystem contributing as an essential and beneficial food item to mankind since ancient time. India's total potential for fish culture is about 3.5 million hectares of which fresh water ponds cover 1 million hectares Shrivastava (1999). Maharashtra is endowed with an area of about 1,79,930 ha under reservoir. The total area under ponds and tanks are estimated to be about 2.2 million hectares and the resources are widely spreading through the length and breadth of the country. The area under ponds and tanks are holding potential of fish production would provide employment opportunities to about two million people Dwivedi (2000).

The interrelationship between the physicochemical parameters and plankton production of tank water and its relation with fluctuation of zooplankton are of great importance and basically essential in fish culture. Zooplankton constitutes are important food item of many fishes. The larvae of carps feed mostly on zooplankton. Zooplankton also plays an important role in the food chain as they are second in tropic level as primary consumers and also as contributes to next tropic level Sunkad and Patil (2004).

In aquatic habitats, environmental factors include various physical properties of water such as the solubility of gases and solids, light penetration, temperature and density. Chemical factors such as hardness, phosphate and nitrates are very important for growth of primary productivity. Tropical and sub-tropical reservoirs are known to be more productive than temperate reservoirs and shallow smaller reservoirs are generally more productive than large reservoirs due to their high primary production.

The relationship between the physicochemical parameters and plankton production of pond water and their relation with monthly fluctuation of zooplankton are of great importance and basically very much essential in care of fish culture. Fishes are more dependent on water temperature, pH, dissolved oxygen, free CO2, alkalinity and some other salts for growth and development Nikolosky (1963). Any change of these parameters may affect the growth, development and maturity of fish Jhingran (1985). Different causal influences, which determine the quality of water, show a characteristic change from season to season Munwar (1970); Islam et al., (1974); Chowdhury and Mazumder (1981); Nasar et al., (1991).

Often times, limnological studies involve different approaches and objectives. Studies have shown that there is a close link between the quality of water and the composition and abundance of plankton in any aquatic system. Knowledge of the fish population dynamics of both commercially exploited as well as currently unexploited species is essential. This has three applications: to assess the levels of current exploitation relative to maximum sustainable yield, to assess the potential of harvesting additional species (subject to practicability and socio-cultural acceptability), and to assure biodiversity conservation.

Submerged and floating water plants serve a number of important functions. In wetlands, a well-developed macrophyte community provides shelter against predation for vulnerable prey species like small zooplankton and fishes Crowder and Cooper (1982) and Batzer (1998). In addition, macrophytes are usually covered with epiphytes that are grazed upon by several invertebrates that are themselves an important fraction of the diet of many fishes and birds Batzer and Wissinger (1996).

Physical and chemical characteristics of water bodies affect the abundance, species composition, stability, productivity, and physiological condition of aquatic organism populations. Biological methods used for assessing water quality include the collection, counting, and identification of aquatic organisms; biomass measurements; measurements of metabolic activity rates; measurements of the toxicity, bioconcentration,and bioaccumulation of pollutants; and processing and interpretation of biological data.

Limnology deals with the biological productivity of inland water and with all its causal influences which determines its causal influences involve meterological, physical, chemical and biological factors, "which determine the quality and quantity of biological production. Physico–chemical analysis indicates the changes in different factors and their influence on biological status of the system. Limnological study will define the biological, chemical and physical nature of each reservoir, as well as its hydrological regime including those elements imposed by humans. India is having very rich sources of inland waters in the form of lake, reservoirs and rivers.

Submerged and floating water plants serve a number of important functions. In wetlands, a well-developed macrophyte community provides shelter against predation for vulnerable prey species like small zooplankton and fishes Crowder and Cooper (1982) and Batzer (1998). In addition, macrophytes are usually covered with epiphytes that are grazed upon by several invertebrates that are themselves an important fraction of the diet of many fishes and birds Batzer and Wissinger (1996).

Limnology is the study of fresh or saline waters contained within continental boundaries. Limnology and oceanography together cover all aquatic ecosystems. Although many limnologists are freshwater ecologists, physical, chemical, and engineering limnologists all participate in this branch of science. Limnology covers lakes, ponds, reservoirs, streams, rivers, wetlands, and estuaries, while oceanography covers the open sea. Limnology evolved into a distinct science only in the past two centuries, when improvements in microscopes, the invention of the silk plankton net, and improvements in the thermometer combined to show that lakes are complex ecological systems with distinct structures.

Today, limnology plays a major role in water use and distribution as well as in wildlife habitat protection. Limnologists work on lake and reservoir management, water pollution control, and stream and river protection, artificial wetland construction, and fish and wildlife enhancement. An important goal of education in limnology is to increase the number of people who, although not full-time limnologists, can understand and apply its general concepts to a broad range of related disciplines. A primary goal of Water on the Web is to use these beautiful aquatic

ecosystems to assist in the teaching of core physical, chemical, biological, and mathematical principles, as well as modern computer technology, while also improving our students' general understanding of water - the most fundamental substance necessary for sustaining life on our planet.

Horne and Goldman (1994) also studied the Populations of algae and the animals that feed on them are lower in oligotrophic lakes because of low nutrient concentrations. Thus the water remains clear. Decay of the relatively small amount of organic matter in oligotrophic lakes does not completely deplete the hypolimnetic supply of dissolved oxygen. Therefore, lack of oxygen does not restrict animals from living in the hypolimnion of oligotrophic lakes. Lake trout, for example, require cold, well-oxygenated water and primarily live in the hypolimnion of oligotrophic lakes. Minnesota's oligotrophic lakes are found in the northeast region of the state, where infertile soils are covered with mixed conifer forests. Extremely deep oligotrophic lakes such as Lake Superior and Lake Tahoe have hypolimnia that remain completely saturated with oxygen the entire year. However, many moderately deep lakes (with maximum depths greater than about 30 meters) may develop anoxia in the lower hypolimnion during late summer but may still be classified as oligotrophic because of their very low nutrient concentrations, low algal abundance, and relatively high transparency (high secchi depth). These lakes may have a two-story fishery, with warm and cool water fish in the epilimnion and metalimnion and cold water fish (such as trout) in the cold, oxygen rich portion of the hypolimnion. The cold-water fishery is therefore very sensitive to increased inputs of organic matter from sewage or erosion (external inputs), and to increased algal and macrophyte production (internal inputs) due to eutrophication since these factors will accelerate the rate and extent of hypolimnetic oxygen depletion in the summer. Algae or macrophytes grow so thickly in some eutrophic lakes that light penetrates only a short distance and nutrients below that depth are not assimilated. As discussed earlier, phosphorus is typically the limiting nutrient in freshwater lakes, meaning that the plants deplete all available phosphorus before depleting other nutrients. In a hypereutrophic lake, algae may become so abundant that they suffer from self-shading. In those cases, photosynthesis is limited by light rather than by nutrients. When a great abundance of phosphorus is

available in a lake, nitrogen may become limiting. In such lakes, certain species of blue-green algae that can fix atmospheric nitrogen have a clear competitive advantage and frequently become dominant. They dominate the algal community until another nutrient, or usually light, becomes limiting. In many infertile lakes in northeastern Minnesota, both phosphorus and nitrogen may be extremely low during midsummer. Since most sources of either point source or nonpoint-source pollution involve increased inputs of both N and P, these lakes are extremely sensitive to such pollution, irrespective of which is technically "most" deficient.

Eutrophic lakes show wide seasonal changes in their biological and chemical conditions. Because of the great amount of organic matter produced in these lakes, the decay rate is high in the hypolimnion, causing oxygen to be depleted. Therefore, eutrophic lakes frequently show a complete loss of dissolved oxygen below the thermocline during summers. Clearly, fish and most other animals cannot live in the hypolimnion of such lakes. Warm-water fish that can live in the epilimnion, however, can be quite productive. Bass, panfish, northern pike, walleye, carp, and bullheads thrive in many of Minnesota's eutrophic lakes. Complete or nearly complete oxygen depletion below the thermocline may also be a common feature of many moderately deep (10 to 30 m) mesotrophic lakes, if deep enough to stratify throughout the summer. Therefore, virtually complete anoxia below the thermocline does not necessarily mean that the lake is eutrophic.

Another oxygen-related problem in eutrophic lakes is winterkill. A dense snow cover over the ice reduces light penetration and keeps oxygen-producing photosynthesis from occurring. The high organic content of the water, however, provides considerable food for the decomposers. If the decomposers succeed in using all the available dissolved oxygen, a fish kill can occur.

In certain cases, a winterkill may lead to a more balanced fishery and possibly even improved water quality. Fish that survive a winterkill will have reduced competition for food for a period of time and so may grow faster and to a larger size. Fewer small fish reduces predation on the larger zooplankton, such as the water flea, Daphnia sp., leading to increased zooplankton grazing on algae and a resultant

increase in water clarity. This general scheme, involving fishery manipulations to reduce the abundance of zooplanktivorous fish, has been termed biomanipulation, and is being tried in many urban lakes where it is economically impractical to reduce nutrient inputs enough to significantly reduce algae. In these situations the offending fish may be removed by intense stocking of gamefish, by intensive netting and trapping, or even by poisoning the entire fishery and starting over with greatly reduced planktivores.

The specific nature of a problem and the reasons for collecting samples will dictate which communities of aquatic organisms will be examined and which sampling and analytical techniques will be used.

The following communities of aquatic organisms are considered in specific sections that follow:

PLANKTON: A community of plants (phytoplankton) and animals (zooplankton), usually drifting or suspended in water, non-motile or insufficiently motile to overcome transport by currents. In fresh water they generally are small or microscopic in size; in the marine or estuarine environment, larger forms are observed more frequently.

PERIPHYTON: A community of microscopic plants and animals associated with the surfaces of submersed objects. Some are attached, some move about. Many of the protozoa and other minute invertebrates and algae found in the plankton also occur in the periphyton.

MACROPHYTON: The larger plants of all types. They are sometimes attached to the bottom (benthic), sometimes free-floating, sometimes totally submersed, and sometimes partly emergent. Complex types usually have true roots, stems, and leaves, the macro algae are simpler but may have stem and leaf like structures.

MACROINVERTEBRATES: The invertebrates defined here are those retained by the US Standard No. 30 sieve. They are generally bottom-dwelling organisms (benthos).

AMPHIBIANS, AQUATIC REPTILES, BIRDS and MAMMALS: These vertebrates also may be affected directly or indirectly by spills or other discharges of pollutants and may be useful in monitoring the presenmce of toxic substances or long-term changes in water quality. Discussion of these organisms is not included.

Large numbers of bacteria and fungi are present in the plankton and periphyton and constitute an essential element of the total aquatic ecosystem. Although their interactions with living and dead organic matter profoundly affect the larger aquatic organisms, techniques for their investigation are not included herein. Field observations are indispensable for meaningful biological interpretations, but many biological factors cannot be evaluated directly in the field. These must be analyzed as field data or field samples within the laboratory. Because the significance of the analytical result depends upon the representativeness of the sample, attention is given to field methods as well as to associated laboratory procedures. Before sampling begins, clearly define study objectives. For example, the frequency of a repetitive sampling program may vary from hourly, for a detailed study of diel variability, to every third month (quarterly) for a general assessment of seasonal conditions, depending on objectives. The scope of the study must be adjusted to limitations in personnel, time, and budget. Before the development of a study plan, examine historic data for the study area and conduct a literature search of work by previous investigators.

Whenever practicable, biologists should collect their own samples. Much of the value of an experienced biologist lie in personal observations of conditions in the field and in the ability to recognize signs of environmental changes as reflected in the various aquatic communities. The primary orientation is toward field collection and associated laboratory analyses to aid in determining the status of aquatic communities under field conditions and to aid in interpreting the influence of past and present environmental conditions. The methods selected are necessary for the appraisal of water quality. Principal emphasis is on methods and equipment, rather than on interpretation or application of results. The complex interrelationships existing in an

aquatic environment often require mint different field and laboratory procedures; consequently, frequent cross-references between sections have been made

Many other types of studies may be, and are being, conducted that are oriented more toward laboratory research. Such laboratory studies will develop further basic knowledge of community and/or organism responses under controlled conditions and will aid in predicting effects of future changes in environmental conditions on the aquatic communities. However, such studies are not within the scope of this book.

PLANKTON

The term "plankton" refers to those microscopic aquatic forms having little or no resistance to currents and living free-floating and suspended in natural waters Planktonic plants, "phytoplankton," and planktonic animals, "zooplankton," are covered during this study. The phytoplankton (microscopec algae) occurs as unicellular, colonial, or filamentous forms. Many are photosynthetic and are grazed upon by zooplankton and other aquatic organisms. Other organisms occurring in the same environment are dealt with elsewhere. The zooplankton in fresh water comprises principally protozoans, rotifers, cladocerans, and copepods; a greater variety of organisms occurs in marine waters.

BENTHIC MACROINVERTEBRATES

Benthic macro-invertebrates are animals inhabiting the sediment, or living on or in other available bottom substrates of fresh-water, estuarine, and marine ecosystems. During all or part of tubes, or nets that they live on or in; roam freely over rocks, organic debris, and other substrates; or burrow freely in substrates. Although they vary in size from small forms, difficult to see without magnification, to other individuals large enough to see without difficulty, macro-invertebrates are considered historically by definition to be visible to the unaided eye and retained on a U.S. Standard No. 30 sieve (0.595-mm or 0.600-mm openings.) The standard sieve for collecting freshwater, estuarine and marine benthic macro-invertebrates is the U.S. Standard No.30 sieve; however, some estuarine and marine programs use the U. S. Standard No. 50 sieve (0.300-mm openings). For all aquatic assessment programs, use of the No. 30 sieve to collect benthic fauna of freshwater, estuarine, and marine

habitats or from any transport system is recommended. To accommodate some old historical data bases and if the data-quantify objectives of the study permit, a U.S. Standard No.28 sieve (1.0-mm openings) might be utilized. To obtain a more representative sample of the benthos that would include smaller forms or early life-stages, and other taxa of macro-invertebrates, a U.S. Standard No. 60 sieve (0.250-mm openings) may be used. The standardization of bioassessment for species composition, taxa richness, diversity, evenness, trophic levels, and major taxonomic spatial and temporal patterns may be enhanced significantly by the conventional use of a U.S. Standard No.30 sieve.

The major macro-invertebrates found in freshwater are flatworms, annelids, mollusks, crustaceans and insects. The major macro-invertebrate groups included in estuarine and marine waters are bryozoans, sponges, annelids, mollusks, roundworms, cnidarians (coelenterates), crustaceans, insects, and echinoderms.

RESPONSE TO ENVIRONMENT

The species composition and population or species density (numbers of individuals per unit area) of macro-invertebrate communities in streams, lakes, estuaries, and marine waters can be uniform from year to year in unperturbed environments. Typically, however, life-cycle dynamics produce variations in species composition and abundance either temporally or spatially. Most aquatic habitats, particularly free-flowing streams and waters with acceptable water quality and substrate conditions, support diverse macro-invertebrate communities in which there is a reasonably balanced distribution of species among the total number of individuals present. Such communities respond to changing habitats and water quality by alterations in community structure (invertebrate abundance and composition). However, many habitats, especially disturbed ones, are dominated by a few species. Macro-invertebrate community responses to environmental changes are useful in assessing the impact of municipal, industrial, oil, and agricultural wastes, and impacts from other land uses on surfaced waters. Four types of environmental changes for which patterns of macro-invertebrate community structure change have been documented are increased inorganic micronutrients, increased organic loading, substrate alteration, and toxic chemical pollution.

Inorganic micronutrients and severe organic pollution usually result in a restriction in the variety of macro-invertebrates to only the most tolerant ones and a corresponding increase in density of those tolerating the polluted conditions, usually associated with low dissolved oxygen concentration. In some cases severe organic pollution, siltation, or toxic chemical pollution may reduced or even eliminate the entire macro-invertebrate community reduce or even eliminate the entire macro-invertebrate community from an affected area. Not all cases conform to those described because conditions may be mediated by other environmental (biological, chemical, and physical) conditions.

Humanity has always had a complex and symbiotic relationship with nature. However, as the impact of human activity on nature has become more intense in recent decades, this relationship has come under close scrutiny. The way we govern biodiversity has a direct bearing on sustaining life on Earth. Protected areas and community based conservation are the two major streams of governance models attempted globally for biodiversity conservation. Both these models have had their share of successes and failures. What is clear now, is the need to move away from the often polarized 'for or against' debates that have characterized the discourse on biodiversity governance, towards a repertoire of models that can be adapted and applied to different situations. The Indian experience with multiple, often integrated, approaches to conserving biodiversity that balance conservation and development is immensely relevant to these global debates by Krishnan et a1., (2012).

Assessing the impact of a pollution sourced generally involves comparing macro-invertebrate communities and their physical habitats at sites influenced by pollution with those collected from adjacent unaffected sites. This can include a gradient away from point sources of contaminations the procedure includes sampling and analyzing types of communities from different sites and subsequently determining whether the presumed pollution-affected community differs from non-affected ones. The basic information required for most community structure analysis a count of individuals per species. From the count data, communities can be characterized and compared according to community structure density, diversity, community metrics, pollution indicators, or other analyses, including various statistical methods. Biomass

and productivity estimates also can be determined with the organisms collected 1-4 equally desirable is a characterization of the dissolved oxygen concentration, substrate, water depth, type of sediment, grain size of the sediment, total organic carbon (TOC), and other site and situation specific characteristics.

While the following macro-invertebrate methods traditionally are used for sampling and quantifying benthic invertebrate communities, other methods also are being evaluated in an effort to develop and implement narrative biological criteria for surface water.

Concept of eutrophication was first introduced by Weber (1907). Eutrophic lakes are exactly opposite to that of Oligotrophic lakes in all respect. Generally these lakes are shallow with usually less than 18 m depth with gentle sloping sides and possess an extensive littoral zone with more marsh vegetation. The water is turbid due to dense growth of phytoplankton and presence of more suspended particles, which significantly reduces the light penetration. Thus high rate of photosynthesis production is restricted only to upper waters. The colour of lake water may be green, yellow or brownish green. The lake water is rich in nutrients because of the continuous land drainage, input of sewage and phosphates containing fertilizers and may due to over enrichment of nutrients, primarily phosphorus and nitrogen and can occur under natural or man-made conditions. In natural course it is slow process of lake ageing which ultimately leads to succession.

Eutrophication level of water body may be judged by several factors that include both physico-chemical and biological parameter. Manmade Eutrophication is due to the absence of control measures, proceeds at an accelerated rate compared to the natural phenomenon and is one of the main forms of water pollution. Eutrophication is the naturally occurring process, but it has been accelerated in recent times due to excessive man induced activities around the aquatic system. The resultant increase in fertility in affected lakes, reservoirs causes symptoms such as algal blooms, heavy growth of rooted aquatic plants, algal mats, de-oxygenation and in some cases, unpleasant odor, which often affects most of the vital uses of the water such as water supply, recreation, fisheries (both commercial and recreational) or aesthetics. However, man is responsible for accelerating the process many folds

endangering the very survival of water bodies all over the world.The physicochemical properties of water, occurrence new plankton types other than those who were previously dominant, increasing scum due to algal bloom increases load of nutrients leads the lake to Eutrophication.

Babar (2010) also studied the geology area belongs to Deccan Basalt formations of late Cretaceous to early Eocene period. The occurrence of impact of meteorite yielded the rare mineral called the muskelynite (impactite mineral) indicating that the lake is of meteorite impact origin. All the physicochemical parameters of water including pH, Chlorides (Cl), total hardness, total dissolved Solids, Ca, Mg, Na, K, CO_3, HCO_3 and SO_4 are higher and very greater than the

BIS (1991) and WHO (1992) maximum permissible limits for drinking and other domestic use of water. The presence of species of bacteria related to water borne diseases were also found higher indicating the non-potable nature of the lake water but the spring (Dhara) water is normal and potable. Occurrence of few species of algae and fungi indicate the characteristic nature of bio flora. The saline crater-lake is a great storehouse of unique floral and faunal assemblages with its unique ecosystem having evolved due to its unusual hydrogeological and climatic conditions. Unplanned expansion of Lonar town characterized by unrestricted construction activities, overcrowding of slums and inadequate civic amenities and faulty infrastructure projects have endangered the crater system and hence should be avoided. The crater slopes have succumbed to soil erosion and denudation from uncontrolled grazing and overgrowth of Prosopis Juliflora Dabhade (2013) Agricultural activities have altered the texture of the crater floor and soil character. Water pollution from release of toxic substances has changed the chemical composition of the lake, lead to the extinction of flora and affected the already dilapidated temples and archaeological monuments in the lake precincts. The lake urgently needs to be accorded immediate protection and special legal status and saved and preserved for future generations to come.

Dhote and Dixit (2011) studied the eutrophication cause due to the cultural heritage and festivals. Peoples here religiously follow the rituals and enjoy festivity. In Indian mythology, water is one out of the five elements, which form the universe. Water bodies play the significant vital role in performing rituals. These rituals

including taking holy dip in scared rivers idol immersion and tazia immersion. Thousands of these idols, tazias are immersed in different water bodies such as lakes, reservoirs, ponds, rivers and canals in and around different parts of India. Similarly during the mohhrum festival, Muslim community immerses tazias every year, these idols are made up of plaster of paris, clay and cloth supported by small iron rods, and is painted with different metal-based paints. On immersion of these idols in the water bodies, the water is contaminated with these metal paints and a change in chemical load in the water body is expected. When idols immersed, these colored chemicals dissolve slowly leading to significant alteration in the water quality. Thousands of Ganesh and Durga idols of various sizes reaching heights up to 45 to 50 feet are immersed in different parts of the country.

India is facing a crisis due to loss of wetlands and water bodies and deterioration in the water quality of these life sustaining systems. Apart from depletion of biodiversity and silent assault on human health due to non-point source (agro-chemical) pollution other resultant environmental risk factors include the reduction in rainwater retention capacity and the loss of livelihood support for the wetland dependent communities who are among the poorest. Welfare of the people of the State of West Bengal depends largely upon the proper functioning of the natural resource systems wherein wetlands are among the foremost which draw attention. The challenge here is to overcome the lack of understanding among the implementers of different development sectors and service providers about the significance of wetland ecosystems in maintaining and supporting human health and welfare. The challenge becomes daunting as the section of the community suffering most from the loss of wetland resources are occasionally the poorest and their demands are not easily visible or audible. The proposed policy direction therefore will be to adopt a participatory and community-based approach to ensure conservation and wise use of wetlands and water bodies. A participatory approach looks into the interconnectedness and interrelations between society and nature contextually. Differences in local conditions which can be occasionally striking (both social and ecological) should be carefully factored in. It also attempts to remain focused on defined landscapes or geographic units, so that it becomes easy for everyone to recognize the conservation activities. Particular care is taken to avoid exclusion of the

poorer communities who tend to avoid or sometimes are purposively left out of the conservation exercises.

The crucial message that any policy document on the conservation of wetlands and water bodies must primarily carry is that no wetlands and water bodies can be filled up, degraded, drained, converted or subjected to any kind of activity which is incompatible with ecological integrity of the wetlands. In addition to compulsory prohibition of further filling up of any wetland or water body irrespective of its size, the present wetland conservation policy has come up with two new directions. This essentially is in the context of the conditions and constraints specific to the State as well as the country. Firstly, as wetlands are the primary receptacles for agricultural discharge containing agro-chemicals, it has brought the crisis of non-point source pollution into the forefront. Unregulated use of fertilizers and pesticides is already having telling effects on human health (especially the children and the farmers), food security and biodiversity stock. Secondly, for the purpose of conserving larger wetlands and water bodies, the concept of catchment area is considered, specifically to delineate the primary boundary for conservation activities specific to the wetlands. This is necessary because most of the larger wetlands in this sub-continent lie outside any protected area under the Forest Act. For the development of country's Conservation of natural resources is one of the most significant indicators. There is not any compulsion of equity, poverty alleviation programmers', education for the child or health care for the poor that thwarts conservation of natural resources. Just as one or two rich countries are not signing the Kyoto Protocol so also some of the members of our society are not recognizing their obligations towards natural resource conservation. And wetlands everywhere, everyday, are being silently filled up.

In India, the government initiatives and scholarship on two major conservation issues one of them is forest and water resources are fairly well known all over the world. Yet there is no immediate sign of decrease in conflicts related to forest and water and of rise in good practices of conservation of water. Matters related to wetlands are somewhat different. Wetlands unlike forest and water have hardly any constituency. Even good research in the field of wetlands is scarce. Between 1994 and 2001, not a single question on the disappearance of urban and periurban wetlands and

water bodies has been tabled in the Lok Sabha. During that time only 4 starred and 16 un-starred questions were asked on wetland conservation. The disappearance of large areas of wetlands in general was accepted by the Environment and Forest Ministry and the absence of corroborative data on the loss was conceded. With this understanding of the context, the wetland conservation activities to be initiated by the State of West Bengal should include. Department of environment Government of west Bengal (2012)

- Prohibition of further filling up of any wetland, water body or paddy field irrespective of its size, on any grounds including so called public interest projects. This will have to be made mandatory by the government throughout the State.

- Disapproval of all construction plans proposed by any authority on a land that is described in the State Land Records as wetlands or water bodies (or any such description like jala, khal, bil, doba etc.) or are paddy fields (where at least one crop of paddy grows in one calendar year) on the basis of the last Cadastral Survey.

- Restoration of all degraded and filled up wetlands and water bodies (including paddy fields and borrow pits) within the fold of third plan of District Development.

- Undertaking extensive awareness programmers' among the people as well as the development functionaries for a sustained period (minimum 10 years). This can be compared with the kind of effort made for population control or polio eradication at the national level.

Unless the above tasks are undertaken without any further delay, there will be little chance of any success in the Governments' effort for conservation of wetlands and water bodies in West Bengal. Finally, conservation of natural resources in general and wetlands in particular, will require an unfaltering political support and spontaneous participation of the citizenry. Without these the implementation of this policy will be largely ineffective.

Now understanding about the wetlands which is defined by the Ramsar Convention article that was "areas of marsh, fen, peatland or water whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt including areas of marine water the depth of which at low tides does not exceed six metres" Conservation Division I Ministry of Environment and Forests Government of India New Delhi (2007).

In our planet wetlands is one of the life support systems where the agricultural lands and forests are there, in different habitat number of endangered plant and animal species are lived. They are a vital element of national and global ecosystems and economies. Wetlands are highly productive ecosystems being only second to the tropical rainforests. They perform many functions that maintain the ecological integrity and also provide many goods and services. The functions and benefits provided by wetlands are especially important for the general public as they support agriculture, tourism, industry, biodiversity conservation, social, economic and cultural activities etc. In West Bengal has different variety of wetlands ranging from coastal and marine wetlands to inland freshwater lakes, rivers, dams and swamps as well as the constructed wetlands in irrigation schemes and sewerage treatment systems and also the mountain wetlands. Some of these wetlands are recognized as important conservation areas like national parks, national reserves, Ramsar sites, important bird sanctuaries and World Heritage Site or Biosphere Reserve like Sundarbans National Park. Apart from being biodiversity hotspots, the wetland resources are equally crucial for income generation, livelihood and wellbeing of the communities. However, due to lack of effective management mechanisms and proper appreciation of their true worth, wetlands have continued to be degraded through unsustainable activities, conversion and overexploitation of their resources. The pressures on wetlands have been exacerbated by catchment degradation and pollution leading to proliferation of invasive species. Drawing lessons from Ramsar guidelines in general and experiences in wetland conservation in India and other countries in context, a policy document should support a set of immediate programmes comprising:

- Identification, inventorisation and classification of all wetlands and water bodies.

- Delineation of catchment areas as the basis of analysis and activities for large wetlands.
- Reduction in non-point source (agro-chemical) pollution.
- Establishment of water quality standards of wetlands and water bodies.
- Development of policy and legal framework.
- Setting up of proper institutions for easier implementation of the wetland conservation programmes.
- Dissemination of information and awareness generation.
- Seeking funds for natural resource conservation as a part of development agenda. Fund for wetland conservation will have to be sought from various development allocations, State or otherwise, in addition to the allocation of the Environment Department. Apart from embarking upon conventional classificatory norms, for wetlands of India, it is imperative to primarily divide them into two classes.

Class 1: Will include all wetlands within protected area under Indian Forest Act, 1927, where the services of Forest Department functionaries as wetland managers and supervisors are constitutionally available.

Class 2: Comprises wetlands or water bodies which are outside such protected area. These wetlands do not have any designated custodians, save and except for small water bodies which are privately owned and occasionally fraught with succession battles among multiple owners where none has any obligation to conserve the wetland. The Parliament has passed the following legislations:

- Wildlife (Protection) Act - 1972
- Water (Prevention and Control of Pollution) Act – 1974.
- Water (Prevention and Control of Pollution) Rules 1975.

- Territorial Water, Continental Shelf, Exclusive Economic Zone and other Marine Zones Act - 1976
- Forest (Conservation Act) – 1980
- Maritime Zone of India (Regulation and fishing by foreign vessels) Act - 1980
- Air (Prevention and Control of Pollution) Act - 1981
- Environmental (Protection) Act – 1986
- Water (Prevention and Control of Pollution) Cess (Amendment) Act, 1991
- Biological Diversity Act, 2002
- Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003.
- Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006

In addition to these there are:

- National Conservation Strategy and Policy Statement on Environment and Development (1992)
- The National Water Policy (2002)
- National Environment Policy (2006A)
- Wetlands (Conservation and Management) Rules 2010.

Apart from the abovementioned Acts, policies and rules Public Liability Insurance Act of 1991, National Environment Tribunal Act of 1995 and National Environment Appellate Authority Act of 1997 have also been enacted. Of late the Union Government has reviewed the National Water Policy 2002 and put in the public domain the revised draft Water Policy 2012 in which the importance of judicious use of water resources, dangers of over7 withdrawal of groundwater, the advantages of in-situ conservation of rainwater, control of runoff and importance of pressure irrigation systems in water conservation have been emphasised. Different

benefits of wetlands involve identification of the status of, and threats to, wetlands which are more specific information on these ecosystems.

Water quality assessment by measuring selected physico-chemical parameters, identification and evaluation of biodiversity values using biological parameters and determining socio-cultural and economic values in relation to wetland use and ecological services (groundwater recharge, flood mitigation, shoreline stabilization etc.) will help monitoring activities. Mapping using GIS is an effective tool in understanding the spatial distribution of wetland resources. Evaluation and identification of benefits of wetlands are specialized tasks. It will require appropriate institutional arrangements with the State-level coordination mechanism at the top.

Biological diversity or biodiversity refers to the variability among living organisms and the ecological complexes of which they are part. It includes diversity within species, between species and of ecosystems. While often understood in terms of the number of species, the term biodiversity has a much wider scope and includes genetic variations within species and between populations of species as well as the variety of ecosystems deserts, forests, wetlands, mountains, lakes, rivers, agricultural landscapes, and so on formed through interaction between living and non-living components of Earth. Dabhade (2006) suggested that Preservation of wetland habitat with all such diversity of organisms is necessary. Rajan et al.,(2009) given the Wetlands (Conservation and Management) Rules. This requires management steps both at the wetland site and at watershed area. It will be possible only through consideration of views of all the concerned for making the assessment and formulating the comprehensive conservation measures.

1.2 NEED OF STUDY

Lonar Crater is a wet land which is important biodiversity sector. It is extremely important for waterfowls, ducks, cranes, and many other migratory birds and microscopic organisms. The lake brine: supports typical microbial flora and fauna

need to be investigated to access its value of wet-land to be recognized as Ramsar Site of India. The crater fascinating physical setup, its relative isolation and Limnological status evolve in a unique way due to the unusual geographical and hydrological and climatic isolation highlights the ecosystem as an ecological wonder. Deteriorating changes: leading towards Eutrophication led to reduction of flora fauna and macrophytes and increase in pathogenic organisms must be investigated thoroughly to conserve the Lake. It is necessary to compile the available data together, so that the remedy for the conservation of the Crater will be possible only through comprehensive conservative measures which will be conceived during the project work. Some of the measures needed on following issues - Human interventions, pollution and degradation, Water and land use pattern, Agriculture in the lake alluvium, Exploitation of water resources must be investigated to save the ecological wonder.

1.3 LONAR CRATER

Lonar crater is believed to be originated due to meteoritic impact and is the third biggest in the world. As it has evolved in a unique way and due to fertile soil inside it has its unique importance. Haggerty and Newsom (2001) also had suggested that the Lonar crater was formed by the impact of a meteorite. Lonar crater the only such in the great basaltic province of India. The remarkable shape, size and uniqueness of crater lake at crater basin being saline has attracted the attention of geologist, ecologists, archaeologists, naturalists and astronomists and has been the subject of several studies on various aspects of crater ecosystem. This inland lake with no effluent is fed by a seasonal drainage mainly confined to its periphery and also by number of fresh water springs.

The crater contains many sub-ecosystems, each constituting a subtle combination of floral and faunal species, due to localized variations in the conditions of soil, water and humidity. The Lonar ecosystem has evolved in a unique way due to

the unusual geohydrological and climatic conditions. However, the same conditions have made it extremely fragile and vulnerable to human interventions. Therefore, the biotic zones resulting from such isolation need immediate protection. Malu (2002) http://www.isslr.org/news/newsone.asp?qnewsid=188 and Kodarkar (2008).

The formation of impact craters is a complex process and depending on the material properties of the target and projectile, parameters of impact, atmospheric effects and on gravity. For the same energy of impact, the greater the height of the ejecta, smaller is the depth of the crater since a significant fraction of the impact energy goes into the generation of the ejecta Walsh et al., (2003). Kumar (2005) suggested that the Lonar crater is a rare meteorite impact structure formed entirely in basalt, it is helpful for the understanding of similar craters on other terrestrial planets and satellites. The Lonar crater has attracted the attention of world geologists for investigation of its origin and the source of salinity of lake water; it is ecological wonder Malu et al., (2007). Recently, research on its geology on line with Barrington carter by Geological Survey of India confirmed meteorite impact responsible for its origin. Palot and Soniya (2003) said that vary few study was done on flora and funna of this habitat.

The time of excavation of material from the crater may last for several minutes following the impact, while the amount of impact melt produced is dependent on the abundance of water in the target rocks Melosh (1989). Target material below the excavation depth is pushed downwards, whereas the strata above this depth may be pushed upwards dePater and Lissauer, (2001) as seen in the Lonar crater. Lonar Crater Lake consist of various eco-tones inhabited a wide range of plant and animals life. Due to High velocity and heat of impacts that basalt rock can be molted and which was thrown out around crater to produce Ejecta Blanket. Some large stones found up to 2 km from the crater. Ejecta Blanket extended outward up to 1350 m from cater rim. Crater Rim is 30 m high and 1380 m diameter. Escarpment height above the lake level is near about 130 m.

1.4 LONAR LAKE

Lonar lake (19058'N and 76o31'E). Is a unique basaltic rock meteorite crater, ranking third in the world, First time it was discovered by J.E. Alexander as a crater in (1823) The lake lies in a nearly circular depression surrounding on all sides by steeply rising escarpments. This inland lake has no outlet. Uniqueness of the lake is its salinity and alkalinity. There are micro-ecosystem, inhabited by a wide range of plant and animal life. The saline lake, marshy areas around it, freshwater streams, natural and manmade plantations, crop fields and the remnants of the original forest and scrub referred to above, all provide special niches for plants and animals. Besides the pea fowls an impressive number of migrant and resident birds are found here. Different locations will be selected for the study of each ecological zone. As it has evolved in a unique way and due to fertile soil inside it has its unique importance. Lonar crater the only such in the great basaltic province of India. The remarkable shape, size and uniqueness of crater lake at crater basin being saline has attracted the attention of geologist, ecologists, archaeologists, naturalists and astronomists and has been the subject of several studies on various aspects of crater ecosystem. This inland lake with no effluent is fed by a seasonal drainage mainly confined to its periphery and also by number of fresh water springs.

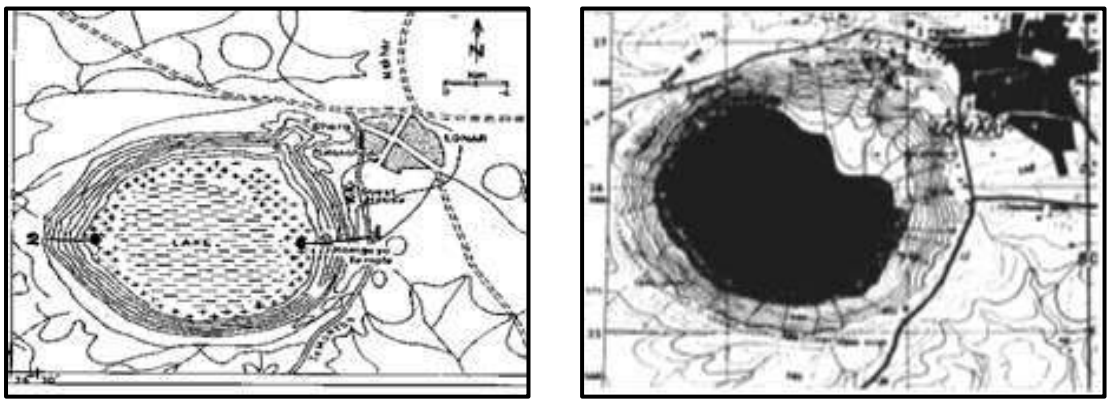


Fig. No.1: Maps of Lonar Crater (Diagrammatic and Topographic View)

Fig. No. 2: Satellite View of Lonar Crater India

The crater contains many sub-ecosystems, each constituting a subtle combination of floral and faunal species, due to localized variations in the conditions of soil, water and humidity. The Lonar ecosystem has evolved in a unique way due to the unusual geohydrological and climatic conditions. However, the same conditions have made it extremely fragile and vulnerable to human interventions.Therefore, the biotic zones resulting from such isolation need immediate protection.

Lake Basin has near about 1.5 km. diameters. Alluvium fan is on several distance from the lake water, during observation it was seen that the size of alluvium fan not similar to all site at sampling site S1 (Ramgaya) it was near about 500 m. with having dip forest up to the Lake water in which different type of vegetation is there some of them annona squamosa, acasica species are medicinal plants. At Sampling site S2 (Kamljadevi Temple) it was near about 150 m. At Sampling site S3 (Mahadev temple) it was near about 230 m. At Sampling site S4 (Dargaha) it was 700 m to 800 m. Alluvium fan have diverse amount of plant vegetation. Circumference of the lake basin is near about 6 km. Diameter is near about 1.83 km (~ 2000 m) Depth from crater rim to the water level in the lake at the centre of the depression 150 m. Rim

Fig. No.3: Alluvium fans of Sampling site S1 near Ramgaya

Fig. No. 4: Ejecta Blanket Sampling sites S1

Fig. No. 5: Alluvium fans of Sampling site S2 Kamljadevi Temple

Fig. No. 6: Allivium Fans of Sampling Site S2

Fig. No. 7: Ejecta Blanket on Sampling Site S2 Near Kamljadevi Temple

Fig. No. 8: Alluvium Fans of Mahadev Temple

Fig. No. 9: Ejaect Blanket of Mahadev Temple

Fig. No. 10: Sampling Sites S3 Alluvium fans containing Deep Forest

Fig. No. 11: Alluvium Fans of Sampling site S3

Fig. No. 12: Alluvium Fans of Sampling Site S4

Fig. No. 13: Ejecta Blanket of Sampling site S4.

1.5 BIODIVERSITY

Lonar crater have the deep forest around the Lake. Forest containing plants are having great medicinal value. The plants like anonna squmosa, acsica nilotica, acasia fusiform, Gunj, At near the mahadev temple there is large banyan tree which having the several meters prop roots, such various type of grass species are also found there. Planktons are organisms that live in the water. They are carried by waves, tides, and currents. Their name comes from the Greek word, "Planktos" meaning drifter. Planktons come in many different shapes and sizes. They are grouped into two categories; plants (phytoplankton) and animals (zooplanktons). Phytoplankton is tiny, microscopic plants and bacteria. They are usually found in the shallow surface waters. Zooplanktons range in size from tiny microscopic organisms such as protozoan and rotifers, to large planktons called macro planktons such as jelly fish, shrimp and fish larvae. Planktons are very sensitive to changes in the quality of the water. They help to tell us about the environmental conditions within the water bodies.

REVIEW OF LITERATURE

The biology of impact craters was studied by Cockell and Lee (2002). Ghosh (2009) Studied the Physics and Chemistry of Meteorites. A meter-scale–resolution digital elevation model, geological map of Lonar Crater and the surrounding area, and radiocarbon ages for histosols beneath the distal ejecta was presented by Maloof et al., (2010). Paleomagnetism of impact spherules from Lonar crater, India was studied by Weiss et al., (2010). Babar (2010) studied Geology, Microecological Environment and Conservation of Lonar Lake.

Rajasekhar and Mishra (2005) Analyzed gravity and magnetic anomalies over Lonar Lake. Osae et al.,(2005) studied chemical data indicate that there is no significant change between the different basalt flows exposed at Lonar. The basalts can be classified as relatively low-K tholeiitic within-plate basalts, with minor Fe and Ca enrichment and slight Mg and Al depletion compared to "average" tholeiites. Son and Koeberl (2007) Chemical variation in Lonar impact glasses and impactites. Newsom and Wright (2011) also studied the presence of phyllosilicates and other aqueous minerals in different impact craters and layered target environments provide evidence of habitable environments, and be used to identify such environments in the proposed landing sites on Mars using orbital and rover instrumentation?. Hagerty and Newsom (2011) also studied that impact-related hydrothermal processes occurred at the Lonar Lake impact structure. In particular, backscattered electron images of shocked Lonar samples demonstrate textural evidence for post-impact hydrothermal alteration including replacement textures, ubiquitous pockets of alteration, alteration of impact glasses, and multiple generations of hydrothermal carbonate growth. Goswami and Murty (2009) studied planetary sciences and exploration of India. Chakrabarti et al., (2006) analyzed trace elements and Nd, Sr, Pb isotopes of impact breccia rocks and target basalts from the Lonar Crater. Louzada et al., (2008) conducted paleomagnetic and rock-magnetic studies of oriented basalts from a terrestrial analogue of craters on other terrestrial planets and the Moon, in order to test for changes in magnetic remanence and properties as a result of shock.

For Lonar crater, they find that shock heating did not exceed ~200°C in the crater wall and ejecta blocks. Rock-magnetic effects of shock are subtle at Lonar. However, greater bulk coercivity in some ejecta blocks relative to the unshocked background basalts was a potential shock indicator that warrants further development.

Maloof et al., (2007) studied Lonar Crater is an excellent site for studies of impact crater formation and deformation, shock magnetization, and fluidized ejecta. The deformation from the crater wall to distal ejecta is illuminated by their paleomagnetic study. The properties of the ejecta blanket demonstrate significant radial mass movement following ballistic emplacement and final structures similar to Martian layered ejecta forms. Kumar and Kring (2008) studied reports over 2500 new measurements of orientations of bedding, faults, and fractures in crater walls and in surrounding bedrock. Misra et al., (2009) studied on the spherules were probably formed by mixing of target basalt melts and chondritic impactor material. Based on Ni abundances, the chondrite component in the submillimeter sized spherules varied between ~12 and 20 weight percent. The topographic profile of the continuous ejecta blanket, total volume, and distal structure are remarkably similar to fluidized ejecta features on Mars. Hence, Lonar Crater may be used to test different physical models for the formation of fluidized ejecta blankets by Maloof et al., (2010).

Shaikh et al., (2010) Camparative study between the Lonar Lake and the Kankaria Lake have very limited degree of self similarity over a shorter range of length scale and thus have a smaller fractal dimension. Richardson Plot technique is powerful tool in study of structural and textural details of irregular objects, thus few lake boundaries are also analyzed using this technique. According to them the natural lakes show more structural complexity as compare to the lakes resulting from human intervention or by interference. However at shorter length scale some textural details are seen that represent textural complexity at shorter length scale. Rao and Bhalla (1984) they studied systematic variation in some magnetic parameters whereas at surrounding localities, these parameters show random variation and suggested that such magnetic property variations are characteristic of shock origin and hence they propose an impact origin for Lonar Lake.

Satyanarayan et al., (2008) worked on the Lonar Crater has varied micro ecosystems with unique bio-diversity. Some initial observations in this regard indicated existence of six species of algal cells, which belonged to saline water tolerant variety. A total of five water samples from different locations from Lonar Crater were collected.

Musaddiq et al., (2001) studied on microbial diversity and ecology of Lonar Lake. Molecular analysis of microbial diversity associated with the Lonar Soda Lake in India was carried out by Wani et al., (2006) and his study revealed the presence of a highly diverse bacterial population and a comparatively less diverse archaeal population. Chavadar and Bajekal (2008) studied on South Seeking Magnetic Bacteria from Lonar Lake. Kanekar, et al., (2008) Studied on culture dependent phenotypic characterization and 16S rDNA based phylogenetic analyses were applied to study cultivable bacterial diversity present in the alkaline Lonar Lake.

More et al., (2012) studied that the phospholipid antimicrobial compound produced by acidophilic Bacillus subtilis was found to be strongly effective against commonly occurring Gram positive and Gram negative and Candida parapsilosis bacteria. Bansod and Bajekal (2006) have studied the characterization of chitinases from microorganism isolated from Lonar Lake. Tambekar and Tambekar (2011) isolated protease from Cohnella thermotolerans from Lonar Lake. Tambekar and Tambekar (2012) have studied the isolation, production dynamics, purification, characterization and optimization of a protease from Bacillus odysseyi isolated and identified by 16S rRNA ribotyping from the Alkaline Lonar Lake. Acidophilic Bacillus subtilis (B.subtilis) strains were isolated from soil samples of Lonar lake and screened for production of phospholipid antibiotic. The purified phospholipid antibiotic showed broad spectrum activity against the test organisms i.e. Escherichia coli (E.coli), Staphalococcusaureus (S. aureus), Pseudomonas aeruginosa (P.aeruginosa) and Candida parapsilosis (C. parapsilosis) More et al., (2012). Tambekar and Tambekar (2012) have studied partial characterization and optimization of alkaline protease production of bacillus pseudofirmus from lonar. The prokaryotic diversity associated with an Indian soda lake (Lonar Crater Lake) located in a basaltic soil area was investigated using a culture-independent approach which

revealed the presence of a highly diverse bacterial population and a comparatively less diverse archaeal population. The majority of the cloned sequences show little affiliation with known taxa (<97% sequence similarity) and may represent novel taxa/sequences and organisms specifically adapted to this basaltic soda lake environment. Diversity analyses demonstrated greater diversity and evenness of bacterial species compared to a skewed representation of species for Archaea Wani et al., (2006). Chavadar and Bajekal (2008) reported the isolation and characterization of megnatotactic bacteria from the sediments along the littoral zone of Lonar lake. Deshmukh and Puranik (2010) studied the application of plackett-burman design to evaluate media components affecting antibacterial activity of alkaliphilic cyanobacteria isolated from Lonar Lake.

Tambekar and Dhundale (2012) studied on the physiological and cultural diversity of bacilli characterized from Lonar lake (MS) India. Thakker and Ranade (2002) studiedAn alkalophilic Methanosarcina isolated from Lonar crater. Distance wise microbial diversity (Distance Decay Analysis) of five different soil samples from Lonar Lake region was studied by Ghodechor et al., (2013).

Tambekaret al., (2013) Isolated phenol degrading bacteria from Lonar Lake. From twelve sediment and water samples collected from four different sites of Lonar Lake two bacterial strains were isolated by using peptone water phenol medium. The bacterial strains were biochemically characterized and identified by 16S rRNA sequencing. The result of the sequencing showed that the isolates belong to phylum Firmicutes and the species were Staphylococcus arlettae (SDT1) and Staphylococcus species (SDT2). The isolated strains were further characterized for their potential to degrade phenol and the phenol degradation was determined by the spectrophotometric method 4-amino antipyrine. Result of the study showed that the isolates (SDT1) and (SDT2) degrade 64% and 75% phenol in the peptone water phenol medium at laboratory level. Thus the isolated gram positive bacteria can be exploited as a candidate of choice for the bioremediation of phenolic effluent. Bajekal and Chavadar (2008) Studied on the basis of presence of titaniferous magnetite crystals in heavily shocked impact glass in the crater and they detected magnetic activity in the surrounding rocks and soil which led to look for magnetotactic bacteria in the

ecosystem. There four magnetotactic isolated bacteria showed the typical 'precise alignment' at the edge of a hanging drop and the 'magnetic south seeking' tactic behavior. Morphologically, two was gram positive rods, one a gram negative short rod and the fourth, a gram positive coccus.

Planktons and zoo benthos play an important role in lake ecosystems as a main determinant of hydro-biological production and community structure Sprules and Munawar (1991). Bhuiyan et al.,(1998) and Cottenie et al., (2001) worked on the physicochemical condition and seasonal variation of zooplanktons. Pailwan et al., (2008) studied the limnological features, plankton diversity and fishery status of three fresh water perennial tanks of Kolhapur District (M.S.) and revealed 67 species of phytoplankton, 35 species of zooplankton. Moreover fishery activities are observed as an extensive type and tanks under investigation are categorized under natural fertility. Limnological evaluation of the fisheries potentials and productivity of a small shallow tropical African reservoir was carried out by Mustapha (2009). Sharma et al., (2009) studied that abiotic factors register limited influence on richness and abundance of phytoplankton and on abundance of constituent groups.

Somani and Pejaver (2004) has studied the density of total zooplankton in Masunda Lake of Thane and observed copepods as the largest contributor followed by rotifers and cladocera. Mukhopadhyay et al., (2007) studied the aspect of zooplankton diversity in relation to physic-chemical environment of the east Calcutta wetlands, a Ramsar site of Kolkata city, India which is heavily contaminated by industrial and municipal wastewater and the study revealed the occurrence of fifteen species of rotifers.

Subhashini and Saradhamani (2003) worked on Hydrobiology of Aliyar reservoir. Dejan et al., (2004) reported that precipitation or turbidity, have been identified as critical factors in the development of zooplankton. Ovie et al., (2009) Studied limnological stock assessment, productivity and potential fish yield of Dasin Kowa and Kiri reservoir.

Rajagopal et al., (2010) studied the zooplankton diversity and physico-chemical conditions in three perennial ponds of Virudhunagar district, Tamilnadu and they reported positive significant correlation between the zooplankton population and physico-chemical parameters like, temperature, alkalinity, phosphate, hardness and biological oxygen demand, whereas negatively correlated with rainfall and salinity. Preliminary survey of plankton in Irrukkangudi reservoir, Virudhunager district, T.N., India was carried out by Kanagasabapathi and Rajan (2010) and reported twenty six different species of phytoplankton belonging to six classes and twenty five different species of zooplankton belonging to four classes Rotifera, Cladocera, Ostracoda and Copepoda.

Different physico-chemical parameters were studied and analyzed Bhawankar etal.,
(2011).TheVariousParameterslikeAtmospherictemperature,watertemperature,pH, Dissolved solids, chlorides, sulfates and phosphates were analyzed. The results revealed that all the parameters were in normal range throughout the year indicated good quality of dam water. Mukherjee (2010) studied on the Plankton diversity and dynamics in a polluted eutrophic lake, Ranchi. In aquatic environments, enhanced growth of choking aquatic vegetation or phytoplankton i.e. algal bloom disrupts normal functioning of the ecosystem, causing a variety of problems. Human society is impacted as well: eutrophication decreases the resource value of rivers, lakes and estuaries such that recreation, fishing, hunting, and aesthetic enjoyment are hindered Pathak and Pathak (2012). The lake has been polluted due to anthropogenic activities like farming, subsequent use of pesticides, discharge of sewage, developmental activities over ejecta blanket, holy rituals, tourism, etc.

The study reflected the nitrate and phosphate level at ten preferred spots to assess the eutrophic level of River Yamuna, Delhi, in summer and monsoon season by Kaur and Singh (2012). Dhote and Dixit (2011) studied the idols which are made by plaster of paris, clay and cloth which are supported by small iron rods, and is painted with different metal-based paints. On immersion of these idols in the water bodies, the water is contaminated with these metal paints and a change in chemical load in the water body is expected. When idols immersed, these colored chemicals dissolve

slowly leading to significant alteration in the water quality. Zooplankton organisms occupy a central position in the food webs of aquatic ecosystem. They do not only form an integral part of the lentic community but also contribute significantly, the biological productivity of the fresh water ecosystem Wetzel (2001).

Shailendra Sharma (2010) studied the Population Dynamics and Seasonal Abundance of Zooplankton Community in Narmada River (India).Tilahun (2010) studied the diversity of culturable alkaliphilic denitrifying bacteria in four soda lakes of ethiopia. Oren et al., (2008) has studied Microbial communities in salt lakes: phylogenetic diversity, metabolic diversity, and in situ activities. Assessment of Factors Influencing Growth and C-Phycocyanin Production of Arthrospira platensis from Meteoritic Crater Lake was studied by Mohite and Wakte (2011) which shows that the isolate exhibited the siderophore production potential revealing its possible use in agricultural industry. Interlandi and Kilham (2010) were analyzed the relationship between phytoplankton diversity and limiting resources (N, P, Si, and light) over two summers in three lakes in the Yellowstone (Wyoming, USA) region.

Pedge et al., (2013) studied the B. plicatilis species of rotifers and their seasonal variation were determined along with physical and chemical parameters of water in Lonar meteorite crater. Assessment of environmental impact was established to provide and evaluate the background picture of water quality of Lonar Lake water. Physico-chemical characteristics were measured and used as indicators to evaluate the water quality of lakes Pedge and Ahirrao (2013). Analysis of gravity and magnetic anomalies over Lonar Lake, India was carried out by Rajasekhar and Mishra (2005). Eutrophication of freshwater and marine ecosystems was studied by Smith (2006). Slusarczyk (2003) studied a low density and diversity of zooplankton assemblage. Individuals of the dominant species Daphnia longispina represented all body size classes and the maximum number of Daphnia females observed in month of May and the normal dial vertical migration of Daphnia, studied in June. Plants have a significant effect on wastewater treatment when treating diluted wastewater, and are a necessary element of the treatment system. Nevertheless, their role depends on the type of treatment process. Plants are relevant to nutrient removal but not to that of organic matter in subsurface flow systems, whereas the opposite occurs in free water

surface systems, the type of species used in FWS systems is not important; all species had good performances, plants did not show a direct effect on bacteria removal but demonstrated an indirect effect through the creation of an hostile rhizosphere environment in turn stimulating the growth of bacterivorous populations, high rate algal ponds are an adequate technology for wastewater treatment, especially when bacteria removal is an important treatment objective, physico-chemical conditions created by the metabolism of algae is the main mechanism responsible for the inactivation and decay of bacteria and parasites cysts studied by Eloy (2006).

Quarcoopome et al., (2008) studied the fisheries and limnology of Bontanga and Libga reservoirs in northern Ghana with the objective of generating information to support the development, management and sustainable use of their fisheries to enhance the socio-economic status of riparian communities. Mustapha (2009) studied the morphometrics and physico-chemical parameters of Oyun reservoir and estimates the potential fish yield of the reservoir according to the morpho-edaphic index. Lashari et al., (2009) studied the temporal and seasonal variations in water quality of Keenjhar. Physico- chemical properties of Keenjhar Lake were within tolerance limit for aquatic biota of Lake, no excessive concentration of any parameters was recorded during their study period, and therefore the water of Keenjhar Lake was safe limit and for the growth of aquatic life, plants either animal. High altitude limnological studies in the Nepal Himalayas have mostly dealt with limnochemistry. These lakes have low conductivity with some exceptions. Conductivity has been shown to decrease with altitudinal increase. Most of the lakes in the Himalayan Region have calcium as the most dominant cation with few exceptions as well as streams are greatly influenced by geolithology, catchment vegetation and land use practices. The trophic status of these lakes is oligotrophic to ultraoligotrophic studied by Gurung et al., (2009)

Chick et al., (2010) studied the role of rotifers in aquatic food webs and they examined density and biomass of metazoan zooplankton in the Upper Mississippi and Missouri rivers from two sampling methods. One of which collection of macrozooplankton method was designed to target cladocerans, adult and juvenile copepods, by filtering 180 L water through a 63-μm mesh. The microzooplankton method was designed to target rotifers and copepod nauplii by filtering 18 L water

through a 20-μm mesh. In semi-terrestrial ecosystems, ph and calcium concentrations are generally the main drivers of variation in species composition of unicellular and multicellular microorganisms, mirroring well described patterns for macro-organisms, providing support for general ecological hypotheses. Other water chemistry variables differed between shell-forming and other organisms, and between Autotrophic and heterotrophic organisms. Even though water chemistry variables controlled the structure of the bryophyte tufts that acted as substratum for the micro-organisms, both water chemistry and bryophyte structure effects were independently significant for diatoms and testate amoebae. On the other hand, no effects of either substratum characteristics or water chemistry were found for rotifers. This was because their species composition is not influenced by chemical factors, apart from ph and calcium, which both strongly influence the occurrence of sphagnum studied by Hajkova et al., (2011).

Gerardo (2001) studied the Limnological characteristics of Crater Lake which affects the rest of the parameters of the lake, such as its oxygenation and water chemistry and the phytoplanktonic community composition among others. Limnological survey of lake was carried out by Verma and Chaudhari (2013) to understand the unique ecosystem. The sources of eutrophication of the lake were observed to be natural run-off water and a small patch of agriculture in the catchment area of the lake. The lake water was observed to be highly saline and alkaline in nature with nutrient enrichment and marginal level of organic pollution. Lonar Lake was observed to support dense bloom of phytoplankton dominated by Spirulinaplantensis, a protein rich blue-green alga of commercial importance. Koeberl et al., (2004) studied on lonar impact crater, Below a thin weathered surface layer, breccia with clasts ranging up to several meters in size was observed at or near the crater rim on all sides. Breccia with smaller clast sizes was observed just below the surface at numerous locations up to several hundred meters from the crater rim. Kumar (2005) Studied Structural effects of meteorite impact on basalt, Evidence from Lonar crater.

Rask et al., (1998) studied the limnological monitoring of the lakes in which Productivity of the lakes decreased from south to north, as was implied by data on

phytoplankton biomass, chlorophyll concentration and primary production of phytoplankton and abundance of rotiferan zooplankton. Mustapha and Omotosho (2002) studied the physico chemical pproperties of temporary pond. Iqbal et al., (2006) measure the quality of water and to evaluate planktonic community. Alvarez – cobelas et al., (2006) studied interactions among rainfall, groundwater and surface water and their Limnological effects were traced seasonally changing of rainfall. Monthly changes in phytoplankton periodicity, nutrient levels, temperature, pH, transparency, conductivity, dissolved oxygen and biological oxygen demand were studied Indabawa (2009)

Kashmir valley in western Himalayas there is expanding urbanization, intensive agricultural practices and unsustainable exploitation of the wetland resources, there physico-chemical parameters are in unusual pattern. In Chatlam wetland is under immense anthropogenic stress like grazing, encroachment, draining of water for irrigation purposes, dumping of agricultural, domestic and municipal wastes etc. In fact chemical parameters like pH, Conductivity, Chloride, Nitrite Nitrogen, Nitrate Nitrogen, Ammonical Nitrogen and Orthophosphate were study by Parray (2010). Haroon et al., (2010) studied Physico-chemical properties of water in any aquatic ecosystem are largely governed by the existing meteorological conditions and are essential for determining the structural and functional status of natural waters.

Casado and Montes (1992) studied the Ecological past problems and normal development of science in Spain. Offem et al., (2009) studied the Physico-chemical factors and zooplankton diversity of Cross River, to quantify the relative importance of local environmental conditions and diversity of the principal zooplankton. Khuhawar et al., (2009) studied the physicochemical parameters of Baghsar Lake; Lake contains adequate food potential and micronutrients for fisheries development. Limnology is a border discipline between geography, hydrology and biology, and is also closely connected with other sciences, from it borrows research methods. Physical limnology (the geography of lakes), studies lake biotopes, and biological limnology (the biology of lakes), studies lake biocoenoses studied by Gastescu (2009). Studies on physicochemical quality of water and in Lonar Lake were done and it was seen that chlorides and salinity of the Lake water was decreasing, but the

biodiversity of the Lonarlake was increasing as it found the presence of some microorganisms i.e. Some Bacillus species, Some Lysinibacillus species and Some Pseudomonas species Shinde and More (2013). Due to high precipitation considerable increase of water level has been observed in the saline cratonic lake at lonar, thereby decreasing salinity of lake water. As a result of pt and accumulation is observed setting in blue green algal bloom (Spirulina) bloom in the lake Badve et al., (1993).

The Lake Ecology section is intended to provide a general background to Water on the Web by introducing the basic concepts necessary to understand how lake ecosystems function. The reader is later referred to a list of texts and journals for more in-depth coverage of the science of freshwater ecosystems. Much of the text, formatting, and figures are based on the four documents listed below, although extensive modifications have been made to include the original lecture notes of Co-principal Investigator Richard Axler. Additional citations have been included to provide appropriate credit studied by Horne and Goldman (1994).

Saksena et al., (2006) studied has been taken up to understand the limnology of the ponds in Kharland area for assessing their prawn culture potential. These ponds are unique in physio-chemical characteristics during their seasonal cycle. From July to October, these ponds have nearly freshwater while from November to May pond water becomes saline. Thus, there is a great possibility of taking up monoculture of both the freshwater and brackish water prawns as well as polyculture of prawns and fishes in the Kharland ponds. Sharma et al., (2008) studied the water quality of Udaipur Lake, there physicochemical and microbiological parameters. Pailwan et al., (2008) also studied the water quality of perennial tanks there Limnological properties, plankton diversity and fishery statues in Kplhapur District. Satpathy et al., (2008) studied the seasonal variation in Lake Water which was observed alkaline and saline throughout the year. Soranno et al., (2010) studied predictive classification modeling, grounded in the theoretical foundation of landscape limnology that creates a tractable number of ecosystem classes to which management actions may be tailored. They demonstrate their system by applying two types of predictive classification modeling approaches to develop nutrient criteria for eutrophication management in north temperate lakes. Their predictive classification system promotes the effective

management of multiple ecosystems across broad geographic scales by explicitly connecting management and conservation goals to the classification modeling approach, considering multiple spatial scales as drivers of ecosystem dynamics, and acknowledging the hierarchical structure of freshwater ecosystems. Such a system is critical for adaptive management of complex mosaics of freshwater ecosystems and for balancing competing needs for ecosystem services in a changing world.

Augustina (2009) studied on species composition, diversity, abundance and distribution of zooplankton as well as some physico-chemical parameters that affect this organism. Sharma et al., (2010) studied on Zooplankton density exhibited a single peak during March. However, a sudden increase was noticed in the month of October which continued till March. This increase is attributed to the settling of rain water return of favourable conditions in post monsoon period. The effect of abattoir wastes and other anthropogenic activities on the distribution and abundance of zooplankton and environmental variables were investigated in Orogodo River, southern Nigeria, showed that changes in water quality of the river have significant effects on the structure of zooplankton assemblages. This feature could be used for biomonitoring of the river health to ensure the protection of the aquatic biota. Considering the usefulness of this municipal river to the community, waste water treatment should be applied in order to minimize the influence on water quality by Arimoro and Oganah (2010).

Fontaneto et al., (2007) describe a new rotifer species of the Brachionus plicatilis complex: Brachionus manjavacas sp., Detailed morphological analyses demonstrated significant differences in body shape and size between B. manjavacas and B. plicatilis s.s., analysed by geometric morphometrics; Only the shape of small pieces of the trophi, named satellites, were consistently different between the species. On a strictly classical taxonomical basis it is absolutely useful to name new species on morphological bases, as we did, and to assess their status as distinct entities. Nevertheless, the two species are broadly similar; therefore, they do not suggest using the small differences in shape of satellites of trophi to identify the species for further ecological studies, but to continue discriminating them on genetic marker bases. Shah et al., (2008) studied on plankton community structure and productivity, its diurnal

and seasonal variations and the influence of physico chemical factors in the Shibsha River of the southwest coast of Bangladesh. Telesh (1999) studied on the filter-feeding microphagous rotifers Conochilus unicornis and Keratella cochlearis dominated most of the microzooplankton communities in the northern parts of the lake, while grasping phytophagous species of the genus Polyarthra predominated in the central and south-eastern parts.

Ferrara et al., (2002) studied the seasonal cycles and population dynamics of the dominant species are described and discussed. They observed that Copepods numerically dominated the community throughout their study period. Phytoplankton are generally microscopic they impart green color of the water, phytoplankton may exceed rooted plants in food production per unit area, many of such forms possess other adaptations to aid floating, while turbulence and upward current movements of water keep phytoplankton near surface where photosynthesis is most effective by Lokhande and Shembekar (2009). Zooplanktons are the grazers on the phytoplankton and a food base for the carnivorous as well as omnivorous fishes, have been reported in percentage composition of different groups. The diversity of various types of zooplankton was studied of fresh water reservoir Nyari – II Rajkot district, Gujarat by Goswami and Mankodi (2012).

Diapausing, fertilized eggs in monogonont rotifers typically are formed after an environmental signal induces amictic females to produce mictic daughters. Mictic females lay haploid eggs that may develop parthenogenetically into males, or that may be fertilized and develop into diapausing, female embryos called resting eggs studied by Gilbert (2004). Badsi et al., (2010) studied on physicochemical parameters indicates that certain environmental factors are essential to the operation and evolution of the closed lagoon of the biological reserve of Massa. These parameters include nutrients (nitrate, orthophosphates), dissolved oxygen, pH and temperature. Rotifers were the most dominant zooplankton group observed during the study period in Massa Lagoon. The studies of the distribution of zooplankton population in the three stations are characterized by the importance of rotifers that are better represented.

The zooplankton is represented by a majority of smaller species of rotifers dominated in abundance and they contribute to a large share in the total zooplankton biomass. This illustrates both their role and importance in energy transfer. This rich zooplankton may be a source of important food for wading birds and sedentary abundant downstream. A better understanding of the structure, evolution and functioning of the aquatic and natural ecosystem is certainly a better preservation of biodiversity. The interactions between the components of biodiversity are fundamental to the understanding of how this ecosystem functions. Caramujo and Boavida (2010) studied the zooplankton communities of 5 temporary ponds in the Northern part of the Natural Park of the Southwest and Vicentina Coast, Southwestern and also studied the Alpha and beta diversity of cladoceran and copepod species.

Qualitative and quantitative analysis of zooplankton and also studied there Limnological factors of Lakes studied by Tijare and Thosar (2008). Sharma (2011) studied Zooplankton diversity, evenness, richness and dominance of species.

Obertegger and Manca (2011) they applied the guild-ratio, an index based on the proportion of functional groups of rotifers, on a long-term data set of Lago Maggiore. By applying seasonal trend decomposition based on smoothing techniques and non-metrical multidimensional scaling, they assessed the response of rotifer functional groups to changes in trophic state and climate.

Torres and Rylander(2006) studied diversity and abundance of littoral cladocerans and copepods nine Ecuadorian highland lakes. Vanjare et al., (2010) and Saler (2009) studied Rotifera and Cladocera are free living zooplankton elements known to dominate freshwater habitats. Few rotifers are known to be parasitic and epizoic living in association with other organisms. Zooplankton from the polluted river Mula, Pune, Maharashtra. The influence of physico-chemical properties of Oyun Reservoir, Offa, Nigeria on its zooplankton composition and abundance were investigated by Mustapha (2009). Sundri and Gomoiu (2009) studied structure of zooplankton community recorded in the Danube River. Okogwu (2010) studied on physico-chemical variables and zooplankton composition. Echaniz and Vignatti

(2010) studied to describe the diversity and changes in the horizontal distribution of crustaceans and rotifers in the episodic wetland.

Baiao and Boavida (2005) they studied the reservoirs suffer from the influence of several human activities. As a consequence, several reservoirs in the Tejo River basin are progressing towards eutrophication. Leitao et al., (2006) studied Zooplankton community composition and abundance of two Brazilian semiarid reservoirs.

Garcia-Morales and Elias-Gutierrez (2007) studied Rotifer fauna of Guatemala and central-southern Belize. Zooplankton communities are important constituents of aquatic ecosystems playing major roles in energy flow between the various organisms of food chains by Shayestehfar (2010). Negreiros (2010) studied Seasonal fluctuations in the dynamics of the plankton rotifer populations in an oligo-mesotrophic branch of a tropical reservoir with respect to the possible influence of environmental conditions and with emphasis on biological interactions.

Over the last 20 years, more and more reliable data concerning global climate change, mainly climate warming, have become available in the literature. Change such as this has also been documented in the Gulf of Gdansk. Climate change has an influence on aquatic ecosystems and especially their biocoenoses, and plankton is one of its most sensitive ecological fractions. Positive and negative statistical correlation in the exclusive relationship between the quantity of plankton groups and water temperature has been observed. When time was applied as a factor, only the annual increments of the blue-green algae correlation were statistically significant, and the regression equation calculated and it rise in the population number of these algae in response to increasing temperature. It was not possible to perform this calculation with the other plankton components. Plinski et al.,(2003). Roy et al.,(2010) studied to estimate zooplankton abundance qualitatively and quantitatively in carp brood fish culture systems.

Sharma et al., (2009) studied two perennial fresh water ponds for taxonomy of rotifers in Jammu. Malaiwan and Peerapornpisal (2009) investigated the diversity of

phytoplankton and the water quality in the reservoir of the Nam Ngum Dam. The physical, chemical and some biological parameters, especially the phytoplankton in each depth profile, were studied. Six divisions of phytoplankton they were found, i.e. Chlorophyta (green algae), Cyanophyta (blue-green algae), Bacillariophyta (diatoms), Pyrrhophyta (dinoflagellates), Chrysophyta (chrysophytes) and Euglenophyta (euglenoids).

Toyosi and Ngamarju (2011) studied Rotifer fauna constitute an important source of natural food resources for aquatic organisms especially the young stage of fish and fisheries. Despite their importance in the sustainability of aquatic ecosystem, adequate information about their species composition in most African inland waters is lacking. Meanwhile understanding the species richness of rotifers could provide baseline information for the management of the productivity of water. A study was conducted to determine the species composition and relative abundance of rotifer fauna in lake Alau, Maiduguri, Borno State of Nigeria. Bielanska-Grajner (2004) studied Psammon rotifers were investigated in two lakes of different trophy and degrees of pollution. Chang et al.,(2009)Studied Seasonal changes of zooplankton communities were monitored at two coastal marine areas, Uchiumi and Fukuura Bays located at the Uwa Sea, east side of Bungo Channel contain ammonium and phosphate concentrations, suggesting that fish farming could accelerate eutrophication more seriously.

The dominant species of mesozooplankton were similar at the two sampling sites with dominance of small coastal calanoid copepod, Paracalanus spp., but the abundances of larger calanoid species, Calanidae, Eucalanidae, Temoridae and Acartiidae, were markedly higher in Uchiumi Bay. Small cyclopoid copepods, Oithona spp. were abundant at both sites, but the densities varied seasonally, and often more abundant at Fukuura Bay. Buyurgan et al., (2010) and Maria-Heleni et al., (2009) both studied Zooplankton community structure and some water parameters and found Rotifera was dominant group.

Chittapun et al., (2009) studied zooplankton communities main components in the three areas were nauplii, rotifers and Cladocera. Cladocera played a major role in structuring rotifer communities in rice fields.

As the Lonar Lake is unique in the world for its alkalinity and salinity of the water but its alkalinity, pH and salinity goes on decrease day by day; Dabhade (2006). Pawar (2010) studied seasonal variation in physicochemical quality of Lonar Lake water and identified alkalinity is increased in monsoon and post-monsoon season while decrease in pre-monsoon season. Likewise the chloride and salinity is increased in pre monsoon season while decreased in monsoon and post-monsoon season. Cockell and Lee (2002) are suggested that the phase of thermal biology, a phase associated with the localized, ephemeral thermal anomaly generated by an impact event.

Siddiqi (2008) and Babar (2010) both studiedon the physicochemical parameters of water including pH, Chlorides (Cl), total hardness, total dissolved Solids, Ca, Mg, Na, K, CO_3, HCO_3 and SO_4 are higher and very greater than the BIS (1991) and WHO (1992) maximum permissible limits for drinking and other domestic. The presence of species of bacteria related to water borne diseases were also found higher indicating the non-potable nature of the lake water but the spring (Dhara) water is normal and potable. Occurrence of few species of algae and fungi indicate the characteristic nature of bioflora, which needs the further investigations and interpretation. The assemblage of geological and micro-ecological attributes of Lonar lake water makes it very interesting for researchers. Study of water quality of Lonar Lake was carried out by Borul (2012) and Pawar (2010) in which he analyzed the physico-chemical characteristics to report the status of water quality of Lonar Lake.

Gaikwad and Sasane (2013) analyzed the water quality of the groundwater in and around Lonar Lake, which shows the higher values mainly for Iron, Total hardness, chloride, fluoride, calcium and magnesium, which revel that the groundwater of the area needs some degree of treatment before consumption, and it also needs to be protected from the perils of contamination. Iron mineralogy has been

studied using Mossbauer spectroscopy on eight glassy impacted samples from different parts of the Lonar Crater Rim Region. Distinct changes are observed when compared to the host basaltic sample Verma et al., (2013) Assessment of environmental impact was established to provide and evaluate the background picture of water quality of Lonar Lake water. Physico-chemical characteristics viz., atmospheric and water temperature, electric conductance (EC), total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), salinity, pH, dissolved oxygen (DO), HCO_3, Cl , SO_4, Na , K , Ca , Mg , NO_3, PO_4 and turbiditywere measured and used as indicators to evaluate the water quality of lakes Pedge and Ahirrao (2013).

Due to the importance of Lonar Lake to humans, the studies were carried out with regard to its water quality in terms of physico chemical characteristics, heavy metal concentration and phytoplankton population Satyanarayan et al., (2008). Influence of bottom water anoxia on nitrogen isotopic ratios and amino acid contributions of recent sediments from small eutrophic Lonar Lake, central India was studied by Menzel et al., (2013).

This has created a constant threat to the ecosystem and its remarkable biodiversity; leading to the eutrophication of this lake by Khobragade, http://wldb.ilec.or.jp/data/ilec/WLC13_Papers/S7/s7-7.pdf

The reasons for pollution and degradation of Lonar lake, its causes such as human interventions, exploitation of water resources, threat to wetland biodiversity, need of preservation of wetland habitat with diversity, the parameters which are indicators of eutrophication, reasons for the eutrophication, remedy for the conservation of the lake, required management steps both at the wetland site and at watershed area, comprehensive conservative measures was discussed by Dabhade (2013). Environmental analysis of Lonar Lake was carried out by Yannawar and Bhosle (2013).

The environmental deterioration of the Lonar crater area has also been caused by anthropogenic reasons as well as extensive plantation of Prosopis juliflora (a variety of Babul) as the plant is becoming naturalized and is replacing the native

assemblage of the crater flora Bodas et al., (2005) and Dabhade (2013). Kodarkar (2008) Studied Seven Principles for the Sustainable Lake Management these are A harmonious relationship between humans and nature is essential for the sustainable use of lakes., A lake drainage basin is the logical starting point for planning and management actions for sustainable lake use, A long-term, preventative approach directed to preventing the causes of lake degradation is essential, Policy development and decision making for lake management should be based on sound science and the best available information, The management of lakes for their sustainable use requires the resolution of conflicts among competing users of lake resources, taking into account the needs of present and future generations and of nature, Citizens and other stakeholders should be encouraged to participate meaningfully in identifying and resolving critical lake problems and Good governance, based on fairness, transparency and empowerment of all stakeholders, is essential for sustainable lake use.

MATERIAL AND METHODS

3.1 DESCRIPTION OF STUDY AREA AND SITE DESCRIPTION

Fig. No. 14: Location of Four Sampling Sites of Lonar Crater

Lonar lake ($19^{0}58$'N and $76^{o}31$'E). Is a unique basaltic rock meteorite crater, ranking third in the world, First time it was discovered by J.E. Alexander as a crater in (1823) The lake lies in a nearly circular depression surrounding on all sides by steeply rising escarpments. This inland lake has no outlet. Recently, research on its geology on line with Barrington carter by Geological Survey of India confirmed meteorite impact responsible for its origin. Uniqueness of the lake is its salinity and alkalinity. There are micro-ecosystem, inhabited by a wide range of plant and animal life. The saline lake, marshy areas around it, freshwater streams, natural and manmade plantations, crop fields and the remnants of the original forest and scrub referred to above, all provide special niches for plants and animals. Besides the pea fowls an impressive number of migrant and resident birds are found here. Different locations will be selected for the study of each ecological zone. As it has evolved in a unique way and due to fertile soil inside it has its unique importance. Lonar crater the only such in the great basaltic province of India. The remarkable shape, size and uniqueness of crater lake at crater basin being saline has attracted the attention of geologist, ecologists, archaeologists, naturalists and astronomists and has been the

subject of several studies on various aspects of crater ecosystem. This inland lake with no effluent is fed by a seasonal drainage mainly confined to its periphery and also by number of fresh water springs.

The crater contains many sub-ecosystems, each constituting a subtle combination of floral and faunal species, due to localized variations in the conditions of soil, water and humidity. The Lonar ecosystem has evolved in a unique way due to the unusual geohydrological and climatic conditions. However, the same conditions have made it extremely fragile and vulnerable to human interventions.Therefore, the biotic zones resulting from such isolation need immediate protection. Due to High velocity and heat of impacts that basalt rock can be molted and thrown out around crater to produce Ejecta Blanket. Some large stones found up to 2 km from the crater. Ejecta Blanket extended outward up to 1350 m from cater rim. Crater Rim is 30 m high and 1380 m diameter.Escarpment height above the lake level is near about 130 m. Lake Basin have near about 1.5 diameters. Alluvium fan is on several distance from the lake water, during observation it was seen that the size of alluvium fan not similar to all site.

SAMPLING PERIOD

During Investigation, two years sampling period was as under-

1. First year i.e. Jan 2013 to Dec 2013.
2. Second year i.e. Jan 2014 to Dec 2014.

Fig. No. 15: Sampling site S1

Fig. No. 16: Sampling site S2

Fig.No. 17: Sampling site S3

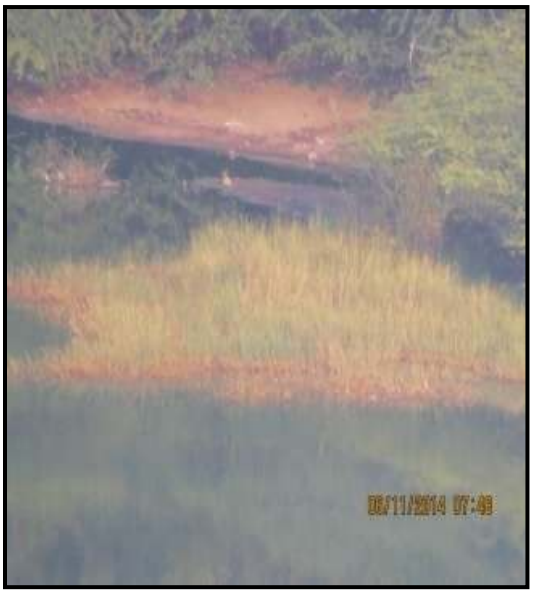


Fig.No. 18: Sampling site S4

There are four sampling sites were selected for the collection of water sample and biological sample during the complete study periods. The details about four sampling sites are given below-

Sampling Site **S1**: Which is Located at south,in front of Krishna temple, near the Ramgaya here the water is shallow. This site was selected for sample collection because it is comparatively less swampy part of the lake.

Sampling Site **S2**: Located at west, near Kamaljadevi Temple. This site is charaterised of shallow water.

Sampling Site **S3**: Located at North, near Mahadev temple characterized by shallow water,rich in zooplankton community.

Sampling Site **S4**: Located at East,Gaibshala's shrineDargha, it is sufficiently shallow and lies besides the agricultural zone of the alluvial fan of the Crater.

3.2 SAMPLING OF WATER SAMPLES FOR PHYSICOCHEMICAL ANALYSIS

Introduction

Water sample was collected by using plastic bottle, glass bottle and polyethylene bottles no any reactive material containing container is use such care

should be taken that the water sample does not change their composition before tests of analysis. Water samples from the bottle the shallow knee-depth areas were collected manually by lowering a closed glass bottle or polyethylene bottles to the bottom, opening and closing it there by hands and taking it out. Monthly water samples were collected early in the morning from four different sampling sites viz., S1, S2, S3, and S4 at four directions of the Lonar Crater.This water sample brings in to the laboratory and analyzed by following the prescribed Standard methods for the Examination of water and Waste water APHA (1998, 2006, 2008) 20^{th} edition edited byLenoreet al.,(1998).

3.2.1 Handling and preservation of collected water samples

After collecting the water samples from desire depths several parameters like temperature, pH, free CO_2,alkalinity, Dissolved Oxygen etc. estimated on the spot.

Collected sample containers were clearly labeled indicated with the name of sampling site, date, time of sampling, type of sample and depth from which water sample is collected. Moderately,priced containers such as polyethylene or polypropylele bottles are considered to be better than borosilicate glass containers which are not only expensive but are heavy and breakable. For the analysis of oxygen the use of ground Stoppard glass bottles preferably BOD bottles (300ml) is used. The water samples in well labeled and tightly capped container were brought to the laboratory in an ice box and kept in a deep freeze in order to arrest the biological activity of the sample. Mercuric chloride at 50mg/L of water sample has been found to be a good preservative to check the biological activity a water samples for analysis other than nitrogen and chloride fractions. As the long-term chemical composition of the sample it is analyzed as early as possible after the collection of water samples.

3.3 PHYSICAL PARAMETERS

Following physicochemical parameter of water were analyzed to know the status of crater and their impact on the lake biological activity. The parameters studies were colour,temperature, turbidity,total dissolved solids (T.D.S.) and Electric conductivity (E.C).

3.3.1 Colours

Water gets its colour due to phytoplankton, zooplankton,sand particles,organic particles and metallic ions. Water may be clear;either they are colourless or light green or blue in colour. Water becomes green in colour when phytoplanktons are more; it develops a brown colour due to zooplankton. Water with black, blackish green,dark brown, red, yellow colouris not good for culture. The red colour of water is due to the presence of high levels of iron and death of phytoplankton. To determine water colour, "Visual Comparison Method" APHA (1998) was used. According to this method, colour is determinded by visual comparision of sample with known concentration of coloured solution. Comparision is also made with special property calibrated glass colour disks. Water colour is compare with that of glass disks held at the end of metallic tubes containing glass comparator tubes filled with samples and colourless distilled water. Sample colour is matched with the colour of tube of clear water and calibrated coloured glass viewed by looking towards a while surface. Each disk is calibrated to correspond with the colours of the platinium-cobalt scale.

3.3.2 Temperature

Record the temperature of the water with the help of standard centigrade thermometer in ^{0}C. It is better to take the sample in a container to measure the temperature immediately. Hofmann (1977)opined that temperature exerts a significant influence on population dynamics not only by its direct influence on embryonic development but also because it is an important characteristic of the determinative situation of the environment. In tropical are seasonal succession mainly depends on changing temperatures and specific adaption to such changes. By observationDhanpathi (1974, 1976) on a pond during summer revealed an interesting fact that when the pond of almost dried up living a small shallow patch of water and faced extreme critical condition the collection showed only one species (B.calyciflorus) with a new variant in large numbers (900/L).

Thus the water temperature helps to determine which species may or may not present in the system. Temperature affects feeding, reproduction, immunity and the metabolism of aquatic animals. Drastic temperature changes can be fatal to aquatic animal.

All species tolerate slow seasonal changes better than rapid changes. Thermal stress or shock can occur when temperature change more than 2 to 3^oF (1 to 2^0C) in 24 hours.

The heat capacity of water is very high making it resistant to changes in temperature, this moderates the daily and seasonal climate changes in temperature. Water temperature affects may biological,chemical processes. Temperature influences the solubility of oxygen and percentage of unionized ammonia in water. Temperature and light intensity normally have closed relationship in natural systems and so their effects on photosynthetic is a useful index of rates of primary production of plant formation under natural conditions. The photosynthetic efficiency is the percent of incident visible radiation that is converted to net primary production during seasons of active photosynthesis.

The temperature of the water is recorded by standard centigrade thermometer graduated 0^0C to 100^0C. The sample is taken in a container to measure the temperature and immediately it is measured on the spot.

3.3.3 pH

The full form of pH is Potentio hydrogeni. It means that the potential of hydrogen ions hence the pH value expressed as the negative logarithm of the hydrogen ion concentration. The pH ranges from 0 to 14. The pH 7 is neutral, less than 7 being acidic and above 7 basic or alkaline. pH is one of the most common water test is a measure of hydrogen ions in the water. The pH scale is logarithmic, so every one unit change in pH represents a ten-fold change in acidity. Measurements above 7 are basic and below 7 are acidic. pH affects the toxicity of other substances , such as ammonia and nitrite. On the field pH is recorded with the help of standard pH paper strip. The paper is dipped in to the water sample and colour is developed which is campared with the standared colour code given. Such determination is fairly accurate. Care should be taken to wash the hand by distilled water before toaching the pH paper strip. In to the laboratory pH is recorded by using ELICO LI 614 PH ANALYSER.

$$pH = -\log 10[H+]$$

$$= \log 10 \frac{1}{[H+]}$$

3.3.4 Transparency

Environmental energy in the form of solar radiation entering into an aquatic ecosystem is fixed by primary producers resulting into the production of glucose through photosynthesis. The extent to which light can penetrate depends on transparency of a standing water column. Further, on the basis of transparency a standing water column stratifies into trophogenic that is photosynthesis is greater than the respiration. In compensatory, where the photosynthesis and respiration are same or equal and in tropholotic zones where the respiration is more than the photosynthesis. Water transparency is depends on turbidity which is directly proportional to the amount of suspended matter. Thus transparency and turbidity play an important role in the energy dynamics of an aquatic ecosystem.

The visibility of any water depth is a measure of light penetration is determined by using a Sacchi Disc. The most common method employed for determination of transparency (light penetration) is Sacchi Disk method (A Sacchi, 1955). For this purpose a metallic disk is a circular metal plate of 20 cm diameter, the upper surface of which is divided into four equal quadrants in such a way that the two quadrants painted alternate black and white a circular iron ring is fixed at the center of the upper surface provides attachment for the graduate's rope during operation. At the center of the lower surface, a weight is attached to facilitate sinking of the disc in proper position. The lower side of the disc is painted in black in order to eliminate reflection of light from the surface. During use the Sacchi disc attached to a graduated rope is lowered into the water and the deapth at which it disappears is first noted. Subsequently the disc is gradually taken up and the average of these two values was taken as the limit (deapth) of visibility (d). The disc is operated from the sunny side with the rope supporting the disc hold vertically between 9 am and 3 pm. when the sun is fairly high in the sky. The transparency as a measure of light extinction coefficient (K) was calculated using following formula of Poole and Atkins.

$$K = \frac{1.7}{\mathrm{d}}$$

Where,

'd' is the depth (m) of Sacchi disc visibility. Two regarding of depth; one at a point when the disc just disappears (A) and the other at which is reappears (B) are taken in cm.

3.3.5 Total Dissolved Solids (TDS)

Most of the salts and a variety of organic substances expect lipid is soluble in water. Thus a water sample either from surface, ground or marine sources contain appreciable quantity of dissolved solids normally confer a degree of hardness to it. TDS in the form of total filterable residue is estimated by gravimetric in mg/l and also directly calculated by using ELICO EC-TDS ANALYSER CM 183 in ppt. If the water sample contains floating oil or grease then TDS ranges among 10 to 30,000mg/l.

"Total Solids" is the term applied to the material results left in the vessel after evaporation of a sample and it's subsequent during is an oven at a defined temperature. Total Solids includes," Total suspended solids" the portion of total solids retained by a filter and total dissolved solids the portion that passes through the filter. For the estimation of TDS, 100ml sample is filtered through specific whatman filter paper. For filtering the sample we must know about the filter having the filter holder, the pore size, porosity , area and thickness of the filter and the physical nature, particle size and the amount of material deposited on the filter are the principal factors affecting separation of suspended from dissolved solids. Dissolved solids are the portion retained on the filter. The filtrate should not have any turbidity such Clear filtrate was evaporated in the evaporating dish. The filtrate is taken into a pre-weighed beaker (W1) or evaporating disc of suitable size and kept in an oven adjusted appropriate 103 ^{0}C for one hour. Sample along with contained was then cooled in a descicator and final weight was taken as (W2).

Calculation:

$$TDS\ mg/L = \frac{\mathrm{A} - \mathrm{B\ X\ 1000\ X1000}}{\mathrm{V}}$$

Where, A = Final weight of the dish in g.

B = Initial weight of the dish in g.

V = Volume of sample taken in ml.

3.3.6 Electrical Conductivity

Conductivity is a measure of the ability of an aqueous solution to carry an electronic current. Solutions of electrolytes conduct an electric current by the migration of ions under the influence of an electric field. Like a metallic conductor, they obey Ohm's law. Exceptions to this law occur only under abnormal condition only, for example, very high voltages or high frequency current. Thus for an applied electromotive force E, maintained constant but at a value that exceeds the decomposition voltage of the electrolyte the current I flowing between the electrodes immersed in the electrolyte R. The reciprocal of the resistance 1/R is called the Conductance, and is expressed in reciprocal of Siemen's/mhos/reciprocal of ohms.

The standard unit of conductance is Specific Conductance K which is defined as the reciprocal of the resistance in ohms of a 1-cm cube of liquid at a specified temperature. The units of specific conductance are the reciprocal ohm cm (or Siemens/cm). The observed conductance of a solution depends inversely on the distance d between the electrodes and directly upon their area A.

$$\mathbf{1/R= kA/d}$$

The electrical conductance of a solution is a summation of contributions from all the ions present. It depends upon the number of ions per unit volume of the solution and upon the velocities with which these ions move under the influence of the applied electromotive force. As a solution of an electrolyte is diluted, the specific conductance k will decreases and fewer ions to carry the electric current are present in each cubic centimeter of solution. However, in order to n express the ability of individual ions to conduct, a function called the Equivalent Conductance $\wedge$ is employed. It may be derived from where A is equal to the area of two large parallel electrodes set 1cm apart and holding between them a solution containing one equivalent per liter, them one equivalent of solute. If C, is the concentration of the solution in gram equivalents per liter, then the volume of solution in cubic centimeters per equivalent is equal to $1000/C_3$, so that it becomes.

$$\wedge = 1000k/C_3$$

At infinite dilution the ions theoretically are independent of each other and each ion contributes its part of the total conductance thus

$$\wedge_{\infty} = \Sigma (\lambda_{+}) + \Sigma (\lambda_{-})$$

Where (λ_{+}) and (λ_{-}) are ionic cations and anions, respectively, at infinite dilution. The ionic conductance is a definite constant for each ion in a given solvent, its value depending only on the temperature. Since these are actually equivalent conductance, symbois such as (1/2) Ba^{2+} are sometimes employed. At finite concentrations interionic forces generally lower the ionic mobilities.

The conductivity of solution is quite temperature dependent. An increase in temperature invariable results in an increases of ionic conductance and for most ions this amounts to 2% per degree. For precise work conductance cells must be immersed in a constant temperature bath. It is customary to select 25^{0}C for measurements. For relative measurements, as in titration, the conductance cell need only, to attain thermal equilibrium with its surroundings before proceeding with conductance measurements.

This ability depends on the presence of ions; on their total concentration, mobility, valence and the temperature of measurement. Solutions of most inorganic compounds are relatively good conductors. Conversely, molecules of organic compounds that do not dissociate in aqueous solution conduct a current very poorly if that all.

The Electrical conductivity is measure by using the ELICO EC-TDS ANALYSER CM 183 or by the ELICO CONDUCTIVITY METER CM 180.

3.4 CHEMICAL PARAMETER

Chemical parameters were analyzed by titration methods while other photometric parameter analyzed by using different ELICO kits, Colorimeter and Spectrophotometer. The chemical parameters are like dissolved oxygen (DO), Free Carbon dioxide(CO2), Alkalinity (Carbonates and Bicarbonates), Chloride, Salinity,Total Hardness, Calcium, Calcium hardness, Magnesium hardness, Iron, Nitrogen, Ammonia(NH3), Nitrates (NO3-N), Nitrite(NO2-N), Total Phosphate,

Sulphates, Silicates , Biological Oxygen Demand, Chemical Oxygen Demand were analyzed to know the status of lake water and its impact on biological activity. These parameters were analyzed once in a month for a period of two years (Jan 2013 to Dec 2014) at selected station of the lake. The average values were obtained.

3.4.1 Dissolved oxygen (DO)

A. Introduction

To ensure the state of dynamic equilibrium of DO maintained by biochemical depletion by bacteria for the food chain and continued reoxy-generation by aeration and photosynthesis thus the availability of right amount of Dissolved oxygen(DO) vitally important for flora and fauna in water. The two main sources of DO are diffusion (From air) and photosynthesis, while major factor responsible for its depletion are biochemical oxidation and respiration by flora and fauna. Generally, in ecosystem free from population, high DO is found in euphotic zone, while its values are negligible in case of polluted water bodies due to the presence of H2S, NH3, Nitrate, Ferrous ions etc. thus there is direct correlation between BOD and COD on one hand and DO on the other hand. On the basis of eutrophication status (organic enrichment level) the aquatic ecosystems are classified into Oligotrophic (Nutrient poor) and eutrophic (Nutrient enriched). In the case of oligotrophic water bodies Do has a narrow range as exhibited by orthograde oxygen curve (DO increase with deapth), while in eutrophic systems clinograde oxygen curve (DO is more in surface and depletes sharply with the depth) is evident. DO is analyzed by titration method like Winkler's and by using the ELICO DO ANALYSER PE 135.

B. Principle

When Winkler's A ($MnSO_4$ or $MnCl_2$) and Winkler's B (strong alkaline iodide azide) are added to a sample, Mn $(OH)_2$ is formed which reacts with DO to form BROWN ppt. of Mn $(OH)_3$. On acidification the liberated iodine which is equivalent to original DO in the sample , is titrated against N/80 Hypo ($Na_2S_2O_3$) (Winkler's C) with starch as indicator.

$MnCl_2 + 2NaOH \rightarrow 2NaCl + Mn(OH)_2$

$Mn(OH)_2 + H_2O + 1/2\ O_2 \rightarrow Mn(OH)_3$

$2Mn(OH)_3 + 2KI + 6HCL \rightarrow 2MnCL_2 + 2KCL + 6H_2O + I_2$

1. Fill 300ml BOD bottle with water sample.

2. Add 2 to 3ml of Winkler's A and Winkler's B

3. A brown ppt. will be formed. Allow it to settle, (it could take 5 to 10 minutes. Keep the bottle away from the direct exposure to light).

4. Dissolve the brown ppt. by adding minimum quantity (add every time a few drops) of the acid so dissolve the ppt. by inverting stoppered bottle.

5. Sometimes black brown flakes are formed in the case of highly turbid water which do not dissolved further.

6. Take supernatant clear brown colour sample for titration in this case.

7. Titrate 100ml of the sample against Hypo with starch as the in indicator (it is better to add the indicator half way through the titration when the brown colour starts fading).

8. End point-Blue colour just disappears.

Calculations

1 ml of Hypo = 0.1 mg of DO

$$\text{DO in mg/L} = \frac{0.1 \text{ X ml of titrant X } 1000}{100}$$

3.4.2 Carbon dioxide (CO_2)

In an aquatic ecosystem sources of CO_2 are community respiration & decomposition, while it consumed in the photosynthesis. Depending on pH or other biological conditiona CO_2 is found in any one of the three species that is free CO_2 CO_3 or HCO_3. Free CO_2 usually combine with water to from carbonic acid, ($H_2O + CO_2 \rightarrow H_2CO_3$). Thus pH of such waters is acidic. When the pH ranges between 6.35-10.33 the carbon is found in the form of bicarbonates (HCO3), while when pH is between 10.33-14 it is in the form of carbonates (CO3).

pH	CO2 species
0-6.35	Carbonic acid
6.35-10.00	Bicarbonates
10.33-14.00	Carbonates

In the absence of free CO_2 which is the only source carbon for autotrophs, soluble bicarbonates are converted into free carbon dioxide & relatively insoluble carbonates.

$$\underset{\text{(Soluble)}}{Ca(HCO_3)_2} \rightarrow \underset{\text{Insoluble}}{CaCO_3} + HO_2 + CO_2$$

B) Principle

Dissolved carbon dioxide (CO_2) usually is the major acidic component of unpolluted surface waters; Free CO_2 reacts with sodium carbonate, or sodium hydroxide to form sodium bicarbonate. Completion of the reaction is indicated potentiometrically or by the development of pink colour characteristic of phenolphthalein indicator is a suitable colour standard until familiarity is obtained with the colour as end point (APHA 1998) . The sample containing free CO_2 in the form of bicarbonates is titrated againstan alkali (0.22NaOH) resulting change in pH from acidic to neutrality to alkalinity is detected by phenolphthalein.

1ml of 0.2272N NaOH → 1mg of free CO_2

1. In 100 ml of sample a few drops of phenolphthalein indicator were added. Development of pink colour indicates absence of free CO_2.

2. If sample remain colourless (sample is acidic to the formation of bicarbonates) Titrate against 0.2272N NaOH.

3. End Point: Pink colour develops.

Calculation

$$\text{Free CO2 mg/L} = \frac{\text{A X N X 44000}}{\text{ml of sample}}$$

Where A= ml titrant and

N = Normality of NaOH

3.4.3 Alkalinity

Alkalinity of water is its acid-neutralizing capacity. It is the sum of all the titrable bases. The measured value may vary significantly with the end point pH used. Alkalinity is a measure of aggregate property of water and can be interpreted in a terms of specific substance only when the chemical composition of the sample is known.

Alkalinity is significant in many used and treatments of natural waters and waste waters. Because the alkalinity of much surface water is primarily a function of carbonate and hydroxide content, it is taken as an indication of the concentration of these constituents.

The measured values also may include contribution from borates, phosphates, silicate, or other bases if these are present. Alkalinity in excess of alkaline earth metal concentration is significant in determining the suitability of water for irrigation. Alkalinity measurements are used in the interpretation and control of water and waste water treatment processes. Raw domestic waste water has an alkalinity less than or only slightly greater than that of the water supply. Properly operating anaerobic digesters typically have supernatant alkalinities in the range of 2000 to 4000 mg. calcium carbonate (CaCO3)/L.

Take 100ml of sample in a conical flask. And add drop of phenolphthalein in it. If the solution remains colourless, the phenolphthalein alkalinity (PA) is zero (indicating absence of carbonates) and total alkalinity with methyl orange is only determined. If the colour changes to pink after addition of phenolphthalein, titrate it with 0.1N HCL until the colour disappears at end point. This is phenolphthalein alkalinity (PA). Now add two to three drops of methyl orange to the same sample and continue the titration further, until the yellow colour changes to pink at the end point, this is total alkalinity (TA).

$$\text{PA as CaCO3 mg/L} = \frac{(\text{A} - \text{N})\text{of HCL X 1000 X50}}{\text{ml sample}}$$

$$\text{TA as CaCO3 mg/L} = \frac{(\text{BXN})\text{of HCLX 1000 X50}}{\text{ml sample}}$$

Where,

A = ml of HCL used only with phenolphthalein

B= ml of HCL used with phenolphthalein and methyl orange i.e . Total HCL used with both the indicators.

3.4.3.1 Carbonate (CO_3) Phenolphthalein alkalinity

Carbonates is define as quantitative capacity to neutralize an acidic solution the alkalinity to natural waters is mainly imparted by three predominant bases, Carbonates, Bicarbonates and Hydroxides (OH). Thus alkalinity is estimated as total or due to individual base.

In natural water CO_2 is responsible for alkalinity

$CO_2 + H_2O \rightarrow H_2CO_3$

$H_2CO_3 \rightarrow HCO_3 + H^+$

$HCO_3 \rightarrow CO_3 + H^+$

The CO_3 and HCO_3 further produce OH resulting into rise in pH.

$CO_3 + 2\ H_2O \rightarrow H_2CO_3 + 2\ OH^-$

$HCO_3 + H_2O \rightarrow H_2CO_3 + OH^-$

Water with free CO_2 also acts on $CaCO_3$ (lime stones) further contributing to total alkalinity:

$CaCO_3 + H_2O + CO_2 \rightarrow Ca(HCO_3)_2$

Water samples with high palnktonic biomass and productivity are usually more alkaline (more than 100mg.).

B. Principle

The acid titrant (0.02N H_2SO_4) converts carbonates in to bicarbonates effectively reducing pH neutrality. The reduction in pH proportional to the strength of CO_3 is detected by phenolphthalein.

C. Procedure

1. In 50 ml sample add 2 to 3 drops of phenolphthalein develops pink colour indicates absence of free CO_2 and alkalinity due to CO_3 an OH.

2. Titrate the sample against 0.02 N H_2SO_4.

3. End point Pink to colourless.

Calculation

1ml of 0.02 N H_2SO_4 = 1mg of $CaCO_3$

CO_3 alkalinity mg/l = ml of titrant into 1000/ml sample

Or = ml titrant into 20mg/l

3.4.3.2Bicarbonates (HCO3) or Methyl Orange alkalinity

A. Principle

pH range produced by bicarbonate ions is indicated by the Methyl Orange. The sample containing HCO_3 when titrated against an acid (0.02N H_2SO_4). The quantity of acid required to reduce the pH from alkaline to acidic direction, is proportional to the strength of HCO_3.

B. Procedure

1. The 50 mL sample after estimation of CO_3 is used for determination of HCO_3 or Methyl Orange alkalinity.

2. In the sample add 2 to 3 drops of Methyl Orange and titrate against 0.02N H_2SO_4.

3. End Point Yellow to Orange.

C. Calculations

HCO_3 alkalinity mg/L =mL Titrant into 1000/ mL sample

Or = mL Titrant into 20

3.4.4 Chloride

Introduction

Chlorinity: chlorinity is defined in relation of salinity as follows:

Salinity = 1.80655 X chlorinity

Although chlorinity is not equivalent to chloride concentration, the factor for converting a chloride concentration in sea water to include bromide, therefore chloride concentration (in g/Kg of solution) is nearly equal to chlorinity in sea water. (APHA,1998). Natural water normally has a low chloride contents compared to bicarbonates (HCO_3) and sulphates (SO_4). High chlorides (CL) are found in inland saline lakes, estuaries and marine waters. High chloride level indicates pollution from domestic sewage and industrial effluents though chlorides level as high as 250mg/L is safe for human consumption, a level above imparts, a salty taste to the potable water.

Principle

The chlorides are estimated by precipitating Cl^- ions in water as silver chloride (AgCl) by titrating agent 0.02 N silver nitrate ($AgNO_3$) which potassium cromate (K_2CrO_4) as indicator.

Procedure

Into 10 ml sample add few drops of K_2CrO_4.

Titrate the sample against 0.02 $AgNO_3$.

End point is noted as yellow to brick red.

Calculation

$$\text{Chlorides mg/L} = \frac{\text{V X N X 35.45 X 1000}}{\text{v}}$$

Where V = Volume of titrant in ml

N = 0.02 (Normality of $AgNO_3$)

v= 10 ml (volume of the sample in ml).

3.4.5 Salinity

Salinity has been defined traditionally as the total solids in water after all carbonates have been converted to oxides, all bromide and iodide have been replaced by chloride and all organic matter has been oxidized.

Salinity is an important unit less property of industrial and natural waters. It originally concived as a measure of mass of dissolved salts in a given mass of solution. To determine the salinity parameter by ERMA HAND REFRACTOMETER was used on the spot and it can also calculated from the chloride value by using following formula.

$$\text{Salinity g/l} = 0.03+1.805 \times \text{Chlorinity}$$

3.4.6 Total Hardness

Hardness of water is mainly imparted by alkaline earth metallic cations mainly calcium and magnesium present in it. In aquatic ecosystems receives calcium from limestone, dolomite and gypsum deposits in the catchment. Originally water hardness was understood to be a measure of the capacity of water to precipitate soap. Soap is precipitated chiefly by the calcium and magnesium ions present. Other polyvalent cations also may precipitate soap, but they often are in complex forms, frequently with organic constituents, and their role in water hardness may be minimal and difficult to define. In conformity with current practice, total hardness is defined as sum of the Calcium and Magnesium concentrations, both expressed as CaCO3 in mg/L.

When hardness numerically is greater than the sum of carbonate and the bicarbonate alkalinity, that amount of hardness equivalent to the total alkalinities is called “Carbonate hardness”; the amount of hardness in excess of this is called “Non-carbonate hardness”. When the hardness numerically is equal to or less than the sum of carbonate and bicarbonate alkalinity, all hardness is carbonate hardness and non carbonate hardness is absent. The hardness may range from zero to hundreds of mg/L, depending on the source and treatment to which the water has been subjected.

Principle

EDTA combines with calcium as well as magnesium and the process is highly pH dependant. When pH is sufficiently high magnesium largely precipitates as $Mg(OH)_2$ and the indicator produces purple colour characteristics of EDTA- Calcium product, while when pH is lower indicates produces blue colour characteristic of calcium and magnesium –EDTA product.

Procedure

Take 50ml of sample in a conical flask. In case of sample with high hardness a smaller aliquot may also be taken. Add 1 ml of buffer to this. If the sample is having higher amounts of heavy metals, add 1ml of Na_2S solution. Add approximately 100mg of Eriochrome Black T indicator; the solution will turn wine-red. Titrate the contents with EDTA solution. The colour changes to Blue at end point.

Calculation

$$\text{Hardness, mg/L as CaCO3} = \frac{\text{ml EDTA used X1000}}{\text{ml sample}}$$

3.4.7 Calcium Hardness

Calcium is the major cation present in natural waters, its main source being teaching of rocks in the catchment. Its concentration restricts water use, while it is an important component in the exoskeleton of Arthropods and shells in Molluscs.

1. Into 50 ml of sample add 1mL of 8% NaOH (pH12)
2. Add a pinch of Eriochrome Black T indicator
3. Titrate the sample against 0.01 M EDTA
4. End point: Pink to purple.

Calculations

$$\text{Calcium (mg/L)} = \frac{\text{T x 400.8 x 1.05}}{\text{V}}$$

Where T = Titrant in mL

V = Sample in mL

1mL of 0.01 M EDTA = 400.8 µg Calcium

$$\text{Calcium hardness (mg/L) as CaCO3} = \frac{\text{T x 100 x1.05}}{\text{v}}$$

1mL 0.1M EDTA = 1000mg $CaCO_3$

3.4.8 Magnesium Hardness

After the calcium the second major cation in natural water is magnesium. This is from the leaching activity of rocks in the catchment. This is a vital component of chlorophyll. Very high concentration of magnesium imparts an unpleasant taste to the potable water. Magnesium hardness calculated from the following formula.

Magnesium hardness mg/l = (T – C) × 0.244

Where, T =Total hardness (mg/l as $CaCO_3$)

C= Calcium hardness (mg/l as $CaCO_3$)

3.4.9 Iron

Iron is one of the most important trace element in biological system. It is an important component of hemoglobin, the Oxygen carrying pigment in blood and an integral part of cytochrome system, respiratory enzyme forming terminal segment of mitochondrial and chloroplast electron transport system. Microbes like Creaonthrix and Leptothrix extract energy from dissolved iron (Ferrous form) by oxidizing it to ferric form.

In natural waters too iron occurs abundantly both in oxidized (ferric) and reduced (ferrous) states depending on aerobic conditions. Thus, in ground water it occurs as ferrous bicarbonate due to anaerobic and alkaline nature of water. On oxidation as in the case of well aerated water, ferrous bicarbonate is oxidized into ferric bicarbonate, a brown insoluble substance, with the loss of CO_2.

Procedure

Into 50ml of water sample add 2ml of HCl and 1ml of hydroxylamine hydrochloride solution. Boil the contents until total sample is reduced to about half. Cool and add 10ml Ammonium acetate buffer and 2ml phenolphthalein. Make total volume 100ml by adding distilled water. After 10 minutes read the absorbance on

spectrophotometer at 510µm using distilled water blank. Read the value of total iron directly from the standard graph.

Soluble iron (Ferrous form) Fe++

Acidify 50ml water sample by adding 1ml of HCL. Add 10ml of Ammonium acetate buffer solution. Add 2ml of phenolphthalein solution. Make total volume of 100ml by adding distilled water. Record the absorbance after 10 minutes on an ELICO NEPHELOMETER CL 52D at 570µm using distilled water blank. Read the value of soluble iron directly from the standard graph (0 to5mg iron /L)

Ferric iron (Fe^{3+})

Ferric iron =Total iron –Ferrous iron.

3.4.10 Nitrogen

In an aquatic ecosystem nitrogen occurs in small amounts in inorganic (NH_3, NO_2, NO_3) and organic forms (urea, amino acids and nucleic acids). Increasing level of organic nitrogen and phosphorus leads to eutrophication, a phenomenon linked with nutrient enrichment leading to initial higher primary production, prolific growth of pollution resistance species loss of biodiversity and under extreme condition fish kills and finally total degradation of an aquatic ecosystem. Globally aquatic resources are facing the problem of eutrophication due to their pollution by raw domestic sewage and industrial effluents rich in organic compounds. Estimation of inorganic and organic nitrogen thus has a great pollution indicator value.

Procedure

Evaporate to dryness 200ml sample, preferably keeping over night in hot air oven adjusted at 60^0C. Then after collect the residue and dissolve it in 4ml of Digestion mixture and by adding 16ml distilled water make total mixture 20ml. Heat to fuming the mixture for about 15 min. and then cool. Introduce the mixture in distillation chamber through funnel and add to it 43.5ml of Hypo. Place 5ml of boric acid solution with 2 to 3 drops of mixed indicator in the distillate collection flasks with tip of the condenser sipped in to the solution. Heat the sample in the flask. The generated stem will pass through distillation chamber. Continue the distillation for 10

min. Stop heating and open the tap to suck out impurities if any. Titrate blue colored solution against 0.01 N HCL.

End point: Blue to Pink.

Calculation:

$$\text{TotalOrganicNitrogen} = \frac{A - B \times N \times 1000 \times 14}{\text{V}}$$

Where,

A= Titrant in ml for experimental sample

B= Titrant in ml used for Blank

N= 0.01

V= Volume of sample in ml.

3.4.10.1 Ammonia (NH3)

Two main sources of these toxic waste products are – a) Decomposition of organic matter and b) Excretory products of ammonotelic organisms. NH3 dissolves in water to form Ammonium hydroxide that further dissociates into ammonium and hydroxyl ions as follows.

$NH_3 + H_2O = NH_4OH = NH_4 + OH^-$

Aquatic autotrophs incorporate nitrogen through ammonium ions at a faster rate.

Procedure

Into 20ml sample adds two ml phenolnitroprusside solution and adds 2ml of alkaline hypochloride solution. Make up total volume to 25ml by adding ammonia free distilled water. The sample was kept in dark place for 1 hr at 25c after which the absorbance was measured at 635nm on SYSTRONICS SPECTROPHOTOMETER 106. The value read as NH4-N/L from the standard graph.

3.4.10.2 Nitrates (NO_3-N): (Phenol disulphonic acid method

In an aquatic ecosystems nitrates are formed on biological oxidation of organic nitrogenous matter received from raw domestic sewage, agricultural run-off and industrial waste containing organic waste matter. In addition to this metabolic wastes, excretory products and decaying organic matter further add organic nitrogen. Such organic nitrogen is mainly oxidized by nitrifying bacteria (eg. Nitrosomonas, Nitrobactor). Nitrogen is also fixed by bacteria (eg. Azotobacter, and algae (eg. Anabaena, Nostoc).

Principle

Nitrates (NO_3-N) react with phenol disulphonec acid producing nitroderivative which in alkaline solution develop yellow colour. The OD of the sample is directly proportional to concentration of NO_3-N.

A. Procedure

Evaporate 25ml sample preferably over night in a hot air oven adjusted at 50c. Dissolve the residue in 0.5ml of phenol disulphonic acid by rotating the flask to run the acid over residue. Add 5ml of distilled water and 1.5 ml of KOH solution. Read the absorbance of yellow coloured product at 410 nm on a SYSTRONICS SPECTROPHOTOMETER 106 using distilled water blank. Read the value of NO_3-N directly from a standard graph.

3.4.10.3 Nitrite (NO_2-N): Azoditidation method

Under acid conditions (pH2-2.5) nitrite irons (NO_2-N) as nitrous acid react with sulphanilic acid forming dizonium salt that combines with 1-napthylamine hydrochloride to form pinkish red azodye. The resultant optical density (OD) is directly proportional to the concentration of nitrite in the sample.

Procedure

In 50 ml of filtered sample 1 ml each of EDTA, sulphanilic acid, and α–naphthylamine hydrochloride solutions were added. The appearance of wine red colour indicates presence of nitrite. The absorbance was measured at 520 nm on

SYSTRONICS SPECTROPHOTOMETER 106. The concentration of NO_2 was read from the standard graph.

3.4.11 Phosphorus: (Total, inorganic, and organic)

In water bodies phosphorus occurs both in its inorganic and organic forms. Of the two inorganic phosphorus orthophosphate plays dynamic role by acting as the limiting nutrient. On precipitation ortho phosphates gets trapped in the sediment, while under reducing conditions as obtained in the most of the eutrophic ecosystem, some of the sedimenatary phosphorus is recycled in soluble form.

Procedure

1. Evaporate 125ml of sample to dryness in a hot air oven adjested above 100c
2. Dissolve the residue in perchloric acid.
3. Heat the flask gently to decolourise the solution.
4. Cool the mixture and add 10ml distilled water.
5. Titrate the sample against 1N NaOH using phenolphthalein as an indicator. End point is slight pink colour.
6. Make up the volume of 25ml by adding distilled water. Add 1ml of Ammonium molybdate and three drops of $SnCL_2$.

Measure the absorbance of blue colour solution at 690nm on a SYSTRONICS SPECTROPHOTOMETER 106 or by using the ELICO NEPHELOMETER CL 52D.

3.4.12 Sulphate

Natural water contains higher level of sulphates contributed from weathering of the rocks. In addition to thisk, domestic sewage contribute sulphate to an aquatic ecosystem and hence high level of sulphates is an indication of pollution from organic matter. Biological oxidation of sulphur containing organic matter and precipitation in zones of high sulphur emission contribute sulphate to the water. For estimation of sulphates in water turbidimetric method is preferred due to its simplicity and quick results.

Procedure

1. In 50ml filtered sample water add 10ml of NaCL-HCL solution, 10ml Glycerol-Ethanol solution and 0.15g barium chloride, stir the mixture for about one hour (use ELICO GI 631 magnatic stirrer).

   Measure the absorbance at 420nm on SYSTRONICS SPECTROPHOTOMETER 106 or by using the ELICO NEPHELOMETER CL 52D run distilled water blank simultaneously.

2. Read the sulphate value directly from the standard graph.

3.4.13Silicate

Due to its high solubility and abundance in rocks natural water contains very high level of silicates. Silica is an important structural component of Diatoms and in ecosystems rich in silicates deposits of silica are found as a result of sedimentation of dead diatoms.

Procedure

Use plastic containers for this estimation as glass contains silica.

1. In 50ml sample add 1ml HCL and 2ml of ammonium molybdate solution.
2. After 10 minutes add 1.5ml of Oxalic acid solution.

Record the absorbance of blue colour solution at 420nm with the help of SYSTRONICS SPECTROPHOTOMETER 106.

1. Read the value of silicate from standard graph.

3.4.14 Biological Oxygen Demand:

BOD indicates the magnitude of water pollution by the oxidizable organic matter. The main sources of organic enrichment are

1. Raw domestic sewage containing carbonicious organic matter.
2. Nitrogenous compounds and
3. Chemically reducing conpounds.

In natural course the organic matter on oxidation (mineralization) enters bio-geo-chemical cycle. However, when a system receives excessive pollution load, its carrying capacity exceeded and due to less oxygen available for oxidation, a net oxygen demand generates. Thus, BOD can be defined as the quantity of DO in ppm required under test condition for complete oxidation of the organic matter in a representative sample.

To prepare dilution water aerates the BOD-free distilled water in a glass container for about half an hour. Add per liter of this water 1ml each of phosphate buffer solution (reagent C), magnesium sulphate solution (reagent D), CaCL2 solution (reagent D), calcium chloride solution (reagent E), and ferric chloride solution (reagent F).

Adjust pHof sample to neutrality (7.0) using 1N sulphuric acid (reagent G) or 1N sodium hydroxide solution (reagent H) as the case maybe. To ensure that not all the oxygen of sample is exhausted during incubation, dilute the sample with dilution water as the table, according to the expected BOD content of the sample. Fill two sets of BOD bottles with this water and add 1ml of allylthiourea solution (solution I) to each bottle. Determine the dissolved oxygen content (DO)in one set immediately following the Winkler's method of oxygen estimation. Incubate the other set of BOD bottles at 20c for fivedays in a BOD incubator. Take out the bottles after five days and determine immediately their dissolved oxygen content (D5)

Calculation

$BOD_5(mg/L) = (D_o - D_5)$ X Dilution factor

Where,

D_o = initial DO in the sample

D_5 = DO after 5 days.

3.4.15 Chemical Oxygen Demand

Take 20ml of sample in 250-500ml COD flask (round bottom or conical flask with a ground joint for liebig reflux consider). If the sample is expected to have COD more than 50mg/L, add 10ml of 0.25N potassium dichromate solution. Extreme care

should be taken in case of low COD samples. A small trace of organic matter in glassware may contribute a significant error. Add a pinch of Ag_2SO_4 and $HgSO_4$**.** If the sample contains chlorides in higher amount HgSO4 is added in the ratio of 10.1 to the chlorides. COD cannot be determined accurately if the sample contains more than 2000mg/L of chlorides. Add 30ml of sulphuric acid. Reflux atleast for two hours on a water bath or a hot plate. Remove the flask, cool and add distilled water to make the final volume to about 140ml. Add2-3 drops of terroin indicator mix thoroughly and titrate with 0.1 N ferrous ammonium sulphate. Run a blank with distilled water using same quantity of the chemical.

Calculation

$$\text{COD (mg/L)} = \frac{(b - a)X \text{ N offerrous ammonium sulphate } X\ 1000\ X\ 8}{\text{ml sample}}$$

3.5. COLLECTION AND PRESERVATION OF PLANKTON SAMPLE

Once the sampling locations and sites are determined prepare for field sampling. Label the sample container with sufficient information to avoid confusion. On the label indicates date, time, sampling site, sampling area, type of sample, and depth. Use waterproof labels because due water their label information may erase and they enclosed in a protective container to avoid breakage. According to sampling plan monthly Sample were collected from four different sites of lake by towing Nylon plankton Net. Various types of plankton nets, simple conical nets have been used for many years with little modification in design or improvement in accuracy. Their major source of error is that filtration characteristics of conical nets usually are unknown. Filtration efficiency in No. 20 mesh cone nets range from 40 to 77%. For collection of plankton sample fine silk No. 25 used having the aperture size 64µm and approximate 33% open area which is use full for all type of Nannoplankton APHA (1998). This net used repeatedly operated to get concentrated samples. Concentration of samples was done by using a bore cut wide syringe with fine mesh size netting fitted on mouth. The water sieved inside the tube of syringe without piston is dipped in the inserting the piston in the tube of syringe is poured away so as to prepare a data searching was done for identification of new species. These concentrated samples were collected in sampling bottles.

Variable fixation and preservation method were adopted which were based on the purpose of fixation, i.e. whether the samples were preserved for cytological, anatomical, morphological or taxonomic study. The 2% formalin for Protozoans, 4% formalin for Rotifers, and 6% formalin for Cladocera and Copepodes were used for fixation. The organisms belong to Protozoa and Rotifera were also killed by submerging them into hot water and then were transferred to 2-4% formalin to avoid their distortion. Lugol's iodine was used for preservation of algae and protozoans. Preserve zooplankton samples with 70% ethanol or 5% buffered formalin. Ethanol preservatives is preferred for materials to be stained in permanent mounts or stored. Formalin may be used for the first 48 hrs. of preservation with subsequent transfer to 70% ethanol. Formalin preservative may cause distortion of pleomorphic forms such as protozoans and rotifers. Make formalin in sucrose saturated water to minimized carapace distortion and loss of eggs in crustaceans, especially cladocerans**.** Use a narcotizing agent such as carbonated water, menthol saturated water, or neosynephrine to prevent or reduce contraction or distortion of organism, especially rotifers, cladocerans and many marine invertebrates Gannon, et al.,(1975).Adding a few drops of detergents prevents the clumping of preserved organisms. Preserve samples as soon as most animal movements has ceased, usually within half hour of narcotization. To prevent evaporation add 5% glycerin to the concentrated sample.

3.6 METHOD FOR QUALITATIVE ANALYSIS OF PLANKTON

Collected concentrated plankton sample withdraw subsample with an accurately calibrated pipette. Clean pipette regularly. To prepare wet mounts transfer 0.1 ml to a glass slide, place a cover slip over the sample and ring cover slip with an adhesive such as clear nail polish to prevent evaporation. For semi permanent mounts, add a few drops of glycerin to the slid. As the sample ages the water evaporated leaving the organisms imbedded in the glycerin. If the cover slip is ringed with adhesive the slide can be retained for a years if stored in the dark.

Such prepared slide observed under the Olympus Phase Contrast Microscope and INVERTED MICROSCOPE (COSLAB) and photographed with the digital camera DC 10+.

3.7 METHODS FOR QUANTITATIVE ANALYSIS OF PLANKTON

From all sampling stations Zooplanktons sample were collected monthly by filtering 200 liters of water through the plankton mesh size 25µ. These samples were collected in separate sampling bottles of 30ml capacity. This quantitative water samples bottle is also labeled indicating name site, date and time.

3.7.1 Quantitative Analysis of plankton

Estimation of zooplankton density was made by counting 1ml sub-sample of the well mixed standard sample in a Sedwick Rafter counting chamber; the counts were converted to number of organism per liter of water.

Sedwick- Rafter Cell Method

Sedwick –Rafter cell slide is having cavity of 1cc or 1ml capacity with dimension of 50mm x 20 x10 mm.

1. Exactly 1ml of sample was taken on the slide; a special cover slip (supplied with Cell) was kept on the cavity (cell).

2. If the sample is too concentrated, then there is a possibility for several organism lie over each other and too close to one another make the entire counting troublesome leading to inaccurate results. In order to avoid it, plankton sample was suitably diluted.

3. All zooplankton present in the cavity i.e. 1ml sample, were then counted from one corner of the counting cell. The rafter was moved horizontally along the first row of squares and the organism in each square of row was thus counted.

4. When the first one row was finished, the next consecutive row was adjusted using the mechanical device or stage.

5. The procedure was repeated by taking another 1ml sample and till about 10 replicates were counted.

6. In this way, total number rotifers present in sample were counted by using the formula,

$$N = n \times v/V$$

Where, N=Total number of planktons

n=Average number of plankton in 1ml of sample,

v=Volume of plankton concentrate (ml)

V= Volume of total water filtered (ml)

B. Lackey Drop Method

This method is employed for high density samples; it is a simple technique for enumeration of phytoplankton. In this method a sample is shaken gently to mix the content uniformly and 1ml of sample is taken on a cavity slide with the help of a pipette and after putting the cover slip planktons are counted under a microscope.

$$\text{Phytoplankton (Units/L)} = \frac{n \times c \times 10}{V}$$

Where, n =No. of plankton in 1ml sample

c =Volume of concentrate in 1ml

V = volume of Total sample filtered or sediment in ml.

Species Diversity

Shannon-Weaver Diversity Index

For examining diversity of all species Shannon-Weaver Diversity Indices is most widely used. It is derived from function used in the field of information to describe the degree of uncertainly of predicting the species which picked from random community by an ecologist.

As the number of species increases the uncertainty of occurrence increases.

The index assumes,

i. All species represented in sample,

ii. Individuals are randomly sampled from an indefinitely large population

Shannon- Weaver diversity Index calculated as,

$P= n/N$

Shannon Index (H) = $\sum pi \ln pi$

Simpson Index (D) = $1/\Sigma pi^2$

Where,

p = is proportion of (n/N)

n = Particular species

N = Number of individuals

Evenness Index (e) was calculated by the formula ,

$e = H / \log_e s$

Where,

H = Shannon- Weaver Index

S = Number of species

Species richness (R) was estimated by following formula:

$R = S/\sqrt{N}$

Where,

S = Number of species

N = Number of individuals

Collection and preservation of Algae and diatoms

The collection of algae is requires minimum equipment: vials, jar and newspapers. Plankton net, which should be at least as fine as 24 mesh is required.

Floating of algal mats and aquatic seed plants furnish the larger forms as well as the small epiphytic forms .Collection of concentrated can be made by diatoms, desmids and many planktonic forms. A large handful of material is held over a wide mouthed jar and squeezed thoroughly until nothing more drips into the jar.Many

motile forms die and disintegrate rapidly so special care is keeping collection cool and examine it as soon as possible.

Algae are preserved in3.5 to 4.0 % formalin solution in vials and jars. Low that is 2.5 percent of formalin gives good preservation with little if any shrinkage.

Diatoms are unicellular algae, usually microscopic, that are characterized by having cell wall of silica, and the critical identification usually involves examination of cleaned material with an oil immersion objective. Cleaning is accomplished by boiling the material with nitric or sulphuric acid to which an oxidizing agent (usually potassium dichromate) is added. It is then repeatedly washed with distilled water, allowing the frustules to settle before decantydrax or euparol.

Staining of free living ciliates and flagellates

A combined method for rapid fixation and adhesion of free living ciliates and flagellates, Dabhade (2006).

Take a drop of a biological material on a clean slide, remove the escess of sample with blotting paper. Add a drop of "N" Fixative (Saturated Mercuric chloride 10 Volumes +Glacial Acetic Acid 10 Volumes +Formaldehyde 10 Volumes +Tertiary Butyl alcohol 0.5 Volumes) while still wet and keep it for five minutes. Pass through the following solutions.

Lugol's iodine	5min
70% alcohol	5min.
50% alcohol	5min.
30% alcohol	5min
Haematoxylene	15min. to 30min.
Acid water	Few dips.
Rinse in tap water	5min.
30% alcohol	5min
50% alcohol	5min.

70% alcohol	5min.
90% alcohol	5min.
Eosine	Few dips
90% alcohol	5min
Xylene	Few dips.

Mount in DPX/Canada balsam.

"N" Fixative = Saturated,Mercuric chloride 10 Volumes + Glacial Acetic Acid 10 Volumes + Formaldehyde 10 Volumes+ Tertiary Butyl Alcohol 0.5 Volumes.

Logol's Iodine = 6g Potassium iodine dissolved in 40ml of distilled water. Add Iodine 4g. And dilute it to 100 ml (Add 60ml of Distilled water).

Haematoxylene stain = 0.5g of Haematoxylene dissolved in 50ml of hot Distilled water, cool and dilute it by adding 350ml of hot distilled water, add 100ml of aqueous Tungstophosphosphoric acid.

Acid water = 5 drops of conc. HCL in 100 ml distilled water.

RESULT AND DISCUSSION

4.1 PHYSICAL PARAMETERS

4.1.1 Colour

Colorationis a unique properties of lake water on which we can determine the status and quality as well as roughly predicted the phytoplankton and zooplankton density of that lake. Lonar water appears variable colour in different seasons that means different months also because of changing weather. During the study periods in month of January to May it was Olive green colour it might be due to monsoon during which some organic materials, sand particles are drained with flow of water, in month of Jun to September it was Yellowish Green and in month of October to December it was Pale green might be due to plankton population increases in that months. On sampling site S4 was observed Dark olive Green in 2000 to 2003 observed by Dabhade (2006). Siddiqi (2008) observed the colour of crater water resemblances dark green pea or called it 'algal soup'.

The lake water observed to be blue green in colour due to dominance of algal bloom in lake water was studied by Verma et al., (2013). According to Borul (2012) colour of the lake water is also light green to dark green because of the dense algae population with predominating spirullina. Satyanarayan et al.,(2008) observed the colour of the lake which was strong murky to murky. Yannawar et al.,(2013) observed Greenish colour during its study periods. We know color of water is due to phytoplankton, zooplankton, sand particles, organic particles and metallic ions etc. If water colour is clear or colorless or light green or blue in color when phytoplankton is more, If Zooplanktons are their then it develops a brown color. Water with black, blackish green, dark brown, red, yellow color is not good for culture. The red colour of water is due the presence of high levels of iron and death of phytoplankton. According to APHA (1998)color is determined by visual comparison of sample with known concentration of colored solution .Comparison is also made with special property calibrated with that of glass disks held the end of metallic tubes containing glass comparator tubes filled with sample and colorless distilled water. Sample color is matched with the color of tube of clear water and calibrated colored glass viewed by looking towards a white surface. Each disk is calibrated to correspond with the colors of the platinum-cobalt scale.

Fig. No. 19: Show Olive Green colour during January

Fig. No. 20: Show Pale Green colour in November

Fig. No. 21: Show Yellowish Green during the September

4.1.2 Temperature

Temperature of water was recorded monthly, during the study periods mean of temperature was observed 26.38±2.2556. The highest water Temperature in 2013 was observed in month of May which was 31 ^{0}C from sampling site S4 and Lowest was 21^{0}C in month of August from sampling site S1. In 2014 highest water Temperature was observed in month of July which was 32^{0}C from sampling site S4 and Lowest was 21^{0}C in month of November from sampling site S1. From the four different sampling sites mean water temperature was different, in sampling site S1 it was 25.583±2.314, in sampling site S2 it was 25.83±2.48, in S3 it was 26.92±2.84 and in sampling site S4 it was 27.5±3.12 degree Celsius in 2013. During 2014 on sampling site S1 it was 25.25±2.4, S2 25.67±2.34, S3 26.67±2.15 and S4 26.29±2.4 degree Celsius. In 2013 water temperature was rising in all four sampling site while in 2014 it was quite similar in first two sampling site that is S1 and S2, slight increasing the temperature value in site S3 and S4. The mean value of 2013 annual water temperatures was 26.458ºC±2.736and 26.38±2.2556 ºC in 2014 depicted in **Table no 1**and **Graph plate I.**

In present study the water temperature 2013 and 2014 in four sampling sites S_1, S_2, S_3 and S_4 were compared it observed't' value in S1 was found 0.345079, in S2 it was 0.169031, S3 0.243114 and in S4 -0.07571 that is it did not show much variation in temperature in first three sites but slight fluctuation in the sampling site S4. The observed 'p' value of both the years on different sampling sites are, in S1 it was 0.737712, S2 0.867317, S3 0.810169 and S4 0.940333 such value are accepted due to vary few change in temperature. The 'f' values of such sites are 0.888297 in S1, 0.859524 in S2, 0.36494 in S3 and S4 was 0.258379, according to it all such values are accepted due to slight change and such change in water temperature was observed due to seasonal variation, site to site probably due to variable times of observations. The water temperature is important factor for indicating the quality of water. It affects the aquatic organism, chemical solutes and dissolved oxygen and carbon dioxide in water.The water temperature shows seasonal variation in change in atmospheric temperature, but in the present investigation water temperature found higher in the month of May and July and lower in August and November. The

different groups of algae may have different temperature optima for the growth, the maximum temperature for chrysophytes growth tend to be about 24 to 27^0C and this in part explain their presence in arctic lakes and rare occurrence in warm water lakes. The optimum temperatures for the growth of most diatoms are found to be around 20^0C.

The diatomsNitzschia, Amphiprora and Cylindrotheca are common under ice flora during winter stratification in temperate lakes. Most of the green algae favour the temperature of 20 to 30^0C for their growth and when the temperature raised then green algae replaced by the blue green algae. Therefore the temperature of water may decide that which groups of algae is more favored in that water. The water temperature can influence the growth of algae both by direct and indirect, the direct effects is on algal metabolism due to increases in biological activity of algal cells like rate of diffusion, carrier mediated uptake, cell division and overall growth by a factors of about 2 for each 10^0C rise in temperature and thereafter their decline with further increases in temperature has been observed. Another one direct effects observed on change in light compensation point as the respiration rate decreases with decreasing temperature. This trend supported by the observation of Dabhade (2006). Water Temperature shows positive correlation with pH, turbidity, T.D.S. Conductivity, Carbonate, Total hardness and magnesium hardness but it shows negative correlation with dissolved oxygen, CO_2, bicarbonate, calcium hardness in 2013 and 2014. The ambient atmospheric and sub surface water temperature show marked seasonal changes by Siddiqui (2008) the maximum water temperature was observed 35^0C in summer while minimum was observed 23^0C in winter season. Yannawar et al., (2013) average temperature detected 24.6^0C.Baloch et al., (2008) studied the water temperature range between 13.5^0Cto 32^0C is reported to be suitable for the development of the planktonic organisms.

4.1.3 pH

Lonar Lake is famous for its alkalinity but now a day it was observed that its pH value goes on changing. The pH value of all four sampling sites was 10 though out the study periods. The pH value was 10.5 in 2000 to 2003 according to Dabhade (2006). Tambekar et al.,(2012) studied the soda lake are a specific type of salt lake

with high to extremely high carbonate alkalinity, a pH from 9 to 11. Average pH was 8.13 recorded by Yannawar et al.,(2013) the controversial results obtained by Pawar (2010) observed the pH 10.2 to 10.5.

Lonar Lake water pH was decreases due to thatnumber of world's different researcher and scientist take attention on the Lake, whether this alkaline lake can loss their alkaline nature such question mark on them?. Behind this several microbiological activity may responsible for lowering the pH of Lake these are, it may due to the production of carbon dioxide by respiring bacterial cells, Oxidation of hydrogen sulphide or sulphur to sulphuric acid or other acid sulphates, due to decomposition of organic matters, assimilation of ammonia as a source of nitrogen, formation of nitrites or nitrates and liberation of phosphates from organic compounds.

4.1.4 Electrical Conductivity

Electrical Conductivity measured monthly the mean of both the years was 12.621 mS. ±2.5289. Highest conductivity was measured 16.4 mS in the month of May on sampling site S3 and lowest was 9.4 mS in April on sampling site S1 in 2013. In 2014 highest was recorded in the month of Jun on sampling site S1 17.4 mS and lowest was 7 mS on S2 in the month of August. Electrical conductivity was more in 2014 than 2013 due to ionic composition of water which was more in 2014 than 2013.

Form the four different sampling site mean conductivity was measured, on sampling site S1 it was 11.867 ± 1.2695mS, on site S2 it was 12.708±1.61 mS, on sampling site S3 it was 13.26±1.786mS, on S4 it was 12.925±1.79 mS in 2013. In 2014 sampling site S1 was observed 12.713±3.44mS, on S2 12.43±3.373 mS on S3 site it was 12.57±3.375 mS and on sampling site S4 it was 12.5±2.961 mS. The Electrical conductivity of four sampling site was observed less in 2013 than 2014 in sampling site S1 while in 2014 all four site have near about same conductivity just very few fluctuation in their values but in 2013 such conductivity values was increases from sampling site S1 to sampling site S4. In 2014 sampling site S1 have highest value in the month of Jun due to the flow of clay soils in rainy seasons which tend to have higher conductivity because of the presence of such material that ionizes when they added in to the water hence conductivity was observed more as compared

to other. For comparative study related to overall both years it was observed that in 2013 12.69±1.658mS and in 2014 it was 12.553±3.1887mS hence the conductivity of both the years was observed nearer to equal.

The Electrical conductivity of four sampling sites compared with the two years by taking their 't' values are, in sampling site S1 it was -0.79843, S2 0.25646, sampling site S3 0.62892 and sampling site S4 was 0.422953. The 'p' values of sampling site S1 was 0.43315, sampling site S2 was 0.79998, S3 was 0.53587 and sampling site S4 was 0.67645. The 'f' values of sampling site S1 was 0.002535, S2 was 0.021111, sampling site S3 was 0.04536 and sampling site S4 was 0.109464. All such values are accepted and no more change was observed during the study periods. Electrical conductivity of Lonar Lake was 19273 to 19493 mg/L was observed by Pedge et al.,(2013). Electrical conductivity values are in **Table no.2** and**Graph plate II**.

4.1.5 Total Dissolved Solids (TDS)

Total dissolved solids (TDS) is used to measure amount of particles that dissolved in water, that is nitrates, calcium, magnesium, sodium, potassium, iron, carbonates and bicarbonate. During the study periods mean of TDS was observed 6.9107±1.0044 ppt. Total dissolved solids were found to be maximum in the month of Jun on sampling site S4 which was 8.3 ppt. and minimum was 4.2 ppt in month of January on sampling site S2 in 2013. In 2014 highest value of TDS was observed on sampling site S2 in month of February which was 8.5 ppt and lowest was 5.5 ppt in the month of January on S1. The mean of TDS in all four sampling sites are S1 6.38±0.889ppt. In sampling site S2 it was 6.2±1.019ppt, in sampling site S3 it was 6.82±0.751ppt. And on sampling site S4 it was observed 6.617±1.0134ppt, in 2013. While in 2014 sampling site S1 was 7.271±1.076ppt, on sampling site S2 it was observed7.242±1.007ppt, on sampling site S3 it was 7.315±0.908ppt and on sampling site S4 it was 7.447±0.762ppt. The mean of TDS in2013 was observed 6.503±0.925ppt and in 2014 it was increases to 7.319±0.9185ppt.

The TDS of four sampling sites of both the years are observed 't' value on sampling site S1 was -2.21473, on S2 it was -2.51941, on sampling site S3 it was -1.46496 and on sampling site S4 it was -2.26764. Their 'p' value was on S1 0.037442, on S2 it was 0.019521, on S3 0.157078 and S4 0.03352. The 'f' values are on S1 0.536632, S2 0.968477, S3 0.537149 and S4 0.358462 all these values are accepted there is no any major change in TDS. But during the 2013 TDS value was less as compared to 2014. The highest TDS value was recorded on sampling site S4 near the Dargaha and S2 near the Kamaljadevi Temple because of the erosion of rocks and soils of the escarpment that may be contain calcium bicarbonates, nitrogen, iron phosphates, sulphates and some other minerals can entered in to the lake water and they dissolved in it due to that the value of TDS goes on increases during the study periods. The total dissolved solid is in the range of 6.4 mg/L to 15.2 mg/Lobserved by Pawar (2010).Average TDS was 770 was observed by Yannawar et al.,(2013) According to Gaikwad and Sasane (2013) Lonar lake water has very high TDS about 5696 mg/L, showing unsuitability of water for domestic use and possibility of pollution by the various human activities. Pedge et al.,(2013)observed strong relationship between the physicochemical parameters according to it TDS values possessed a strong positive relationship with pH, chlorides, salinity and EC.

The TDS values are mention in **Table no. 3** and **Graph plate no III.**

4.1.6. Transparency

Transparency was estimated with the help of Sacchi disc. During the study periods transparency was nil observed. On sampling sites S3 and S4 throughout the periods there was marshy area due to that it was not observed and on sampling sites S1 and S2 during rainy season slightly transparency was observed and was decreases in the winter season. **Physical parameter Photo Plate I**

Similar results were observed by Siddiqi (2008). In Monsoon season turbidity is increases due to rain water flow in the reservoir from all sides, similar result obtained by Agarwal and Rajwar (2010), according to them increased turbidity in

monsoon month attributed to soil erosion in nearby catchment also suspended solids. Turbidity was found different i.e. maximum turbidity found in month of February, due to human activity and decrease in water level reported by Manjare et al.,(2010).

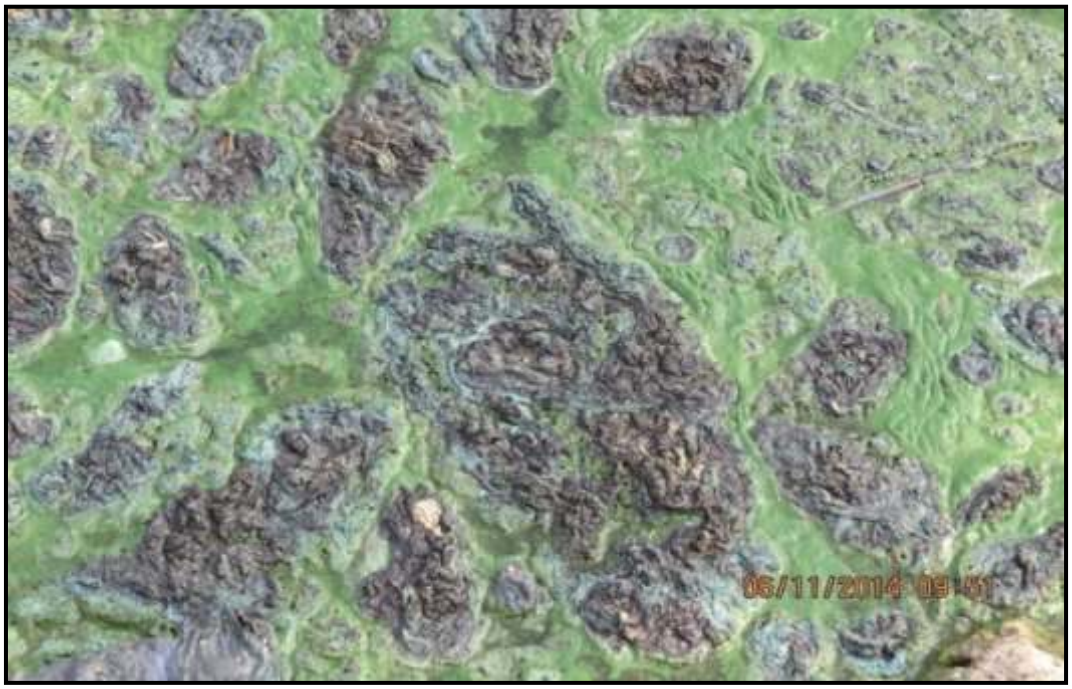


Fig. No. 22: Physical Parameter on Sampling Site S4 shows dence algae and Marshy place

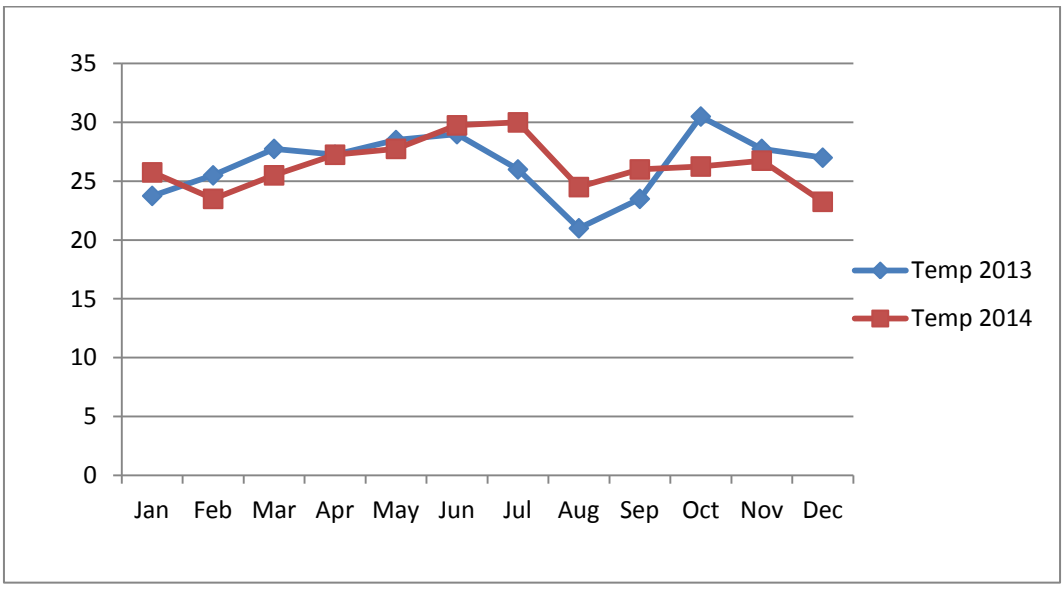
Fig. No. 23: Algal Blooms on Sampling Site S3

Fig. No. 24: Algal Blooms on Sampling Site S3

Table No. 1: Comparison of mean Water Temperature in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Temperature Mean	2014 Temperature Mean
01	January	23.75±0.95743	25.75±0.5
02	February	25.5±0.57735	23.5±1.29099
03	March	27.75±0.95743	25.5±0.57735
04	April	27.25±0.95743	27.25±0.95743
05	May	28.5±1.91485	27.75±0.95743
06	Jun	29±1.1547	29.75±1.25831
07	July	26±0.8165	30±1.63299
08	August	21±0	24.5±0.57735
09	September	23.5±0.57735	26±0.8165
10	October	30.5±1.29099	26.2±50.95743
11	November	27.75±0.95743	26.75±1.25831
12	December	27±1.1547	23.25±2.62996

Graph Plate I -Physical Parameters

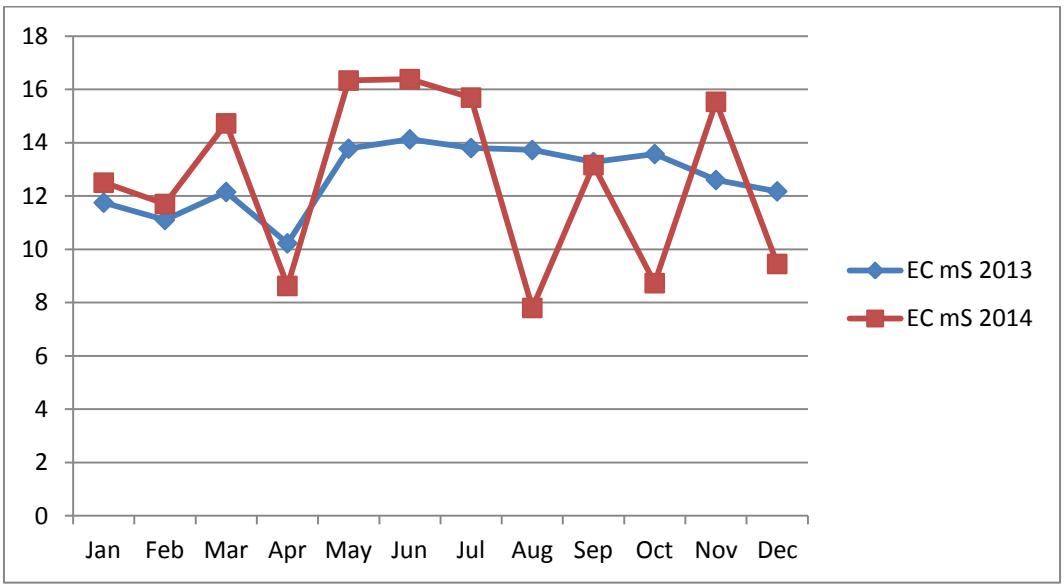


Graph plate No. 1: Shows Temperature variation in 2013 and 2014

Table No. 2: Comparison of mean of Electrical Conductivity in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 EC mS Mean	2014 EC mS Mean
01	January	11.75±0.36968	12.5± 0.82462
02	February	11.1±0.54772	11.7± 0.3559
03	March	12.15±0.35119	14.725± 1.09962
04	April	10.225±0.69462	8.625± 1.25797
05	May	13.775±1.97716	16.3325± 0.48767
06	Jun	14.125±1.08743	16.385± 0.67791
07	July	13.8±2.00167	15.6925± 0.34481
08	August	13.725±0.88459	7.8± 0.5831
09	September	13.275±1.2842	13.16± 0.11195
10	October	13.575±2.6056	8.73± 0.101
11	November	12.6±1.08628	15.535± 0.34924
12	December	12.175±0.47871	9.45± 0.05774

Graph Plate II -Physical Parameters

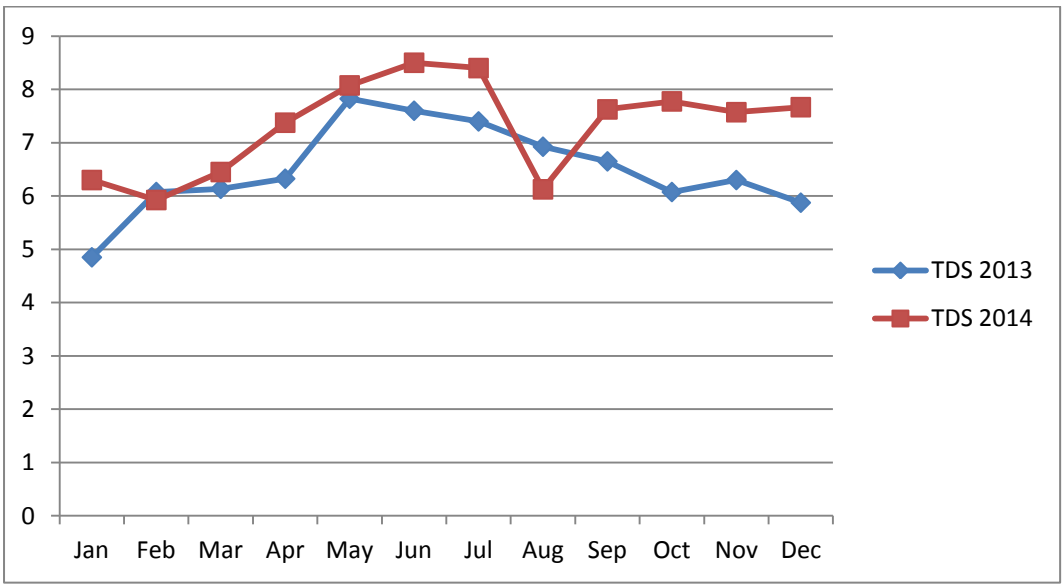


Graph plate No. 2: Shows EC variation in 2013 and 2014

Table No. 3: Comparison of mean of Total Dissolved Solids in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 TDS ppt Mean	2014 TDS ppt Mean
01	January	4.85±0.75056	6.3±0.8756
02	February	6.075± 0.20616	5.925±0.17078
03	March	6.135± 0.68768	6.45±0.67577
04	April	6.325± 0.09574	7.375±0.05
05	May	7.825± 0.3304	8.075±0.05
06	Jun	7.6± 0.46904	8.5±0
07	July	7.4± 0.1633	8.4±0.08165
08	August	6.925± 0.15	6.125±0.35
09	September	6.65± 0.3	7.625±0.20616
10	October	6.075± 0.88459	7.775±0.06137
11	November	6.3±0.83666	7.5725±0.16681
12	December	5.875±0.40311	7.66667±0.08165

Graph Plate III -Physical Parameters



Graph plate No. 3: Shows TDS variation in 2013 and 2014

4.2 CHEMICAL PARAMETERS

4.2.1 Dissolved Oxygen (DO)

The Dissolved oxygen is one of the major parameter of Lake Water the mean value of DO during the study periods was 4.485±2.796 mg/L. The highest value of DO was recorded in the month of September on sampling site S4 which was 11mg/L and lowest was 0.3 mg/L on same sampling site in the month of May 2013. While in 2014 the highest value of DO was recorded in the month of Jun on sampling site S4 which was 12.2mg/L and lowest was 0.3mg/L on same site in the month of April. The mean value of DO was recorded on four different sampling sites are on sampling site S1 it was 5.475±2.782mg/L, on S2 4.27±2.647mg/L, on S3 it was 3.942±3.3mg/L and on sampling site S4 it was 4.8±2.783mg/L in 2013. In the 2014 sampling site S1 DO was recorded 4.125±2.725mg/L, on S2 it was 4.43±2.55mg/L, on S3 4.03±2.558mg/L and S4 4.8±3.662mg/L.

The mean DO in a 2013 was observed 4.625±2.725mg/l and in 2014 it was observed 4.35±2.832mg/L. The comparative study of both years on four different sampling sites by taking their 't' values these are on S1 1.200854, on sampling site S2 it was -0.15718, on S3 -0.08175 and on S4 0.011698. The 'p' value on sampling site S1 was 242578, on S2 0.876536,onS3 0.935582 and S4 0.990772. Then 'f' values are 0.945762, 0.899828, 0.871218 and0.743031 onS1, S2, S3, S4 respectively.

Dissolved oxygen (DO) was vary few in summer season while more in monsoon on sampling site S1 and S2 it was slightly more as compared to sampling site S3 and S4. Vary low value of DO was recorded on sampling site S4. DO value was decreases from 2013 to 2014 on sampling site S3 and S4. During several month value of DO is highest due to the rain water entered in to lake and on that day value of DO was observed vary high but in summer 2013 and 2014 month of May and April DO was observed negligible while on other month DO recorded below 4mg/L.

Dissolved Oxygen is lowest during the summer and it may due to low rate of diffusion of atmospheric oxygen because the water surface is always covered with scum of organic detritus and algae. During several months they DO values was observed very negligible which indicates the Lake water is eutrophic Dabhade (2006). Average DO was recorded 1.64mg/L by Yannawar et al.,(2013). The solubility of

oxygen increases by low temperature and salinity Piska (2000), Bhave and Borse (2001).The DO value was observed more in winter as well during the early summer season because the photosynthetic activity is more during that period. The dissolution of oxygen from the atmosphere is the major source of oxygen in any water body. The rate at which the oxygen diffuses in to the water from the atmosphere increases as the water turbulence increases. Although the dissolution of oxygen from the atmosphere occurs at the surface, its downward movement in to the water body required mechanical mixing or mass flow of water. The rate of diffusion of dissolved oxygen through water is so slower. The another source of dissolved oxygen in water is photosynthesis by phytoplankton's, which are usually occurs in subsurface water. **Table no. 4 and Graph plate. No. I**

4.2.2 Carbon dioxide(CO_2)

During study periodsFree Carbon dioxide (CO_2) was observed absent on all four sampling sites. Free CO_2 was absent due to the activity of respiration in Lonar Lake water. It indicates that water contain high amounts of zooplanktons are there means respiration was more and less amounts of photosynthesis is there. May these free CO_2 converted carbonate as well as in bicarbonates. Same results were observed by Dabhade (2006).

4.2.3 Total Alkalinity

Total alkalinity is due to the presences of carbonates and bicarbonates. When free CO_2 was absent in the lake water then that may converted in to this form of alkalinity. There are two type of alkalinity was observed in this study.

4.2.3.1 CO3 (Carbonate Phenolphthalein alkalinity)

During the study period mean of Carbonate was found 1181± 774.3 mg/L. The highest value of carbonates value was observed on sampling site S1 in the month of Jun is 1740mg/L and lowest was observed 340mg/L in the month of December on sampling site S4 in 2013. In 2014 highest carbonates value was observed 3194mg/L in the month of November on sampling site S1 and lowest was observed in the month of January on site S3 was 442mg/L.

The mean Carbonates values of four different sampling sites in 2013 are S1 729.83±382.95mg/L, S2 726.1±402.7mg/L, S3 717.3±379.3mg/L and on sampling site S4 it was 718±382mg/L. In 2014 on sampling site S1 1695±887.5mg/L, on sampling site S2 1537±833mg/L, on S3 1650±751.9mg/L and sampling sites S4 it was 1674±826.4mg/L. The mean value of carbonates in 2013 was observed 722.7±374.3mg/L and in 2014 it was 1639±801.8mg/L. The comparative study of both years on four different sampling sites are by taking their 't' values are S1 was -3.45887, on sampling site S2 it was -3.03611, on sampling site S3 it was -3.83687 and on S4 -3.63964. The 'p' value of S1 was 0.002234, S2 0.006064, S3 0.000897 and S4 0.001446. The 'f' values on S1 was 0.009614, S2 0.02344, S3 0.032211 and S4 0.016578 are observed.

All such values show the values are accepted and on that basis the values of 2013 and 2014 was different due to the change in pH of and also due to the runoff of alkaline substances and inorganic substances along with water. During the summer the carbonate values was much higher than the monsoon. In 2014 all sampling site was observed the high value of carbonates than 2013 it means the carbonates value goes on increases in to the lake water.Alkalinity of water characterized by its capacity to neutralize a strong acid is an important attribute of water. Pawer (2010) was observed the 3751mg/L Alkalinity in Lonar Lake water. Now a day the alkalinity of Lake Water decreases with decreasing the pH and According to Borse and Bhave (2000), the pH of water above 7 may be due to the presence of carbonates and bicarbonates. Yannawar et al.,(2013) Average alkalinity was observed 3660mg/l. The values of carbonates are shown in **Table no. 5 and Graph plate no. II.**

4.2.3.2 HCO_3 (Bicarbonate or Methyl Orange alkality)

The mean value of Bicarbonates(HCO3) was observed 1167±446.5mg/L. The maximum value of bicarbonates in 2013 was observed on sampling site S4 in the month of May which was 2284mg/L and minimum was on sampling site S3 in the month of Jun which was 161mg/L. In 2014 the maximum value observed on S2 in month of February which was 2224mg/L and minimum was 8mg/L on sampling site S1 in month of April. The mean value of bicarbonates on four sampling sites was observed in 2013 are on sampling site S1 it was 1097.83±396.67mg/L, on sampling

site S2 it was 1027±307.3mg/L, on sampling site S3 it was 1108±388.8mg/L and on S4 it was 1124±466.6mg/L. In 2014 the value of bicarbonates was observed on sampling site S1 it was 1207±505.5mg/L, on sampling site S2 1284±505mg/L, on S3 it was 1260±554.3mg/L and sampling site S4 it was observed 1230±518.9mg/L.

The bicarbonates value of both years compared with their specific sites by taking their 't' values are on sampling site S1 it was -0.5885, on sampling site S2 -1.40658, on S3 -0.87721 and on sampling site S4 -0.527. The 'p' value of S1 was 0.562159, S2 0.173522, S3 0.380985 and sampling site S4 it was 0.603467. The 'f' value of S1 was 0.434129, S2 was 0.062602, S3 0.616691 and S4 0.730512 all such values are accepted there is slightly change in their values in 2013 and 2014. The bicarbonates value in 2013 is lesser than 2014 for all four sampling sites. The highest value of bicarbonates was observed on sampling siteS4 due to the high density of zooplankton on that site and may due to the flow of fresh water from agricultural field runoff in to the lake water sites. **Table no. 6**and **Graph plate no. III.**

The total value of carbonate and bicarbonate increases in summer and decreases in the month of monsoon it may due to dilution water in rainy season and in summer less water increases the percentage of alkalinity in water body same results observed by Mazher et al.,(2004). In the natural and polluted waters, there are many other salts of weak acids such as silicates, phosphates, borates etc. which cause alkalinity in addition to that of carbonates and bicarbonates by Haroon et al.,(2010). Similar results were observed by Kanekar et al.,in (2008) the alkalinity in terms of Calcium carbonates which was found in between the range of 1500 to 1650mg/L.

4.3 HARDNESS

4.3.1 Total Hardness

The mean of Total hardness during the study was 81.385±26.543mg/L. The highest value of total hardness was observed on sampling site S4 in the month of Jun which was 162mg/L. and the lowest was observed on the sampling site S2 in the month of December in 2013. While in 2014 the highest value of total hardness was observed on the sampling site S1 in the month of May which was 178mg/L and lowest was observed on sampling site S1 in month of February which was 36mg/L.

The mean of Total hardness from four sampling sites in 2013 are on sampling site S1 it was 93.5±27.662mg/L, on sampling site S2 it was 78.5±30.69mg/L, on S3 79.42±30.21mg/L and on sampling site S4 it was 83.67±33.66mg/L. In 2014 the mean of total hardness was observed on S1 it was 84.83±35.301mg/L, on S2 76±12.71mg/L, on S3 79±16.42mg/L and on S4 it was 76.17±19.88mg/L. In 2013 the mean of Total hardness was observed 83.77±30.24mg/L and in 2014 it was 79±22.317mg/L. Total hardness of both years of four different sampling sites was compared by taking the 't' values these are on sampling site S1 it was 0.669423, on S20.260718, S3 0,041978 and on sampling site S4 it was 0.6646. The 'p' values of four sampling sites are on sampling site S1 0.510191, on S2 0.796735, on S3 0.966895 and on S4 0.513213. Then the 'f' values are 0.431377, 0.006846, 0.054531 and 0.094743 on S1, S2, S3 and S4 respectively.

During the study periods Total hardness was observed more on sampling site S4 generally in the summer while the value was recorded vary low in the winter. The water hardness was understood to be a measure of the capacity of water to precipitate soap and the soap is precipitate by the presence of calcium and magnesium ions.Total hardness of water increases mainly due to the presence of these two ions and such ions may increases due the human washing clothes, bathing activities etc. **Table no. 7.**And **Graph plate no. IV.** The total harness was recorded higher in summer; it might be due to decrease in water level and rate of evaporation of water. Similar results observed by Satyanarayan et al.,(2008). Yannawar et al.,(2013) observed 130mg/L average total hardness. Shinde et al.,(2013) was observed controversial results. According to Verma et al.,(2013)Total Hardness was 138- 141mg/L in 2009 but now values of total hardness was observed slightly more during this study.

4.3.2 Calcium

Calcium is major cation found in water. During the study period calcium was found 35.161± 16.12mg/L. The maximum Calcium value was found on sampling site S2 in the month of February which was 70.7mg/L and minimum was 20.2mg/L in the month of Jun on sampling site S4 in 2013. In 2014 the maximum calcium value was observed on same sampling site which was observed in 2013 but the value was much increase than it which was 101mg/L in the same month and minimum was 15.15mg/L

in the month of September on site S1. In 2013 the four different sampling sites mean of calcium was observed values are on S1 it was 32.2575±8.49068mg/L, on S2 34.298±16.028mg/L, on S3 30.85±5.902mg/L and sampling site S4 it was 31.068±7.3998mg/L. In2014 on sampling site S1 it was observed 39.063±16.416mg/L, on S2 it was 39.69±23.92mg/L, on S3 36.48±15.69mg/L and S4 it was 37.59±25.33mg/L.

The mean calcium value of first year was observed 32.118±7.3998mg/L and in second year it was 38.204±20.161mg/L. The comparative study of both years on four sampling site by taking their 't' value was observed on sampling site S1 it was -1.27545, on S2 -0.64848, onS3 -1.1635 and on S4 -0.85572. the 'p' value on S1 was 0.215453, S2 0.523386, S3 0.257092 and S4 0.401377. The 'f' value was observed onS1 0.038582, S20.199762, S3 0.003021 and S4 0.000298. All values are accepted; in 2013 the observed calcium value was less than 2014 it means the value was increases in the lake water. The Diatoms predominates in the calcium rich water. **Table no. 8**and **Graph plate no. V.** The maximum desirable limit of calcium in drinking water is 75mg/l (W.H.O), therefore above recorded value of calcium, it indicate water is not use for drinking purpose. Maximum value of calcium in winter season, controversial result obtained by Harney and et al.,(2013) recorded calcium hardness minimum in winter season. Ravikumaret al.,(2005) reported the maximum calcium hardness in April month in Ayyanakere tank in Harapanahalli town in Davangere district of Karnataka.

4.3.3 Calcium Hardness

The mean of both years calcium Hardness was 8.7739±4.0228mg/L. The highest value of Calcium Hardness was observed in the month of February on sampling site S2 which was 17.64mg/L and lowest was observed on sampling site S4 5.04mg/L in 2013. In 2014 the highest value was observed in the same month on same sampling site which was 25.2mg/L and lowest was on sampling site S1 in month of July which was 3.99mg/L. The mean of calcium hardness on four different sampling sites was observed, in S1 it was 8.0483±2.1171mg/L, on sampling site S2 it was 8.5575±3.9997mg/L, on S3 7.7±1.47mg/L and on S4 it was 7.753±1.8513mg/L in 2013. In 2014 the values of calcium hardness was observed on sampling site S1

which was 9.7475±4.0961mg/L, S2 has 9.905±5.97mg/L, S3 9.1±3.915mg/L and S4 has 9.38±6.323mg/L. The average mean of calcium hardness in 2013 observed value was 8.0146±2.494mg/L and in 2014 it was 9.5331±5.0312mg/L.

The calcium hardness of both the years compared with each other from their four sampling sites by taking 't' values these are, on sampling site S1 it was -1.27658, S2 -0.64959, S3 -1.15981 and S4 was -0.8557. The 'p' values are on sampling site S1 0.215063, S2 0.522682, S3 0.25856 and S4 0.401386. The 'f' values are on S1 0.038398, S2 0.199775, S3 0.002968 and S4 0.000305. All values are accepted the variation on it is due to the change in concentration of calcium hardness in the lake water. The observed calcium hardness in 2013 was less than 2014 hence the value of calcium hardness goes on increases in lake water. Similar results obtained by Siddiqi (2008). Borul (2012) obtained 110 to 162mg/L calcium hardness and Pawar (2010) Recorded the Calcium is an important element influencing flora of ecosystem which play role in metabolism and growth and the highest calcium hardness was found in pre-monsoon season due to evaporation of lake water during summer while least content was recorded in monsoon and post-monsoon season. Average Calcium hardness 40mg/L was observed by Yannawar et al.,(2013). Satyanarayan et al.,(2008) also say the calcium hardness was in the same range. **Table no. 9** and **Graph plate no. VI.**

4.3.4 Magnesium Hardness

Magnesium Hardness was calculated from removing calcium hardness from total hardness. The mean of both years was 17.07±6.5372mg/L. The highest value observed in the month of May at sampling site S4 37.3mg/L and lowest was 7.09mg/L on site S4 in 2013 December. While in 2014 highest and lowest was observed on sampling site S1 in different month highest was 41.02mg/L in May and Lowest was 4.68mg/L in February. Mean of Magnesium hardness on four sites in 2013 are S1 has 20.8275±6.9061mg/L, S2 17.077±7.9042mg/L, S3 17.48±7.466mg/L and S4 18.514±8.2817mg/L. In 2014 observed values are S1 18.312±8.7053mg/L, S2 16.12±3.108mg/L,S3 17.05±3.8mg/L and S4 16.29±4.133mg/L. The mean of whole year in 2013 was observed 18.474±7.5525mg/L and 2014 it was 16.94±5.3046mg/L. The comparative study of Magnesium hardness in both years by taking their't' values

are on S1 0.784451, S2 0.391556, S30.177458 and S4 0.834322. The 'p' values are on S1 0.453839, S2 0.001153, S3 0.034341 and S4 was 0.029727. All such values are accepted in 2013 Magnesium hardness was observed high as compared to 2014 and also observed high in the month of May. Similar results were obtained by Satyanarayan et al.,(2008)and controversial results obtained by Pawar (2010). Yannawar et al.,(2013) Average magnesium hardness was recorded 21.75mg/L. **Table no. 10**and **Graph plate no. VII.**

4.4 CHLORIDE

During the two years study periods mean of Chloride was 4355.9±855.96mg/L observed. The highest value of chloride was observed in the month of February on sampling site S1 in 2013 which is 5537.29mg/L and lowest was in April on same site which was 3282.6mg/L. In 2014 highest was in August on S4 6594.07mg/L and lowest in October on S3 was 2467.32mg/L. The mean observed value of chloride in first year on four sampling sites are S1 has 4180.63±684.94mg/L, S2 4080.7±480.86mg/L,S3 4249±496.6mg/L and S4 4406.9±512.26mg/L and in second year S1 was 4498.5±1061.7mg/L, S2 4660±1298mg/L, S3 4610±990.8mg/L and S4 4162±979.4mg/L. The mean value of chloride in 2013 was observed 4229.3±545.39mg/L and in 2014 it was 4482.6±1072.7mg/L.

The 't' value of four sampling sites of both years are S1 -0.87143, S2 -1.44949, S3 -1.1275 and S4 0.76628. The 'p' value was S1 0.392928, S2 0.161349, S3 271679 and S4 0.451654. The 'f' values are S1 0.161567, S2 0.002646, S3 0.030717 and S4 0.041808 all such values are accepted chloride of 2014 was observed vary high than 2013 it means chloride values increases in the lake water. Values shown in **Table no. 11**and **Graph plate no. VIII.** The chloride value was higher in summer and minimum during winter season in both the year of study period. Similar result obtained byBorul (2012). Shinde et al.,(2011), according to them Higher level of chlorides in natural water is indication of pollution and domestic sewage. The result obtained by Pulugandi (2014) was chloride value minimum in winter and maximum in monsoon season.Chlorides occur naturally in all types of water. In nature fresh water its concentration is low. The maximum chloride value was observed in month of May and minimum value in month of August by

Bhawankar et al.,(2011). Pawar (2010) recorded the high value of Chloride in pre-monsoon season while minimum in monsoon and post- monsoon. Verma et al.,(2013) observed variable high range of chloride in Lake water. Several controversial results also found by Satyanarayan et al.,(2008) according to it average Chloride content was 2135mg/L making it unit for both Human and Cattle consumption and also for agricultural use. Chloride value of Lonar Lake was exceedingly high perhaps unprecedented by Siddiqi (2008). Yannawar et al.,(2013) observed chloride value in post- monsoon was 3017.5mg/L, in pre monsoon it was 3337mg/L and in monsoon it was 31.90mg/L.

High chloride found in inland saline lake, chloride level indicates pollution from domestic sewage through chloride level as high as 250 mg/L is safe for human consumption; a level above imparts a salty test to the potable water. Chloride was observed in variable ranges at sampling site S1 and S2 it was slightly fluctuated while on sampling site S3 and S4 it was greatly fluctuated because of the main fresh water stream is joining at site S4 brings down to its chloride level which in summer through not adding much water rich in discharge of domestic wastes, have comparatively which is adding during the monsoon and winter by Dabhade (2006).

4.5 SALINITY

Salinity can also calculated from chloride also, during the study periods mean of salinity was 7947.3±1556.3g/L. The highest value of salinity was observed in the month of February on sampling site S1 which is 10160.9g/L and lowest was in month of April on same site was 6023.7g/L in 2013. In 2014 the highest value was found on sampling site S2 in the month of July which was 13530.5g/L and lowest was on S4 in month of September 4501.5g/L. The mean value of salinity on different sampling sites in2013 was S1 7617.29±1241.24g/L, S2 7434.4±844.99g/L, S3 7786±871.3g/L and S4 7576.9±1769.3g/L. in 2014 S1 has 8202.7±1958.6g/L, S2 8489±2354g/L, S3 8400±1813g/L and S4 7577±1769g/L. The average mean in 2013 was observed 7727.3±985.15g/L and in 2014 it was 8167.4±1956.1g/L.

The comparison of both years by taking their ‘t’ values on four sampling sites are S1 -0.87451, S2 -1.46156, S3 -1.05824 and S4 0.854375. The ‘p’ value was S1

0.391287, S2 0.157998, S3 0.301427 and S4 0.4021105. The 'f' values of sampling site was S1 0.145681, on S2 0.002003, on S3 0.022415 and S4 0.048428. Above all values are accepted and difference was observed in Salinity in 2014 was slightly higher as compared to 2013.It not shows very significant difference in total four sites during the study periods. **Table no. 12**and**Graph plate no. IX.**

The low temperature of the water may also higher amount of inorganic salts dissolved in it responsible for high salinity of the lake by Pawar (2010).Similar results obtained by Borul (2012). Yannawar et al.,(2013) observed average salinity during its study periods it was 2326.6mg/L and in pre monsoon it was high near about 6023.31mg/L. In some saline lake known salinity ranges from 200000mg/L in Salt Lake of Utah, United States and in Dead Sea Russia. Salinity of Borax Lake in California reported range of 28000-60000mg/L Wetzel (2001). According to Siddiqi (2008) salinity ranges from 2300-3900. An immediate and significant effect of rise of water level of the lake is responsible for change in water quality Dabhade (2006) they also observed the Lonar Lake water have increases water level several feet due to the well submerge which was located near the Kamaljadevi temple. They also suggested the water from the lake is percolating into the Crater Lake which is situated several hundred feet lower that the levels of surrounding plateau.

4.6 PHOSPHATE

Lonar crater is totally surrounded from all sides in to alluvium fan agricultural activity was done and several fresh water springs are also be there such water is use for Bathing and washing of clothes due to that such water entered in to the lake water by Phosphates was estimated. The mean of Phosphate from both the years was found 1.6378±1.245mg/L. The highest value of phosphates was observed in the month of May on sampling site S4 which was 3.4mg/L and lowest was in S1 month of December was 0.2mg/L in 2013 while in 2014 highest was 5.07mg/L in the month of September on sampling site S1 and lowest was 0.03mg/L on S3 in the month of August. The mean phosphates values from four sampling sites in 2013 are S1 1.15083±0.57326mg/, S2 1.2958±0.7688mg/L, S3 1,154±0.637mg/L and on S4 1.175±0.8829mg/L. in 2014 it was in S1 2.6242±1.6977mg/L, S2 2.069±1.324mg/L, S3 2.017±1,594mg/L and S4 1.617±1.345mg/L. During the first year mean

phosphates was observed 1.194±0.7045mg/L and in next year it was 2.0817±1.49448mg/L.

During the study the 2013 compared with 2014 by taking 't'from four sampling sites are S1 -2.84828, S2 -1.74957, S3 -1.74062 and S4 -0.95092. The 'p' values are S1 0.009349, S2 0.094131, S3 0.095721 and S4 0.351974. the 'f' value of S1 was 0.001153, S2 0.084876, S3 0.005124 and S4 0.178236. During the study periods Phosphates values was an increase, in 2013 it was less but in 2014 it was more. On sampling site S3 and S4 observed value of phosphates was more as compared to other two sites because on these site several agricultural activity was done that may use the fertilizers and pesticide which contain the phosphate that may the source of phosphates which was found in the lake water and another one things there is rocks which may contain the organic phosphorus and during the rainy season it may runoff with water and entered in to the Lake hence the concentration of phosphorous was increases in it. Shown in **Table no. 13** and **Graphplate no. X**.

Due to surface water runoff, agriculture run off, washer man activities increases inorganic phosphate in water in rainy season therefore phosphate level increases in monsoon season. Similar results obtain byBorul (2012) observed phosphates value in the ranges of 0.42 to 0.82mg/L. The phosphate of Lake Water was found 0.47mg/L in post-monsoon season while 0.42mg/L and 0.43mg/L in the pre-monsoon and monsoon season studied by Pawar (2010). Siddiqi (2008) Reported total phosphates in to the range of 2.8-2.9mg/L indicating good biotic utilization by the variety of aquatic biotic life forms and that it is not a limiting factor to biological growth in Crater Lake and such phosphates indicate eutrophication trends in Crater Lake. Satyanarayanet al.,(2008), Verma et al.,(2013)the phosphates values was ranges from 4 to 6mg/L. In post monsoon phosphates was 0.904mg/L and monsoon it was 1.690mg/L and average 1.076mg/L observed by Yannawar et al.,(2013). Higher concentration of phosphates which acts as the nutrients which is responsible for the increasing the growth of algae and plants and lid to Eutrophication, nitrates and phosphates their impacts are extremely varied and potentially destructive and both are in water body can contributed high BOD by Dabhade (2013) and Leng (2009).

4.7 SULPHATES

The mean of Sulphates from both the years was found 1.1118±0.7158mg/L. The highest value of Sulphates was recorded in the month of October on sampling site S2 which was 2.08mg/L and lowest was observed in the month of July on S4 0.22mg/L in 2013. The highest value of Sulphates in 2014 was observed on S4 in the month of February which was 5.43mg/L and lowest on S1 in April 0.3mg/L. The mean of Sulphates in 2013 from four different sampling sites are on S1 it was 1.01417±0.46281mg/L, 1.025±0.5522mg/L on S2, on S3 0.994±0.414mg/L and on S4 it was 1.1383±0.4883mg/L. In 2014 on observed values on sampling site S1 was 0.7142±0.3422mg/L, S2 1.195±0.802mg/L, S3 1.148±0.647mg/L and S4 1.666±1.33mg/L. The mean of Sulphates in 2013 was 1.0429±0.4696mg/L and in 2014 it was 1.1806±0.8975mg/L

The Sulphates in the lake water estimated for two years therefore that values compares with each other by means of 't' test, 'p' test and 'f' test, the 't' test of all four sampling site are S1 1.805594,S2 -0.60483, S3 -0.6919 and S4 -1.29016. The 'p' values are on S1 0.084685, S2 0.551478, S3 0.496237 and S4 0.21039. The 'f' value on S1 was 0.331041, S2 0.231533, S3 0.15484 and S4 0.00245. All values are accepted but there was a change in Sulphates concentration in the 2014 which was high as compared to 2013. On sampling site S4 Sulphates values was increases due to which lake water on this site was contain maximum diversity of plankton. Similar results obtained by Dbhade (2006). Borul (2012), Satyanarayan et al.,(2008) observed sulphates values in the range of 20 to 26.4 mg/L. Pawar (2010)observed Sulphates was 22 mg/L in pre-monsoon and monsoon season and 21 mg/L in post-monsoon season. **Table no. 14**and **Graph plate no. XI.**

4.8 SILICATES

During the study periods mean of Silicates was observed 0.3183±0.2194mg/L. The highest values was estimated in the month of August on sampling site S4 0.58mg/L and lowest was in December on S1 0.07mg/L in 2013 while in 2014 highest was observed in February on S1 1.1mg/L and lowest in September on S2 0.06mg/L. The mean of Silicates in 2013 from four sampling sites are S1 0.2375±0.127mg/L, S2 0.2442±0.1183mg/L, S3 0.264±0.081mg/L and S4 0.2867±0.1713mg/L. In 2014

mean of silicates was observed on four sites S1 0.4092±0.281mg/L, S2 0.438±0.336mg/L, S3 0.311±0.253mg/L and S4 0.357±0.224mg/L. In first years the observed mean value of Silicates was 0.2581±0.1258mg/L and in next year it was 0.3785±0.2721mg/L. During the study periods both years was compared to calculated their 't' values on four sites S1 had -1.92834, S2 -1.87774, S3 -0.60912 and S4 -0.86039. The 'p' values are S1 had 0.066817, S2 0.073738, S3 0.548683 and S4 0.398854. The 'f' values are S1 0.013939, S2 0.001659, S3 0.00073 and S4 0.389167. From above values on different sampling sites show variation in the concentration of silicates in 2013 silicates was less as compared to 2014 and silicate was observed slightly more on sampling sites S1 and S4.Contents of silicates may have triggered the overwhelming growth of Bacillariophyceae.

Silicate contents of the lake were recorded vary low from August silicates gradually increase during post-monsoon months and reach at its maximum during summer months by Dabhade (2006). Silicates is known to regulate availability and abundance and dominance of Diatoms in many aquatic environments, it has been recognized as determinant of algal community structure of the lake Siddiqi (2008) there are no studies on the range of values, temporal and spatial variations of silica and their biogeochemical importance in succession of phytoplankton community in aquatic environments, more so in extreme, hyper alkaline, saline environments as in impact crater lake. **Table no. 15**and **Graphplate no. XII.**

4.9 IRON

During the study periods mean of Iron was found to be 2.4483±1.1604mg/L. The highest values observed in the month of March on S4 was 4.12mg/L and lowest in Jun on S3 was 0.92mg/L in 2013. While in 2014 highest was observed also on S4 but in the month of August which was slightly more 4.96mg/L than 2013 and lowest on S1 was 0.28mg/L in month of October. The mean of Iron in 2013 on four sites was S1 3.01667±1.0298mg/L, S2 2.3967±0.7309mg/L, S3 2.233±0.918mg/L and S4 2.29±0.9978mg/L and in 2014 S1 was 2.47±1.4488mg/L, S2 2.683±1.336mg/L, S3 2.163±1.397mg/L and S4 was 2.333±1.328mg/L. The mean of Iron in 2013was 2.4842±0.9505mg/L was observed and 2014 it was 2.4125±1.3474mg/L. Both the study years was compared with related to their sampling sites by taking't' values.

The‘t’ values on S1 was 1.065388, S2 -0.65201, S3 0.145085 and S4 -0.09038. The ‘p’ values are S1 0.298254, S2 0.52115, S3 0.885965 and S4 0.928807. The ‘f’ values are S1 0.272863, S2 0.057125, S3 0.17965 and S4 0.357117. All observed values are accepted but in sampling sites S4 and S3 it was just more as compared to other two sites. Iron was observed vary trace amount during the study periods.

Ferrous was also recorded in almost traces as compared to to other observations of chemical parameters by Dabhade (2006). Siddiqi (2008) Iron exists in the form of soluble forms either as reduces ferrous or oxidized ferric forms it is essential micro nutrients and in chemically complex iron and manganese cycle in aquatic ecosystems, iron cycle is indeed regulated by bacterial metabolism in etrophic aquatic ecosystem.Shinde et. al.,(2013) observed vary less amounts of iron which was 0.40- 0.45mg/L. Heavy metals present in lake water do not pose any problem as the concentration were well within the limits by Satyanarayan et al.,(2008) also observed the iron values in the ranges of 1.76-1.90mg/L similar results of iron observed by Verma et al.,(2013). Yannawaret al.,(2013) observed average iron 8.33 mg/L. **Table no. 16**and **Graphplate no. XIII.**

4.10 NITROGEN

Nitrogen is most important parameter of the aquatic ecosystems. During the study periods the mean of nitrogen was observed 0.398±0.1769mg/L. The highest values was observed on sampling site S4 in the month of Jun which was 0.72mg/L and lowest was in the month of July on S1 was 0.08mg/L in 2013. In 2014 highest was in the month of April on S4 was 0.74mg/L and lowest was in the month of July on S1 was 0.12mg/L. The mean values of nitrogen on four sampling sites in 2013 was S1 0.18167±0.06767mg/L, S2 0.2858±0.1075mg/L, S3 0.498±0.135mg/L and S4 0.4708±0.1679mg/L. In 2014 S1 was 0.22±0.0512mg/L, S2 0.411±0.063mg/L, S3 0.548±0.11mg/L and S4 0.568±0.128mg/L. The mean value of nitrogen in 2013 was observed 0.3592±0.1794mg/L and in 2014 it was 0.4369±0.1673mg/L. For the comparative study between these two years on four sampling sites taking the ‘t’ values on S1 it was -1.56528, S2 -3.46907, S3 -0.99588 and S4 -1.59822. The ‘p’ values on S1 0.131789, S2 0.00218, S3 0.330135 and S4 0.124259 and ‘f’ values are S1 0.367875, S2 0.094439, S3 0.500462 and S4 0.386368. The nitrogen value was

observed more in the summer and Manson while lower in the winter. On sampling site S4 and S3 nitrogen values observed more than the other two sampling sites. The elemental nitrogen utilized by the Cyanophyceae members directly. The algae can utilize inorganic nitrogen compounds such as nitate, nitrites and ammonia as well as organic nitrogenous compounds like urea, uric acid and amino acids for their nitrogen need. The high concentration of nitrogen is toxic for the most algae.

The Lake water containing oxygen also interfere with the activity of nitrogenase enzyme complex in the nitrogen fixation generally it occurs in non-heterocystous species under anaerobic or microaerobic condition. It has been suggested that the occurrence of trichomes of Oscillatoria in bundles may be one mean of achieving microaerobic environment. Similar results obtained by Dabhade (2006) Nitrogen content of the lake water has been observed in the range of 0.05 to 0.7mg/L. Nitrogen often in concentration with the other naturally occurring elements, in most of the natural aquatic ecosystems often nitrogen is limiting to plant production by Siddiqi (2008).**Table No. 17 and Graph Plate no.XIV.**

4.11 AMMONIA

Ammonia observed in the lake water due to the several reasons one of them is Decomposition of organic matter or may due to the excretory product from Ammonotelic organism. During the study periods observed mean of Ammonia was 10.948±6.1051mg/L. The highest value of ammonia in 2013 was observed in the month of December on sampling site S3 30mg/L and 3mg/L lowest was observed on sampling site S4 in Jun. In 2014 highest value observed in April on S4 30mg/L and lowest in the month of October on same site was 2mg/L. The mean value of ammonia in 2013 from four different sampling sites was S1 13.333±6.1674mg/L, S2 13.275±5.4301mg/L, S3 11.72±6.74mg/L and S4 9.4583±5.7218mg/L. In 2014 mean of ammonia on sampling site S1 was 10.758±5.4206mg/L, S2 8.725±3.703mg/L, S3 8.228±4.283mg/L and S4 12.1±9.2mg/L. The mean ammonia in 2013 was 11.946±6.0524mg/L and in 2104 it was 9.9506±6.0558mg/L.

Comparative study between these two years by taking their ‘t’ values on four sampling sites are S1 1.089877,S2 2.398098, S3 1.513631 and S4 -0.84465. The ‘p’

values on S1 was 0.287561, S2 0.0254, S3 0.144354 and S4 0.407398. The 'f' values on S1 was 0.676003, S2 0.219925, S3 0.148083 and S4 0.13032. All the values of ammonia was accepted, there was slightly change in their concentration.

Ammonia was observed high as well as low in the sampling site S4 during summer it was observed high and in the winter was low. Then also as compared to both years value of ammonia was observed vary slightly unchanged. High amounts of ammonia and ammonical toxic compounds are produced during decomposition of the algae. Toxicity of these compounds kills the organisms Dabhade (2006).During the decomposition lot off ammonia produce along with low dissolved oxygen. Khobragade observed ammonia in lake water was 11.46mg/L. Ammonia is the product of organic decomposition Siddiqi (2008).**Table No. 18 and Graph Plate no.XV.**

4.12 NITRITES (NO_2N)

During the study periods mean of Nitrites was 6.3833±4.8696mg/L observed. The highest value of Nitrites was observed in the month of May on S4 20mg/L and lowest was in March on S3 0.9mg/L in 2013. On sampling site S1 in the month of February it was observed that the Nitrites values near about same 19.5mg/L in 2014 and lowest is 0.5mg/L on S4 month of August. The mean value of Nitrites on four sampling sites are S1 7.11667±4.2244mg/L, S2 7.05±3.999mg/L, S3 6.958±5.92mg/L and in S4 it was 7.4417±6.598mg/L in first year. In the second year S1 had 5.325±5.0575mg/L, S2 6.633±4.343mg/L, S3 6.517±5.11mg/L and S4 was 4.015±3.433mg/L. In 2013 the observed mean value of Nitrites was 7.1417±6.598mg/L and in 2014 it was 5.625±4.5178mg/L. Nitrites value was compared in between the both years and all four sampling sites by taking 't' values are S1 had 0.941857, S2 0.244472, S3 0.195628 and S4 1.591337. The 'p' values are S1 0.356494, S2 0.809131, S3 0.846697 and S4 0.125802. The 'f' values are S1 0.560503, S2 789116, S3 0.633843 and S4 0.04025. All values are accepted because there is no any much difference in both years. The value of Nitrites was increases in summer month while decreases in winter. On sampling site S4 Nitrites value was observed more as compared to other sampling sites. Shinde et al.,(2013) observed nitrite in traces amount. **Table no. 19**and **Graphplate no. XVI.**

4.13 NITRATES (NO_3N)

During the study periods mean Nitrates was observed 9.6042±6.3111mg/L. The highest Nitrates was observed in the month of May on site S3 which was 17.4mg/L and lowest was in the July on S2 was 5mg/L in 2013 while in 2014 highest was in the month of October on S1 36.6mg/L and lowest was in December on S1 was 1.2mg/L. The mean value of Nitrates on four sampling sites in 2013 was S1 had 9.567±4.2707mg/L, S2 8.183±3.0907mg/L, S3 10.83±3.922mg/L and S4 9.467±3.9204mg/L. In 2014 S1 had 10.583±9.0375, S2 9.817±7.248mg/L, S3 10.32±9.222mg/L and S4 8.517±7.77mg/L. The mean of Nitrates in 2013 was observed 9.4±3.7862mg/L and in 2014 it was 9.8083±8.1294mg/L.

For the comparative study 't' values was taking on four sites from both the years these are S1 -0.35233, S2 -0.71811, S3 0.023045 and S4 0.378147. The 'p' values on four sites was S1 0.727941, S2 0.480246, S3 0.981822 and S4 0.708945 and 'f' values on S1 0.019732, S2 0.008738, S3 0.008553 and S4 0.032261. All values are accepted because from the both years Nitrates values are not much fluctuating just on the sampling site S3 and S1 which was observed variation and high as compared to other sites. Nitrates is highly oxidized form of nitrogen, in natural water due to runoff fertilizers, decayed vegetable and domestic waste are increases the amount of nitrogen in water.**Table no. 20** and **Graph plate no. XVII.**

Dabhade (2006) obtained same results i.e. high values of nitrates observed in winter season and gradually increased in summer season. Nitrates is act as nutrient for growth of plants, excess amount of nitrogen helps for rapid growth of algae and other plants in water, Nitrates is found very small amount in nature because ongoing process of growth and decaying. Most stable form of nitrogen is nitrates which enhances the growth of plankton density and primary production. Parida et al.,(1999). Yannawaret al.,(2013) Nitrate was not detected during its study periods. Khobragade observed 11.27mg/L nitrates. The nutrients responsible for Eutrophication are nitrates and phosphates their impacts are extremely varied and potentially destructive and both are in water body can contributed high BOD by Dabhade (2013). Pawar (2010) observed nitrates value in the pre-monsoon was 4.2mg/L, in monsoon it was 4.54mg/L and in post monsoon it was 2.7mg/L. Shinde et al.,(2013) recorded the

nitrates in the range of 21.30 to 32mg/L. Siddiqi (2008)the range of nitrates recorded between 13.7 to 19.4mg/L. Natural concentration rarely exceed 10mg/L and higher concentration above 20mg/L are a health hazard.

4.14 BIOLOGICAL OXYGEN DEMAND (BOD)

Biological oxygen demand (BOD) is very important parameter of lake water because on that basis we determine the status of planktons present in to it. The BOD values were high due to the contribution of nitrates and phosphates present in the lake water Dabhade (2013).So the BOD was estimated monthly by taking the water sample form the lake and analyzed in to the laboratory. During the study periods mean of BOD was observed 162.19±94.642mg/L. The highest values was recorded in 2013 on sampling site S4 in August which was 355mg/L and lowest was in May on same sites was 15mg/L. In 2014 highest was 360mg/L on sampling site S3 in March while lowest was in April on S4 was 15mg/L. The mean value of BOD in 2013 on four sampling sites was S1 182.25±91.3625mg/L, S2 145.5±80.816mg/L, S3 122.9±77.68mg/L and on S4 160.63±110.64mg/L and in 2014 S1 had 157.08v98.799mg/L, S2 179.6±96.78mg/L, S3 167.1±97.2mg/L and S4 182.5±111.2mg/L was observed. The mean of BOD in 2013 was 152.82±90.763mg/L and in 2014 it was observed 171.56±98.425mg/L.

For the comparative study between these two years we take the ‘t’ values on fours sampling sites these are on S1 0.647855, S2 -0.93643, S3 -1.22964 and S4 -0.48307. The ‘p’ values are on S1 0.523783, S2 0.359217, S3 0.231819 and S4 0.633819 and ‘f’ values on S1 0.799827, S2 0.560014, S3 0.469129 and S4 0.986874. All such values are accepted but in summer it show fluctuation on all sites. Observed BOD values were more in 2013 but it goes on increases in 2014 on all sites. BOD in summer was high as compared to winter. **Table no. 21**and **Graph plate no. XVIII.** KhobragadeThe low rate of primary production in aquatic ecosystem of lonar lake is also indicates that the low value of BOD that ranged from 0.1 to 0.9mg/L by Borul (2012). Verma et al.,(2013) observed BOD ranges from 38-40 mg l^{-1} showing that the lake water is organically polluted. BOD was observed in the range of 48-96mg/l by Satynarayan et al.,(2008). Shinde et al., (2013) observed high value of BOD in the lake water which was in the range of 1380 to 1864.

4.15 CHEMICAL OXYGEN DEMAND (COD)

The mean of chemical oxygen demand (COD)throughout the study periods was observed 265.51±117.77mg/L. The highest COD was observed in 2013 in month of May on sampling site S4 was 430mg/L and lowest was observed on same site but in the month of Jun which was 130mg/L. In 2014 the highest was observed in same month and same site but values of COD was more as compared to 2013 which was 580mg/L and lowest was on same site and same value but in month of August. The mean of COD in 2013 on four sampling sites was S1 206.083±96.556mg/L, S2 211.75±94.732mg/L, S3 222±99.24mg/L and S4 231.42±102.62mg/L and in 2014 on S1 311±123.98mg/L, S2 299.6±112.8mg/L, S3 323.1±115.9mg/L and S4 319.2±137.7mg/L. In 2013 mean of COD was observed 217.81±95.648mg/L and in 2014 it was 313.21±119.33mg/L.

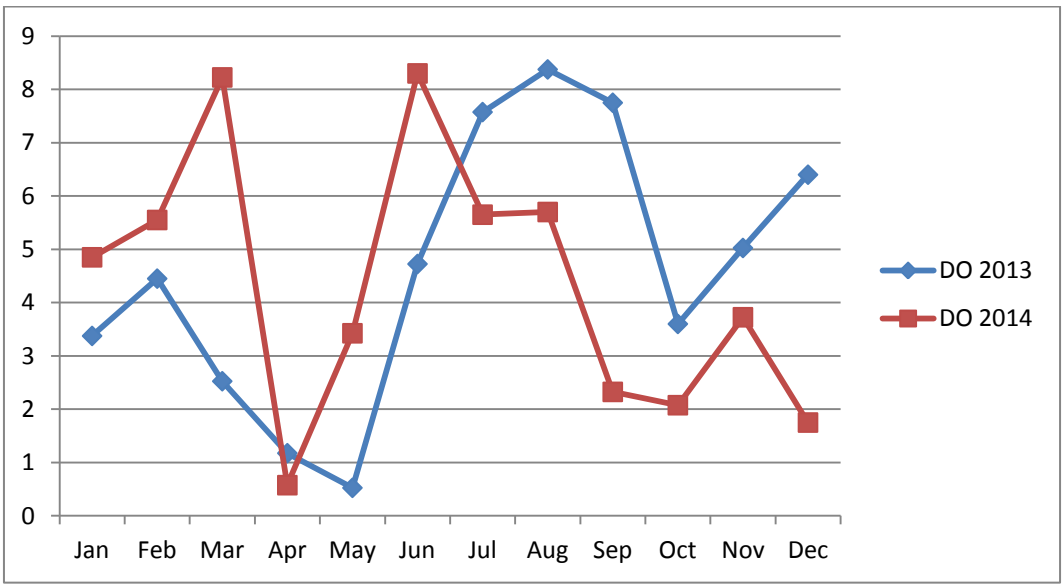
The comparative study of both years on four sampling sites was observed by taking their 't' values are on S1 -2.31275, S2 -2.06574, S3 -2.29508 and S4 -1.76972. The observed 'p' values on sampling sites S1was 0.030457, S2 0.050829, S3 0.031636 and S4 0.090634 and 'f' values on S1 0.419923, S2 0.572674, S3 0.615984 and S4 0.34331.

The COD value was observed more in 2013 and which was also increases in 2014. On sampling site S4 the value of COD was more during the whole study periods. Verma et al.,(2013) observed COD ranges from 350-405 mg l^{-1} showing that the lake water is organically polluted. Borul (2012) observed COD ranges from 0.01 to 0.06mg/L. Satynarayan et al.,(2008) observed highest COD value was 392mg/L. while lowest 276mg/L the COD and BOD ratio ranged between 75 and 10.66 indicating presence of biologically recalcitrant substances of organic nature. Shinde et al.,(2013) observed COD in the range of 620 to 3168. **Table No. 22 and Graph Plate no.XIX.**

Table No. 4: Comparison of mean ofDissolved Oxygen in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 DO mg/L Mean	2014 DO mg/L Mean
01	January	3.375±0.5909	4.85±1.65227
02	February	4.45±0.3	5.55±1.1
03	March	2.525±0.45735	8.225±1.56924
04	April	1.175±0.20616	0.575±0.20616
05	May	0.525±0.17078	3.425±2.12662
06	Jun	4.725±0.29861	8.3±2.65456
07	July	7.575±0.38622	5.65±3.51141
08	August	8.375±2.05649	5.7±0.39158
09	September	7.75±1.25831	2.325±0.85391
10	October	3.6±3.25269	2.075±0.40311
11	November	5.025±2.02052	3.725±1.20381
12	December	6.4±2.10871	1.75±1.7253

Graph Plate I -Chemical Parameters

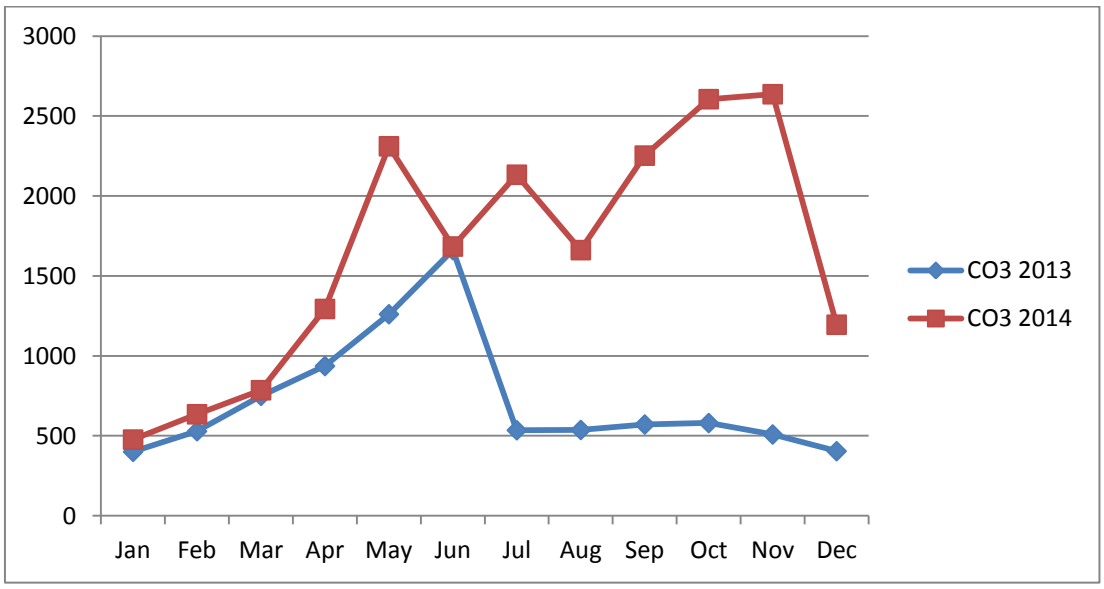


Graph plate No. 4: Shows DO variation in 2013 and 2014

Table No. 5: Comparison of mean ofCarbonate in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 CO3 mg/L Mean	2014 CO3 mg/L Mean
01	January	400±32.6599	476.5±31.8067
02	February	529±35.0809	635±25.219
03	March	750±44.2719	785.5±17.6163
04	April	936.5±39.6106	1293.5±234.739
05	May	1260.5±93.4862	2311±471.668
06	Jun	1661.5±69.2315	1684±437.81
07	July	535±25.7941	2133±312.485
08	August	536.75±18.7506	1661.5±475.811
09	September	571±30.8761	2252.5±579.672
10	October	580±87.5595	2605.5±322.988
11	November	508.5±49.9967	2636.5±485.994
12	December	404±67.0124	1195±234.023

Graph Plate II -Chemical Parameter

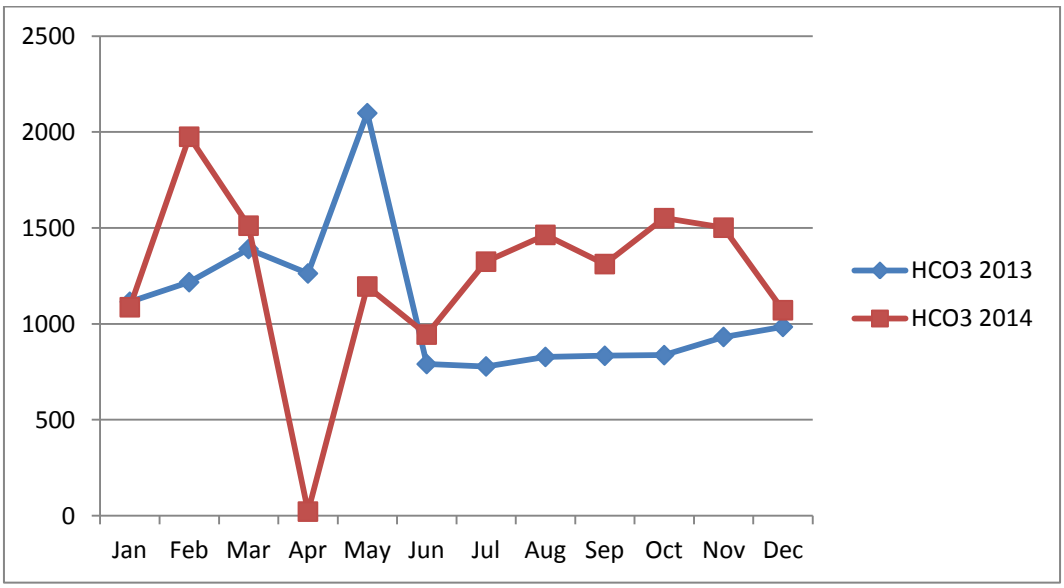


Graph plate No. 5: Shows Carbonates variation in 2013 and 2014

Table No. 6: Comparison of mean of Bicarbonates in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 HCO3 mg/L Mean	2014 HCO3 mg/L Mean
01	January	1115.5±165.685	1087±204.916
02	February	1217.5±200.216	1975.5±316.153
03	March	1390.5±219.462	1512±121.04
04	April	1263±89.4054	22±15.0555
05	May	2098.5±184.574	1195±159.687
06	Jun	791±104.62	944.5±168.225
07	July	778.5±43.2474	1324.5±198.604
08	August	828±20.4613	1464±256.245
09	September	834±17.0489	1312±209.813
10	October	837±15.2643	1551±245.115
11	November	931±72.9018	1501.5±301.734
12	December	984.5±146.646	1071.5±179.32

Graph Plate III -Chemical Parameters

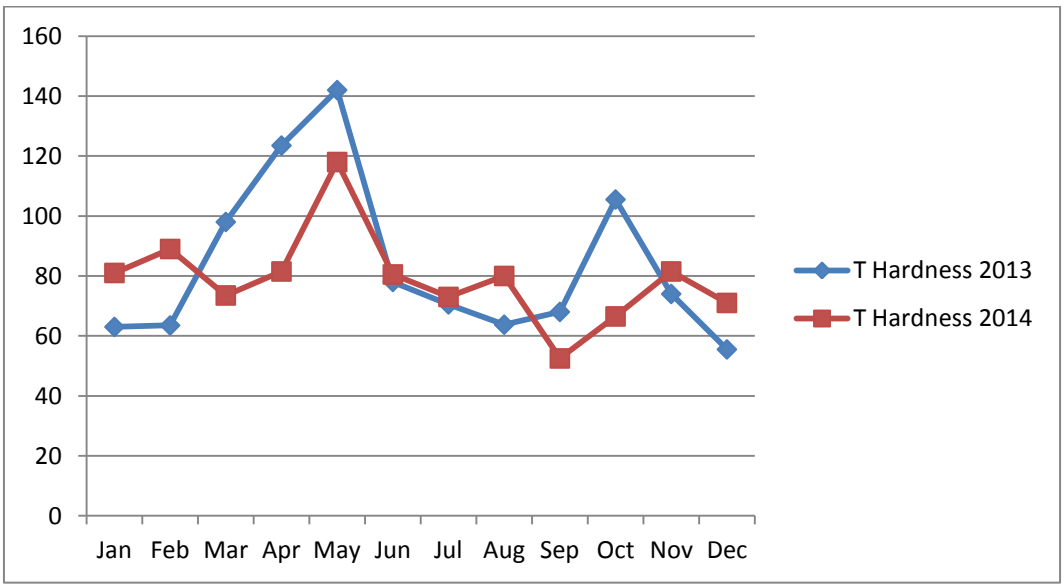


Graph plate No. 6: Shows Bicarbonates variation in 2013 and 2014

Table No. 7: Comparison of mean of Total Hardness in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 T. Hardness mg/L	2014 T. Hardness mg/L
		Mean	Mean
01	January	63±15.0997	81±23.6361
02	February	63.5±5.25991	89±38.3145
03	March	98±5.41603	73.5±2.51661
04	April	123.5±5.25991	81.5±1.91485
05	May	142±19.1137	118±40.2327
06	Jun	78±6.9282	80.5±11.8181
07	July	70.5±4.43471	73±6.63325
08	August	63.75±5.67891	80±7.30297
09	September	68±8.64099	52.5±8.544
10	October	105.5±24.7857	66.5±8.22598
11	November	74±23.2092	81.5±8.69866
12	December	55.5±36.5285	71±13.7113

Graph Plate IV -Chemical Parameters

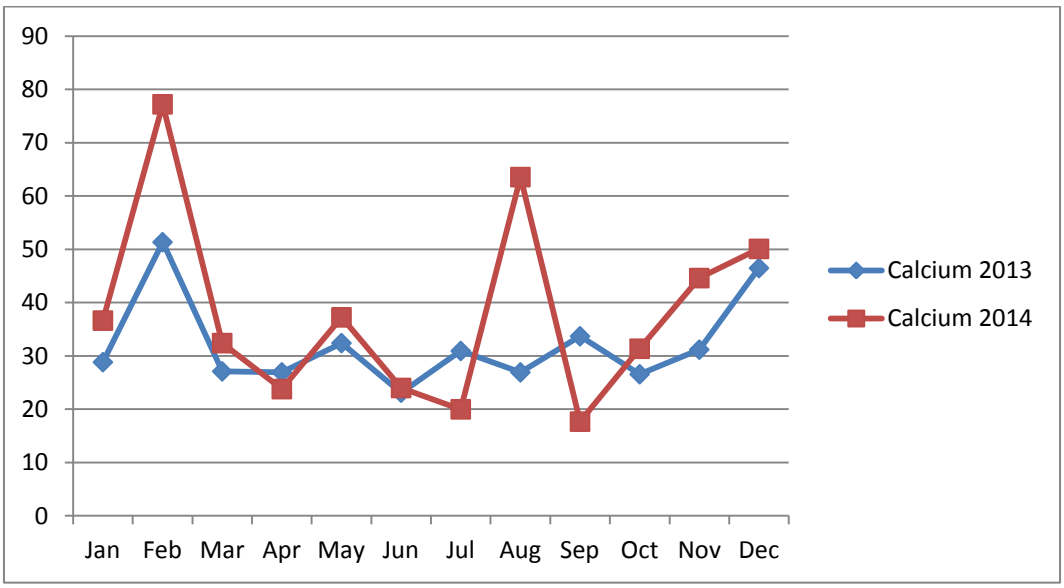


Graph plate No. 7: Shows Total Hardness variation in 2013 and 2014

Table No. 8: Comparison of mean of Calcium in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Ca mg/L Mean	2014 Ca mg/L Mean
01	January	28.825±6.00674	36.625±19.2699
02	February	51.3375±14.6228	77.2075±22.6612
03	March	27.095±4.11049	32.4±2.43295
04	April	26.915±2.3759	23.7725±1.43799
05	May	32.4±2.09284	37.24±1.86258
06	Jun	23.1±2.86938	23.985±8.14687
07	July	30.9275±5.34168	19.98±5.19135
08	August	26.915±3.42611	63.5425±18.775
09	September	33.685±4.16664	17.67±2.057557
10	October	26.56±3.36725	31.3475±4.19784
11	November	31.175±3.49893	44.6025±12.3894
12	December	46.475±12.442	50.075±17.1146

Graph Plate V -Chemical Parameters

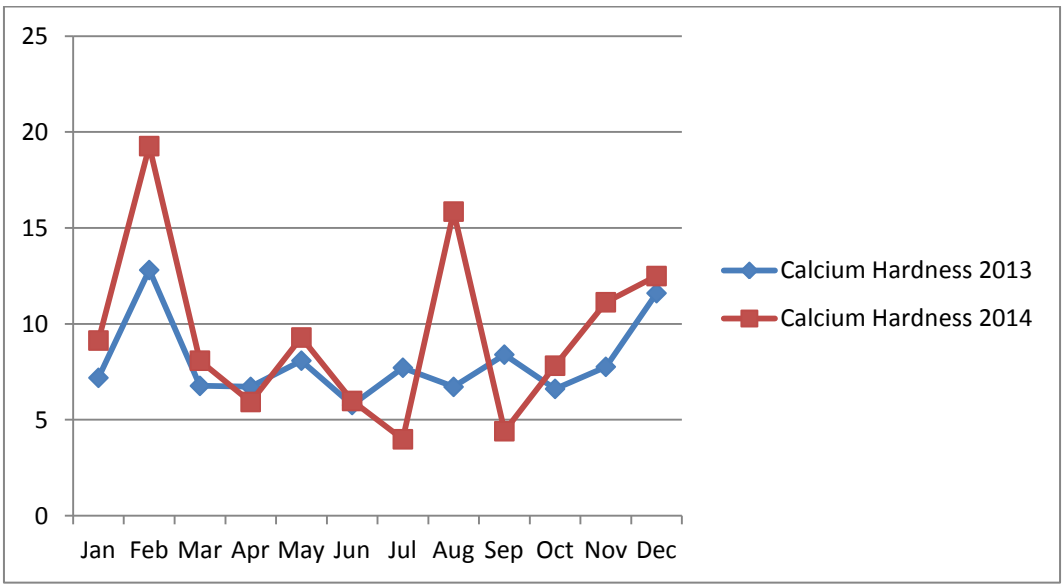


Graph plate No. 8: Shows Calcium variation in 2013 and 2014

Table No. 9: Comparison of mean of Calcium Hardness in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Ca Hardness mg/L Mean	2014 Ca Hardness mg/L Mean
01	January	7.1925±1.49847	9.135±2.93249
02	February	12.81±3.64941	19.2675±5.6567
03	March	6.7725±1.03413	8.085±0.60622
04	April	6.72±0.59397	5.9325±0.35864
05	May	8.085±0.52849	9.2925±0.46564
06	Jun	5.775±1.81764	5.985±2.03241
07	July	7.7175±1.3323	3.99±1.29878
08	August	6.72±0.85732	15.855±4.68477
09	September	8.4±1.04298	4.41±0.51439
10	October	6.615±0.8487	7.8225±1.04825
11	November	7.765±0.86631	11.13±3.09112
12	December	11.6025±3.10239	12.495±4.27115

Graph Plate VI -Chemical Parameters

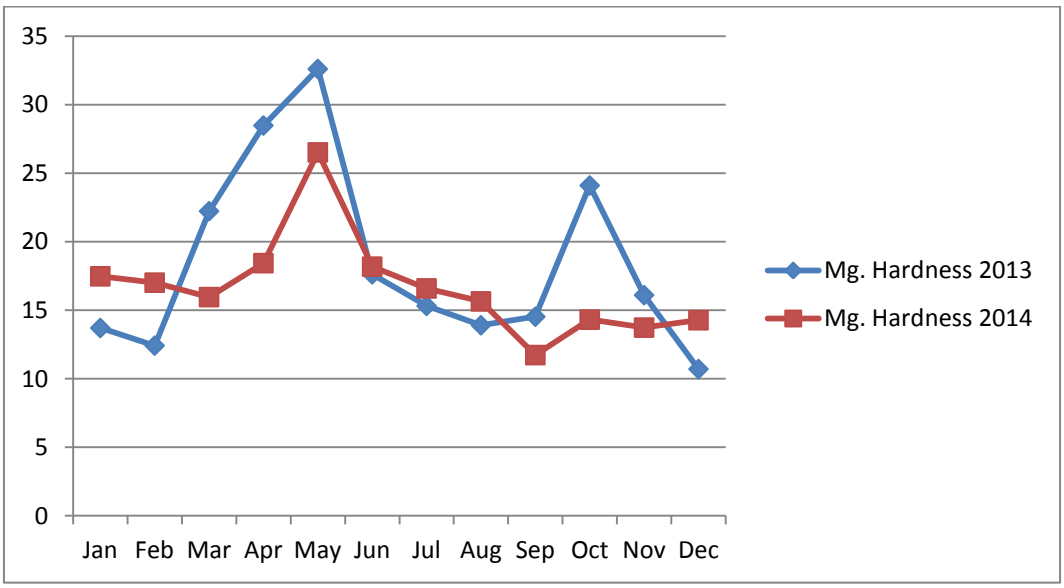


Graph plate No. 9: Shows Calcium Hardness variation in 2013 and 2014

Table No. 10: Comparison of mean of Magnesium Hardness in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Mg. Hardness mg/L Mean	2014 Mg. Hardness mg/L Mean
01	January	13.7025±3.89337	17.475±6.08242
02	February	12.415±1.22935	17.01±9.35419
03	March	22.225±1.11766	15.9575±0.6107
04	April	28.475±1.20381	18.435±0.55224
05	May	32.6±4.53799	26.515±9.72261
06	Jun	17.6175±1.54733	18.1775±2.59517
07	July	15.315±1.3422	16.59±1.73914
08	August	13.9±1.5487	15.645±7.25186
09	September	14.525±2.23364	11.7275±2.1712
10	October	24.1±5.86799	14.3125±6.62355
11	November	16.1±5.49424	13.732±1.78289
12	December	10.7075±9.32016	14.27±2.90146

Graph Plate VII -Chemical Parameters

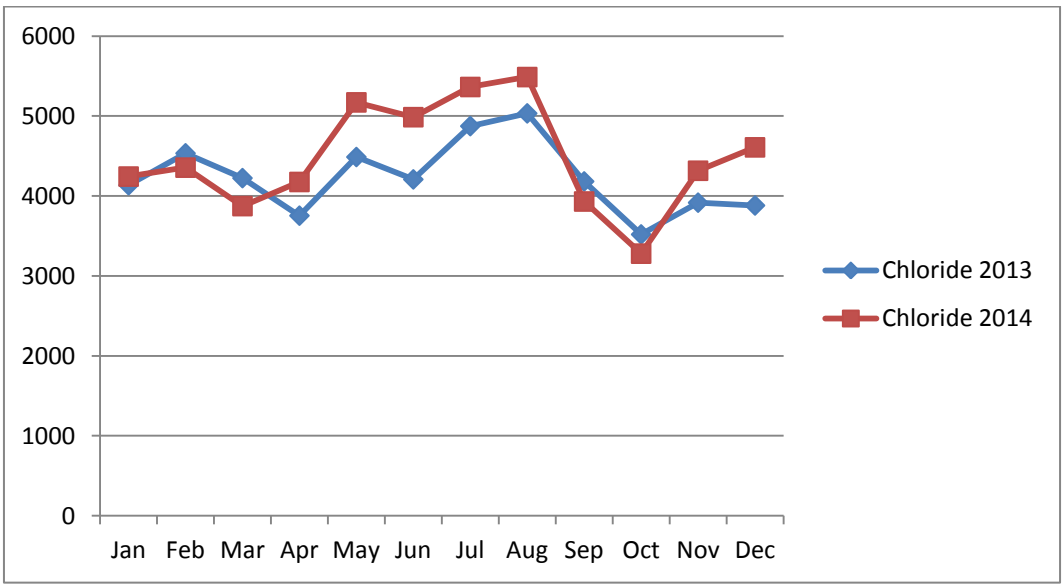


Graph plate No. 10: Shows Magnesium Hardness variation in 2013 and 2014

Table No. 11: Comparison of mean of Chloride in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Chloride mg/L Mean	2014 Chloride mg/L Mean
01	January	4135.24±525.183	4243.25±211.812
02	February	4534.06±678.976	4355±889.441
03	March	4223.8±269.446	3874±654.828
04	April	3754.1±343.884	4175.5±196.87
05	May	4487.93±613.224	5171±867.289
06	Jun	4207.92±417.348	4985.75±374.378
07	July	4874±211.649	5363.59±1539.39
08	August	5033.5±182.805	5487.75±1326.23
09	September	4182.5±246.146	3931.41±1599.88
10	October	3519.75±159.054	3279.12±582.719
11	November	3917±194.434	4316.04±1329.65
12	December	3881.5±267.6	4608.5±757.005

Graph Plate VIII -Chemical Parameters

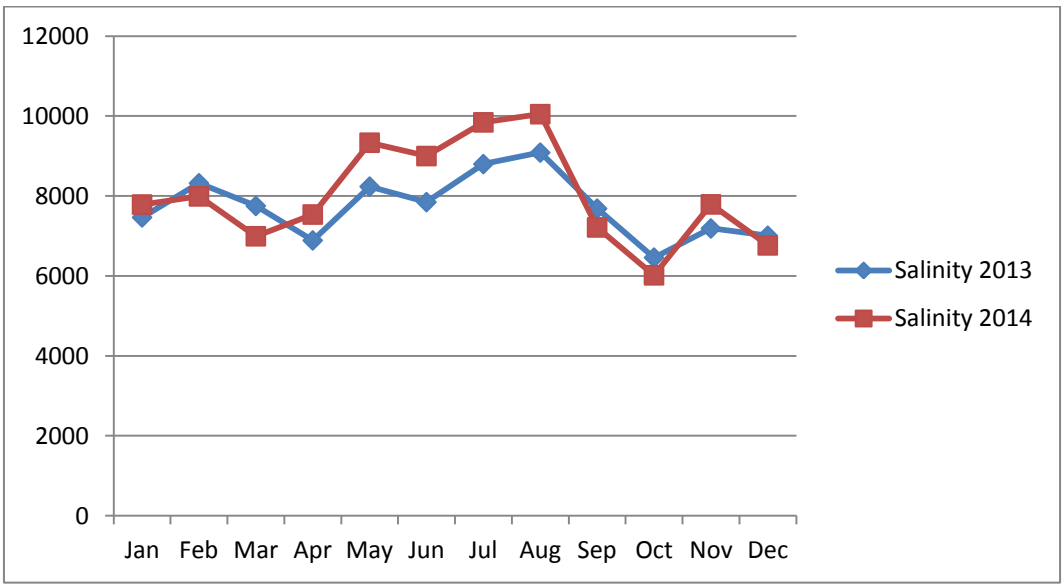


Graph plate No. 11: Shows Chloride variation in 2013 and 2014

Table No. 12: Comparison of mean of Salinity in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Salinity mg/L Mean	2014 Salinity mg/L Mean
01	January	7464.14±947.956	7786.5±388.045
02	February	8319.95±1245.93	7991±1632.32
03	March	7750.78±494.42	6993±1181.73
04	April	6888.85±630.983	7537.25±355.649
05	May	8235.38±1125.24	9333.5±1565.72
06	Jun	7846.4±917.417	8999.75±675.893
07	July	8798±382.218	9842.15±2824.76
08	August	9086±330.495	10047.1±2408.41
09	September	7684±472.292	7214.11±2935.76
10	October	6459.25±291.82	6017.19±1069.29
11	November	7188.25±356.652	7790.47±2400.02
12	December	7006±483.189	6765.28±8456.6

Graph Plate IX -Chemical Parameters

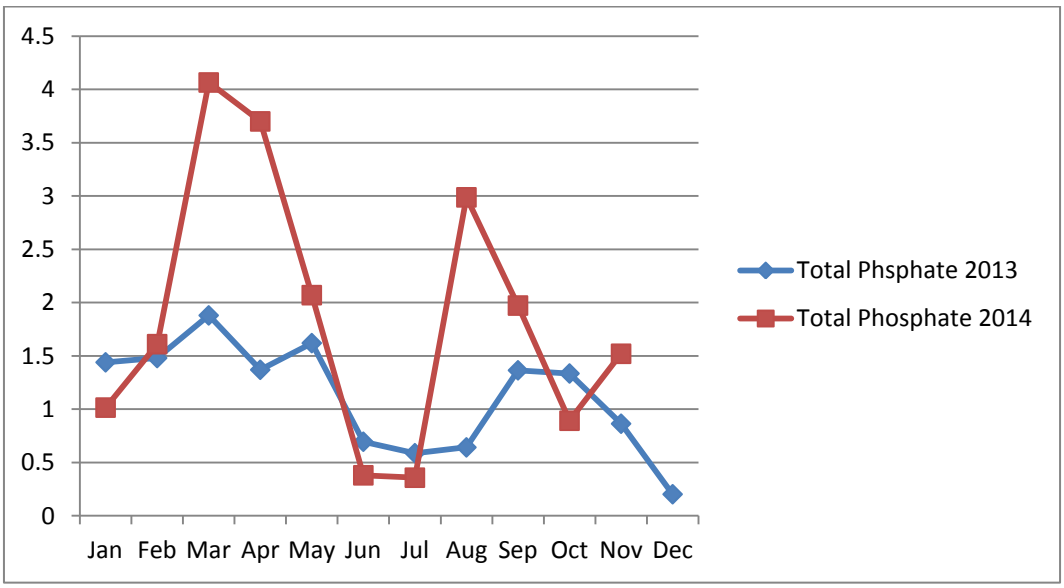


Graph plate No. 12: Shows Salinity variation in 2013 and 2014

Table No. 13: Comparison of mean of Phosphates in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Phosphates mg/L Mean	2014 Phosphates mg/L Mean
01	January	1.44±0.66433	1.015±0.43432
02	February	1.48±0.61752	1.61±0.72415
03	March	1.88±0.71643	4.065±0.4919
04	April	1.37±0.5392	4.1875±0.83412
05	May	1.62±0.35214	3.7±0.91742
06	Jun	0.695±0.10755	2.07±0.59983
07	July	0.5875±0.18608	0.38±0.25033
08	August	0.642±0.36646	0.3575±0.38965
09	September	1.365±0.56051	2.9875±1.51317
10	October	1.335±0.90314	1.9725±0.92056
11	November	0.864±0.49078	0.892±1.15313
12	December	0.2025±0.0556	1.52±0.63765

Graph Plate X -Chemical Parameters

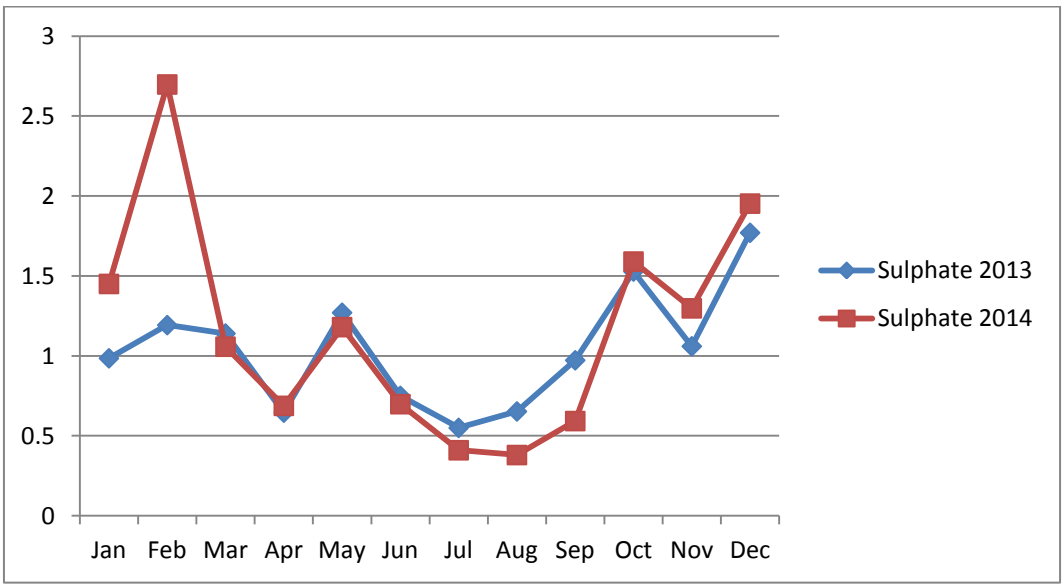


Graph plate No. 13: Shows Total Phosphate variation in 2013 and 2014

Table No. 14: Comparison of mean of Sulphates in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Sulphates mg/L Mean	2014 Sulphates mg/L Mean
01	January	0.985±0.3048	1.45±0.48504
02	February	1.1925±0.57789	2.6975±1.89032
03	March	1.14±0.13663	1.0575±0.09777
04	April	0.645±0.29183	0.6875±0.50724
05	May	1.27±0.70621	1.180.39724
06	Jun	0.75±0.19201	0.698±0.28465
07	July	0.55±0.35052	0.41±0.1052
08	August	0.6525±0.31721	0.38±0.12517
09	September	0.9725±0.30653	0.5925±0.22381
10	October	1.5275±0.43053	1.59±0.91502
11	November	1.06±0.21229	1.2975±0.59388
12	December	1.77±0.33407	1.9525±0.50908

Graph Plate XI -Chemical Parameters

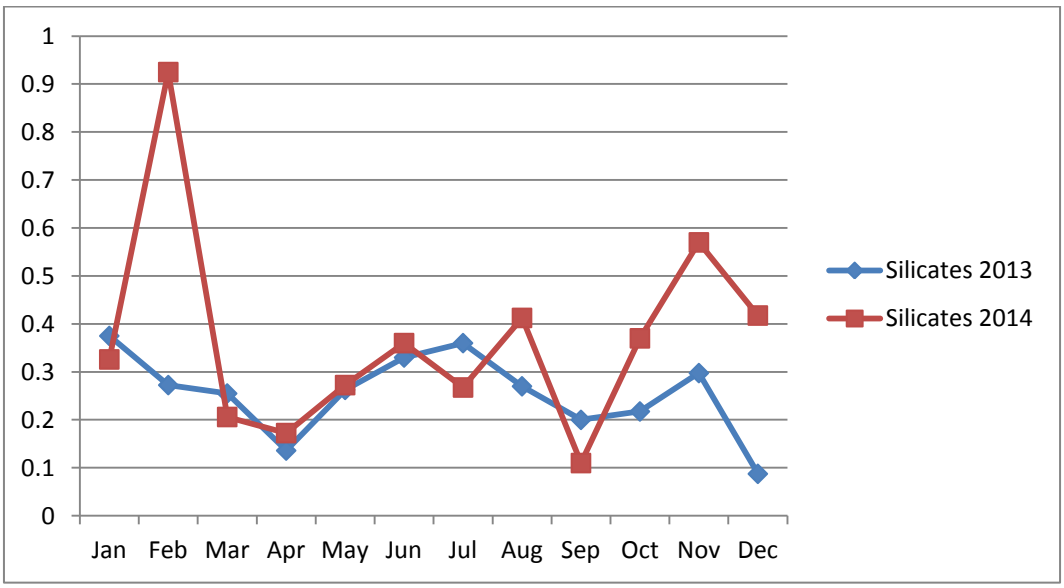


Graph plate No. 14: Shows Sulphates variation in 2013 and 2014

Table No. 15: Comparison of mean of Silicates in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Silicates mg/L Mean	2014 Silicates mg/L Mean
01	January	0.375±0.16031	0.326±0.16879
02	February	0.2725±0.06602	0.925±0.16623
03	March	0.255±0.09609	0.925±0.16623
04	April	0.136±0.06	0.1725±0.11206
05	May	0.2625±0.09979	0.2725±0.07411
06	Jun	0.33±0.11747	0.36±0.28012
07	July	0.36±0.04967	0.2675±0.08302
08	August	0.27±0.21307	0.4125±0.27281
09	September	0.2±0.11225	0.11±0.04243
10	October	0.2175±0.0818	0.37±0.11804
11	November	0.2975±0.12894	0.57±0.31379
12	December	0.0875±0.01708	0.4175±0.38379

Graph Plate XII -Chemical Parameters

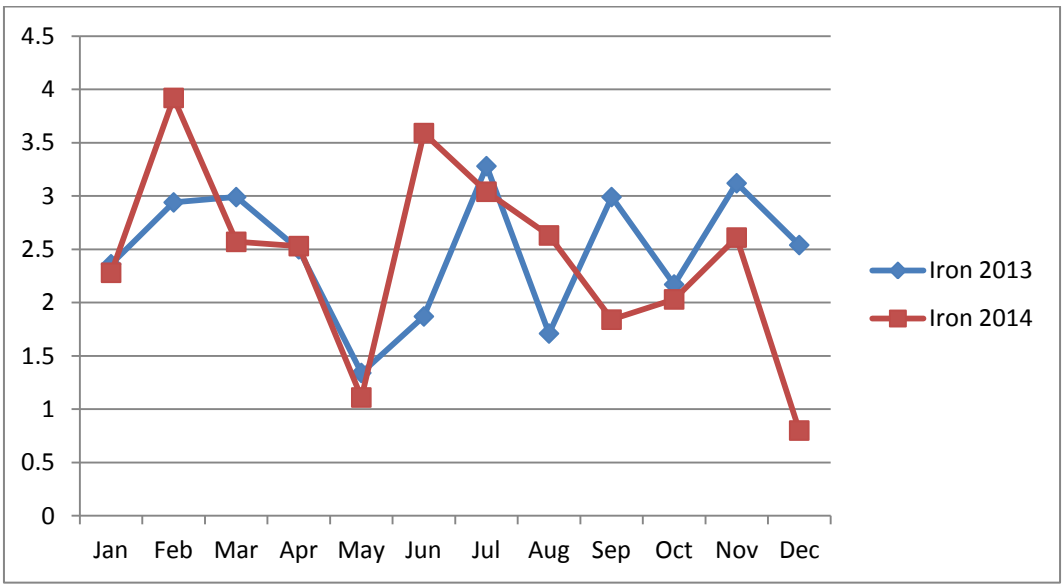


Graph plate No. 15: Shows Silicates variation in 2013 and 2014

Table No. 16: Comparison of mean of Total Iron in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Iron mg/L Mean	2014 Iron mg/L Mean
01	January	2.36±1.01719	2.28±0.83586
02	February	2.94±0.98279	3.92±0.62567
03	March	2.99±1.03968	2.57±1.64769
04	April	2.5±0.45898	2.53±0.32721
05	May	1.34±0.28	1.11±0.21008
06	Jun	1.87±1.18721	3.59±0.61308
07	July	3.28±0.61623	3.04±0.46533
08	August	1.71±0.37148	2.63±1.75647
09	September	2.99±0.92916	1.84±0.64992
10	October	2.17±1.13405	2.03±2.71477
11	November	3.12±1.2628	2.61±1.27807
12	December	2.54±1.25902	0.8±0.53166

Graph Plate XIII -Chemical Parameters

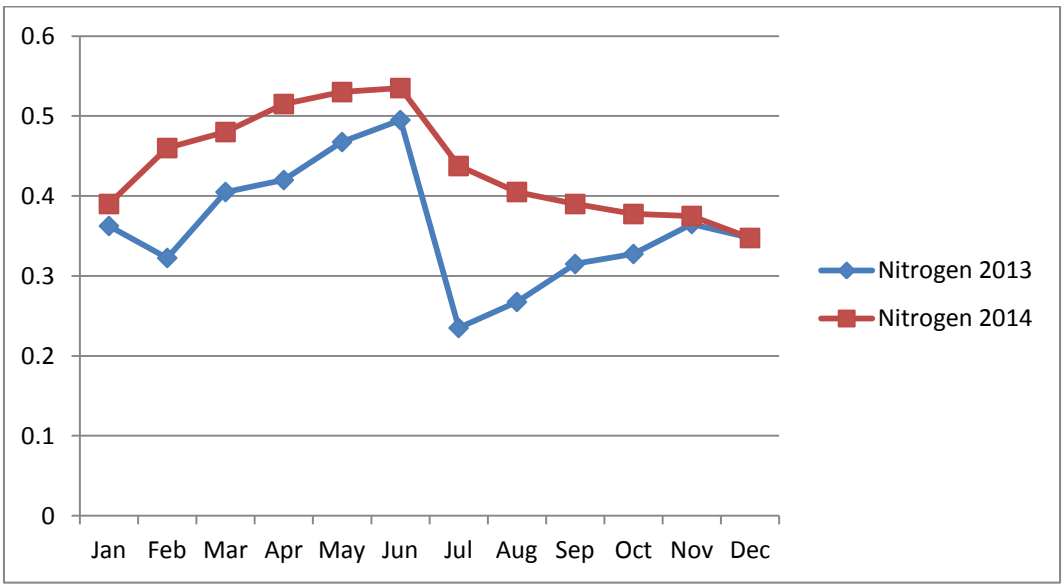


Graph plate No. 16: Shows Total Iron variation in 2013 and 2014

Table No. 17: Comparison of mean of Nitrogen in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Nitrogen mg/L Mean	2014 Nitrogen mg/L Mean
01	January	0.3625±0.228674	0.39±0.174929
02	February	0.3225±0.190504	0.46±0.206559
03	March	0.405±0.259936	0.48±0.172047
04	April	0.42±0.239861	0.515±0.216256
05	May	0.4675±0.246221	0.53±0.22
06	Jun	0.495±0.316354	0.535±0.219469
07	July	0.235±0.12261	0.4375±0.228674
08	August	0.2675±0.134009	0.405±0.173686
09	September	0.315±0.131022	0.39±0.137356
10	October	0.3275±0.138414	0.3775±0.132759
11	November	0.365±0.068069	0.375±0.064031
12	December	0.3475±0.09215	0.3475±0.076322

Graph Plate XIV -Chemical Parameters

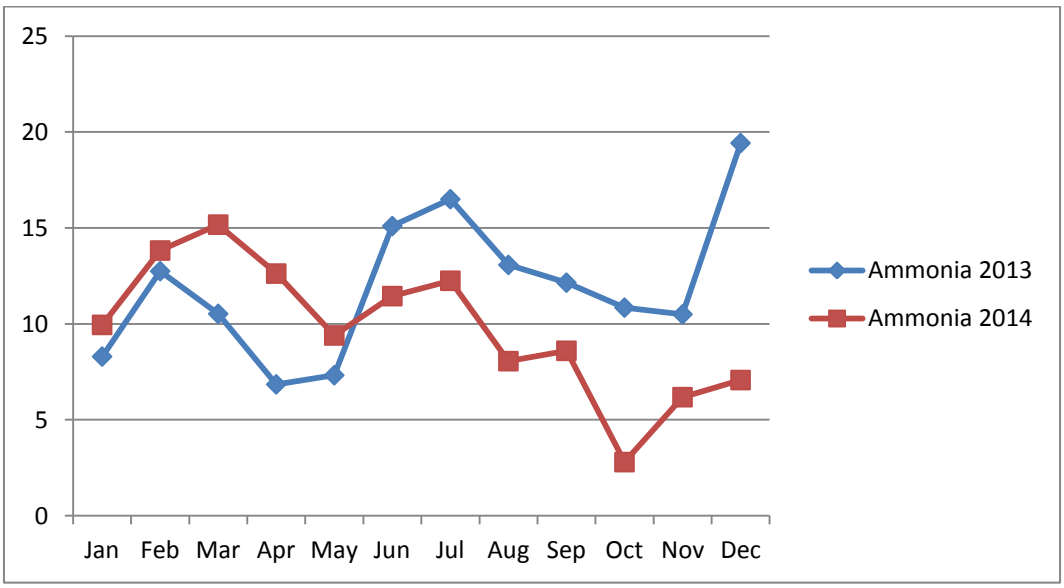


Graph plate No. 17: Shows Nitrogen variation in 2013 and 2014

Table No. 18: Comparison of mean of Ammonia in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Ammonia mg/L Mean	2014 Ammonia mg/L Mean
01	January	8.3±0.74386	9.95±2.08087
02	February	12.75±3.8863	13.825±0.55603
03	March	10.525±2.70331	15.175±7.59973
04	April	6.85±1.5	12.625±11.6288
05	May	7.325±1.45	9.4±4.24343
06	Jun	15.1±8.2	11.45±7.91157
07	July	16.5±4.49073	12.25±6.08523
08	August	13.075±8.74974	8.06±5.13249
09	September	12.15±5.51936	8.6±6.71267
10	October	10.85±6.07536	2.8±2.24054
11	November	10.5±8.31585	6.1825±1.4059
12	December	19.425±7.75559	7.075±4.24294

Graph Plate XV -Chemical Parameters

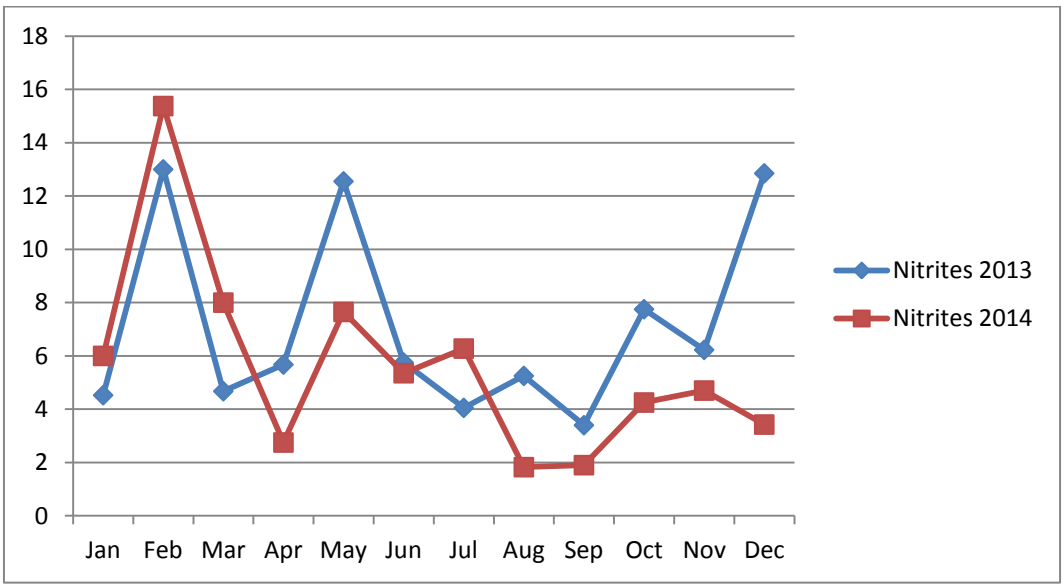


Graph plate No. 18: Shows Ammonia variation in 2013 and 2014

Table No. 19: Comparison of mean of Nitrites in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013Nitrites mg/L Mean	2014 Nitrites mg/L Mean
01	January	4.525±3.70169	6±4.27083
02	February	13±6	15.375±7.39121
03	March	4.675±6.26066	8±1.41421
04	April	5.675±3.22632	2.75±1.25831
05	May	12.55±6.54294	7.65±4.10974
06	Jun	5.75±3.0957	5.35±3.06974
07	July	4.05±2.7037	6.275±4.39346
08	August	5.25±2.75379	1.825±2.32289
09	September	3.4±0.4899	1.9±1.69902
10	October	7.75±4.272	4.25±1.93305
11	November	6.225±3.87503	4.7±5.27573
12	December	12.85±4.89455	3.425±1.78582

Graph Plate XVI -Chemical Parameters

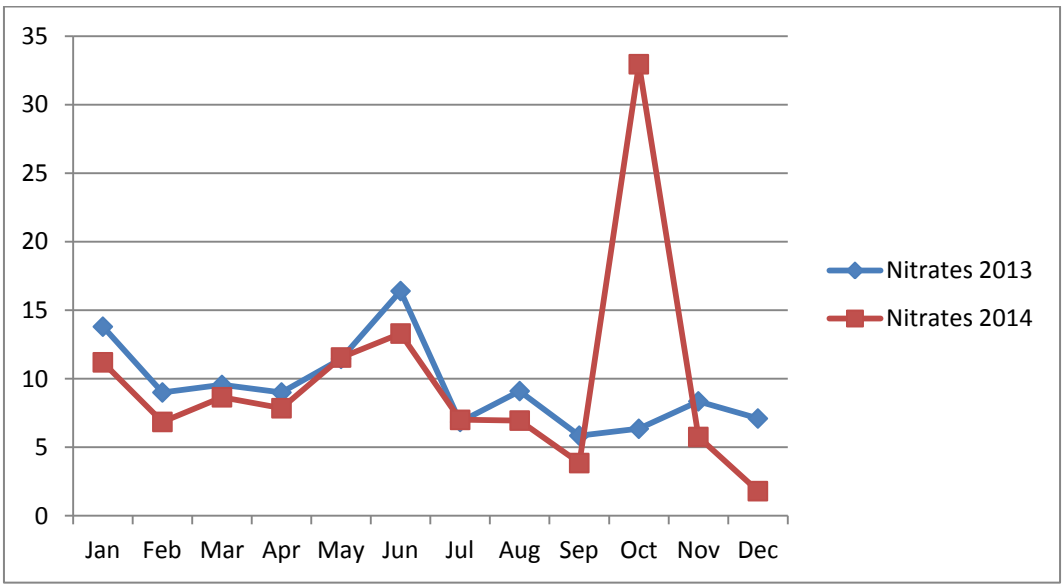


Graph plate No. 19: Shows Nitrites variation in 2013 and 2014

Table No. 20: Comparison of mean of Nitrates in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 Nitrates mg/L Mean	2014 Nitrates mg/L Mean
01	January	13.8±2.70801	11.2±2.68825
02	February	9±1.54919	6.85±0.77244
03	March	9.55±4.272	8.65±2.08726
04	April	9±1.52315	7.85±0.92916
05	May	11.45±5.34509	11.55±6.35479
06	Jun	16.4±1.68918	13.3±1.22746
07	July	6.85±3.25761	7±1.39523
08	August	9.1±2.77369	6.95±5.03686
09	September	5.85±0.68069	3.85±0.7188
10	October	6.35±0.66081	32.95±4.272
11	November	8.35±2.90459	5.75±1.50886
12	December	7.1±0.68313	1.8±0.58878

Graph Plate XVII -Chemical Parameters

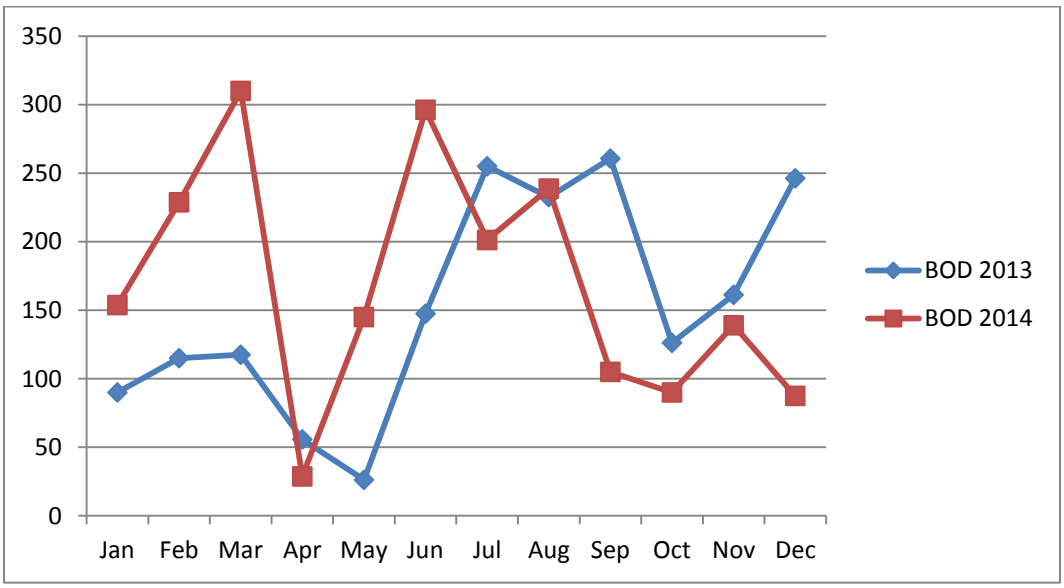


Graph plate No. 20: Shows Nitrates variation in 2013 and 2014

Table No. 21: Comparison of mean of Biological Oxygen Demand in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 BOD mg/L Mean	2014 BOD mg/L Mean
01	January	90±10.8012	153.75±37.2771
02	February	115±16.8325	228.75±37.9418
03	March	117.5±22.1736	310±42.4264
04	April	55.75±8.22091	28.75±10.3078
05	May	26.25±8.53913	145±91.1043
06	Jun	147.5±41.7333	296.25±42.106
07	July	255±24.8328	201.25±116.001
08	August	232.5±90.5999	238.75±25.6174
09	September	260.625±58.5368	105±38.2971
10	October	126.25±108.963	90±17.3205
11	November	161.25±59.3542	139±55.1324
12	December	246.25±72.7295	87.5±86.2651

Graph Plate XVIII -Chemical Parameters

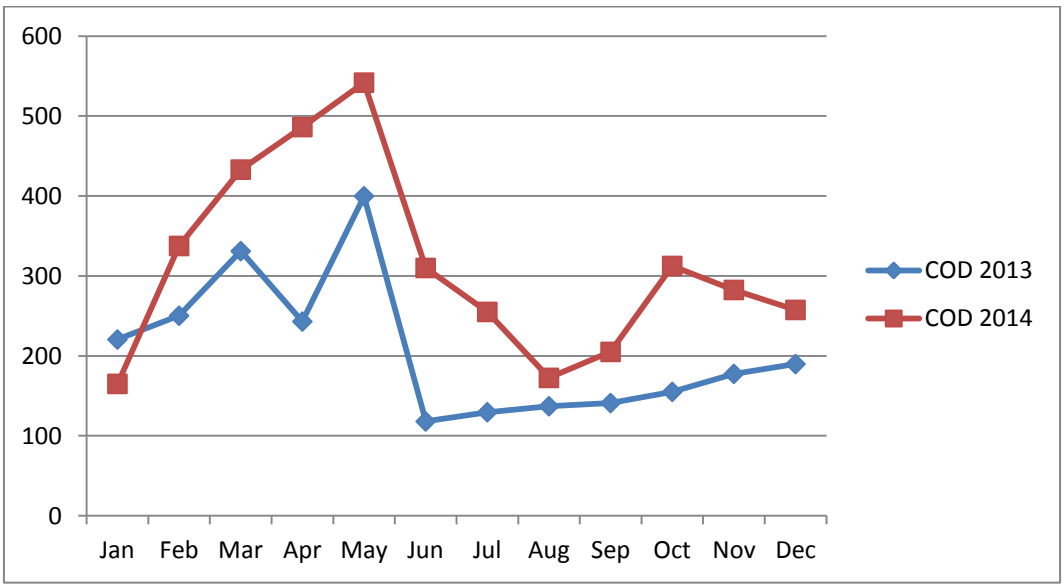


Graph plate No. 21: Shows BOD variation in 2013 and 2014

Table No. 22: Comparison of mean of Chemical Oxygen Demand in all four sampling sites during 2013 and 2014

Sr. No.	Month	2013 COD mg/L Mean	2014 COD mg/L Mean
01	January	220.5±21.3151	165±23.80476
02	February	250.25±16.37834	337.5±27.53785
03	March	331±29.41655	433±35.53402
04	April	243±17.54043	486.25±28.68652
05	May	399.75±26.2091	541.75±28.5
06	Jun	118±8.640988	310±24.4949
07	July	129.5±14.47987	255±19.14854
08	August	137±6.63325	172.5±38.6221
09	September	141±5.477226	205±53.22906
10	October	155±4.760952	312.5±43.49329
11	November	177.5±9.712535	282.5±22.17356
12	December	189.75±14.66004	257.5±22.17356

Graph Plate XIX -Chemical Parameters



Graph plate No. 22: Shows COD variation in 2013 and 2014

4.3 BIOLOGICAL ANALYSIS OF WATER

Sample analyzed by both qualitative and quantitatively and identified their diversity, density, species richness, species evenness etc. Lonar crater is a highly alkaline Lake it is not a conspicuous factor but many species of Rotifers are having preference for more alkaline waters. Dhanapathi (2000)has observed that species such as Brachionus, Keratella, Mytilina and Platyas build higher population during the periods when alkalinity is also high.

4.3.1 Qualitative Analysis of Zooplankton

Lake brine itself and ephemeral ponds surrounding the lake basin containing diverse planktons that includes Rotifers such as Brachionus sp., Keratellasp, Lecanesp, Cephalodellasp, Colothecasp., Polyarthrasp., Hexarthasp., Philodinasp., etc. **Rotifer PhotoplatesNo.I TO II.** Cladocerasuch as Allonasp., Alonellasp., Daphniasp.**CladoceraPhotoplateNo.III.** Some species of Copepoda like Cyclops sp.Ostracoda such as Cypris subglosa, some other Zoo-benthos and macro-invertebrates were also recorded. Phytoplankton includes Algae and diatomsamong which Spirulina was dominant.**Algae and Diatoms PhotoplatesNo.IV to V.**

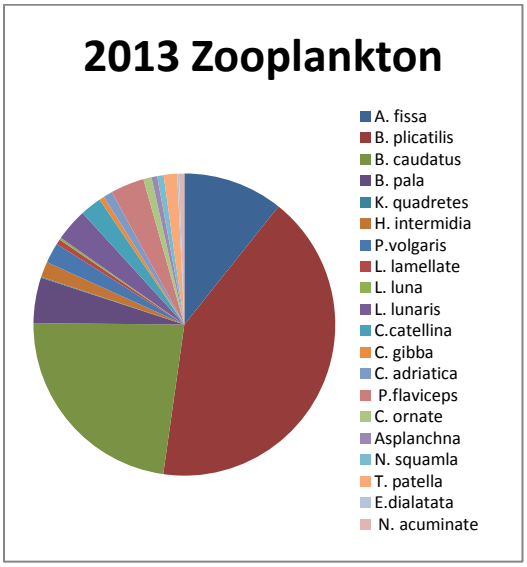
Total 14genera and 20 species of Rotifers were encountered. Rotifers are chiefly fresh water forms and presence of rotifer in abundance is indicate suitable condition for their survival Dhanapati (2000). Malu et al.,(2000) studied the three genus of Brachionus thse are falcatus, plicatilis and caudatus. In rotifera species Keratella sp. and Brachionus sp. were reported by Kedar et al.,(2008) in Rushi Lake at Karanja. Balaraman (2008) was find several genera from some ephemeral wetlands of southern Kerala and these genera are Phiolodina, Trichoceraca, Keratella, Cephalodella, Lecane, Lepadella, Monostyla, Platyas, Epiphanes, Dicranophorus and Conochilus. Kaushik and Sexena (1995) have also reported genus Brachionus in abundance. Occurance of genus keratela with Brachionus indicate nutrient rich status of water body. According to Goel and Charan (1991)K. tropica and Brachionus Calyciflorus are the pollution tolerant species and indicate accumulation of organic matter and theses species reported dominant in polluted fresh water lake of Kolhapur. In several Ephemeral pond also found Cladocera, Ostracoda, and copepod. The Cladocera like Allona, Alonella, Daphnia.Gadekar et al., (2014) also found that Cladocera were minimum in Monsoon but they recorded that maximum cladocera found in winter.Raut et al.,(2012) they found Cladocera dominated in summer season

over other zooplankton. In monsoon season the physico-chemical factor like dissolved oxygen, temperature, turbidity, transparency also play an important role to controlling the density and diversity of Cladocera Edmonson (1959); Baker (1979).

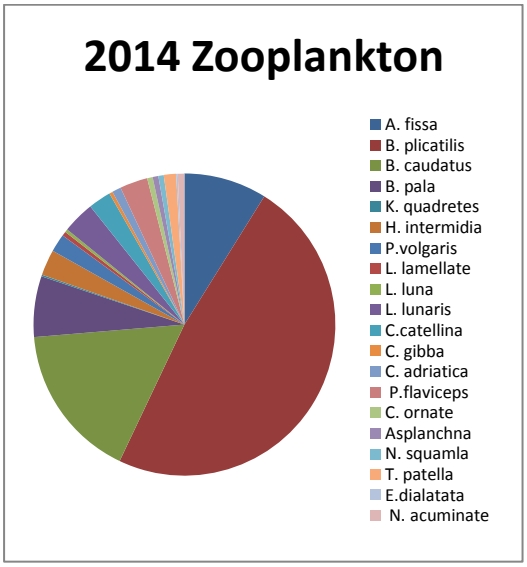
Among cladocera Alona sp. and Moina were most abundant.The Cladoceranes are primary consumers which feed on algae and fine particlulates thus it influence the energy of food chain and cycling matter in the dentritus. Sitare (2013).By Pradhan (2014) found dominancy of Copepods in summer month during study period.Calanoid (diaptomus sp.), Eucyclopes sp., microcyclopes sp. and Presence of Diatomus and cyclopes also observed by Pawar and Pulle (2005) in Pethwadaj dam Nanded. The single Ostracoda species observed in Lonar Lake that was cypris subglobosa by Siddiqi (2008). The highest density of ostracoda found in summer by Sontakke and Mokashe (2014) in Kagzipura Lake. Water level decreases in summer and metabolic activities of biotic component increases. This result found by them and Jayebhaye (2010) worked on river kayadhu, near Hingoli city, Hingoli district, Maharashtra and Ramulu (2011) study on perennial tank in Warangal district, A.P. As compared to other zooplankton population Ostracoda shows minimum population, similar observation are got by Lahane and Jaybhaye (2013) according to them Ostracoda population are less due to the feeding pressure of fishes and Ostracoda are small Crustaceans having bivalve carapace enclosing the laterally compressed body.

Graph plate I- Biological Parameter

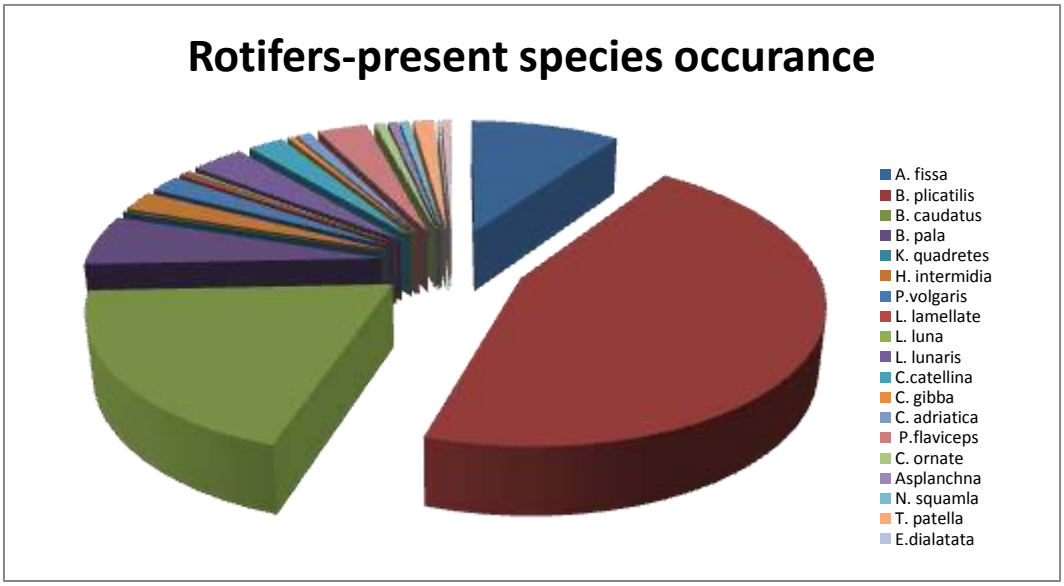
(A)



(B)



(C)



Graph Plate No. 23: Values of dominance and abundance of Rotifer species in A) 2013 B) 2014 and C) Both.

4.3.2 Quantitative Analysis of Zooplankton

Quantitative analysis of zooplanktons was done by using the Sedgwick-Rafter cell counting method. Number of individuals was observed in one ml of sample. Rotifers are dominant throughout the study periods all such results of Rotifers are given below.

4.3.2.1 Anuaeropsis fissa

The number of individuals per ml of sample was observed. During the study periods mean of Anuaeropsis was 61.646±12.511 individuals found in per ml of sample. Highest number of individuals found in the month November on sampling site S2 which was 76 individuals in a one ml of plankton sample while lowest was 36 individuals on S3 in December in 2013. In 2014 highest was observed in April on sampling site S4 92 individuals while same lowest individuals which was observed in 2013 but found on S4 in the month of February. During the 2013 mean values of individuals on four different sampling sites like S1, S2, S3 and S4 are 59.67±5.49931, 58.25±7.7709, 55.67±12.27, and 63.67±9.9484 respectively. In 2014 values of four sampling sites are 65±11.233, 61.58±11.51, 59.25±16.95 and 70.08±17.58. The mean value of first years on all sampling sites was 59.313±9.3903 and in next year it was

63.979±14.734. For comparative study of both years and on same sampling sites was taking their‘t’ value which was observed. In sampling site S1 it was -1.47719, S2 -0.83153, S3 -0.59318 and S4 -1.10026. The ‘p’ values of four site was S1 0.153797, S2 0.414608, S3 0.559107 and S4 0.283115 while ‘f’ values was S1 0.025798, S2 0.208466, S3 0.299132 and S4 0.071687. All values are accepted because there is no much fluctuation for observed value of individuals. Annureopsis was observed increased their number during the study periods by Dabhade (2006). **Table No. 23, Graph Plate I.**

4.3.2.2 Brachionus plicatilis

The number of individuals per ml of sample was observed. The mean of Brachionus plicatilis throughout the study periods was 288.48±99.34 found in per ml of sample. The highest individuals number was in the month of Jun on sampling site S3 which was 325 and lowest was observed in March on S2 was 172 individuals in 2013 while in 2014 the individuals number was highest on S3 in December was 568 and lowest on S4 in January was 160 individuals. The mean individuals number on four sampling site in first year was S1 had 234.67±39.41, S2 226.33±48.348, S3 was 223.8±54.18 and on S4 it was 232.92±38.372. In next year observed number of individuals on four site was S1 331.92v92.65, S2 337.3±84.94, S3 363.1±118.4 and S4 357.9±125.7.

During the first year mean of individuals was observed 229.42±44.306 while in next year it was 347.54±104.2. The comparative study of both years on their sampling sites was observed by taking ‘t’ values that was on S1 -3.34596, S2 -3.93139, S3 -3.70608 and S4 -3.2939. The ‘p’ values are S1 0.002925, S2 0.000713, S3 0.001232 and S4 0.00331 while the ‘f’ values are S1 0.008558, S2 0.074616, S3 0.015349 and S4 0.000451. All values are accepted but there was increasing the number of individuals. In 2013 individual’s number was observed more and in 2014 it was increasing. Such Brachionus species was densely observed in Lonar water sample. Zooplankton community of Lonar Lake contain only Rotifers and in which only genus of Brachionus, which was found due to the uniqueness of high pH and alkalinity, the occurrence of which is definite indication of eutrophication of the Lake

Malu et al.,(2000).Brachionus plicatilis, polyarthrasp.domination indicates that water is highly polluted, studied by Damodare et al.,(2006). **Table No. 24, Graph Plate II.**

4.3.2.3 Brachionus caudatus

The number of individuals per ml of sample was observed. During the study periods mean of Brachionus caudatus was 123.24±22.041 found in per ml of sample in 2013 the highest number of individuals was observed on sampling site S3 in the month of March while the lowest was observed on S2 in the month of July which was 68 individuals. In 2014 highest was observed on sampling site S4 in December 164 individuals and lowest was on also same sampling site but in the month of April was 38 individuals.

The mean individuals number in 2013 on four sampling sites, on S1 it was observed 130.167±18.886, S2 116.83±23.186, S3 129.4±23.77 and on S4 130±18.201 while in 2014 it was 120.08±21.765, 115.09±14.56, 123.1±18.11 and 120.4±33.54 on four sampling site respectively. The mean individuals number in 2013, 130.17±21.251 and in 2014 it was 119.88±22.522 was observed. The comparative study between both years and with four sampling site was observed by taking their 't' which was S1, S2, S3 and S4 are 1.212123, 0.115974, 0.734289 and 0.86999, the 'p' values are 0.238323, 0.908725,0.470527 and 0.3937 while the 'f' values are 0.646088, 0.138197, 0.380866 and 0.054102 respectively on four sites. All values are accepted because in 2013 number of individuals is more than next year; the number of individuals was decreases by comparing the both years. Brachionidae was always either dominant or else co-dominant and then mainly with the Lecanidae by Claps et al.,(2011).**Table No. 25, Graph Plate III.**

4.3.2.4 Brachionus pala

The number of individuals per ml of sample was observed. During the study period mean number of Brachionus pala was 36.948±16.655 observed. The highest number of individuals in 2013 was on sampling site S4 in month of December which was 53 individuals found in per ml of sample and lowest was 8 individuals on same site but in month of May. In 2014 the highest number of individuals was observed on sampling site S4 in December which was 72 individuals and lowest was on S3 in

February was 17 individuals. The mean of individuals found in four sampling sites in 2013 was on S1 28.167±7.408, S2 30.583±12.717, S3 23.67±10.36 and S4 25.417±14.532 while in 2014 mean of number of individuals observed on S1 was 40.833±11.777, S2 43.75±12.71, S3 46.08±16.32 and S4 57.08±15.09. Total mean of individuals in 2013 was 26.958±11.504 and in 2014 it was 46.938±14.983 individuals per one ml of sample.

The comparatives study of both year on their four sampling sites was observed by taking't' values these are on S1 -3.15375, S2 -2.53707, S3 -4.01655 and S4 was -5.23616. The 'p' values are S1 0.004607, S2 0.018779, S3 0.000579 and S4 was 2.98E-05 because on sampling site S4 number of individuals are largely fluctuating. The 'f' values on four sampling sites are S1 0.139424, S2 0.99806, S3 0.146985 and S4 0.902686. All values are accepted but in 2013 individual's number are more and which was increases in 2014 also, slight fluctuation was observed on sampling site four and on which large number of individuals are also observed rather than the other three sites. The relative density of Brachionus pala during the three years study periods was 3.42 and -2.453 observed by Dabhade (2006). **Table No. 26, Graph Plate IV.**

4.3.2.5 Keratella quadretes

The number of individuals per ml of sample was observed. During the study periods mean of Karatella quadetes was found 0.8958±1.3257 individuals. The highest number was observed in month of December on S3 which was 3 individuals and in august no any individuals observed on all four sampling site in 2013 while in 2014 highest was observed on sampling site S4 during the same month and observed number was double and in month of February again no anyone was observed. The mean number of individuals on four sampling sites in 2013 was S1 0.1667±0.389. S2 0.1667±0.389, S3 1±1.206 and S4 0.8333±0.7177 while in 2014 observed mean individuals are S1 0.5833±0.9003, S2 0583±0.996, S3 1.333±1.303 and S4 2.5±2.236. In 2013 total mean of all four sampling site was 0.5417±0.8241 observed and in 2014 observed mean individuals was 1.25±1.6177. For comparative study of individuals on four sampling sites in both years was observed by calculating their 't' values, these are on S1 -1.47151, S2 -1.34952, S3 -0.65044 and S4 -2.45845, the 'p' values are S1

0.155313, S2 0.190896, S3 0.522141 and S4 0.022296 while the 'f' values are S1 0.009772, S2 0.004198, S3 0.802763 and S4 was 0.000724. All values are accepted. The perennial species, Brachionus calciflorus, Keratella quadrata and Keratella tropica displayed remarkable density peak during the rainy season Tayade (2012). **Table No. 27, Graph Plate V.**

4.3.2.6 Hexarthra intermedia

The mean individuals' number observed throughout the study periods in one ml of sample was 14.146±7.8378. The highest number was observed on sampling site S4 in December was 21 individuals and lowest was 2 on S3 month of July in 2013 while in 2014 highest was on same sampling site but observed in the month of July and number was also increase which is 36 individuals and lowest was on S1 in October 9 individuals.

The mean number of individuals on four sampling sites are in 2013 was 8.9167±4.2525, 7.667±5.105, 10±5.222, 10.083±5.6802 respectively. In 2014 observed number was 14.333±4.6188, 18.67±6.61 and 17.17±3.38, 26.33±6.61 on S1, S2, S3 and S4 respectively. In 2013 total mean of individuals observed on four sampling sites was 9.1667±5.0248 and in 2014 it was 19.125±6.9485. The comparative study of individuals found during study periods on four sampling sites are compared by taking their 't' values these are on S1, S2, S3 and S4 was -2.9887, -4.56234, -3.99089 and -6.4587 respectively. The 'p' values are 0.006769, 0.000153, 0.000617 and 1.69E-06, on sampling site S4 in both the years was more change observed in form of individual, while 'f' value on four sampling site are 0.788864, 0.404627, 0.164604 and 0.623604. All values are accepted and it was observed that number of individuals in 2013 was more and number of individuals increases during the 2014. **Table No. 28, Graph Plate VI.**

4.3.2.7Polyarthra vulgaris

During the study periods one ml of sample containing mean of number of individuals of Polyarthra vulgaris was 12.948±6.4569 observed. In the month of May 27 individuals are observed on S4 which was highest number of individuals while in

month of January lowest was observed on S3 which was 3 individuals in 2013. In 2014 on same month and same sampling site but 29 slightly more individuals than 2013 was observed while in July on S3 there was 2 individuals are observed. In 2013 mean of number of individuals on four sampling sites are on S1 was 9.667±5.2455, S2 10.5±5.108, S3 12.5±5.266 and on S4 it was 15.33±6.6378. In 2014 observed number of individuals are on S1 it was 10.417±5.9614, S2 13.5±5.214, S3 14.58±8.017 and S4 17.08±7.354. Overall observed mean in 2013 was 12±5.8492 while in 2014 it was 13.896±6.9443. For the comparative study between these years 't' values was taken on four sampling sites these are on S1 it was -0.32719, S2 -1.42383, S3 -0.75244 and S4 -0.61192, the 'p' values on S1 was 0.746618, S2 0.168524, S3 0.459761 and S4 0.546861 and 'f' values S1 was 0.678707, S2 0.947059, S3 0.178996 and S4 0.739907.

All values are accepted because all values are in same range but the probability of individuals found on sampling site was more than other three sampling sites and observed individuals number was more in 2013 and number increases during the 2014 also. According to the number of individuals it also predicted that the sampling site S4 in summer there were observed rate of individuals was more. **Table No. 29, Graph Plate VII.**

4.3.2.8Lecane lamellate

During the study periods one ml of sample containing mean of number of individuals of Lecane lamellate was 3.1354±2.4349 was observed. During the 2013 highest number of individuals was observed on sampling site S3 in month of Jun which was 11 individuals while on S1 in month of April no any individuals was observed. In 2014 highest was observed on S4 in April which was 12 number of individuals while in Julylowest was observed on S3 there was only 2 individuals observed. During the first year mean of all four sampling site observed individuals on S1 was 1.75±0.9653, S2 2.4167±1.6214, S3 3.583±2.875 and S4 3.583±2.875. In next year mean number of individuals was observed on S1 2±1.4142, S2 2.167±1.586, S3 3.583±1.564 and S4 5.667±3.525. Overall mean of total number of individuals observed during 2013 was 2.9167±2.2676 and in 2014 it was 3.3542±2.597. Comparative study between the both years on their four sampling sites was calculated

by their 't' values, on sampling site S1 it was -0.50578, S2 0.381841, S3 0 and S4 -1.38224, the 'p' values are on S1, S2, S3 and S4 are 0.618041, 0.706243,1,0.180771 respectively while 'f' values are 0.220986,0.942894,0.055083 and 0.333279 on S1 to S4 respectively. All values are near about similar slightly change was observed on sampling site S1 which was increases in 2014 but on other three are almost same and in sampling site S3 it was same due to that there was no any change observed on their number. **Table No. 30, Graph Plate VIII.**

4.3.2.9 Lecane luna

During the study periods mean observed number of individuals of all four sites in one ml of sample was 1.8125±1.3865. The highest number was observed on sampling site S4 in April was 3 numbers of individuals and in month of Jun no any individuals can observed in 2013. While in 2014 in month of May 7 numbers of individuals observed on S4 and in the month of April again no individuals can observed. In 2013 mean number of individuals on sampling site S1 was 1.3333±1.07309, S2 0.8333±0.9374, S3 1.083±0.9 and S4 1.75±1.0553 and in 2014 it was 1.9167v0.9962, 2.167±1.403, 2.333±1.073 and 3.083±2.109 respectively on four sites. During the first year mean number of individuals was observed 1.25±1.0211 and in next year it was 2.375±1.4822. The comparative study of both years on four sampling sites was calculated by taking their 't' values, 'p' values and 'f' values are on four sampling sites viz. S1, S2, S3 and S4 are -1.38007, -2.73667, -3.09128, -1.9587, 'p' values are 0.18143,0.012043,0.005333,0.062944 and 'f' values are 0.809616, 0.19648, 0.570257 and 0.03036 respectively. The observed numbers of individuals on all sampling sites are increases from S1 to S4 and sampling sites S4 had maximum probability for the individuals. Number of individuals in both years compared with each other then number of individuals in 2013 was more and in 2014 it was observed increasing. **Table No. 31, Graph Plate IX.**

4.3.2.10 Lecane lunaris

During the study periods mean number of individuals observed on four sampling sites in one ml of sample was 22.063±7.2993. In 2013 highest number of individuals are observed in the month of July on site S4 was 34 number of individuals and lowest was observed 9 individuals on S3 in Jun. During 2014 highest was

observed on same site but in month of May 39 number of individuals and lowest on S1 which was 12 in the month of October. In 2013 mean of total number of individuals observed on four sites was, S1 15.8333±4.5093, S2 18.917±5.213, S3 17.75±5.276 and S4 24.5±6.974 and in 2014 it was, S1 22.417±7.255, S2 22.58±5.744, S3 26.08±7.115 and S4 18.42±7.609. Overall total mean of number of individuals observed in 2013 was 19.25±6.296 and in 2014 it was observed 24.875±7.2041 number of individuals. Comparative study of both years on four sampling sites by calculating their 't' values are observed on S1 was -2.66986, S2 -1.63751, S3 -3.25881 and S4 was -1.31448 and 'p' values are on S1 0.013992, S2 0.115749, S3 0.003596 and S4 0.202223 while 'f' values are S1 0.129858, S2 0.753319,S3 0.335786 and S4 was 0.77756. All values are accepted because there was no much fluctuation observed on number of individuals but number was more in 2013 and which was increases in 2014. On sampling site S4 it was observed that the numbers of individuals are increase and maximum probability to observe such species on that area and it was also observed that during the study periods sampling site S1 it was less as compared to other sites. **Table No. 32, Graph Plate X.**

4.3.2.11 Cephalodella catellina

During the study periods one ml of sample contain mean of 14.958±5.3408 number of individuals of Cephalodella catellina was observed. Highest number was observed in month of October on sampling site S2 which was 20 numbers and 2 numbers of individuals are observed on S3 in July during 2013. While in 2014 on sampling sites S4 27 number of individuals was observed in April and11 was on S1 in October. The mean number of individuals observed on four sites in 2013 was on S1, S2, S3 and S4 are 12.5±3.4772, 12.667±3.9158, 12±5.394, 12±5.394 and 12.5±6.6538 respectively. In 2014 it was 17.583±4.8516, 17.92±4.188, 17.42±3.919 and 17.08±5.664 respectively on four sites. The overall mean of total number of individuals was observed on four sampling sites in 2013 was 12.417±4.8634 and in 2014 it was 17.5±4.5616. Comparative study of both years on four sites was observed individuals by calculating their 't' values are on S1 it was -2.95011, S2 -3.17206, S3 -2.8145 and S4 -1.81698. The 'p' values are on S1 was 0.007401, S2 0.004413, S3 0.010097 and S4 was 0.082869 while 'f' values are on S1 0.284442, S2 0.827672, S3

0.304262 and S4 0.602401. During the study periods observed number of individuals are more in 2013 and it was increase along with their sites in 2014. Sampling sites S2 and S4 both sites shown more probability for the individual's number. **Table No. 33, Graph Plate XI.**

4.3.2.12 Cephalodella gibba

During the study period one ml of sample containing mean of number of individuals on all four sampling sites was 2.8125±1.6753 observed. The highest number of individuals was observed on sampling site S2 in December which was 8 number of individuals and on sampling sites S4 single was observed in July 2013 while in 2014 highest was observed on S3 in May which was 7 number of individuals and no individuals was observed in the month of February on sampling sites S4. During the 2013 mean of number of individuals was observed on four sampling sites S1, S2, S3 and S4 are 3.333±1.2309, 3.4167±2.3916, 2.75±1.357 and 2.4167±1.379 respectively. In 2014 number of individuals on four sites was 2.667±1.3707, 2.25±1.288, 3.25±2.261 and 2.417±1.73 respectively. The mean of overall number of individuals observed in 2013 was 2.9792±1.6566 and in 2014 it was 2.6458±1.6947. Comparative study of both the years on four sampling sites are calculated by 't' values are S1 1.253566. S2 1.487801, S3 -0.65679 and S4 was observed nil. The 'p' values on S1 was 0.223158, S2 0.150997, S3 0.518128 and S4 was 1 while observed 'f' values was on S1 0.727548, S2 0.051332, S3 0.104599 and S4 0.464156. During the study periods all values are observed no much fluctuation they are nearly similar on four sites no much variation was observed. **Table No. 34, Graph Plate XII.**

4.3.2.13C. adriatica

During the study periods observed mean of number of individuals was 6.1563±4.2977. The highest number of individuals was observed in 2013 on sampling sites S1 in the month of January which was 14 individuals and low count on sampling site S2 in December was single. In 2014 high count was observed in the month of July on sampling sites S4 which was 20 individuals and on S3 in month January no any individuals was observed. The mean values of individuals in 2013 on four sampling

sites are in S1 4.6667±3.8455, S2 3±3.4378, S3 6.667±2.462 and S4 7.333±3.0251 and in 2014 it was observed that S1 5.25±2.9271, S2 5±2.697, S3 6.5±4.317 and S4 10.83±6.64. Overall mean of 2013 was 5.4167±3.572 observed and in 2014 it was 6.8958±4.8432. For comparative study of both experimental years on their four sampling sites was calculates by't' values are S1 -0.41813, S2 -1.58565, S3 0.116176 and S4 -1.69876 while the 'p' values on S1 was 0.679908, S2 0.127089, S3 0.908567 and S4 0.103464 and 'f' values are S1 0.379159, S2 0.433432, S3 0.07552 and S4 0.018307. All such values are accepted only on sampling site S3 there was low count of individuals. The probability of number of individuals is more in 2013 and which was increases in 2014. On sampling site S4 high counts observed in 2014. **Table No. 35, Graph Plate XIII.**

4.3.2.14Philodina Sp.

During the study periods mean of Philodina sp. was 20.708±6.9478. The maximum count observed on sampling site S4 in the month April which was 32 individuals and nil was on also same sites but in January 2013. While in 2014 maximum count was on also on same sites in month of March which was 32 individuals and low count on S1 in month of September which was 11 individuals. The mean number of individuals in 2013 on four sites viz. S1, S2, S3 and S4 was 17±6.4244, 19±7.3113, 18.92±6.999 and 24.75±8.7814 respectively. In 2014 on all four sites mean counts were 20.917±4.3371, 19.67±5.598, 21.58±5.838 and 24.75±8.781. The overall mean of four sites in 2013 was 19.917±7.7647 and in 2014 was 21.5±6. Comparative study between both years on four sampling sites are calculated by their 't' values, these are on S1 -1.75037, S2 -0.2508, S3 -1.0135 and S4 was 0.271573 while observed 'p' values on four sites were 0.09399, 0.804294, 0.321841 and 0.788483 and 'f' values 0.208261, 0.389259, 0.55743 and 0.676743. All values are accepted because there was no much fluctuation in same year. During the study periods the number of individual's counts was more in the 2013 and which was increases in 2014. On sampling site S4 maximum counts was observed throughout the study periods and low counts was observed on other sampling sites.

Philodina sp. Firstly recorded in Lonar Crater by Dabhade (2006).**Table No. 36, Graph Plate XIV.**

4.3.2.15Collotheca Sp.

During the study periods mean number of individuals of Colotheca sp. was 4.5313±5.1829 observed. The maximum counts of individuals in 2013 was observed on sampling site S2 in January which was 30 individuals and on sampling site S1 in February was observed nil. In 2014 maximum was observed in the month of May on sampling sites S4 which was 12 individuals and nil count was observed on S3 in July. The observed mean of number of individuals during 2013 on four sites viz.S1, S2, S3 and S4 was 4.3333±6.9718, 4±8.2682, 4.5±5.09 and 6.4167±6.0672. In 2014 observed mean counts were 3.0833±2.0207, 3.167±2.167, 4.167±4.041 and 6.583±3.728 respectively. The mean individual's number in 2013 from four sampling sites was 4.8125±6.5547 and in 2014 it was 4.25±3.3422. Comparative study of both years on four sampling sites was calculated by means of 't' values these are, on S1 0.596539, S2 0.337729, S3 0.177662 and S4 -0.08107 while 'p' values are S1 0.556904, S2 0.738769, S3 0.860614 and S4 0.936116 and 'f' values are S1 0.000276, S2 0.000104, S3 0.456422 and S4 0.121219. All values are accepted because no much fluctuation was observed. Throughout the study periods number of individual's counts was observed somewhat similar.**Table No. 37, Graph Plate XV.**

4.3.2.16 Asplanchna Sp.

During the study periods mean of Asplanchna sp. in one ml of sample counts was 3.8958±2.09. The maximum number of individuals was observed on sampling sites S2 in Jun that was 7 individuals and on S1 no any individual was observed in January 2013. In 2014 maximum count was 9 individuals in March on S3 while on S2 which was not observed on same site and same month like 2013. During 2013 the mean by their four sampling sites was S1, S2, S3 and S4 are 2.5±1.67874, 3.0833±2.0652, 3.333±1.435 and 4.5833±1.5643 respectively, the number of counts was increases from sampling site S1 to S4 in 2013. While in 2014 all four sites observed mean counts number was 4.0833±1.6765, 3.833±2.209, 4.75±2.701 and 5±2.296 respectively, on sampling site S3 counted number was more than the other

three sites. The overall mean in 2013 of four sites was 3.375±1.8175 and 2014 was 4.4167±2.2297. For comparative study between the two years on their four sampling sites by calculating 't' values was S1 -2.31183, S2 -0.85918, S3 -1.6044 and S4 -0.51949 while observed 'p' values are on S1, S2, S3 and S4 was 0.030535, 0.399505, 0.122887 and 0.608605 respectively and 'f' values on four sites was 0.996518, 0.827564,0.046786 and 0.218671.

All values are accepted due to slight fluctuation in their sites. The number of count was more in 2013 and it was increase in 2014. Asplanchana sp. is a large carnivorous rotifer, feeding on Brachionus or Ascomorpha type rotifers Hutchinson (1967). Supported by Suarez-Morales and Vazquez-Mazyy (1993) the Asplaanchna sp. acts as predator on Brachionus. Dhanapathi (2000)Asplanchna sp. also occurred during periods with high alkalinity values. **Table No. 38, Graph Plate XVI.**

4.3.2.17 Notholca squamla

The one ml of sample was counted, during the study periods mean of Notholca Squamla was 4±2.3215 number of individuals. The mean of maximum count was observed in month of November on S2 which was 8 individuals while minimum was one on S2 in May 2013. During the 2014 maximum count was observed on S4 in December which was 9 individuals and minimum was single on S1 in the month of January. The mean of number of individual's counts on four sites S1, S2, S3 and S4 was observed 3.25±1.76455, 3.333±2.4985, 4.083±1.311 and 4.667±2.0765 respectively. In 2014 mean observed counts on four sites were 3±1.4142, 3.333±2.06, 3.417±1.929 and 6.917±2.61 respectively. The overall mean of number of counts in 2013 on four sites observed was 3.833±2.4246 and in 2014 it was 4.1667±2.5544 individuals. The comparative study between both years on four sampling sites was done by calculating 't' values on S1 0.382971, S2 0, S3 0.990203 and S4 -2.18803 while 'p' values was S1 0.705417, S2 1, S3 0.332842 and S4 0.039577 and 'f' values are on S1, S2, S3 and S4 was 0.474769, 0.532471, 0.216454 and 0.811565 respectively. Maximum number of counts was observed on sampling sites S3 and S4 in both years. Sampling site S4 had maximum probability of occurrence of individuals than other sites. **Table No. 39, Graph Plate XVII.**

4.3.2.18 Notholca acuminate

The one ml of sample was counted, during the study periods mean of Notholca acuminate was 4.125±2.7957 number of individuals. The mean of maximum count was observed in month of September on S1 which was 8 individuals while minimum was one on S4 in January 2013. During the 2014 maximum count was observed on S4 in August which was 14 individuals and minimum was single on S3 in the month of December. The mean of number of individual's counts on four sites S1, S2, S3 and S4 was observed 3.5±1.9504, 3.25±1.9598, 2.833±1.337 and 3.083±1.832 respectively. In 2014 mean observed counts on four sites were 4.6667±3.6515, 4.667±2.871, 5.333±3.025 and 5.667±3.725 respectively. The overall mean of number of counts in 2013 on four sites observed was 3.1667±1.8141 and in 2014 it was 5.0833±3.2606 individuals.

The comparative study between both years on four sampling sites was done by calculating 't' values on S1 -0.9486, S2 -1.41177, S3 -2.61839 and S4 -2.1556 while 'p' values was S1 0.353131, S2 0.172005, S3 0.015692 and S4 0.042318 and 'f' values are on S1, S2, S3 and S4 was 0.105839, 0.221092, 0.011679 and 0.026668 respectively. Maximum number of counts was observed on sampling sites S3 and S4 in both years. Sampling site S4 had maximum probability of occurrence of individuals than other sites. The number of individuals observed in first years as compared to next the observed number was increases. **Table No. 40, Graph Plate XVIII.**

4.3.2.19 Testudinella patina

The observed mean per ml of sample throughout study periods of Testudinella patina was 8.7083±3.4333 number of individuals. In 2013 maximum number of counts was observed on sampling sites S4 in December which was 14 individuals and minimum count was single on same sites in January. In 2014 maximum counts was on S4 but in the month of November observednumber was 16 individuals and minimum was 3 individuals on site S3 in same month which was observed in 2013. The mean values of four sampling sites viz. S1, S2, S3 and S4 was 6.41667±3.26018, 8.0833±3.4499, 8.25±3.596 and 9.0833±3.5792 respectively. In 2014 it mean of individuals counted was 8.25±2.7675, 8.833±3.099, 9.75±3.223 and 11±3.49. Overall mean of individuals in 2013 from four sampling sites was 7.9583±3.5005 and in 2014

it was 9.4583±3.2286 number of individuals counted. Comparative study of both years on four sampling sites was calculated by 't' values, on sampling sites S1, S2, S3 and S4 are -1.48508, -0.56022, -1.07606 and -1.32811 respectively while the 'p' values on such sites are 0.151711, 0.580992, 0.293562 and 0.197758 and 'f' values are 0.596086, 0.728567, 0.722594 and 0.934978. All values are accepted slightly fluctuation was observed on sampling sites S4 than other three sites in both years. Probability of occurrences individuals are more on S4 than other sites. The number of individuals goes on increases throughout the study periods. The Testudinellidae reached its maximum level in the flooding period by Claps et al.,(2011). **Table No. 41, Graph Plate XIX.**

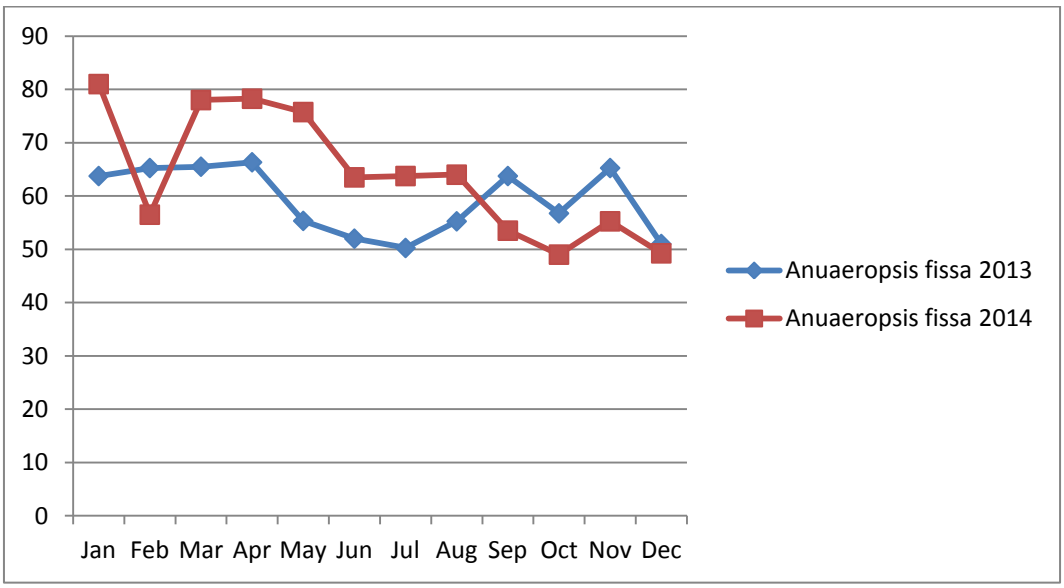
4.3.2.20 Euclanis dialatata

The one ml of sample was counted, during the study periods mean of Euclanis dialatata was 1.1458±1.2138 number of individuals. The mean of maximum count was observed in month of January on S1 which was 6 individuals while no individuals were observed on S3 in July 2013. During the 2014 maximum count was observed on S4 in November which was 4 individuals and no any individuals observed in the month of Jun on all four sampling sites. The mean of number of individual's counts on four sites S1, S2, S3 and S4 was observed 0.91667±1.72986, 1.0833±1.5643, 1±1.044 and 1.0833±0.9003 respectively. In 2014 mean observed counts on four sites were 1±0.7385, 0.833±1.03, 1.417±1.084 and 1.833±1.337 respectively. The overall mean of number of counts in 2013 on four sites observed was 1.0208±1.3126 and in 2014 it was 1.2708±1.1059 individuals. The comparative study between both years on four sampling sites was done by calculating 't' values on S1 -0.15348, S2 0.46241, S3 -0.95903 and S4 -1.61173 while 'p' values was S1 0.879423, S2 0.648328, S3 0.347967 and S4 0.121276 and 'f' values are on S1, S2, S3 and S4 was0.008821, 0.181318, 0.905023 and 0.205326 respectively. Maximum number of counts was observed on sampling sites S1 and S4 in both years. Sampling site S1 had maximum probability of occurrence of individuals than other sites. The number of individuals observed in first years as compared to next the observed number was increases. **Table No. 42, Graph Plate XX.**

Table No. 23: Monthly variation in rotifer species Anuaeropsis fissa showing mean and standard deviation of the year 2013 and 2014.

Sr.No.	Month	2013 A. fissa Mean	2014 A. fissa Mean
01	January	63.75±8.73212	81±2.581989
02	February	65.25±2.217356	56.5±17.91647
03	March	65.5±9.865766	78±9.416298
04	April	66.3333±6.757712	78.25±12.39287
05	May	55.3333±1.290994	75.75±7.36546
06	Jun	52±4.041452	63.5±7.187953
07	July	50.25±4.193249	63.75±14.66004
08	August	55.25±7.675719	64±6.683313
09	September	63.75±4.349329	53.5±11.23981
10	October	56.75±14.31491	49±10.64581
11	November	65.25±7.182154	55.25±8.220908
12	December	5112.49	49.25±11.92686

Graph Plate No. I: Biological Parameter

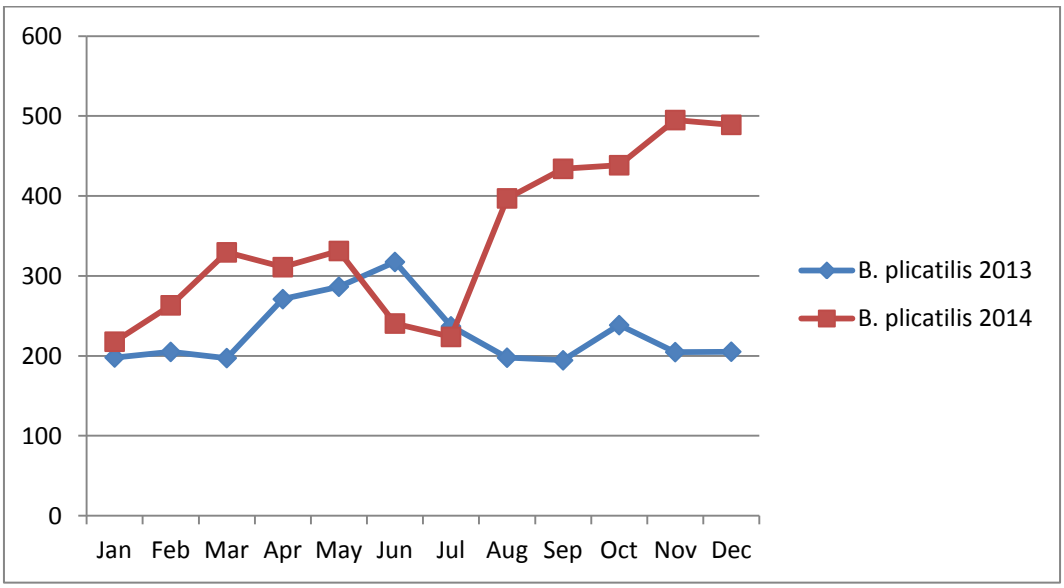


Graph Plate No. 24: Values of dominance and abundance of A. fissa in 2013 and 2014

Table No. 24: Monthly variation in rotifer species Brachionus plicatilis showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 B. plicatilis Mean	2014 B. plicatilis Mean
01	January	198±9.3452305	217.75±45.434018
02	February	205±13.97617	263.25±23.428971
03	March	197.25±24.649206	329.5±27.87472
04	April	271±11.83216	311±9.8994949
05	May	286.5±20.436895	331.25±15.129992
06	Jun	317.5±7.5938572	240.5±20.728402
07	July	237±18.366636	223.75±54.670986
08	August	197.75±11.026483	397±47.791213
09	September	194.5±9.7125349	434±29.439203
10	October	238.5±13.304135	438.5±36.601457
11	November	204.75±56.505899	495±19.714631
12	December	205.25±10.045729	489±89.21136

Graph Plate No. II: Biological Parameter

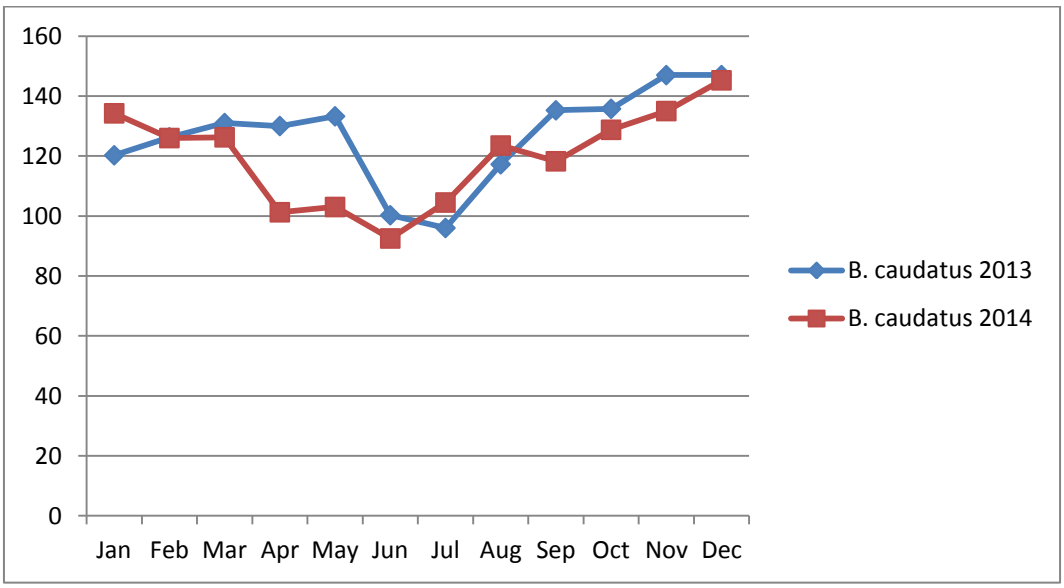


Graph Plate No. 25: Values of dominance and abundance of Brachionus plicatilis in 2013 and 2014

Table No. 25: Monthly variation in rotifer species Brachionus caudatus showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 B. caudatus Mean	2014 B. caudatus Mean
01	January	120.25±10.71991915	134.25±9.810708435
02	February	126.25±7.5	126±12.51665557
03	March	131±36.74234614	126.25±6.849574196
04	April	130±19.61292091	101.25±43.41562699
05	May	133.25±6.800735154	103±11.28420725
06	Jun	100.25±13.57387196	92.5±19.50213664
07	July	96±21.47867159	104.5±4.654746681
08	August	117.25±15.84034932	123.5±6.608075867
09	September	135.25±6.994045086	118.25±19.36276495
10	October	135.75±11.44188213	128.75±13.79311422
11	November	147±6.480740698	135±22.78888618
12	December	147±15.4488403	145.25±16.68082732

Graph Plate No. III: Biological Parameter

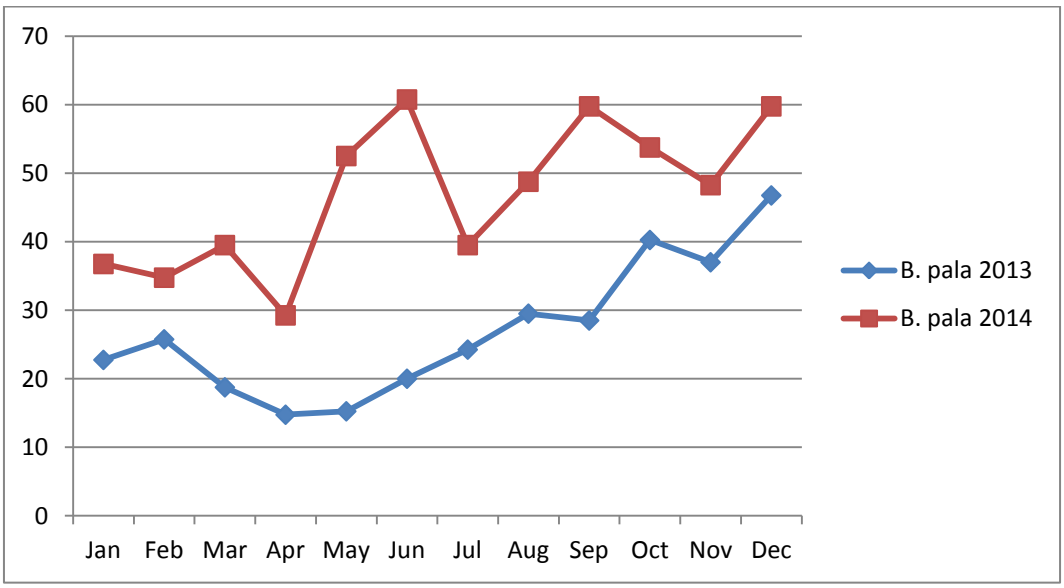


Graph Plate No. 26: Values of dominance and abundance of Brachionus caudatus in 2013 and 2014

Table No. 26: Monthly variation in rotifer species Brachionus pala showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 B. pala	2014 B. pala
		Mean	Mean
01	January	22.75±10.04573	36.75±11.177
02	February	25.75±3.095696	34.75±16.256
03	March	18.75±2.5	39.5±14.387
04	April	14.75±5.315073	29.25±4.9917
05	May	15.25±7.632169	52.5±11.733
06	Jun	20±9.128709	60.75±5.5
07	July	24.25±6.238322	39.5±9.037
08	August	29.5±7.852813	48.75±12.093
09	September	28.5±2.081666	59.75±5.5603
10	October	40.25±1078193	53.75±17.746
11	November	37±5.887841	48.25±16.46
12	December	46.75±7.455423	59.75±13.426

Graph Plate No.IV: Biological Parameter

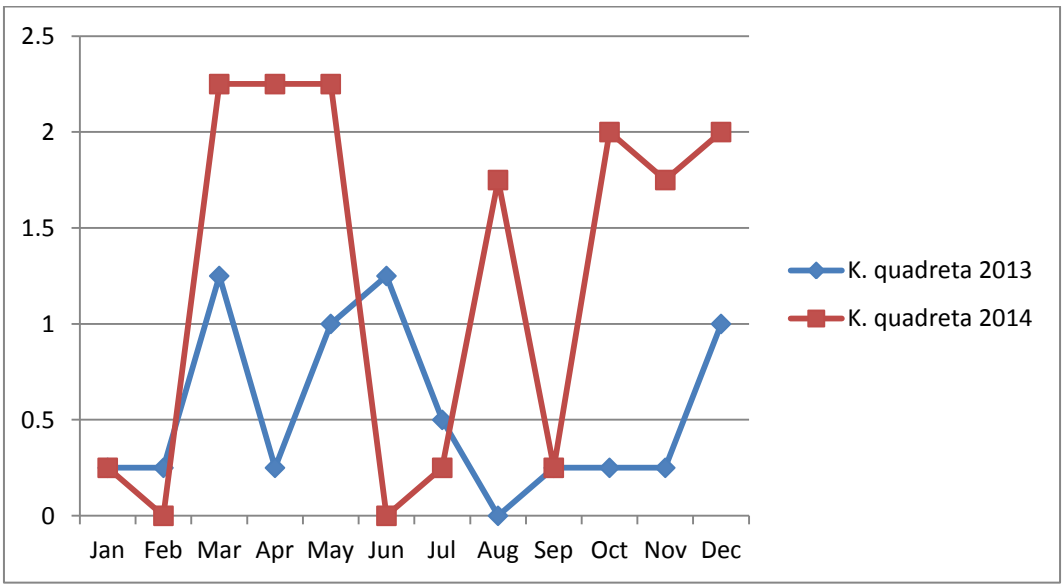


Graph Plate No. 27: Values of dominance and abundance of Brachionus pala in 2013 and 2014

Table No. 27: Monthly variation in rotifer species Keratella quadreta showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 K.quadretas	2014 K. quadretas
		Mean	Mean
01	January	0.25±0.5	0.25±0.5
02	February	0.25±0.5	0±0
03	March	1.25±0.95742711	2.25±2.21735578
04	April	0.25±0.5	2.25±2.21735578
05	May	1±0.81649658	2.25±0.95742711
06	Jun	1.25±1.5	0±0
07	July	0.5±0.57735027	0.25±0.5
08	August	0±0	1.75±0.95742711
09	September	0.25±0.5	0.25±0.5
10	October	0.25±0.5	2±0.81649658
11	November	0.25±0.5	1.75±2.36290781
12	December	1±1.41421356	2±2.82842712

Graph Plate No. V: Biological Parameter

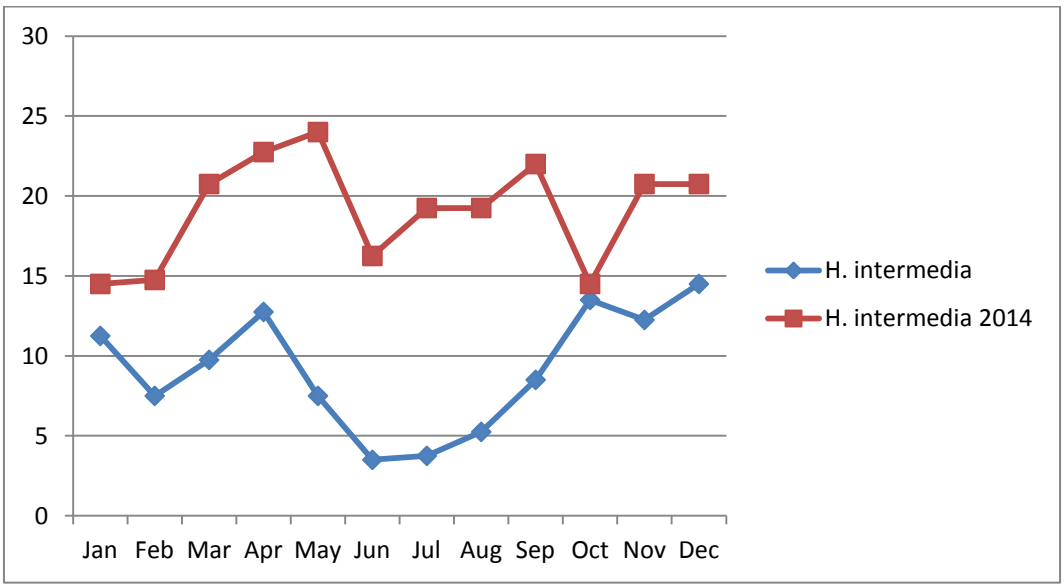


Graph Plate No. 28: Values of dominance and abundance of Keratella quadreta in 2013 and 2014

Table No. 28: Monthly variation in rotifer species Hexaarthra intermedia showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 H. intermedia	2014 H. intermedia
		Mean	Mean
01	January	11.25±3.594	14.5±4.655
02	February	7.5±3.6968	14.75±2.217
03	March	9.75±3.8622	20.75±5.5
04	April	12.75±6.1847	22.75±6.292
05	May	7.5±3.4157	24±6.976
06	Jun	3.3±1.7321	16.25±5.058
07	July	3.75±2.0616	19.25±11.64
08	August	5.25±2.63	19.25±2.986
09	September	8.5±3.873	22±8.287
10	October	13.5±3.4157	14.5±7.937
11	November	12.25±3.304	30.75±10.97
12	December	14.5±6.5574	20.75±4.992

Graph Plate No. VI: Biological Parameter

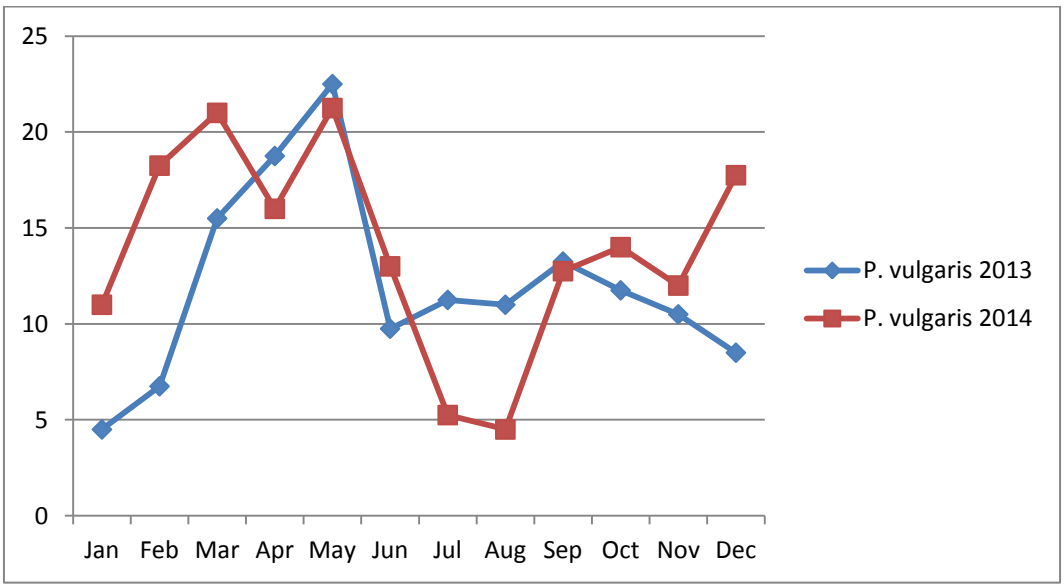


Graph Plate No. 29: Values of dominance and abundance of Hexarthra intermedia in 2013 and 2014

Table No. 29: Monthly variation in rotifer species Polyarthra vulgaris showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 P. Vulgaris Mean	2014 P. Vulgaris Mean
01	January	4.5±1.291	11±4.397
02	February	6.75±3.0957	18.25±3.862
03	March	15.5±3.4157	21±3.162
04	April	18.75±4.5735	16±6.831
05	May	22.5±3.1091	21.25±7.719
06	Jun	9.75±1.7078	13±3.266
07	July	11.25±4.3493	5.25±2.5
08	August	11±5.9442	4.5±1.291
09	September	13.25±1.5	12.75±0.957
10	October	11.75±6.994	14±2.708
11	November	10.5±1	12±7.348
12	December	8.5±2.6458	17.75±9.878

Graph Plate No. VII: Biological Parameter

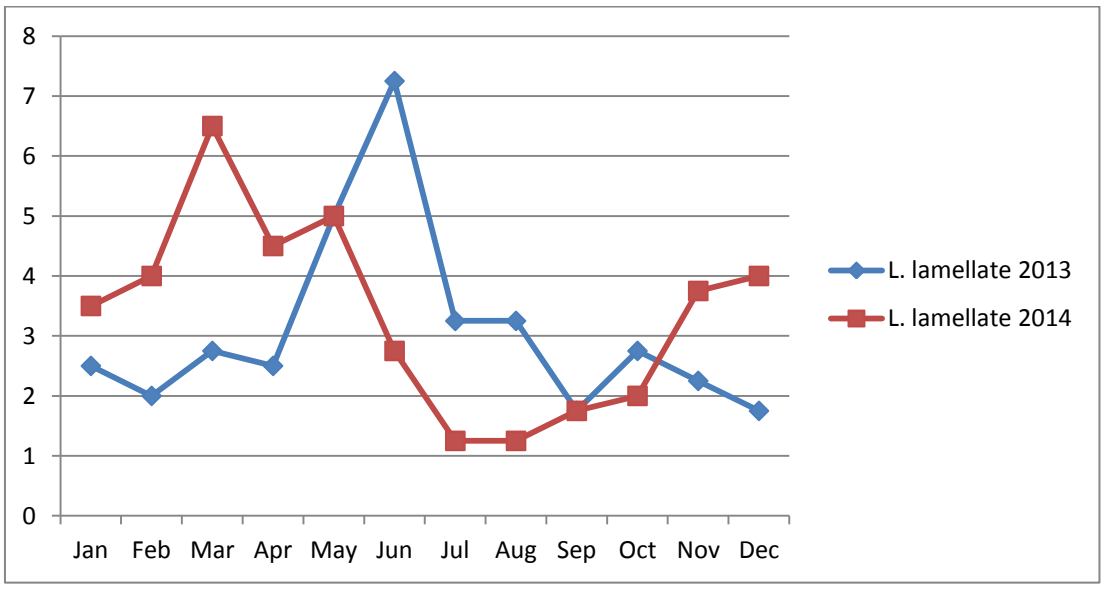


Graph Plate No. 30: Values of dominance and abundance of Polyarthra vulgaris in 2013 and 2014

Table No. 30: Monthly variation in rotifer species Lecane lamellate showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 L. lamellate	2014 L. lamellate
		Mean	Mean
01	January	2.5±0.577	3.5±1.291
02	February	2±1.414	4±0.816
03	March	2.75±1.708	6.5±2.38
04	April	2.5±1.915	4.5±5.066
05	May	5±1.826	5±3.367
06	Jun	7.25±3.5	2.75±2.754
07	July	3.25±2.872	1.25±1.5
08	August	3.25±3.403	1.25±0.5
09	September	1.75±1.708	1.75±0.5
10	October	2.75±0.957	2±0
11	November	2.25±0.5	3.75±2.5
12	December	1.75±0.957	4±2.16

Graph Plate No. VIII: Biological Parameter

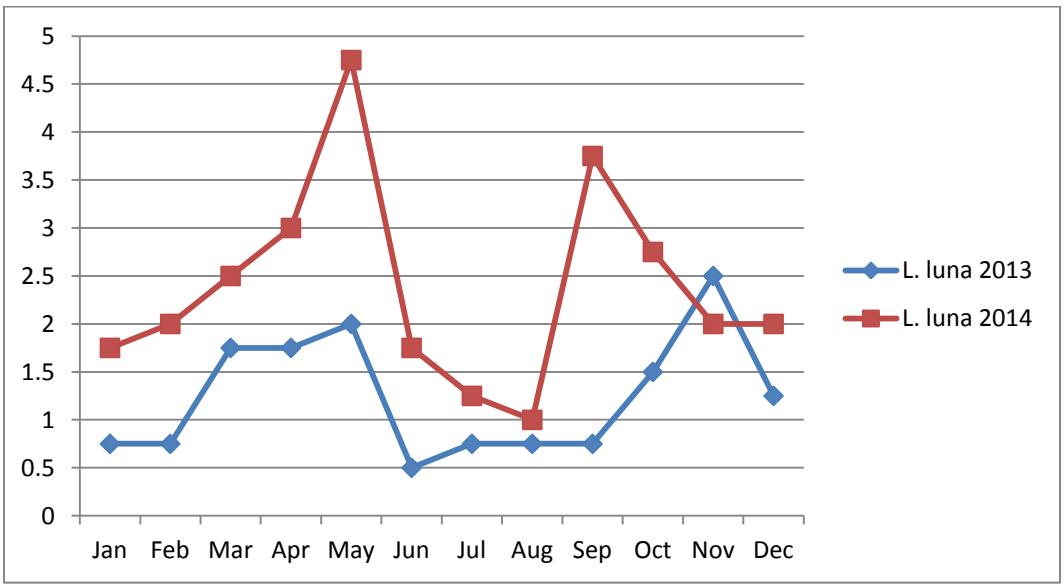


Graph Plate No. 31: Values of dominance and abundance of Lecane lamellate in 2013 and 2014

Table No. 31: Monthly variation in rotifer species Lecane luna showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 L. luna	2014 L.luna
		Mean	Mean
01	January	0.75±0.957	1.75±0.957
02	February	0.75±0.5	2±0.816
03	March	1.75±1.258	2.5±1.291
04	April	1.75±1.258	3±2.16
05	May	2±1.155	4.75±1.708
06	Jun	0.5±1	1.75±1.258
07	July	0.75±0.5	1.25±0.5
08	August	0.75±0.957	1±0.816
09	September	0.75±0.957	3.75±1.708
10	October	1.5±0.577	2.75±0.5
11	November	2.5±0.577	2±0.816
12	December	1.25±0.957	2±0.816

Graph Plate No. XI: Biological Parameter

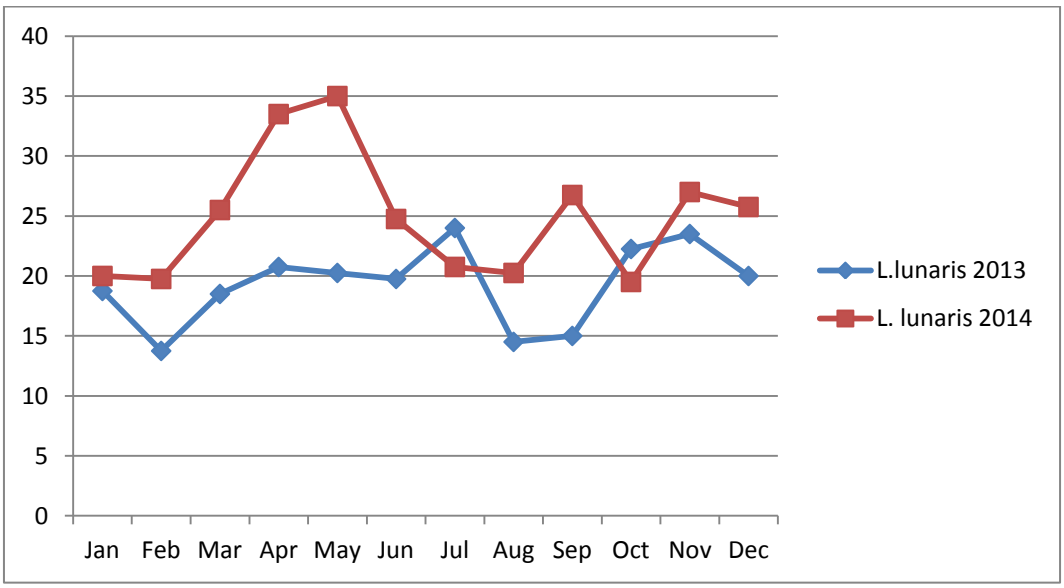


Graph Plate No. 32: Values of dominance and abundance of Lecane luna in 2013 and 2014

Table No. 32: Monthly variation in rotifer species Lecane lunaris showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 L.lunaris Mean	2014 L.lunaris Mean
01	January	18.75±5.737	20±4.082
02	February	13.75±3.594	19.75±6.85
03	March	18.5±4.655	25.5±8.103
04	April	20.75±3.096	33.5±3.416
05	May	20.25±6.652	35±3.742
06	Jun	19.75±11.95	24.75±2.986
07	July	24±9.522	20.75±4.113
08	August	14.5±3	20.25±2.217
09	September	15±2.944	26.75±8.382
10	October	22.25±3.594	19.5±6.245
11	November	23.5±5	27±6.218
12	December	20±6.583	25.75±8.655

Graph Plate No. X: Biological Parameter

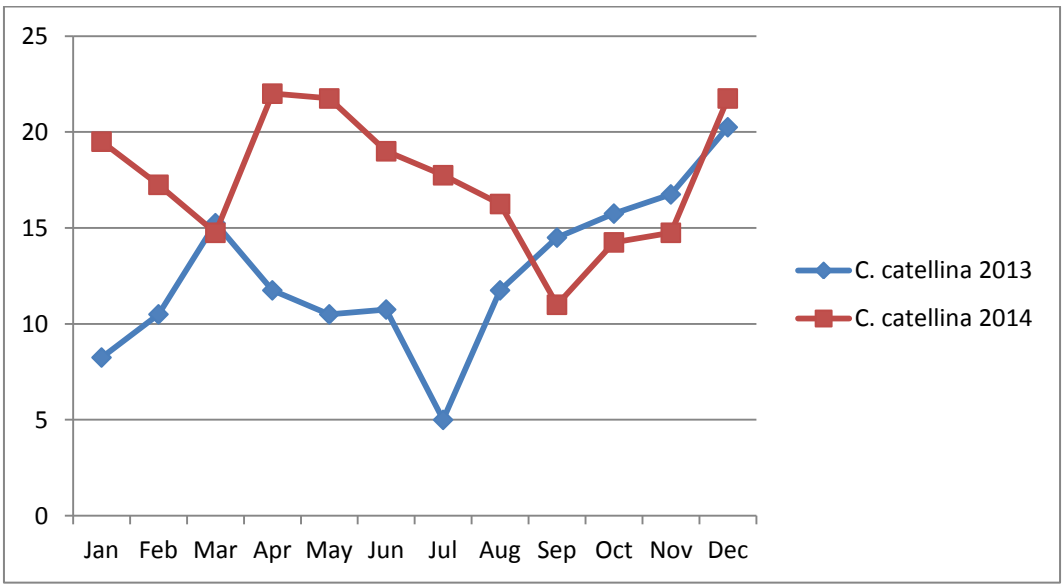


Graph Plate No. 33: Values of dominance and abundance of Lecane lunaris in 2013 and 2014

Table No. 33: Monthly variation in rotifer species Cephalodella catellina showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 C. catellina Mean	2014 C.catellina Mean
01	January	8.25±3.5	19.5±2.38
02	February	10.5±3.109	17.3±2.5
03	March	15.25±3.775	14.8±2.22
04	April	11.75±1.893	22±3.92
05	May	10.5±1.291	21.8±2.87
06	Jun	10.75±6.344	19±4.97
07	July	5±2.582	17.8±6.24
08	August	11.75±1.258	16.3±1.71
09	September	14.5±1.291	11±2.45
10	October	15.75±4.193	14.3±3.2
11	November	16.75±2.5	14.8±2.22
12	December	20.25±4.992	21.8±4.65

Graph Plate No. XI: Biological Parameter

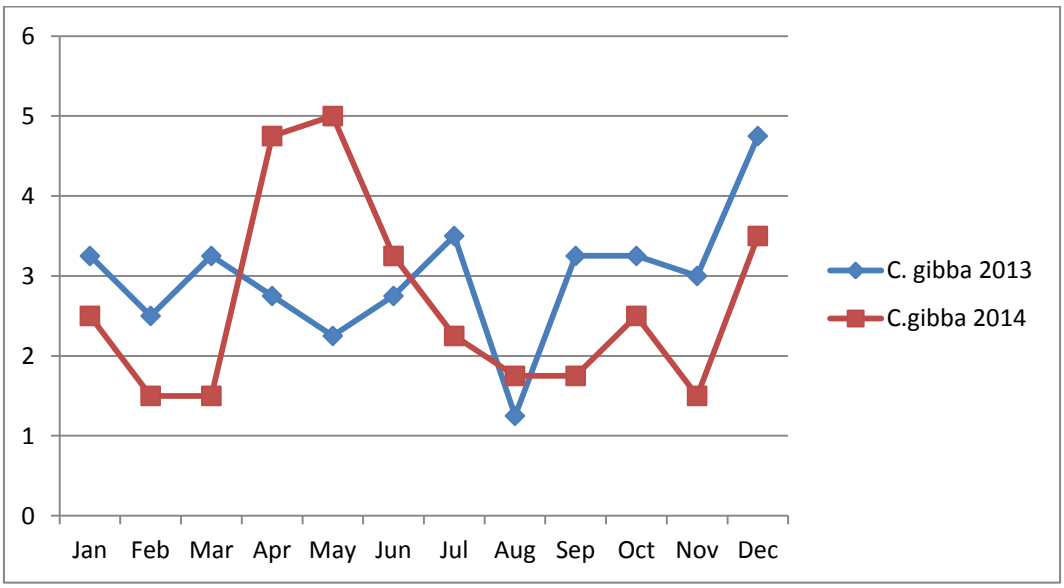


Graph Plate No. 34: Values of dominance and abundance of Cephalodella catellina in 2013 and 2014

Table No. 34: Monthly variation in rotifer species Cephalodella gibbashowing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 C. gibba	2014 C.gibba
		Mean	Mean
01	January	3.25±1.258	2.5±1.291
02	February	2.5±0.577	1.5±1.291
03	March	3.25±2.217	1.5±1.291
04	April	2.75±0.957	4.75±2.0616
05	May	2.25±0.5	5±1.4142
06	Jun	2.75±0.957	3.25±2.2174
07	July	3.5±3	2.25±1.2583
08	August	1.25±1.5	1.75±0.5
09	September	3.25±0.5	1.75±0.9574
10	October	3.25±1.708	2.5±1.291
11	November	3±2.16	1.5±0.5774
12	December	4.7±52.217	3.5±1.291

Graph Plate No. XII: Biological Parameter

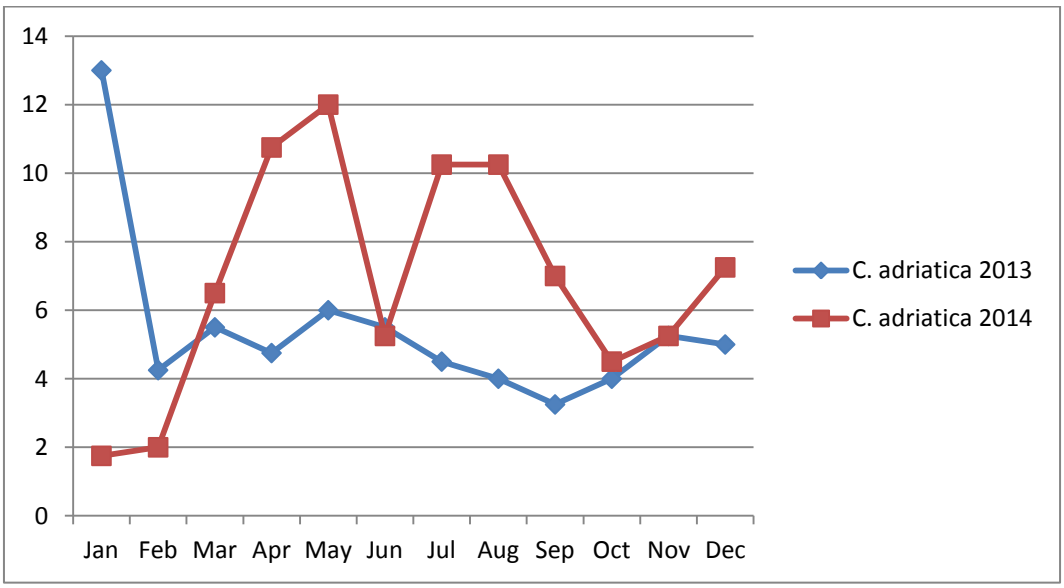


Graph Plate No. 35: Values of dominance and abundance of Cephalodella gibba in 2013 and 2014

Table No. 35: Monthly variation in rotifer species Cephalodella adriaticashowing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 C. adriatica Mean	2014 C. adriatica Mean
01	January	13±0.816	1.75±1.258
02	February	4.25±1.708	2±0.816
03	March	5.5±3.512	6.5±2.082
04	April	4.75±2.217	10.75±4.856
05	May	6±4.082	12±5.888
06	Jun	5.5±3.873	5.25±2.754
07	July	4.5±4.359	10.25±7.805
08	August	4±2.944	10.25±5.439
09	September	3.25±1.5	7±4.163
10	October	4±2.309	4.5±1.291
11	November	5.25±1.708	5.25±2.062
12	December	5±4.082	7.25±3.775

Graph Plate No. XIII: Biological Parameter

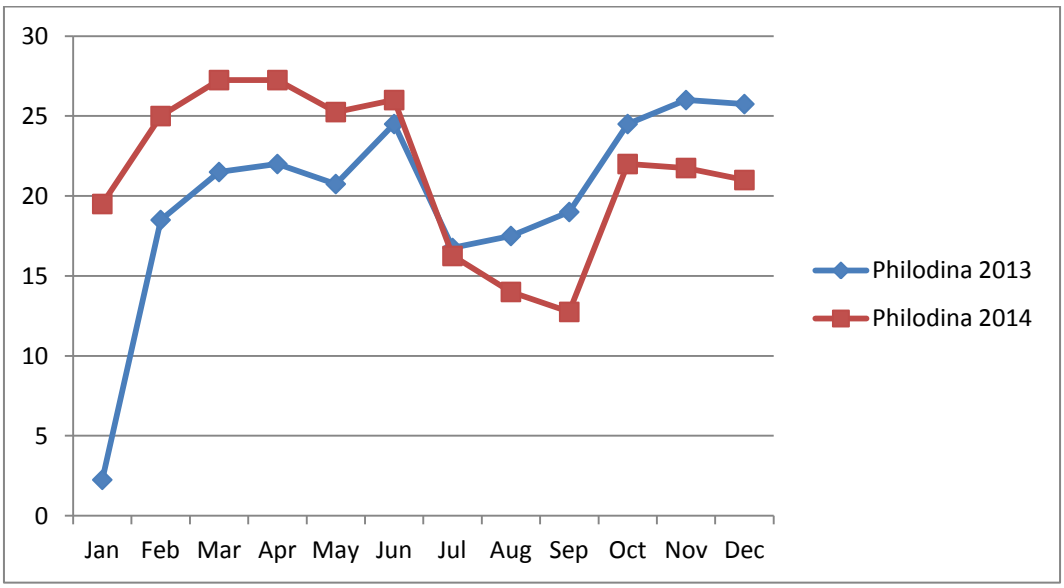


Graph Plate No. 36: Values of dominance and abundance of Cephalodella adriatica in 2013 and 2014

Table No. 36: Monthly variation in rotifer species Philodina sp.showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 Philodina sp.	2014 Philodina sp.
		Mean	Mean
01	January	2.25±1.708	19.5±3.416
02	February	18.5±5.972	25±4.163
03	March	21.5±7.55	27.25±2.5
04	April	22±8.165	27.25±7.5
05	May	20.75±7.719	25.25±2.217
06	Jun	24.5±5.686	26±4.32
07	July	16.75±4.113	16.25±3.304
08	August	17.5±6.856	14±2.828
09	September	19±2.582	12.75±1.5
10	October	24.5±1.915	22±2.449
11	November	26±3.651	21.75±2.217
12	December	25.75±0.957	21±6.831

Graph Plate No. XIV: Biological Parameter

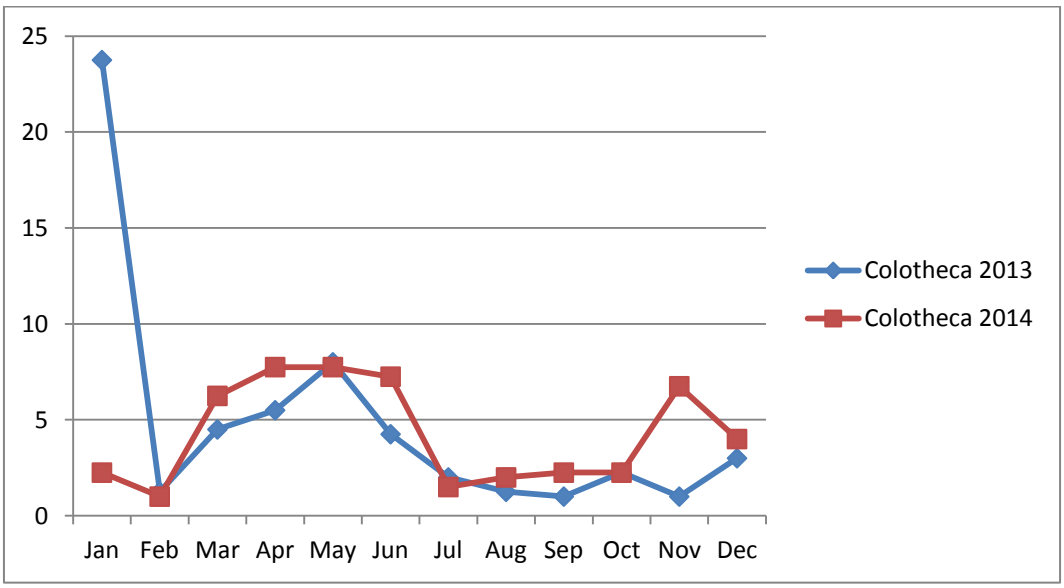


Graph Plate No. 37: Values of dominance and abundance of Philodina sp. in 2013 and 2014

Table No. 37: Monthly variation in rotifer species Colotheca sp.showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 Colotheca sp.	2014 Colotheca sp.
		Mean	Mean
01	January	23.75±5.058	2.25±1.708
02	February	1.25±1.893	1±0.816
03	March	4.5±2.3805	6.25±3.304
04	April	5.5±4.4347	7.75±2.872
05	May	8±4.3205	7.75±5.315
06	Jun	4.25±1.893	7.25±1.5
07	July	2±1.8257	1.5±1.291
08	August	1.25±0.8165	2±0
09	September	1±0.8165	2.25±1.258
10	October	2.25±1.2583	2.25±1.893
11	November	1±0.8165	6.75±2.217
12	December	3±0.8165	4±2.16

Graph Plate No. XV: Biological Parameter

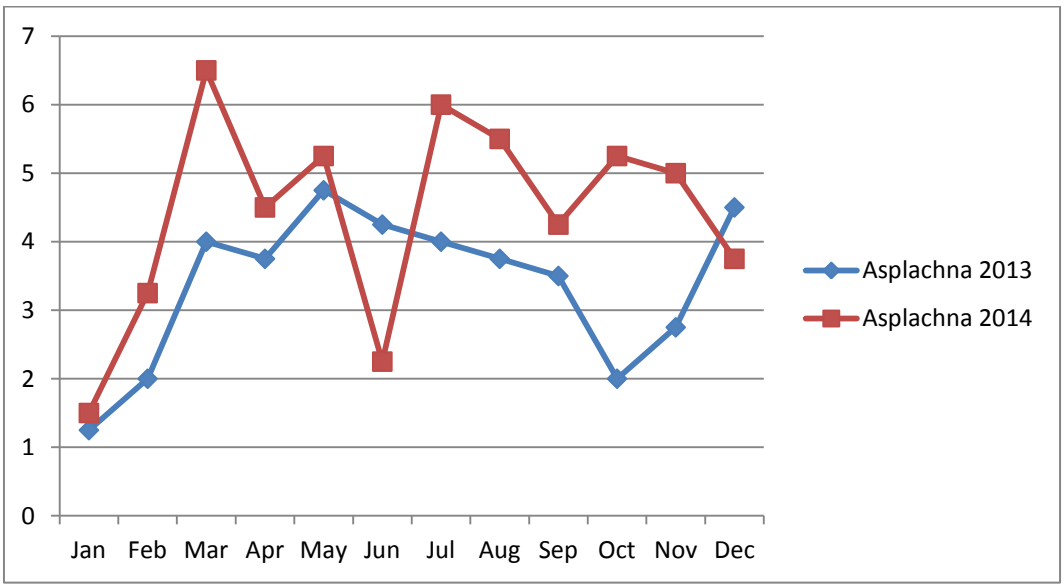


Graph Plate No. 38: Values of dominance and abundance of Colotheca sp. in 2013 and 2014

Table No. 38: Monthly variation in rotifer species Asplachna sp.showing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 Asplachna sp.	2014 Asplachna sp.
		Mean	Mean
01	January	1.25±0.957	1.5±1.291
02	February	2±1.414	3.25±1.2583
03	March	4±1.826	6.5±2.0817
04	April	3.75±2.062	4.5±2.3805
05	May	4.75±1.893	5.25±2.2174
06	Jun	4.25±2.217	2.25±1.7078
07	July	4±1.414	6±2.1602
08	August	3.75±1.708	5.5±1.7321
09	September	3.5±1.291	4.25±1.893
10	October	2±1.414	5.25±2.2174
11	November	2.75±1.708	5±2.582
12	December	4.5±1.732	3.75±0.9574

Graph Plate No. XVI: Biological Parameter

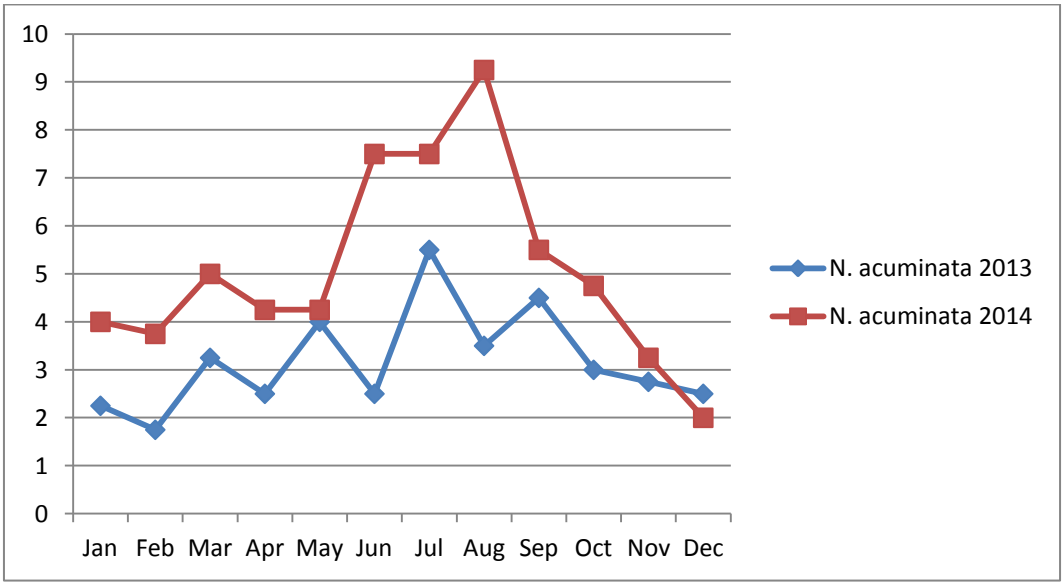


Graph Plate No. 39: Values of dominance and abundance of Asplachna sp. in 2013 and 2014

Table No. 39: Monthly variation in rotifer species Notholca acuminatashowing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 N. acuminata	2014 N. acuminate
		Mean	Mean
01	January	2.25±0.957	4±0.816
02	February	1.75±0.5	3.75±0.957
03	March	3.25±1.893	5±1.414
04	April	2.5±1.291	4.25±1.708
05	May	4±1.414	4.25±2.63
06	Jun	2.5±1.291	7.5±2.38
07	July	5.5±2.38	7.5±3.317
08	August	3.5±2.082	9.25±5.5
09	September	4.5±2.646	5.5±5.802
10	October	3±2.16	4.75±2.754
11	November	2.751.258	3.25±0.957
12	December	2.5±1.291	2±1.414

Graph Plate No. XVII: Biological Parameter

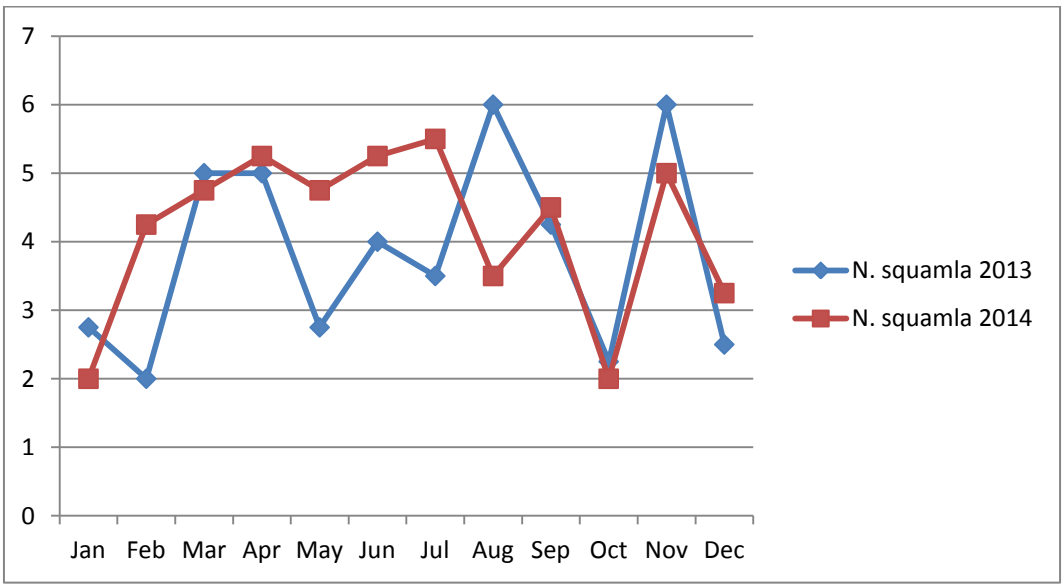


Graph Plate No. 40: Values of dominance and abundance of Notholca acuminata in 2013 and 2014

Table No. 40: Monthly variation in rotifer species Notholca squamlashowing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 N. squamla Mean	2014 N. squamla Mean
01	January	2.75±0.957	2±0.816
02	February	2±0.816	4.25±2.062
03	March	5±2.944	4.75±2.062
04	April	5±1.826	5.25±2.63
05	May	2.75±1.708	4.75±2.754
06	Jun	4±0.816	5.25±2.754
07	July	3.5±2.082	5.5±3.109
08	August	6±2	3.5±1.291
09	September	4.25±2.5	4.5±3
10	October	2.25±1.258	2±0.816
11	November	6±1.633	5±3.651
12	December	2.5±1.291	3.25±3.862

Graph Plate No. XVIII: Biological Parameter

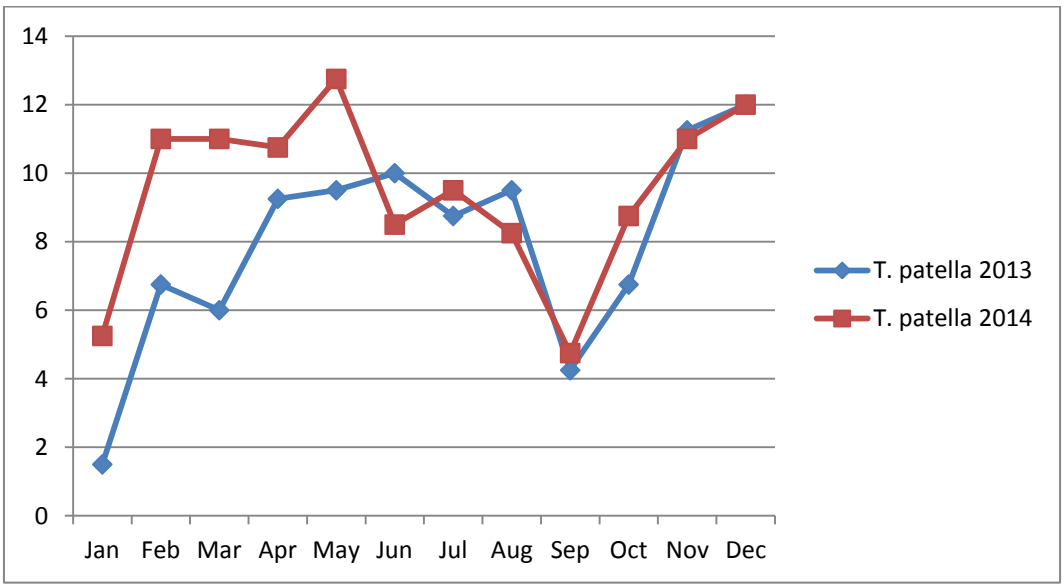


Graph Plate No. 41: Values of dominance and abundance of Notholca squamla.in2013 and 2014

Table No. 41: Monthly variation in rotifer species Testudinella patellashowing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 T. patella	2014 T. patella
		Mean	Mean
01	January	1.5±0.577	5.25±1.71
02	February	6.75±1.893	11±1.83
03	March	6±2.828	11±1.41
04	April	9.25±2.5	10.8±2.22
05	May	9.5±2.082	12.8±0.96
06	Jun	10±2.944	8.5±1.29
07	July	8.75±1.893	9.5±1.73
08	August	9.5±2.887	8.25±2.99
09	September	4.25±2.217	4.75±1.71
10	October	6.75±2.217	8.75±4.65
11	November	11.25±1.5	11±4.16
12	December	12±1.633	12±1.41

Graph Plate No. XIX: Biological Parameter

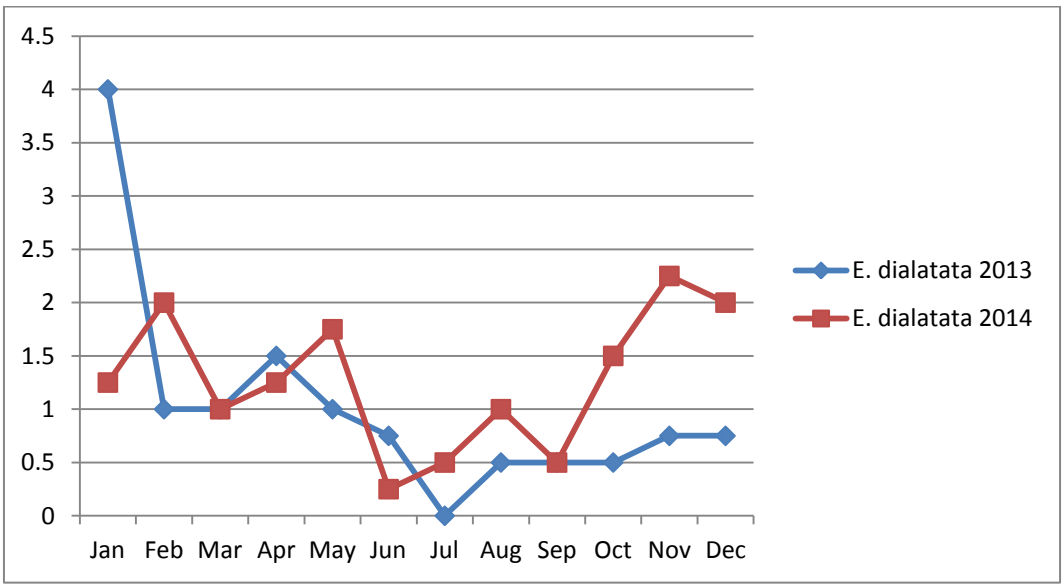


Graph Plate No. 42: Values of dominance and abundance of Testudinella patella in 2013 and 2014

Table No. 42: Monthly variation in rotifer species Euclanis dialatatashowing mean and standard deviation of the year 2013 and 2014

Sr.No.	Month	2013 E. dialatata	2014 E. dialatata
		Mean	Mean
01	January	4±1.83	1.25±0.96
02	February	1±0.82	2±0.82
03	March	1±1.41	1±0.82
04	April	1.5±0.58	1.25±1.5
05	May	1±1.41	1.75±1.71
06	Jun	0.75±0.96	0.25±0.5
07	July	0±0	0.5±0.58
08	August	0.5±0.58	1±0.82
09	September	0.5±0.58	0.5±0.58
10	October	0.5±1	1.5±1.29
11	November	0.75±0.5	2.25±1.26
12	December	0.75±0.96	2±0.82

Graph Plate No. XX: Biological Parameter



Graph Plate No. 43: Values of dominance and abundance of Euclanis dialatata in 2013 and 2014

4.3.3 Species Diversity

To measure the dominancy, to measure the status of water quality we must know the species diversity indices such as Shannon-Weaver diversity index, Simpson index, species evenness and richness in any water body.

4.3.3.1 Shannon weaver diversity index (H)

For the seasonal fluctuations of zooplankton Shannon-Weaver diversity index (H) is used as important component. As the Shannon Weaver index is higher it indicated greater species diversity and as the species diversity is greater food chain is longer, a number of inter-specific interactions which reduced oscillation and increase stability of community to some extent Ludwik and Reynolds (1998).

Shannon Weaver diversity index of rotifer in 2013 ranged from 1.57036 to 1.98404. The highest diversity was recorded in the month of December and lowest in February. While in 2014 the values ranges from 1.6714 to 2.02699. The highest was observed in the month of Jun and lowest was in December. During the study periods mean of diversity index was observed 1.844628±0.010947. **Table No. 43, Graph Plate XXI.**

4.3.3.2 Simpson diversity index (D)

The rotifer Simpson diversity index (D) in 2013 was ranged from 3.1293 to 4.73997. While in 2014 it was 2.8407 to 4.53131. The highest was observed in the month of July and lowest in November. During the study periods mean of diversity was 3.933±0.2468.**Table No. 43, Graph Plate XXI.**

4.3.3.3 Zooplankton Evenness

During the present study the Rotifer species was dominant, such twenty species of Rotifers mean of Evenness in ranges from 0.35±6.457 to 5.59±0.599. Evenness indicate that all the species in sample are equally abundant or not, that the species evenness decreased or increasing size of zooplankton population. Shinde et al.,(2012).**Table No. 44, Graph Plate XXII.**

4.7.2.3 Zooplankton Richness (R)

Richness of rotifer species ranged from 0.05±0.002 to 11.2±2.303. Thirupathaiah et al.,(2012) recorded highest rotifer richness in October. **Table No. 44, Graph Plate XXII.**

Table No. 43: Monthly variation in rotifers showing mean and standard deviation of Simpsons Diversity index (D) and Shannon Weaver diversity index (Hs) 2013 and 2014.

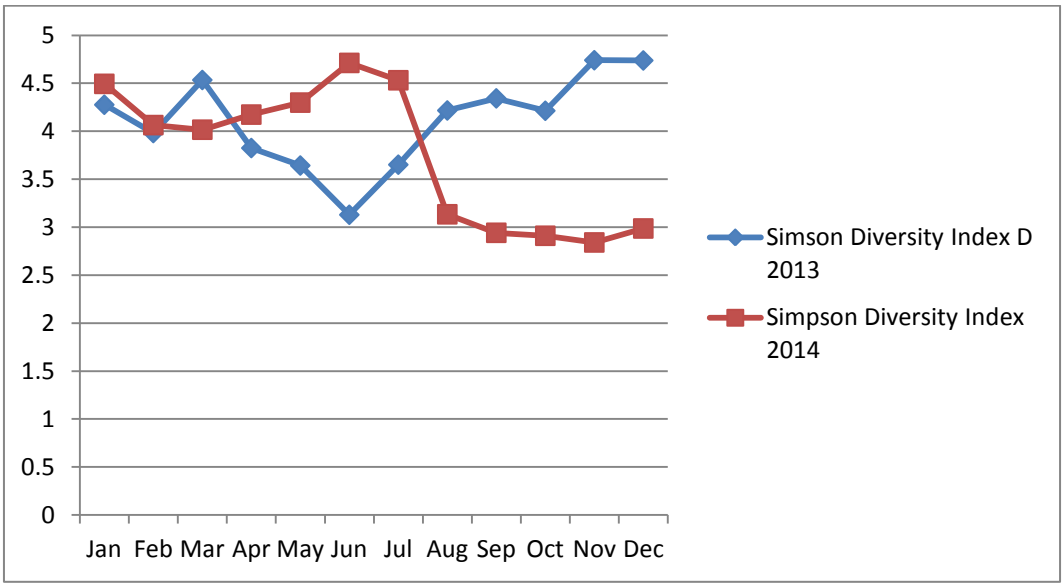
	2013		2014		SD of 2013-14	SD of 2013-14
Month	**Simpson D**	**Hs**	**Simpson D**	**Hs**	**Simpson D**	**Hs**
Jan	4.276163	1.88327	4.49384	1.90683	0.153922	0.016656
Feb	3.981036	1.57036	4.06402	1.89021	0.058681	0.22617
Mar	4.534156	1.96791	4.01575	1.92941	0.366567	0.027224
Apr	3.824934	1.84266	4.17358	1.99337	0.246531	0.10657
May	3.64252	1.82237	4.29816	2.02435	0.463607	0.142817
Jun	3.129324	1.71465	4.712	2.02699	1.119117	0.220855
Jul	3.651483	1.81115	4.53131	1.98341	0.62213	0.121802
Aug	4.216333	1.88671	3.13421	1.69423	0.765176	0.136104
Sep	4.342511	1.88695	2.94121	1.6416	0.990867	0.173489
Oct	4.213333	1.88499	2.91033	1.63937	0.921363	0.173677
Nov	4.739979	1.97336	2.8407	1.63775	1.342994	0.237308
Dec	4.737554	1.98404	2.98646	1.67514	1.238208	0.218427

Table No. 44: Rotifers species Mean and Standard Deviation of Evenness and Richness in 2013 and 2014

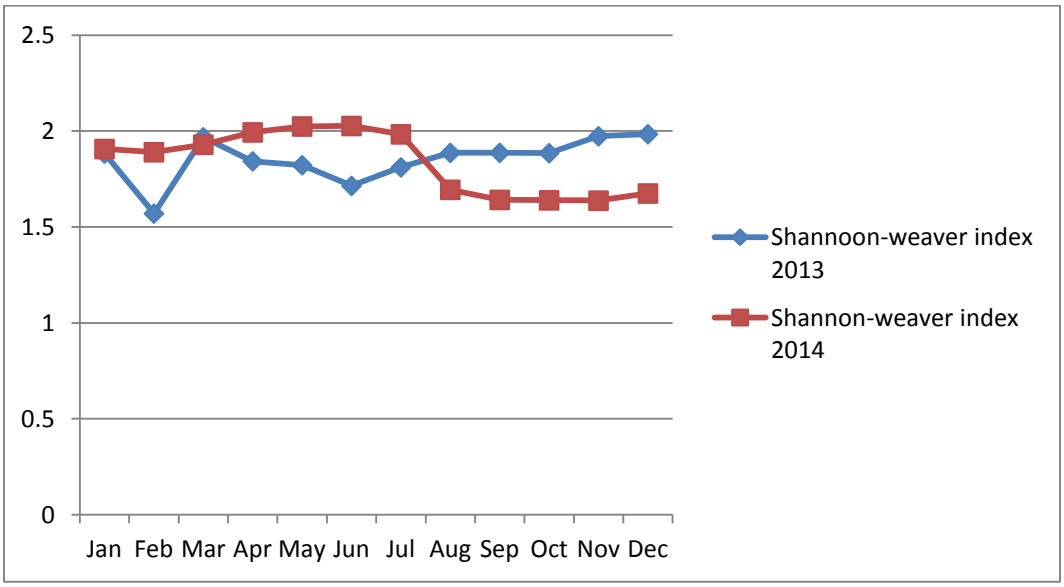
Rotifers	Mean R 2013	Mean E 2013	Mean R 2014	Mean E 2014	SD R 2013-2014	SD E 2013-2014
A. fissa	2.34	1.047	2.42	1.02	0.058	0.019
B. plicatilis	9.54	0.794	12.8	0.73	2.303	0.044
B. caudatus	5.39	0.882	4.48	0.89	0.641	0.004
B. pala	1.15	1.333	1.75	1.11	0.424	0.937
K. quadreta	0.02	1.137	0.05	2.7	0.016	1.106
H. intermedia	0.39	1.901	0.71	1.45	0.23	0.322
P. vulgaris	0.51	1.834	0.52	1.74	0.007	0.064
L. lamellate	0.13	4.725	0.13	6.28	0.004	1.1
L. luna	0.05	-1.68	0.09	6.05	0.025	5.463
L. lunaris	0.82	1.453	0.93	1.33	0.079	0.089
C. catellina	0.53	1.759	0.66	1.49	0.089	0.19
C. gibba	0.13	5.165	0.1	6.01	0.019	0.599
C. adriatica	0.23	2.711	0.26	2.95	0.018	0.171
Philodina	0.84	1.724	0.81	1.4	0.024	0.232
Colotheca	0.21	5.235	0.16	3.81	0.034	1.01
Asplachna	0.14	5.009	0.15	3.63	0.004	0.978
N. acuminate	0.14	4.154	0.18	2.95	0.03	0.854
N.squamla	0.16	3.632	0.16	3.34	0.005	0.203
T. patella	0.31	2.787	0.35	1.95	0.03	0.59
E. dialatata	0.04	-4.22	0.05	4.91	0.002	6.457

Where, R= Richness, E= Evenness, SD= Standard deviation, M= Mean.

Graph Plate No. XXI: Biological Parameter Simpson Diversity Index.

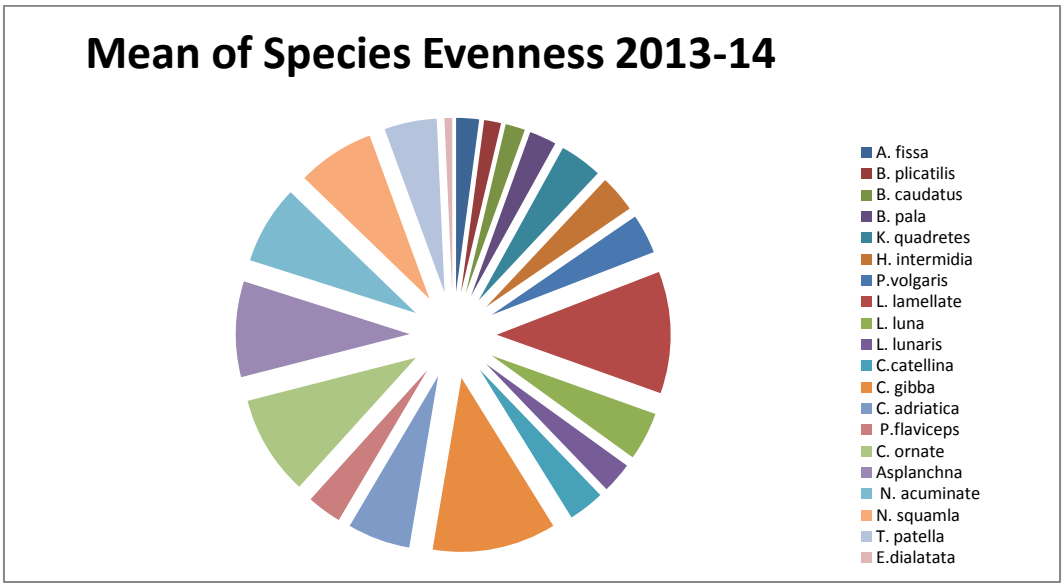


Graph Plate No. XXII: Biological Parameter Shannon-weaverr Diversity Index.

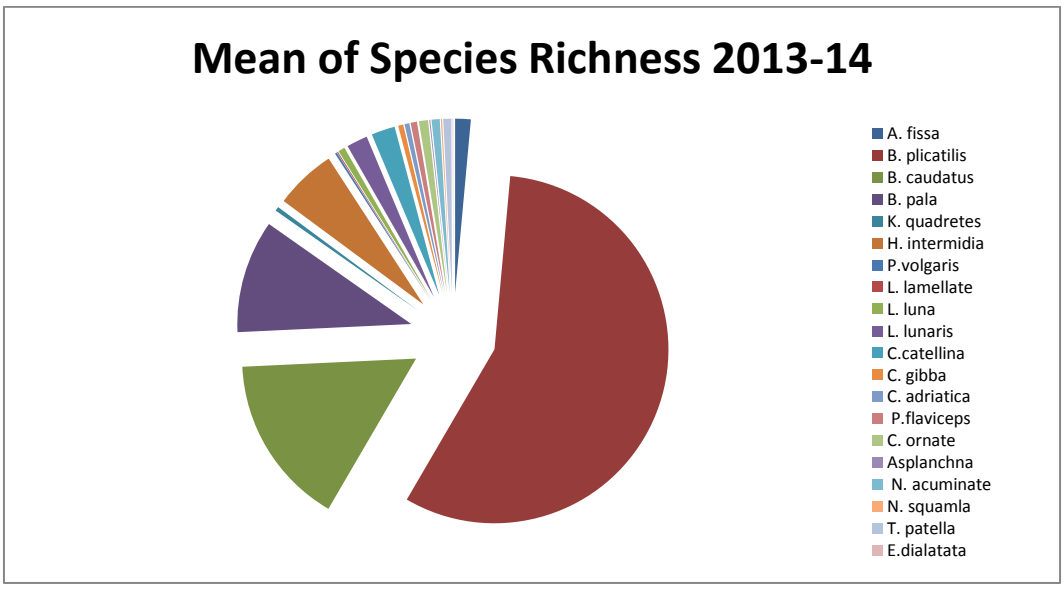


Graph Plate No. 44: Values of Rotifer Species Simpson and Shannon Diversity Index in 2013 and 2014

Graph Plate No. XXIII: Biological Parameter Evenness



Graph Plate No. XXIV: Biological Parameter Richness



Graph Plate No. 45: Values of Rotifer Species Evenness and Richness in 2013 and 2014

PHYTOPLANKTON

In to the saline Lake water Blue green algae and bacteria are the most striking features were observed. In to the high alkaline medium there is no any chance for the survival of such microscopic organisms than also these types of microscopic forms are extremely adapted tothis condition. Luxuriant growth of Spirulina is not known

anywhere except Lonar Lake. Other than Spirulina, Chlorophyceae (Green algae): Chlamydomonas sp.,Oedogonium sp., Rhizoclonium sp.

Cyanophyceae (Blue green algae): Anabaena sp., Arthospira, Nostoc spharicum, Ocillotoria, Spirulina subsalsa, Hydrodycton.sp.

Bacillariophyceae (Diatoms)

Asterionella,Closterium sp., Fragillaria, Cyclotella, Navicula, Navicula sp., Nitzschia, Nitzschia sp., Spirogyra, Cosmanum monomazum,Dichothrix gypsophila, Trachelophellum apiculatum, Ulothrix aequalis, Micrasterias sp., Pediastrum Duplex, Synedra sp.

Thus, the blue green algae constitute the major among phytoplankton community and particularly Spirulina is the dominant. The abundance of rapid multiplication of these alga are conspicuous along with other blue green algae, the Arthospira, Ocillotoria, immediately after the onset of monsoon and gradually decrease as the dry spell continues until June was reported by Badve et al.,(1993).

It appears that the Lonar Lake water gets slightly diluted at S1 and S4 because of the discharge of small stream in to Lonar Lake near these stations. The dilution of lake water at these sampling points makes the water quality tolerable for the growth of algae. Therefore the algal density might have been more at Station S1 and S4 while at other stations the higher levels of salts in lake water might have been responsible for relatively low count of chlorophyceae and bacillariophyceae. The algal species of cyanophyceae group were found to dominate the phytoplankton population in Lonar Lake. Bacillario-phyceae species viz. Fragillaria, Navicula and Cyclotella were found to be more tolerant to saline-alkaline lake water than chlorophyceae (green algae). The most sensitive group in Lonar Lake water was chlorophyceae. The members of chlorophyceae were found to be present only at Station 1 in very negligible amount.

The occurrence of particular species of algae determined more by ecological condition than its geographical location. Any detached fragment or plants travel over

and it populate the large watersheds of many water bodies. Edmondson (1959).The algae present mainly in those places where the moisture and minerals is present.

1. Anuraeopsis fissa

Lorica with two, four or six spines in the anterior dorsal margin, lorica divided into two plates or undivided, if divided with dorsal and ventral plates; dorsal plate is arched and ventral plate is flat. Posterior margin of Lorica is truncated with or without spines; foot with two toes. It measures 200 to250 um in length and 50 to75 um in width.Rotifers PhotoPlate No. XIV (fig a and b).

Reported by

Edmondson and Huchinson (1934) from Panjab

Dhanapati (1978) from Andhra Pradesh

Sharma(1979) from Calcutta

Dabhade (2006) Lonar Lake Maharashtra

Distribution: Cosmopolitan.

2. Brachionus plicatilis Muller (1786)

The corona is surrounded by cilia, beating movement of which create water current to bring food particles to mouth. Lorica smooth with occipital margin having six angular saw toothed spines. Ventral margin is undulating with one or three notches. Foot opening posterior. Summer forms of B. plicatilis were observed enlarged, measures 250 to 300µm in length and 75 to 100µm in width. Rotifers PhotoPlate No. XIV (fig c, d and e).

Reported By

Vasisht and Basith (1971) from Panjab.

Tiwari and Sharma (1977) from W.Bengal.

Sharma (1980) from Orissa.

Dabhade (2006) Lonar Lake Maharashtra

3. Brachionus caudatus Barrios and Daday, (1894)

Lorica smooth with occipital margin having four angular saw toothed spines (fig, 1) Ventral margin is undulating with single notch (fig.1 and 2). Foot opening posterior summer form of which is enlarged, the size increases in width, it measures 100 to 150um in length and 50 to 75um in width.Rotifers PhotoPlate No. XIV (fig f.).

Reported by

Arora (1963) from Nagpur

Dhanapathi (1964) from Andhra Pradesh

Dabhade (2006) Lonar Lake Maharashtra

4. Brachionus pala Wesenberg-Lund, (1903)

Maximum length 150 um and width 50 to 75um .Lorica smooth with occipital margin having four angular spines. Lateral spines are longer than the medians. Ventral margin is plane. Posterior margin broadly oval. Foot is long and opening posterior. Brachionus exhibit changes in form (cyclomorphsis)due to temperature. Rotifers PhotoPlate No XIV(fig. g.).

Reported by

Anderson (1889) from Calcatta

Arora (1963) from Nagpur (Maharashtra)

Sharma (1979) from Calcatta

Dhanapathi and Rama Sarma (2000) from A.P.

Dabhade (2006) Lonar Lake Maharashtra.

5. Brachionus urceolaris Muller (1773)

Maximum length 115um and width 80um.Lorica broadly oval, thin, with dorsal and ventral spines.Ventral margin nearly smooth. Anterior dorsal margin with six spines, median spines longer than laterals; Ventral margin nearly straight, Foot opening posterior, sinus ‘V’ shaped; Posterior opening of the lorica is rectangular. Rotifers PhotoPlate No XIV(fig h and i).

Reported by

Anderson (1889) from Calcatta
Arora (1963) from Nagpur (Maharashtra)
Sharma(1979) from Calcatta
Dhanapathi and Rama Sarma (2000) from A.P.
Dabhade (2006) Lonar Lake Maharashtra

6. Keratella quadreta Muller (1786)

Dorsal plate ornamental with polygonal facets, facets sometimes not clear; anterior median spines generally longer than the laterals. Dorsum with three median plaques, a small area present between the last median plaque and posterior margin with single long curved spine. It measured 50um in length and 20um in breadth. Rotifers PhotoPlate No XV(fig. j and k).

Reported By

Edmondson and Hutchinson (1934) From Kashmir and Nilgiri hills.
Sharma (1979) From (Calcutta) W. Bengal
Dabhade (2006) Lonar Lake Maharashtra.
Distribution: Europe, America, Canada, India (Cosmopolitan)

7. Testudinella patinaHermann, (1783)

Corona is a ciliary wreath; eyes apical. Lorica distinct with anterior dorsal margin bow shaped shows the enlarged microphotograph to show dorsal margin of the organism, foot retractible opening circular and at one third distance from posterior end, annulated; ending in ciliated cup Body length is measured 170um inclusive corona extended out and foot, width 155um. PhotoPlate No.XV(fig o).

Reported by

Anderson (1889) from Calcutta, West Bengal Edmondson and Hutchinson (1934), Kashmir.

Wulfert (1966) from Baroda, Gujarat.
Sharma(1979)from W. Bengal
Dhanapathi and Rama Sarma (2000) from A.P.
Arora and Mehra (2003) from Delhi
Dabhade (2006) Lonar Lake Maharashtra

8. Hexarthra intermedia Wizneiwski,(1929)

Body conical and large. Ventral arm has one pair of hooks and eight filaments. Unci bear five teeth. Lower lip absent foot absent. PhotoPlate No.XV(fig l).

Reported by

Edmondson and Huchinson (1934) from Kashmir.

Vasista and Gupta (1967) from Panjab.

Dhanapathi and Rama Sharma (2000) from Andhra Pradesh

Dabhade (2006) Lonar Lake Maharashtra

9. Polyarthra indica Segers and Babu (1999)

A foot less pelagic rotifer, with six pairs of skipping appendages (paddles) either in the shape of sword or blades.Body illoricate and little squarish. Four groups of major lateral paddles inserted dorsally and ventrally in the neck region. Each group with three paddles of equal length extending beyond the posterior end of the body.Accessory pair of ventral paddles present between ventral bundles.Vitellarium with four to six nuclei. Trophy modified virgate type.PhotoPlate No XV(fig m).

Reported by

Segers and Babu (1999) from Kerala

Dabhade (2006) Lonar Lake Maharashtra

10. Philodina flaviceps

The body is elongate, widest in the middle, and strongly tapered posteriorly. It is composed of a short anterior head, long, thick, middle trunk, and short, narrow, posterior foot. The body is enclosed in a well-developed intraepidermal lorica. The body is encircled by about 16 circumferential rings, or annuli, and consequently appears to be segmented but the divisions are confined to the lorica (which is intraepidermal) and are superficial.The annuli are of different diameters and allow the body to shorten by telescoping.

The smaller annuli of the head and foot telescope into the larger ones of the trunk so that the head and foot can be completely retracted into the trunk. The head narrows posteriorly to become a short neck which joins the wider trunk. The corona is

completely retractable into the trunk and is not visible when retracted. The trunk is the wide, long, middle region of the body plus the first two annuli of the tapered posterior body. It begins with the first wide annulus posterior to the narrower head and extends posteriorly to the anus, The trunk consists of six annuli with the anus is on the sixth. The annuli of the head and foot telescope into the trunk to shorten the animal. The foot extends posteriorly from the trunk and is the region of the body posterior to the anus. It tapers posteriorly and consists of four annuli. The posterior annulus of the foot bears a pair of dorsal spurs and four small, sticky toes. Philodina were collected from the ditches on the periphery of lake water in the particular places of bird baths. PhotoPlate No XV(fig tand u).

Reported by

Murray (1906) from Himalayas.

Dabhade (2006) Lonar Lake Maharashtra

11. Collotheca sp.Ehrenberg,(1832)

Sessile, attached to each other forming a spherical colony, or attached singly to the substratum, solitary. The appearance of head is greatly modified by the lobulation of corona in the order Floscullariacea and Collothecacea, the corona is scalloped into broad or slender lobes, exhibit a radial arrangement.Corona large, with five short blunt lobes arranged pentagonally and with long cilia holdfast short giving a hood like appearance, the cilia at the rim's edge of the in-fundibulum sweep food into the mouth. Posterior part is covered by transparent long gelatinous case. More or less circular or kidney shaped corona and a gelatinous envelope that may incorporate foreign bodies or faecal balls **Hymen, (1951)**.PhotoPlate No. XV (fig q and r).

Reported by

Sharma (1998)from Dehli.

Dabhade (2006) Lonar Lake Maharashtra

Distribution :India and Australia.

12. Euchlanis dialatataEhrenberg, (1932)

Lorica with dorsal and ventral plates with longitudinal sulci. Dorsal plate with a 'U' shaped notch posteriorly. Mastax with four club shaped teeth on each uncus.

Foot slender and two jointed. Toes blade like and fusiform.Length of dorsal plate is -252um, Width of dorsal plate -182um, Length of ventral plate -238um, Width of ventral plate -168um, Length of toes 84um. Photo Plate No. XV (fig v).

Reported by:

Edmondson and Hutchinson (1934) from Kashmir.

Dhanapathi (1976) from Andhra Pradesh.

Sharma (1979) from Calcutta (West Bengal).

Dabhade (2006) Lonar Lake Maharashtra

Distribution: Cosmopolitan

13. Lecane ovalisMuller, (1776)

Lecanid of very common occurrence and variable. Lorica is more flexible than generally thought and broadly oval with broad dorsal sinus. Second foot joint sub square. Toes slender, parallel sided and ending in claws.Total length is -175um, Width - 120um, Length of toe -50um. Photo Plate No. XV (fig w).

Reported by:

Anderson (1889) from Calcutta, W. Bengal

Edmondson and Hutchison (1934) from Punjab and Kashmir.

Wultert (1966) from Baroda, Gujarat

Dhanapathi (1976)from Andhra Pradesh

Sharma (1978) from West Bengal

Dabhade (2006) Lonar Lake Maharashtra

Distribution: Cosmopolitan.

14. Cephalodella gibbaEhrenberg, (1832)

Body elongate and gibbous dorsally. Lorica is with firm plates. Lateral clefts narrow interiorly and widening posteriorly. Foot is small and conical. Toes are long, slightly curved and ending in blunt tips. Total Length of body 160um, Width of body 72um, Length of toes 50um.

Reported by:

Edmondson and Hutchinson (1934) from Kashmir & Ladakh.

Wulfert (1966) from Baroda, Gujarat.

Sharma (1979) from Calcutta, W. Bengal

Dabhade (2006) Lonar Lake Maharashtra

Distribution: Cosmopolitan.

15. Asplanchna sp.Leydig, (1854)

Body is large transparent and sacciform. Foot and toes are absent Germinovitellarium ribbon like and with approximately 50 nuclei. Trophi is incudate having robust and curved apophyses. Rami have a large distinct tooth on its inner margin. Rami apices are asymmetric with right being single and left bifurcate. Known to feed on other rotifers preferably on Lecane, Brachionus sp. and even smaller sized specimens of itself.Length of the body 650um, Width of the body 265um. PhotoPlate No.XV(fig p).

Reported by:

Dabhade (2006) Lonar Lake Maharashtra

Distribution: Cosmopolitan

CLADOCERA , COPEPODA AND OSTRACODA PHOTO PLATE NO. XVI

16. Daphnia magna

Body compressed; form oval or elliptical in outline, except as modified by crest on head (helmet)in some species like D. magna head shield bears pair of longitudinal ridges on longitudinal side of the median keel. Posterior end of the fornix is either rounded or pointed. Valves reticulated; dorsal and ventral margins rounding over toward each other and provided with spinules and a posterior spine. Cervical sinus absent. Rostrum well marked and pointed. Antennules small or rudimentary, not movable; located behind rostrum. Abdominal processes 3-4; the anterior most long and horseshoe shaped. Posterior dorsal margin of the post abdomen is deeply sinuated. Parthenogenetic eggs often numerous.Ethippium with two eggs.Male without rostrum; antennules large, movable and first legs with hook and flagellum.Large spinuate genital papilla at base of post-abdominal claw.Length, female-5.0mm; male 2.0mm.or more.**Photo Plate No. XVI. Cladocera (fig. c)**

Reported By:

Dabhade (2006) Lonar Lake Maharashtra

18. Bosmina longirostrisMuller (1785)

Female : Body almost oval in outline. Postero-dorsal corner of valves distinctly angular. Postero-ventral corner produced into backwardly directed spine markings on head and valvs not distinct. Head large,more or less arched in front of eye. Eye usually large. A small sensory hair situated nearer to eye than to the base of the antennules. Antennules almost parallel to each other, delicate and curved; olfactory seatae on side, inserted near base of antennules. Antenna small, with 3- and 4 segmented rami. Post abdomen almost quadrate. Claw with proximal pectin of 3-6 spinules and distal pectin of 7-10 spines continued distally into the minute spinules.

Size:Length: 0.64 mm.Male : not known in India.**Photo Plate No. XVI. Cladocera (fig. d)**

Reported By:

Sharma, (1978) from West Bengal

Dabhade (2006) Lonar Lake Maharashtra

Distribution : Cosmopolitan,

19. Alonella nana Baird, (1850)

Body almost oval in outline.Dorsal margin convex.Posterior margine almost straight. Posteroventral corners of the valve with one, some times two denticles. Rostrum pointed. Antennules with sensory seta distal to middle of posterior margin: Antennal setae : 0-0-3/1-1-3. Ocellus is nearer to eye than apex of rostrum. Post abdomen short, with about six anal spines; claws with to basal spines.Length : 0.22mm.**Photo Plate No. XVI. Cladocera (fig. e).**

Reported by:

Dabhade (2006) Lonar Lake Maharashtra

OSTRACODA

20. Cypris subglobosa

Breadth at least ¾ the length.Length 1.2 mm, heght about 3/5 the length, width ¾ the length. Surface of valves strongly punctured with small pits, the pattern resembling a thimble. Color green. Lateral portion of carapace is prominently swollen. Dorsal margin convex, ventral margin concave and sinuated.

Reported By:

Siddiqi (2008)

21. Algae and diatoms

Spirulina is the most dominating blue green algae in Lonar lake occupied complete surface of water.**Photo Plate No. XVII. Algae and Diatoms (fig. a).**

Reported By:

Dabhade (2006) Lonar Lake Maharashtra

Diatoms. The Bacillariophyta are the diatoms. With their exquisitely beautiful silica shells, or frustules such as that of Odontella, are diatoms among the loveliest microfossils. They are also among the most important aquatic microorganisms today: they are extremely abundant both in the plankton and in sediments in brine and the freshwater ecosystems in the peripheral ponds, and because they are photosynthetic they are an important food source for macro- organisms.

20. Navicula sp.

Cleve is a diatom with lanceolate valves with parallel striations. It measures 32-36mm in length and 8-9 mm in breadth.**Photo Plate No. XVII. Algae and Diatoms (fig. b and c).**

Reported By:

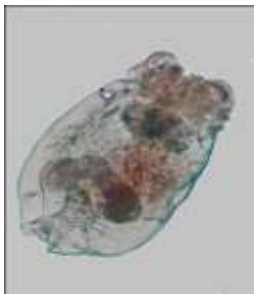
Dabhade (2006) Lonar Lake Maharashtra

21. Nitzschiasp. was collected from the ponds with low salinity found along with green algae Palmella. The same water was also rich in huge mass of Spirogyra algae.**Photo Plate No. XVII. Algae and Diatoms (fig. d,e,fand g).**

Reported By:

Dabhade (2006) Lonar Lake Maharashtra

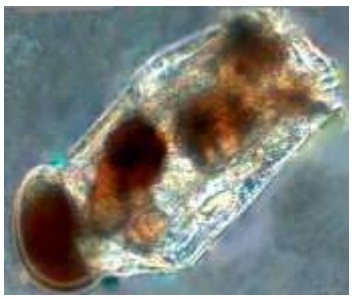
PHOTO PLATE NO. I. ROTIFERS



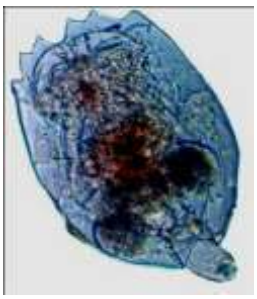
a. Anuraeopsis fissa

b. Anuraeopsis fissa.

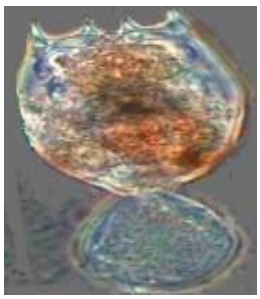
c.Brachionus plicatilis Corona withdrawn into the lorica. With prominent magenta colored eye spot.



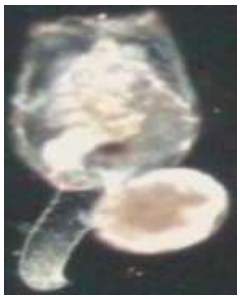
d. Brachionus plicatilis Corona expanded out of the Lorica. Elongated cyclomorphic form.



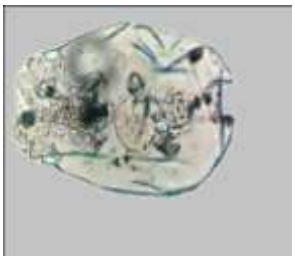
e. Brachionus plicatilis



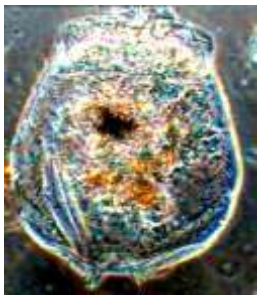
f. Brachionus caudatus



g.Brachionus pala



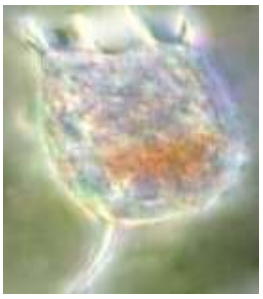
h. Brachionus urceolaris (Lorica only)



i. Brachionus urceolaris

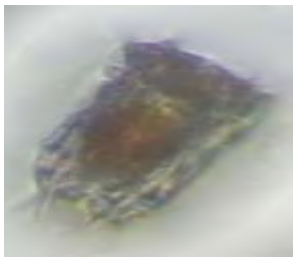
PHOTO PLATE NO. II. ROTIFERS

j. Keratella quadreta

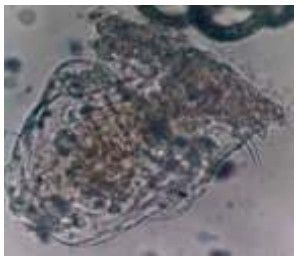


k. Keratella tropica.

l. . Hexarthra intermedia



m. Polyarthra. vulgaris



n. Synchaeta sp.

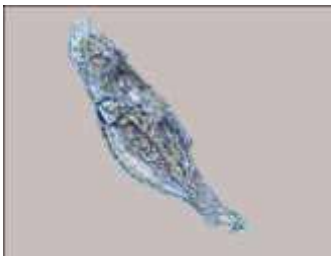
o. Testudinella patina

p.Asplachna sp.

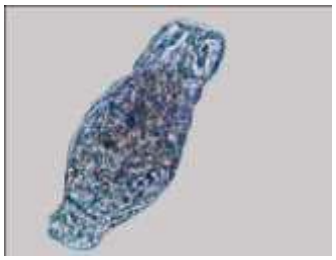
q. Collotheca sp

r. Collotheca sp

s.Rotifer Illoricate form

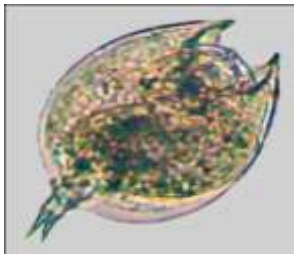


t.Philodina sp.



u.Philodina sp.

v. Euclanis dialatata

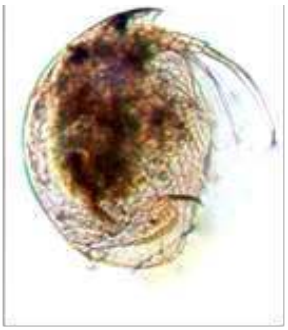


w. Lecane ovalis

x. Rotaria rotatoria

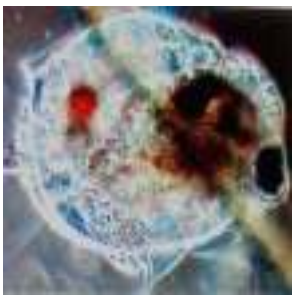
PHOTO PLATE NO. III. CLADOCERA

a.Allona sp.

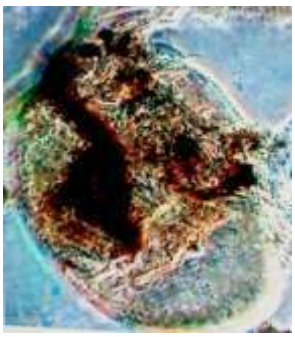


b. Allonella sp.

c. Daphnia magna



d. Bosmina longirostris

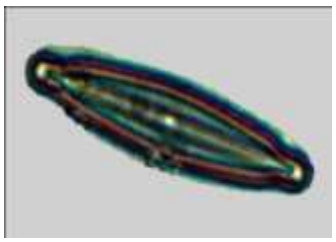


e. Alonella nana

PHOTO PLATE NO. IV. ALGAE AND DIATOMS

a.Spirulina sp.

b. Navicula sp.

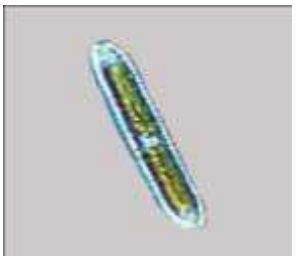


c.Navicula sp.

d. Nitzschia sp

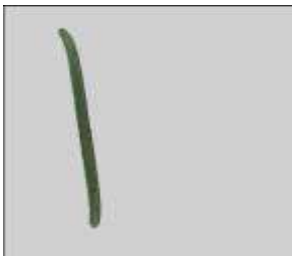
e. Nitzschia sp.

f. Nitzschia sp



g. Nitzschia sp.

h. Oscillatoria princeps



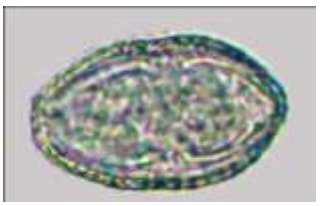
i. Oscillatoria chalybea

j. Fragilaria

k. Synedra sp.

l. Ulothrix aequalis

m. Micrasterias sp.

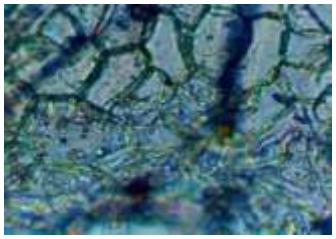


n.Cosmanum monomazum

o. Pediastrum duplex

p. Spirogyra sp.

q. Dichothrix gypsophila



r. Hydrodection

PHOTO PLATE NO. V. ALGAE AND DIATOMS

s.Trachelophellum apiculatum

t. Nematode Warm

u. Filamentus algae

MACROINVERTEBRATES

The littoral zone of the lake were mostly eutrophic where high allochthonous inputs caused predominantly eutrophic conditions. There are large varieties of

organisms living on the sediments of the lake silt, feeding on algae, bacteria and particulate detritus (Organic matter). Among the organisms occurring at this level are Eristalis, Liriope, Cranefly larvae, Dragonfly larvae, Mayfly larvae, Chironomids, and mosquito larvae , Nematode worms, were observed.

FISH FAUNA

No any fresh water fish can tolerate such a high salinity, and as nobody has made any attempt to introduce any salt tolerant fish seed fish fauna was found totally absent.

AVIAN FAUNA

The avian fauna is rich in wet land dwelling water fowls and ducks. Among the ducks, ghees and grabes are the remarkable European Shelduck Tadorna ferruginea (Ruddy shelduck) or Brahmani ducks are the regular visitors for several decades in thousands of population have been observed in winter. Ruddy shelducks are European migrants (Ali S. and S. Dillon Ripley, 1987).

The lake has given shelter to many migratory and resident birds throughout the year. Those who stay in the wetland and around it are enlisted excluding common terrestrial avin fauna.

T. Tadorna, (Common shelducks), Dendrocygnar bicolor (Large Whistling teal) D. jawanica (Lesser Whistling teal or Tree duck), Netta rufina (Redcrested Pochard), Aythya ferina (Common Pochard), Aythya fuligula (Tufted Duck), Aythya marila, (Scoup Duck), Aythya baeri (Baer's Pochard), Anas platyrhynchos (Mallard), Anas acuta (Pintail), Anas gibberifrons (Gray teal), Anas crecca (Common teal), Bucephala clangula (Goldeneye Duck), Mergus merganser (Goosander or Common Merganser).

PHOTO PLATE NO. VI AVIAN FAUNA

a.

b.

c.

d.

e.

f.

g.

h.

Anas clypeata (shovellers)

Closely related with swans and geese, ducks have webbed feet and water repellent plumage. The typical rounded duck-bill reaches its highest development and specialization in shovellers. The duck feeds on minute animals with the help of its spatulate, comb- toothed-edged bill. The shovellers are winter migrants of India and are quite common and wide spread over the entire

PHOTO PLATE NO. VII AVIAN FAUNA

Lonar lake provide habitats for waterfowls-Porphyrio porphyrio (Purple Moorhen), Gallinula chloropus (Moorhen), Amaurornis bicolor, Rallus aquaticus (Water Rail), Crex crex (Corn Crake),Venellus indicus (Redwattled Lapwing), V. malabaricus (Yellow-wattled Lapwing), Himantopus himantopus (Blackwinged stilt).

a. Himantopus himantopus (Blackwinged stilt)

b. Sterna aurantia The **Indian River Tern** or just **River Tern**

c.

d.

PHOTO PLATE NO. VIII AVIAN FAUNA

Venellus indicus (Redwattled Lapwing): Ground plovers are collectively known as lapwings in India. Redwattled is the most *common among them. "did* you do it?..... *Did you do it" its high pitched* interrogative call gets highly neurotic at the slightest apprehension of intrusion during the nesting season. Its Marathi name is Titwi. I can be seen around marshes, cultivation, and on pastures and wetlands. It runs in a characteristic plover fashion, going a short distance and then suddenly standing motionless. Food comprises insects, small worms and mollusks. It nests insmall depression on ground.

Remarkable fascinating occurrence is of Pavo cristatus (Common Peafowl), which are the resident of Lake Forest in the alluvium. Monitoring the movement of population ecology of water fowl and other migratory birds in relation to Spirulina bloom could encourage to exploit this neglected salt crater lake for some commercial venture in future may become the reason of its deterioration (Dabhade, 2006).

SUMMARY AND CONCLUSIONS

During the present study, water quality Parameters of the Lonar Lake were found maximum above the permissible limit. Crater water was observed with variable colour during the different month in two different years, the observed colours are green, olive green, yellowish green. The olive green colour was due to the high turbidity which was observed during that periods and green colour due to the presences of phytoplanktons and variable suspended particulate material near the water surface. Lonar crater does not have any inlet or out let, it is closed and protected from heavy wind and retained higher level of humidity and has a localized temperature system, the lake basin is partly screened from direct sunlight at different places and at different times of the day.

The alkaline pH of the lake influences the chemical states of nutrients such as phosphate and ammonia, and toxicity of other substances such as nitrites. This is reflected in range of slight fluctuation of hydrogen ion concentration brought about by operational dynamics of bicarbonates, and carbonates.

Transparency was studied by the Secchi disc depth,which was observed nil throughout the study periods, it was observed maximum during summer months and optimum during monsoon and winter months of the year due to turbidity and suspended organic matter during monsoon months, dense amount of algal blooms, marshy place around the sampling sites in the winter months affecting light penetration,suspended matter increase and transparency decrease. High TDS levels, especially due to dissolved salts. Electrical Conductivity in Lonar Lake is affected primarily by the geology of the area through which the water flows. Conductivity and dissolved solids are directly proportional to each other mainly due to ionic composition of the water and nature of bottom deposits influence the conductivity. Conductivity of this range indicates that the water is not suitable for certain species of fish or macro-invertebrates. It was observed that warmer is the water higher is the conductivity.

Dissolved oxygen were observed very low in summer and somewhat more during the rainy season because aeration of lake water may observe at the same time of sampling due to which such variable dissolved oxygen was recorded, low value of it was due to the algal blooms, the nutrients and oxygen.The decomposers take the lead of decomposition of the dead algae consuming the available oxygen in water. Oxygen increases during winter due to low temperature and during early summer due to increased photosynthesis. Low level of oxygen indicates that the lake water is getting mixed with organic pollutants of anthropogenic activities. These organic matters are decomposed by aquatic micro-organisms which utilizes available oxygen led to depletion in oxygen level of the lake.

Due to the high amounts of zooplankton community the maximum respiration was done by that the free carbon dioxide was absent throughout the study it means that which was may converted in to the two different form that may carbonates and bicarbonates due to that the high values of alkalinity was observed. Such alkalinity might be due to alkaline particles through surface run off. Lonar Lake with such a value of total alkalinity can be considered productive. The total alkalinity values showed increase in summer and decrease in the monsoon period.It is also believed alkalinity of the lake may be due to two saline springs at its bottom.

Total Hardness of water observed more due to the alkaline earth metallic cations present in the water bodies. During the study it was observed that, in winter it high while its values increases during the summer and monsoon. Total Hardness was due to the both presence of calcium as well as magnesium. High total hardness of water can be attributed to carbonate rich sediments and leaching of the same. Chloride level indicates the lake water is polluted from domestic sewage might be rich in chlorides. The variation in chlorides is because of the main fresh water stream is joining at sampling site S4 brings down to its low chloride level which in summer though not adding much water rich in discharge of domestic wastes, have comparatively which is added during monsoon and winter. Salinity was also calculated out from the chloride and values of salinity were observed slight

fluctuation during the winter and summer season. Presence of Hydrogen sulphide indicate organic pollution of the lake and responsible for low DO concentration. The induced nutrients through agriculture activities in the lake had increased production of green algae and probably resulted into eutrophication of the lake. The pungent smell of Hydrogen sulphide evolved from the lake margins is prevalent inside the lake. Sulphates and phosphates are also important parameter for the Lake water study. Occurrences of both the parameters indicate eutrophic condition of ecosystems. Silicates in the lake are due to overwhelming population of algae particularly Bacillariophyceae and its degradation.

Comparatively high values of nitrates were gradually increased during summer months in the lake. Pollutants in domestic sewage and manure used in agriculture inside the lake however, contain much higher levels of nitrates may get into groundwater or streams from fertilized fields, from domestic effluent, or from runoff of manure.Various forms of nitrogen include ammonia, nitrates and nitrites. Together with phosphorus, nitrates in excess amounts accelerated eutrophication, causing dramatic increases in aquatic plant growth and changes in the types of phytoplanktons and zooplanktons that live in the lake water. Ammonia affected plankton and primary production of the lake by its harmful effects.Nitrogen and phosphorus are to important nutrients contributed to eutrophication of the lake.

In Lake water increase plant nutrients like Nitrites and Phosphates which acts as a nutrition for the developments of algae, they divide rapidly and increases there Number and finally they developed in to the algal blooms on the surface of water which then decomposed due to bacteria which increased biological oxygen demand, As BOD and COD increases there is problems for respiration of Zooplankton which is present in to that water body due to that dead and decomposition of plankton take place and lake move towards the Eutrophication. Lonar lake is a highly productive wetland with stagnant water because a flow-through agricultural land in the alluvium constantly adding more nutrients to it. The lake also gets most of their nutrients from recycling rather than from the outside fairly productive streams. Thus, intense

fertilization of field in alluvial fans, domestic sewage of the village Lonar and its runoff into the lake basin has greatly increased aquatic primary production of the lake.

The blue green algae (Cyanophyceae) constitute the major among phytoplankton community and particularly Spirulina is the dominant. The abundance of rapid multiplication of these algae is conspicuous along with other blue green algae and diatoms (Bacillariophyceae).

The zooplankton community is very limited species diversity but high density and dominated by rotifera,while cladocera and copepoda were not observed in the lake except the ephemeral ponds and detaches in the periphery of the lake basin. Among the rotifer dominant species is Brachionus plicatilis, Lecane sp., Cephalodella sp., Notholaca sp. while the Philodina sp.was found and other rotifers species like Hexarthra sp. Polyarthra sp. also increasing their numbers, the cladocera (diaphanosoma brachyurum, d.magna, d.longiceps, allona sp., allonela sp.), Cyclops sp.and Ostracoda like Cypris sp. are also observed only in the ephemeral low salinity ponds at the periphery of the lake.

Among the macroinvertebrate organisms are Eristalis, Liriope, Cranefly larvae, Dragonfly larvae, mayfly larvae, Chironomids and mosquito larvae, Nematode worms, was observed.

The avian fauna is rich in waterfowls especially the moor hens. During the winter season migratory birds visit to Lake.Various species of aquatic birds including Ducks, geese, have been recorded from the lake and its surroundings. The specially remarkable European shelduck (Tadorna ferruginea).

Lonar Crater is one of the most important meteorites impact crater evolved from its unique way. In to the world it is third rank. This Crater Lake evolved from near about over the thousands years before and it is famous for its alkalinity and salinity. For that below figure show salt which is observed near the alluvium, people those visit to Crater Lake collected this salt and which is use in kitchen.

Fig. No. 25: Show Salt Observed in the alluvium

Around the Lake or in the alluvium fans in to the Lake water spirulina sp. is most dominant it has great medicinal importance and having the rich source of proteins, vitamins and minerals with high digestibility, along with spirulinaother algae are also developed. Lake water contained selected zooplanktonic community like the Protozoa, Rotifera, Cladocera, Copepoda and Ostracoda, usually represents the floating animal communities. They are dominant with high density appears because small number of salt tolerant species have increases there number those species not tolerate they are not survive for long time. Around the lake several medicinal plants are developed but due to the over exploitation of Prosopois juliflora there number reduces. It is need of maintenance of Ecological balance of flora and fauna and their inter-relationship.Unfortunately the lake is getting polluted due to anthropogenic activities and consequently, the lake is in peril.

Due to the flow of domestic effluents from the Lonar town, chemical fertilizers and pesticides generally which was used during the agricultural activity done in to the alluvium fans of the Lake. On the fresh water springs bathing activities and washing of cloths are done and they used soaps, detergents and pollutants to lake and has deteriorated the original quality of the lake and its water sources by changing its chemical composition.

Deep forest is seen along the Lake, but the plants are cut for the different purposes like fuls, furniture and it may be use for building materials resulted in deforestation, over grazing of cattle's and goats had caused soil erosion and

denudation to the bank and escarpment of the lake. During the Navratri festival and fair at Kamaljadevi temple located inside the lake the tracking activities of the pilgrim's increases to such an extent that not only over burden the fragile ecosystem but also threatened it by dumping their wastes and garbages. Though the lake is not of an ordinary occurance in India, it is now threatened also by sudden rise of its water level, therefore, there is need to conduct a systematic study to find out the cause.

RECOMMENDATIONS/IMPLICATION/SUGGESTIONS

6.1 RECOMMENDATIONS/IMPLICATION/SUGGESTIONS

Annual fair at Kamljadevi temple: This temple is located in the Southern side of Lonar Crater. Due to this temple large number of pilgrims trek over the ejecta blanket throughout the year. A heavy load of pilgrims is during Navratri festival more than two lakh pilgrims for ten days of the fair visit the temple every day. This huge numbers of pilgrims is obviously beyond the carrying capacity of this fragile ecosystem. Several stalls are stretched from Ramgaya temple to Kamalajadevi temple for sailings eatables, toes, ritual offering, like flowers, coconuts and many other things. That crate pills of garbage's around Lake basin.

Due to the over load trekking of pilgrims many trees, shrubs and herbs are cut as the pilgrims were in boisterous and festive mood which provoked the activities such as braking of branches twigs along the way they also throw stones in to the Lake or at birds and monkey chasing small animals, singing loudly shouting and screaming etc.. the problems is greatly enhanced due to new trained of hunting animals

consequently the peacocks that are the residence of crater ecosystems unfortunately get killed by some of the peoples. The unregulated access of the people in to the carter lids to hunting of small fauna and birds. Such incidences are illegal and disturbing this indicates a bad sign of what is going to happened in futures. There are two serious threats associated with this annual episode firstly the present trained indicates a steady rice in the numbers of pilgrims and secondly due the improving transport facilities and other amenities that has ultimately crated imbalances in the ecosystem.

Deforestation : The deforestation on the escarpment and in the forest of alluvium is enhanced due to the agricultural activities the framers cut trees and carry the fire wood and fodder while retaining to the town from their fields which are at the bottom of crater.

Cattles grazing: Cattle's grazing activities is also increases due to agricultures in the carter since this farmers carry their cattle's from the town to agriculture and back.

Bathing and laundry activities: The local inhabitants have been regularly using Dhara water for bathing, washing and laundry activities. Bathing and laundry activities: Dhobighat activities can easily acquire dangerous proportion as this activity was innocuous earlier but now with the advent of detergents and other toxic soaps. The detergents have longer toxic life unlike the conventional soaps which were relatively biodegradable. Since all this effluent also drain in to Lonar Crater and cause unpredictable damage to the fragile flora of the lake that has evolved in the highly specific saline water of the Lonar Lake.

6. 2 CONCLUSIONS REGARDING THE GEOPHYSICAL ENVIRONMENT

1. Lonar crater is a unique hypervelocity meteoritic impact crater in basaltic rock. Due to its immense geological and natural value, it needs to be accorded immediate protection and legal status commensurate with the perceived requirements.

2. The geological structure of the crater comprises of seven integral and inseparable zones, i.e., i) Ejecta Blanket, ii) Rim, iii) Slopes containing ravines, iv) Basin or floor, v) Saline Lake, vi) Perennial sweet water springs, and vii) Little Lonar or the Ambar Lake. Each of these needs to be recognized and protected.

3. Till recently, the importance and significance of the Ejecta Blanket was not recognized by the Town planning authorities, or by other government departments. Consequently, the Lonar town has continued to expend and

encroached the ejecta blanket. The Lonar-Mantha highway, the construction of the percolation tank and the buildings of Lonar Municipal Corporation, Sardar Patel High-school, Forest Rest House, B. and C Rest House ect.on the crater rim are all example of the indifference and apathy regarding the value of the ejecta blanket on the rim. Therefore, the ejecta blanket has become the most vulnerable and endangered zone of the crater system due to haphazard development.

4. After the ejecta blanket, the next most threatened zone of the crater is the rim. Several concrete structures have already cropped up over the parts of the rim. Immediate steps are necessary to prevent the further encroachments on the rim.

5. The banks or slopes of the crater have started succumb to the soil erosion and denudation due to uncontrolled cattle grazing, trekking over of the pilgrims to temples at the bottom and the residents to their fields in the crater. This zone is relatively intact and will remain so if cattle grazing and other human activities are stopped.

6. The perennial stream or Dhara is being severely polluted by the use of detergents and soaps, and the unhygienic conditions of its banks and surroundings. These activities need to be stopped urgently, since their impact on the lake would be irreversible, if allowed to continue.

7. The crater floor has been subjected to agriculture for well over a century, leading to an alteration of the natural texture of the floor. In recent years, agricultural practices have led to the release of significant amounts of pesticides. Insecticides, fertilizers into the soil and water bodies, there by polluting them severely. Unlike the non-captive streams, rivers or lakes which invariably have an inflow and outflow, the Lonar lake a captive water body which has an inflow but no outflow. Therefore, the level of tolerance to non-biodegradable substances like detergents is exceptionally low at the Lonar Lake, leading to severe and irreversible pollution even with-relatively small quantities of toxic substances released into it.

8. The lake has been threatened by a sudden rise in its water level since 1984, which is historically abnormal. In our considered opinion, this has led to a direct threat to the temples around the lake, which due to their age, are already facing varying degrees of dereliction and dilapidation. The interface between the lake zone and the shore has been disturbed and changed as a consequence.

9. The geological studies have so far concentrated, their attention on the meteoritic impact phenomenon, on the causes of lake salinity. It is however noted that no systematic study of the recent rise in the lake water has been conducted. Similarly, there still continues to be an ambiguity about the remains of meteoritic material and its present location if any. Considering the importance of the phenomenon, the Geological Survey of India should continue with such studies. On behalf of R. A. College Washim, proposals to Rajiv Gandhi Foundation for Science and Technology were sent many times so as to elaborate scientific studies and establishment of Laboratory at Lonar but it is the matter of grave concern that Government has ignored such proposals.

10. The Lonar ecosystem has evolved in a unique way due to the unusual geohydrological and climatic isolation. However, the same conditions have made it extremely fragile and vulnerable to human interventions. Therefore, the biotic zones resulting from such isolation, need immediate protection.

11. The crater contains many sub-ecosystem, each constituting a subtle combination of floral and faunal species, due to localized variations in the conditions of soil, water and humidity. There is a very subtle balance and an interphase between these sub-systems. Therefore, barring the natural evolutionary changes, all sudden man-made changes such as plantation of exotic plants must be avoided.

12. The microflora of the saline lake shows a higher degree of specialization among all the floral and faunal components of the ecosystem. This includes the alkaliphilic and anaerobic hallophilic bacteria, thermophilic streptomycetes, etc. researches have established the fact that, these microbial species have the maximum economic potential in terms of further research and development. If this potential is to be protected for the national interest, statutory provisions well have to be put into place, so that the intellectual property rights over this biological diversity are not taken away by foreign companies or scientists. The legal provisions for such protection will become available only after the proposed biological diversity (protection) act, 1998 is passed by the parliament and promulgated. Till such a time, the provisions available within the wildlife protection act, 1972 and its amendments, should be used as basis for enforcing the above mentioned actions.

13. The natural vegetation over the ejecta blanket and rim has already disappeared due to agriculture, grazing and constructions. This needs to be restored wherever possible. A vegetative cover of this kind will function as natural buffer zone for protecting the crater ecosystem, and it will also further the cause of forest regeneration that may also help to stop soil erosion of the escarpment.

14. The forest cover over the slopes of the crater has shown a marked improvement during last two decades due to the extensive afforestation programmes undertaken by the forest department. This activity is laudable and should be continued with vigour. However, the department has unwittingly introduced many exotic species into the crater, which are disturbing the natural species composition.

15. It is a matter of grave concern that, Prosopis juliflora, an exotic species introduced by forest department, is rapidly replacing several other indigenous species. This phenomenon is a major threat to the floral diversity within the crater ecosystem and therefore needs immediate rectification. Prosopis juliflora needs to be eradicated immediately, so that the succession of indigenous species can take place. Plantation of indigenous species is recommended.

16. Trees and shrubs on the crater floor are being cut at an alarming rate. This deforestation needs to be stopped immediately.

17. Pollution of lake water due to soaps, detergents, pesticides etc. is changing the chemical composition of the lake. If left unchecked, it may lead to the extinction of several species of the microflora.

18. The undesirable and unnecessary activities during the annual Yatra of Kamljadevi, are an important threat to the ecosystem, and therefore need to be contained immediately, and phased out as early as possible or concept of Eco-tourism is to be implemented.

6.3. CONCLUSIONS REGARDING THE CULTURAL ENVIRONMENT

19. Lonar crater and the town contain more than 60 archaeological/ historical monuments/ precincts. Some of these are master pieces of art and hold immense heritage value and therefore deserve a complete protection.

20. The Archeological Survey listed only nineteen monuments and has ignored the rest. Similarly, the AS! Recognizes the monuments merely as serial numbers, and not by their original names. These obvious inadequacy needs rectification.

21. The ASI has neglected those monuments which are included in the list of protected monuments. Many temples inside the crater have now been reduced to heaps of collapsed pillars, stones and figurines. Therefore,

a) Structure which is still standing will need to be repaired and restored carefully, and b) in case of those which have collapsed, the figurines, carved sculptures, etc. should be salvaged and transferred to the archeological museum proposed at the VMC. Further, there pillars, chiseled stones, etc., should be integrated into the construction work at the VMC,.With a plaque or notice indicating their origin.

22. In case of some temples, the AS! Has carried out renovation work in such a manner that they have become even more disfigured. The restoration work will need to be redone scientifically, in such cases.

23. The monuments inside the crater are facing dilapidation due to recent changes in ecological conditions, like the rise in the water level of the lake, overgrowth of the Prosopis juliflora, etc. Such situations need a concerted effort on the part of all the government departments, so as to prevent further damage to the structures.

6.4. CONCLUSIONS REGARDING THE SOCIO-ECONOMIC AND URBAN ENVIRONMENT

24. In recent years, the growth of Lonar town has accelerated considerably, especially after it became the headquarters of the independent Lonar Tehasil. However, at present this growth is totally unplanned and haphazard. This has resulted into an overcrowding of slums and hutments towards the crater rim.

The civic amenities are woefully inadequate, most roads have not been paved or tarred, the town has practically no underground drainage system the level of hygiene in the market places is very poor, and along the roads it is barely

tolerable, a large number of slum dwellers are in the habit of performing ablutions directly on the roads making them filthy and nauseous. In short, this erstwhile wealthy and decadence.

25. A three storied building located near the Jain Mandir, appears to be contravening the regulation on maximum number of floors allowed. It is obvious that if more buildings come on in this fashion, the skyline of the Lonar crater will be marred. In addition, the craters natural resources (especially water).

26. Several constructions, are appearing on the crater rim adjoining the town. These constructions also include religious structures and graveyards, which might prove difficult to remove in future. Therefore immediate steps must be taken to prevent further developments on the crater rim and the ejecta blanket.

27. The public works departments has undertaken a world bank aided project for widening of Lonar-Mantha road which runs at a tangent to the crater. The widening of this road will results into a constant and heavy vehicular traffic near the crater rim. One fails to understand how the public works department has not taken cognizance of the unique position of the Lonar crater while proposing the road expansion. The road needs to be diverted 2 km before it reaches the town, and merged into the Loni road.

In this section it is emphasized to pull together all the recommendations from previous chapters. However the purpose of this section is to prioritize the recommendations in terms of their urgency so as to serve as operational guidelines. And also as an action programme for the relevant Govt. departments.

It is necessary to mention here that the urgency and the importance of any recommendation, are not necessarily identical. A recommendation may appear to be of minor importance, yet the urgency of its implementation may be very great:

To give an example, removal of Prosopis juliflora may appear as a minor recommendation compared to the later. This is because later is a pro-active measure against possible threats, whereas the, former is a reactive measure against an

immediate threat. Further, there are certain recommendations which merely indicate the direction of future developments of Lonar town should be directed away from the crater. Such recommendations hold a general significance and are not of a time-bound nature.

1. A certain protion of Ejecta Blanket and Rim have survived the impacts of human activities and have retained their original characteristics.This area should be immediately declared as a 'No Development Zone', and the necessary amendments should be made in Lonar Town Development Plan.

2. A stream called 'Nabbi Nala' is the domestics sewage effluent of Lonar town that enters the crater from its nort- eastern side after flowing through the entire Lonar town. A bandh has been constructed to collect sewage at a place that will settle suspended matter up to certain extent there and the supernatant flow will run into the stream approaching to the lake basin. Though this effort minimize the pollution level of that effluent cannot be the measure to control pollution of the lake. The flow of this stream should be immediately diverted away from the crater,as it drains great amount of sewerage into the into the lake. Many times during rainy season the flood water rushing down the stream caused severe erosion of the crater rim and more seriously,led to formation of a major cleavage in the part of the rim wall. Such dangers can irreversibly destroy the natural structure and integrity of crater.

3. The Lonar-Mantha road at one point passes almost tangentially to the rim of the crater. It is recommended that the proposed plan of widening be reconsidered and modified immediately.It is recommended that the road be diverted away from the crater.

4. The State Archaeology Development should immediately include all the archaeological entities in the list of protected monuments.

5. A ban should be immediately imposed on the use of chemical fertilizers and pesticides, and other toxic materials' in the agricultural fields inside the crater. The farmers may rehabilitated to some other places of if impossible they should be encouraged to use organic fertilizers such as composts and vermicomposts etc.

6. A ban should be imposed on use of detergents at Dhara.

7. The motorised lifting of water from Ramgaya Stream at the bottom of the crater lake/ springs should be banned.

8. Forest department should immediately and completely stop the activities of tree felling and cattle grazing by local people inside the crater.

10. The Forest Department should take urgent measures to copmpletely removes the stands of Prosopis juliflora from the crater basin.

11. Children presently use the precincts of the temple as a playground .Such practices damage the structures as well as the sanctily of the temple. Such practices should be stopped immediately.

12. As the salinity of lake water has decreased substantically.A study should be undertaken immediately to confirm the causes of this phenomenon.

13. The hutments on the rim should be removed immediately and relocated elsewhere in the township, preferably towards the north-eastern direction.

14. Certain illegal concrete structures have appeared on the rim. These should be removed immediately.

15. Lonar Crater and area around it is being a Wildlife Sanctuaray, is therefore recommended that the Forest Department should be entrusted with the responsibility of functioning sincerely as the Nodal Agency for carrying out all the activities related to protection and conservation of the crater ecosystem.The Maharashtra State Govertment encourageForest Departmeant by necessary finance.The Forest Department.presently lacks the machinery and manpower required to protect the crater ecology. It should immediately make the necessary provisions for additional/qualified staff and other necessary equipment to ensure an effective conservation of crater ecology.

16. Astrict vigilance should be established to prevents the removal or smuggling of important geological materials from the ctater.The responsibility of enforcing this regulation should vest principally with the Forest Department and with the GSI.

17. For an effective regulation of the activites of local inhabitantas,pilgrims ,and tourists inside the crater, a Visitor Management Center be established.

18. During Kamalajadevi festival, a very large mumber of pigrims enter the crater.It is recommended that during the festival period railings should be erected along the path leading to Kamalajadevi temple,to prevent the pigrims from scattering into crater.

19. Similarly, during Kamalajadevi festival, shops, stalls,etc. should not be allowed inside the crater or on the rim, likewise temporary electricity connection and lightings inside the crater should also be banned.

20. Considering the presents trends in population growth, all further developmental activity should be diverted away from the crater i.e. towards the north-east of Lonar town.

21. It is recommended that the Irrigation Department should not construct any more water impounding structures in the immediate vicinity of the Ejecta Blanket.In case a water impounding structure becomes an absolute necessity, the Ground Water Survey and Development Agency Buldana should be asked to conduct a study before finalizing the site for water impoundment.

An exhaustive documentation and data bank of biodiversity of crater ecosystem should be carried out.

At the schools of Lonar a pledge is to be composed and memorized at every day prayer time so that may inculcate the minds of childhood, that the importance of conservation of Lonar lake is the major responsibility of every citizen of Lonar.

6.5. LONAR LAKE AS A PROPECTIVE RAMSARE SITE

India is one of the contracting parties with Ramsar convention. It has six Ramsar sites as mention earlier. At fourth meeting of the conference of contracting parties to the Ramsar convention at Montreus, Switzerland, 1990 three criteria were finalized to

declare any wetland as a Ramsar site. Lonar Lake is suitable to declare as a Ramsar site under any category of these criteria as mentioned below.

Criteria for representative or unique wetland

Lonar (19°58 N and 76°31 E) ranks among the five largest craters of its kind in the world (Dhabhade et al., 1998) and far from being a strile wonder, it also harbours an oasis of life with its womb.

1. General criteria based on plants or animals

Although the crater in itself is of immense interest as a natural phenomenon, what makes it still more unique is the micro ecosystem which has evolved within it Malu et al., (1998). This consists of various ecotones inhabited by a wide range of plant and animal life. The saline lake, marshy areas around it, freshwater streams, manmade plantations, crop fields and the remnants of the original forest and scrub referred to above, all provide special niches for plants and animals.

Besides the peafowls an impressive is of migrant and resident birds are to be found here black winged stilts, brahminy ducks, grebes, shellducks (European migrants) shovellers, teal, herons, redwattled lapwings, rollers or blue jays, baya weavers, parakeetrs hoopoes, larks and swallous could keep a retinue of birdwatechers active for eons; Greater flamingoes have also been reported.

Among reptiles, the monitor lizard is most prominent, living among the ruins of the many tamples which dot the crater

2. Specific criteria based on waterfowl

Thousand of pea-fowls live inside the crater. While the geography no doubt offers them natural protection, even the villagers and farmers are extremely tolerant of them. Lonar thus have a privilege to harbor the most dense population of peafowls anywhere in Maharashtra.

Anything rare and extraordinary has the power to attract people to it. Recognizing this, the tourist industry in the USA has, for instance, successfully exploited the potential of the **'Arizona crater'** whose fame has spread far and wide.

Thousands of visitors from all over the world throng to see this marvel of nature. Few people, however, even know of India's magnificent hyper-velocity meteorite-impct crater Lonar, which is situated in basaltic terrain and is probably more impressive and fascinating than the ones which currently attract hordes form all over the country.

To summarise Lonar Lake is an ecologically interesting site, full of flora and fauna should be protected as Ramsar site.

BIBLIOGRAPHY

Agarwal, A.K. and G.S. Rajwar (2010): Physico-chemical and Microbial Study of Tehri Dam Reservoir Garhwal, Himalaya, India. Journal of America Science 2010; Vol. 6 (6).

Alvarez -cobelas M., S. Cirujano, C. Rojo, M. A. Rodrigo, E. Pina, J. C. Rodríguez-murillo and E. Montero (2006): Effects of Changing Rainfall on the Limnology of a Mediterranean, Flowthrough-Seepage Chain of Lakes. Internat. Rev. Hydrobiol. Vol. 91(5): 466–482.

Anderson H. H. (1889): Notes on Indian Rotifera. Asiatic Soc. Bengal, Vol. 58: 345-358.

APHA (1998): Standard methods for examination of water and waste water. 20th edition, edited byLenore S. Clescerei, Arnold E. Greenber and Andrew D. Eaton.

APHA (2006): Guidelines for drinking-water quality [electronic resource] incorporating first addendum.Vol. 1, Recommendations. – 3rd ed.

APHA (2008): Standard methods for examination of water and waste water, (21sted.) American Public Health Association AWWA, WEF, Washington, DC.

Arimoro F. O., and A. O. Oganah (2010): Zooplankton Community Responses in a Perturbed Tropical Stream in the Niger Delta, Nigeria.The Open Environmental and Biological Monitoring Journal, Vol. 3: 1-11.

Ariyadej, C., Tansakul, R., tansakul, P. and S. Angsupanich,(2004): Phytoplankton diversity and its relationships to the physico-chemical Environment in the banglang reservoir yala provinceSongklanakarin j. Sci. Technol.Vol.26(5) : 595-607

Arora H. C. (1963): Studies on Indian Rotifera-II, J. Zool. India, Vol. 25: 112-121.

Augustina D. O. (2009): Spatio-temporal Distribuution, Abundance and Species Composition of Zooplankton of Woji-okpoka Creek, Port Harcourt, Nigeria. Research Journal of Applied Sciences, Engineering and Technology Vol. 1(2): 14-34.

Babar, S. M. (2010): Microecological environmentand conservation of Lonar Lake,Maharashtra, India. Environmental Management, Book , Vol.6: 258.

Badsi H., H. O. Ali, M. Loudiki, M. E. Hafa., R. Chakli and A. Aamiri (2010): Ecological factors affecting the distribution of zooplankton community in the Massa Lagoon (Southern Morocco). African Journal of Environmental Science and Technology Vol. 4(11): 751-762.

Badve R. M., K.P.A. Kumaran and C. Rajshekhar (1993): Eutrophication of Lonar lake, Maharashtra. J.Current Science.Vol. 65 (4): 347.

Baiao C. and M. J. Boavida (2005): Rotifers of Portuguese reservoirs in river Tejo catchment: Relations with trophic state.J. Limnetica,Vol. 24(1-2): 103-114.

Bajekal S. S. and M.S. Chavadar (2008): Magnetotactic bacteria from the saline alkaline lonar lake, India,10th International Conference on Salt Lake Research and FRIENDS of Great Salt Lake Issues Forum.

Baker S.L. (1979): Specific status of Keratella cochlearis (Gosse) and k.Ahlastrar (Rotifera : Brachionidea) : Ecological consideration, Can.J. Zool,Vol.7(9): 1719-1722.

Balaraman U. (2008): The unique fauna of Ephemeral wetlands of Southern Kerala, in: proceedings of Taal 2007: The 12th World Lake Conference (ed. Sengupta M. and Dalwani R.): 401-409.

Baloch W. A., Suzuki and Onone (2008): Occurrence of planktonic rotifer, Finialongiseta in southern Kyushu, Japan. Pakistan J. Zool., Vol. 32(3): 279-281.

Bansod V.B. and S.S. Bajekal (2006): Characterization of chitinases from microorganisms isolated from Lonar lake. J. Indian Journal of Bitochnology.Vol 5: 357-363.

Batzer, D. P. (1998): Trophic interactions among detritus, benthic midges, and predatory between bluegills and their prey. Ecology, Vol. 63:1802 –1813.

Batzer, D. P. and S. A. Wissinger (1996): Ecology of insect communities in non tidal biotype. Hydrobiol., Vol.35: 127-162.

Bhave, W. T. and Borse, P. V. (2001): Seasonal variation in temperature, DO, pH and Salinity and their influence on Inanner river water, Jalgaon, Maharashtra. Poll.Res. Vol. 20 (1):79-82.

Bhawankar A.S., L.M. Mudkhede and S. V. Shivanikar (2011): Physico-chemical status of kudala dam tq. Umari dist. Nanded,Maharashatra, India.J. Aqua. Biol., Vol. 26(1): 26 – 30.

Bhawankar, A. S., L. M. Mudkhede and S. V. Shivanikar (2011): Physico-Chemical Status of Kudala Dam Tq. Umari Dist. Nanded,Maharashatra, India. J. Aqua. Biol.,Vol.26 (1): 26 – 30.

Bhuiyan, A. S. and Q. Nessar (1998): A quantitative study of zooplankton in relation to the physicochemical conditions of a freshwater fish pond of Rajshahi. Univ. J. Zool. Rajshahi Univ.,Vol. 17: 29-37.

Bielanska-Grajner. I. (2004): Preliminary investigations of psammon rotifers in two reservoir in Upper Silesia, Int. J. of Oceanography and Hydrobiology, Vo. 33, (1): 37-45.

Bodas M., B. Sen and K.K.K. Nair (2005): Lonar Crater- a geological and ecological enigma, Geological Survey of India, 1-10.

Borse S. K. and Bhave P. V. (2000): Seasonal temperature variation and their influence on the level of dissolved carbon dioxide and pH in river water, Jalgaon. Asian J. Microbiol.Biotech.and Env. Sci., Vol. 2(3and4): 159-163.

Borul S. B. (2012): Study of water quality of Lonar lake. J. Journal of Chemical and Pharmaceutical Research. Vol. 4(3):1716-1718.

Buyurgan O., A. Altindag and M. Kaya (2010): Zooplankton Community Structure of Asartepe Dam Lake (Ankara,Turkey). Turkish Journal of Fisheries and Aquatic Sciences Vol. 10: 135-138.

Caramujo M. J. and M. J. Boavida (2010): Biological diversity of copepods and cladocerans in Mediterranean temporary ponds under periods of contrasting rainfall. J. Limnol., Vol. 69(1): 64-75.

Casado S. and C. Montes(1992): A Short History Of Eighty Years Of Limnology In Spain. Limnetica,Vol.8: 1-9.

Chakrabarti R. and A. R. Basu (2006): Trace element and isotopic evidence for Archean basement in the Lonar crater impact breccia, Deccan Volcanic Provinc, Earth and Planetary Science Letters, Vol. 247: 197–211.

Chang K. H., H.Doi, Y. Nishibe, Y. Obayashi and S. Nakano (2009): Spatial and Temporal Distribution of Zooplankton Communities of Coastal Marine Waters Receiving Different Human Activities (Fish and Pearl Oyster Farmings) The Open Marine Biology Journal,Vol. 3: 83-88.

Chavadar, M. S. and S. S. Bajekal (2008): South Seeking Magnetic Bacteria from Lonar Lake Proceedings of Taal2007:The 12th World Lake Conference, 444-447.

Chick J. H., A. P. Levchuk, K. A. Medley and J. H. Havel (2010): Underestimation of rotifer abundance a much greater problem than previously appreciated.Limnol.Oceanogr.MethodsVol. 8: 79–87.

Chittapun S., P. Pholpunthin and L. Sanoamuang (2009): Diversity and composition of zooplankton in rice fields during a crop cycle at Pathum Thani province, Thailand Songklanakarin J. Sci. Technol. Vol. 31 (3): 261-267.

Claps M. C., N. A. Gabellone and H. H. Benitez (2011): Seasonal changes in the vertical distribution of Rotifers in a Eutrophic shallow Lake with contrasting states of clear and turbid water, J. Zoological Studies Vol. 50 (4): 454-465.

Cockell, C. S. and Pascal Lee (2002): The biology of impact craters. Biol. Rev., **77**, 279±310 "DOI: 10.1017} S146479310100584X 279.

Conservation Division-I Ministry of Environment and Forests Government of India New Delhi (2007): Conservation of Wetlands in India: A Profile (Approach and Guidelines).

Cottenie, K., N. Nuytten, E. Michels and L. D. Meester (2001): Zooplankton community structure and environmental conditions in a set of interconnected ponds. Hydrobiol., Vol. 442: 339-350.

Crowder, L. B. and W. E. Cooper (1982): Habitat structural complexity and interaction fish in a freshwater marsh. Ecology,Vol.79:1688 –1698.

Dabhade D. S. (2013): Eutrophication, a threat to saline lake in a crater at lonar, Maharashtra. J. Asian Journal of Contemporary Sciences. Vol. 2(1): 1-6.

Dabhade, D. S. (2006): Limnological studies on Lonar Crater Lake, Maharashtra. Ph.D. Thesis submitted to S.G.B. Amravati University, Amravati.

Damodare R. A., D. S. Dabhade and R. A. Malu (2006): Studies on Rotarians as Pollution Indicator, J. Aquatic Biodiversity Management and Conservation, Vol. 9: 195-202.

Dejen, E. J., L. A. Vijverberg, J. Nagelkerke and F. A. Sibbing (2004): Temporal and spatial distribution of microcrustacean zooplankton in relation turbidity and other environmental factors in a large tropical lake (L.Tana, Ethiopia), Hydrobiologya, Vol.513:39-49.

Department of environment Government of west Bengal (2012): West Bengal Wetlands and Water Bodies Conservation Policy, 1-16.

dePater I. and J.J. Lissauer (2001): Planetary Sciences, Cambridge Univ. Press, 528.

Deshmukh D.V. and P.R. Puranik (2010): Application of plackett-burman design to evaluate media components affecting antibacterial activity of alkaliphilic cyanobacteria isolated from lonar lake. J. Turkish Journal of Biochemistry–Turk J Biochem. Vol.35 (2): 114–120.

Dhanapati M.V.S.S.S. (2000): Taxonomic notes on the rotifers from India, J.I.A.A.B. Hyderabad,1-78.

Dhote S. and S. Dixit (2011) Hydro chemical changes in two eutrophic lakes of Central India afterimmersion of Durga and Ganesh idol Research Journal of Chemical Sciences Vol. 1 (1).

Dhote S. and S. Dixit (2011): Hydro chemical changes in two eutrophic lakes of Central India after immersion of Durga and Ganesh idol, Research Journal of Chemical Sciences Vol. 1 (1):38-45.

Dwivedi, S.N. (2000): S and T approach for exponential growth in fish production. (In: souvenir, The Fifth Indian Fisheries Forum, CIFE, 14-18.

Echaniz S. A. and A. M. Vignatti (2010): Diversity and changes in the horizontal distribution of crustaceans and rotifers in an episodic wetland of the central region of Argentina. J.Biota Neotrop., Vol. 10(3): 133-141.

Edmondson W. T. and G. E. Hutchinson (1934): Report on Rotatoria. Article IX. Yale North India Expedition.Mem.Cann. Acad. Arts, Sci.,Vol.10:153-186.

Edmonson W. T. (1959) : Fresh water Biology, 2nd Edn. John wiley and sons. Inc., New York. 1248.

Eloy B. (2006): Limnology of natural systems for wastewater treatment. Ten years of experiences at the Experimental Field for Low-Cost Sanitation in Mansilla de las Mulas (León, Spain) J.Limnetica, Vol. 25(1-2): 143-154.

Ferrara O.,D. Vagaggini and F. G. Margaritora (2002): Zooplankton abundance and diversity in Lake Bracciano, Latium, Italy. J. Limnol., Vol.61(2): 169-175.

Fontaneto D., Giordani I., Melone G. and Serra M. (2007): Disentangling the morphological stasis in two rotifer species of the Brachionus plicatilis species complex. J. Hydrobiologia, Vol. 583:297–307.

Gadekar P.G., K.P. Ghoshal and A.S. Gadwe (2014): Studies on zooplankton diversity of Pangdi Lake, Gondia, dist. Gondia, Maharashtra. International J. of Environmental Biology.Vol. 4(1):47-50.

Gaikwad R.W. and V.V.Sasane (2013): Assessment of ground water quality in and around Lonar lake and possible water treatment. J. International Journal of Environmental Sciences Vol.3: 1263- 1271.

Garcia-Morales A. E. and M. Elias-Gutierrez (2007): The Rotifer fauna of Guatemala and Belize: survey and biogeographical affinities Int. J. Trop. Biol. Vol. 55 (2): 569-584.

Gastescu P. (2009): Limnology, Lake Basins, Lake Waters Lakes, reservoirs and ponds,Vol. 3(1): 7-12.

Gerardo U. V. (2001): Limnology of Botos Lake, a tropical crater lake in Costa Rica.J.Rev. Biol. Trop. Vol. 49. Supl. 2: 1-10.

Ghodechor V., R. Prabhu, S. Shaikh, S. Bhutada1 and N. Adhapure (2013): Distance decay analysis of the alkaliphilic bacteria isolated from lonar soda lake. J. Journal of Global Biosciences Vol. 2(6), 2013: 174-180

Ghosh S. (2009): Physics and Chemistry of Meteorites, J. Geological Sociaty India, Vol.74: 560-762.

Gilbert J. J. (2004): Population density, sexual reproduction and diapause in monogonont rotifers new data for Brachionus and a review. J. Limnol., Vol. 63(1): 32-36.

Goel P.K. and V.R. Charan (1991): Studies on limnology of polluted fresh water tanj, InB Gopan, and V.Asthana(Eds) Aquatic Sciences in India. Indian Association for limnology and Occanography.51-64.

Goswami A.P. and P.C.Mankodi (2012): Study on Zooplankton of Fresh Water Reservoir Nyari – II Rajkot district, Gujarat, India. ISCA Journal of Biological Sciences Vol. 1(1): 30-34.

Goswami J. N. and S V S Murty (2009): Planetary sciences and exploration: An Indian perspective, Current Trends in Science, 457-476.

Gurung S. , S. Sharma and C. M. Sharma (2009): A brief review on limnological status of high altitude lakes in Nepal. Journal of Wetlands Ecology, Vol. 3: 12-22.

Hagerty, J.J. and H.E. Newsom (2001): New evidence for impact-induced hydrothermal alteration at the Lonar Crater, India: Implications for the effect of small craters on the mineralogical and chemical composition of the Martian regolith. Lunar and Planetary Science 32, Abs. No. 1131.

Hagerty, J.J. and H.E. Newsom (2011): Hydrothermal alteration at the Lonar Lake impact structure, India: Implications for impact cratering on Mars, Meteoritics and Planetary Science Vol. 38, (3): 365–381.

Hajkova P., J. Bojkova., M. Frankova., V. Opravilova., M. Hajek., K. Kintrova., and M. Hoesak (2011): Disentangling the effects of water chemistry and substratum structure on moss-dwelling unicellular and multicellular micro-organisms in spring-fens. J. Limnol., Vol.70(suppl. 1): 54-64.

Harney N.V., A.A. Dhamani and R.J. Andrew (2013): Seasonal Variation in the Physico-chemical Parameters of Pindavani pond of Central India.J. DOI, Vol. 1 (6).

Haroon G., R.S. Khoiyangbam, S. Ahmad and S.M. Zuber (2010): Limnological Assessment of Antiya Tal, Jhansi to Assess Its Water Quality. International Journal of Lakes and Rivers, Vol. 3, (1): 79-85.

Horne, A.J. and C.R. Goldman.(1994): Limnology. 2 ed..McGraw-Hill Co., New York, New York, USA.

Hutchinson G. E. (1967): A treatise on Limnology, II. Introduction to lake biology and limnoplankton.John Wiley and sons Inc. New York.

Indabawa I. I. (2009): Studies on limnological parameters and phytoplankton dynamics of Nguru lake, Yobe State Nigeria. Bioscience research communications Vol. 21 (4).

Interlandi S. J. and S. S. Kilham (2010): Limiting resources and the regulation of diversity in phytoplankton communities. J. the Ecological Society of America. Vol. 82(5): 1270–1282.

Iqbal F., M. Ali and N. Kanwal (2006): Limnological Study of River Soan (Punjab), Pakistan Agriculturae Conspectus Scientificus, Vol. 71(2): 65-73.

Islam A.K.M.N., A.K.Y. Haroon and K.M. Zaman (1974): Limnological studies of the river Buriganga.Dhaka Univ. Stud.Pt. B., Vol. 22(2): 99-111.

Jayabhaye U.M. (2010) : studies on zooplankton diversity of river Kayadh, near Hingoli city, Hingoli district, Maharashtra .Shodh Samiksha aur Mulyankan (International Research Journal),Vol. 2: 11-12.

Jhingran V.G. (1985): Fish and Fisheries of India. Hindustan Publishing Corporation, Delhi, India.

Kanagasabapathi V. and M. K. Rajan (2010): Preliminary survey of plankton in Irrukkangudi reservoir, Virudhunagar district, T.N., India. Journal of Phytology,Vol. 2(3): 63–72.

Kanekar P. P., A. A. Joshi, A. S. Kelkar, S. B. Borgave and S. S. Sarnaik. (2008): Alkaline Lonar lake, India, A treasure of alkaliphilic and halophilic bacteria. Proceedings of Taal2007: The 12th World Lake Conference. 1765-1774.

Kaur S. and I. Singh. (2012): Acceleralted phosphate and nitrate level: factors to blame forEutrophication in Yamuna river, Delhi, India. International Journal of Plant, Animal and Environmental Science.Vol. 2(3): 183-187.

Kaushik S. and D.N. Saxena (1995): Trophic status of Rotifer fauna of certain waterbodies in central India J. Environ.Biol., Vol. 16(4): 283-291.

Kedar G.T., G.P. Patil and S.M.Yeole (2008): Effect of Physico-Chemical Factor on the Seasonal Abundance of Zooplankton Population in Rishi Lake. Karanja (lad) Dist. Washim (M.S.), Proceeding of Taa12007; The 12th World Lake Conference: 88-91.

Khuhawar M.Y., M. A. Mirza, S. M. Leghari and R. Arain (2009): Limnological Study of Baghsar Lake District Bhimber Azad Kashmir. Pak. J. Bot., Vol. 41(4): 1903-1915.

Kodarkar M.S. (2008): Conservation and Management of Lakes Case Studies from India.Proceedings of Taal 2007: The 12th World Lake Conference: 1442-1445.

Koeberl C., N. Bhandari, D.Dhingra, P.O. Suresh, V.L. Narasimham and S. Misra. (2004) Department of Geological Sciences, University of Vienna, lonar impact crater, india: occurrence of a basaltic suevite?Lunar and Planetary Science Vol. 35: 1751.

Krishnan P., R. Ramakrishnan, S. Saigal, S. Nagar, S. Faizi, H. S. Panwar, S. Singh and N. Ved (2012): *Conservation Across Landscapes: India's* Approaches to Biodiversity Governance. United Nations Development Programme, New Delhi, India.

Kshama-Khobragade. limnological status of Lonar Lake with reference to Eutrophication.**(http://wldb.ilec.or.jp/data/ilec/WLC13_Papers/S7/s7-7. pdf)**

Kumar P. S. and D. A. Kring (2008): Impact fracturing and structural modification of sedimentary rocks at Meteor Crater, Arizona, journal of geophysical research, Vol. 113:1-17.

Kumar P. S. (2005): Structural effects of meteorite impact on basalt, Evidence from Lonar crater, India. J. Geophys. Res.Vol.110: B12402, doi:10.1029/2005JB003662.

Lahane L. D., U. M. Jayabhaye (2013): Diversity of Zooplankton in Pimpaldari tank Dist: Hingoli, Maharashtra, India. International Indexed and Research Journal, Vol. 4: 51-52.

Lashari K. H., A. L. Korai, G. A. Sahato and T. G. Kazi (2009): Limnological Studies of Keenjhar Lake, District, Thatta, Sindh, Pakistan. Pak. J. Anal. Environ. Chem. Vol. 10, (1 and 2): 39-47.

Leitao A. C., R. H. F Freire, O. Rocha and S. T. Santaella (2006): Zooplankton community composition and abundance of two Brazilian semiarid reservoirs. J. Acta Limnol. Bras., Vol. 18(4):451-468.

Leng R. (2009): The impacts of cultural Eutrophication on Lakes: A review of damages and nutrient control measures. J. American association for the advancement of science. Vol. 184(4139): 897-899.

Lokhande M. V. and V. S. Shembekar (2009): Studies on Phytoplankton Diversity of Dhanegaon Reservior, Dhanegaon, Dist. Osmanabad, Maharashtra. International Research Journal of Shodh, Samiksha aur Mulyankan Vol. 2(7): 35-39.

Louzada K. L., B. P. Weiss, A. C. Maloof, S. T. Stewart, N. L. Swanson-Hysell and S. A. Soule (2008): Paleomagnetism of Lonar impact crater, India, J. Earth and Planetary Science Letters Vol. 275: 308–319

Louzada L., I.G.Bethell, and P. M. Poussart (2010): Geology of lonar crater, India**. J.**Geological Society of America Bulletin.Vol.122: 109-126.

Ludwik J.A. and Reynols J.F. (1998): Statistical ecology a primer on methods and computing, A Wiley-Interscience Publication, New York, Vol. 1: 337.

Malaiwan T. and Y. Peerapornpisal (2009): Diversity of Phytoplankton and Water Quality in the Reservoir of Nam Ngum Dam, Lao PDR. KKU Science Journal, Vol 37: 42-49.

Maloof A. C., S. T. Stewart, B. P. Weiss, S. A. Soule, N. L. Swanson-Hysell, K. L. Louzada, I. Garrick-Bethell and P. M. Poussart (2010): Geology of Lonar Crater, India, Geological Society of America Bulletin, Vol. 122(½): 109-126.

Maloof A. C., S. T. Stewart, N. Swanson-Hysell, K. L. Louzada, I. Garrick-Bethell, S. A. Soule, and B. P. Weiss (2007): Lonar Crater, India: An Analog For Martian Impact Craters, Lunar and Planetary Science,Vol.38: 2316.

Malu R. A., D. S. Dabhade and M. S. Kodarkar (2000): Rotifer diversity in Lonar Lake, An Inland Saline Water Body in Maharashtra, Indian Journal of Aquatic Biologists, Hyderabad, India, Vol. 15 (1 and 2): 16-18.

Malu R. A. (2002): Lonar crater saline lake, an ecological wonder in India. (http://www.isslr.org/news/newsone.asp?qnewsid=188).

Malu R. A., D. S. Dabhade and M. S. Kodarkar, (2007): Conservation and management of Lonar Lake, An Ecological Wonder, Maharashtra, India. World Lake Vision-Action report, International Lake Environment Committee Foundation (ILEC), Japan, 208-216.

Manjare S. A., S. A. Vhanalakar and D.V. Muley (2010): Analysis of water quality using physico-chemical parameters tamdalge tank in Kolhapur district, Maharashtra. International Journal of advanced biotechnology and research. Vol. 1(2): 115-119.

Maria-Heleni Z., E. Michaloudi D. C. Boboriand S. Mourelatos (2009): Zooplankton Abundance in The Aliakmon River, Greece. Belg. J. Zool., Vol. 130: 29-33.

Mazher S. and D. Sharief (2004): Water Pollution Studies in the Double Lake (Errentaieri) With Relation to phytoplankton. J. Aqua. Biol. Vol. 19 (1): 15-18.

Melosh H.J. (1989): Impact Cratering: A Geologic Process, Oxford University Press, Oxford,Vol.245.

Menzel P.A., B. Gaye, M. G. Wiesner, S. Prasad, M. Stebich, B. K. Das, A. Anoop, N. Riedel and N. Basavaiah (2013): Influence of bottom water anoxia on nitrogen isotopic ratios and amino acid contributions of recent sediments from small eutrophic Lonar Lake, central India. J. Limnol. Oceanogr.Vol. 58(3): 1061–1074.

Misra S., H. E. Newsom, M. Shyam Prasad, J. W. Geissman, A. Dube and D. Sengupta (2009): Geochemical identification of impactor for Lonar crater, India, Meteoritics and Planetary Science, Vol. 44(7): 1001–1018.

Mohite Y.S. and P.S. Wakte (2011): Assessment of Factors Influencing Growth and C-Phycocyanin Production of Arthrospira platensis from Meteoritic Crater Lake. J. Algal Biomass Utln. Vol. 2 (2): 53– 68.

More S.M., V.A. Shinde, Saiqua Khan, A.V.Girde and V.N.Pawar (2012): Antimicrobial activity of phospholipid compound produced by acidophilic Bacillus subtilis isolated from Lonar Lake, Buldhana, India. Research Journal of Recent Sciences, Vol. 1(11): 22-26.

Mukherjee B., M. Nivedita and D. Mukherjee (2010): Plankton diversity and dynamics in a polluted eutrophic lake, Ranchi. Journal of Environmental Biology,Vol. 31(5):827-839.

Mukhopadhyay S. K., B. Chattopadhyay, A. R. Goswami and A. Chatterjee (2007): Spatial variation in zooplankton diversity in waters contaminated with composite effluents. J. Limnology,Vol. 66(2):97-106.

Munwar M. (1970): Limnological studies on freshwater ponds in Hydrabad, India: The Physicochemical complexes. Hydrobiol., Vol. 23: 179-195.

Murray J. (1906): Some Rotifers of Sikkim, Himalaya, J. R. Microsc. Soc. London. Vol. 9: 637-644.

Musaddiq Mohd., A.K. Fokmare, and Rizwan Khan (2001): Microbial diversity and ecology of Lonar Lake, Maharashtra, India. J. Aqua. Biol., Vol. 16(2): 1-4.

Mustapha M. K. (2009): Limnological evaluation of the fisheries potentials and productivity of a small shallow tropical African reservoirInt. J. Trop. Biol. Vol. 57 (4): 1093-1106.

Mustapha M. K. (2009): Zooplankton assemblage of Oyun Reservoir, Offa, Nigeria. Int. J. Trop. Biol. Vol. 57 (4): 1027-1047.

Mustapha M. K. and J. S. Omotosho (2002): An ecological stusy of temporary pond in Ilorin, Kwara state, Nigeria. Bioscience research communications Vol. 14 (2).

Nasar M.N., M. Safi, M.S. Shana and G. Barua (1991): On the productivity of catfish, Clarias batrachus (L) fry rearing ponds at Mymengsingh, Bangladesh. Bangladesh J. Zool.,Vol. 19(2): 229-235.

Negreiros N. F., M. J. Santos-Wisniewski, R. M. Santos and O. Rocha (2010): The influence of environmental factors on the seasonal dynamics and composition of Rotifera in the Sapucaí River arm of Furnas Reservoir, MG, Brazil. Biota Neotrop., Vol. 10(4): 173-182.

Newsom H. E. and S.P. Wright (2011): Lonar Crater, India: a natural analog for msl landing sites, Analogue Sites for Mars Missions, 6026.

Nikolosky G.V. (1963): The ecology of fishes. Academic Press. London, UK.

Obertegger U. and M. Manca (2011): Response of rotifer functional groups to changing trophic state and crustacean Community. J. Limnol., Vol. 70(2): 1-8.

Offem B.O., Y.A. Samsons, I.T. Omoniyi and G.U. Ikpi (2009): Dynamics of the limnological features and diversity of zooplankton populations of the Cross

River System SE Nigeria.J. Knowledge and Management of Aquatic Ecosystems. Vol.393: 2-19.

Okogwu O. I. (2010): Seasonal variations of species composition and abundance of zooplankton in Ehoma Lake, a floodplain lake in Nigeria.Int. J. Trop. Biol. Vol. 58 (1): 171-182.

Oren A., Baxter B. K. and Weimer B.C. (2008): Microbial communities in salt lakes: Phylogenetic diversity, metabolic diversity, and in situ activities. J.Natural resources and environmental issues. Vol.15: 2-8.

Osae S., S. Misra., C. Koeberl., D. Sengupta and S. Ghosh (2005): Target rocks glasses and melt rocks from the Lonar impact crater, India: Petrogaphy and Geochemistry, Meteroritics and planetary Science Vol. 40 (9/10): 1473-1492.

Ovie S.I., F. Adepoju, and O. Ajayi (2009): Limnological stock assessment, productivity and potential fish yield of Dadin Kowa and Kiri reservoirs. In: Ovie, S.I. and Ajayi, O. Preliminary studies on the limnological stock assessment, productivity and potential fish yield of Ojirami Reservoir, Edo State, Nigeria. Tropical Freshwater Biology.African Journal of Environmental Science and Technology, Vol. 5(11): 956-963.

Pailwan **I. F., D. V. Muley and S. Maske (2008):** Limnological Features, Plankton Diversity and Fishery Status of Three Fresh Water Perennial Tanks of Kolhapur District (M. S.) India. Proceedings of Taal 2007: The 12th would Lake Conference.1643-1649.

Palot M. J. and V. P. Soniya (2003): A Preliminary Report on the Butteflies of Lonar Crater Lake, Buldhana District, Maharashtra. J. Zoos 18 (11): 1267-1268.

Parida R.N., S.Nanda and R.K. Rath (1999): Physico-chemical features of water and soil in rural fish ponds and its relationship with pond productivity. J. of Aquaculture. Vol. 7: 17-23.

Parray S. Y., S. Ahmad and S.M. Zubair (2010): Limnological Profile of a Sub Urban Wetland - Chatlam, Kashmir. International Journal of Lakes and Rivers Vol. 3 (1): 1-6

Pathak H. and D. Pathak (2012): Eutrophication: Impact of Excess Nutrient Status in Lake Water Ecosystem. J Environ Anal. Toxicol. Vol. 2:5.

Pawar A.L. (2010): Seasonal Variation in Physicochemical quality of Lonar Lake Water. Journal of chemical and pharmaceutical research. Vol 2(4): 225-231.

Pawar S.K. and J.S. Pulle (2005): Qualitative and Qualitative study of zooplankton in Pethwaraj Dam, Nanded District (Maharashtra) India: J. Agro. Boil. Vol. 20 (2): 53-57.

Peck D., Ramsar (2013): Ramsar Convention Secretariat, 2013. The Ramsar Convention Manual: a guide to the Convention on Wetlands (Ramsar, Iran, 1971), 6th ed. Ramsar Convention Secretariat, Gland, Switzerland.

Pedge S. S. and S. D. Ahirrao (2013): Assessment of environmental impact on lonar lake water, (MS) India. J. Middle-East Journal of Scientific Research, Vol. 15 (9): 1285-1289.

Pedge S.S., S.D. Ahirrao and V.B. Garad (2013): Seasonal variations with physico-chemical correlation of B. plicatilis in Lonar Meteorite Crater, India.J. Int. J. of Life Sciences, 2013, Vol.1 (4): 317-320.

Piska R. S. (2000): Concepts of aquaculture. Lahari Publications, Hyderabad.

Plinski M., M. I. Zmijewska, M. Sapota, Witek B. and S. Mudrak (2003): Predictional Model of Biocenotic Changes Inoffshore Baltic Plankton Due To TemperatureIncrease. Oceanological and Hydrobiological Studies, Vol.32 (3): 29-41.

Pradhan V.P. (2014): Zooplankto diversity in fresh water Wunna lake. Int. J. of Life Sciences, Vol 2 (3): 268-272.

Pulugandi C. (2014): Analysis of water quality parameters in Vembakotti water reservoir, Virudhunagar district, Tamil Nadu – A report.Res.J. Recent Sci.

Quarcoopome T., F. Y. K. Amevenku and O. D. Ansa-Asare (2008): Fisheries and Limnology of Two Reservoirs in Northern Ghana. West African Journal of Applied Ecology, Vol. 12.

Rajagopal T., A. Thangamani, S.P. Sevarkodiyone, M. Sekar and G. Archunan (2010): Zooplankton diversity and physico-chemical conditions in three perennial ponds of Virudhunagar district, Tamilnadu. Journal of Environmental Biology, Vol. 31: 265-272.

Rajan P. D., S. Krishna, M.C. Kiran and L. Bhaskar (2009): Ministry of Environment and Forests (MoEF), wetlands (Conservation and Management) Rules.

Rajasekhar R. P. and D. C. Mishra (2005): Analysis of gravity and magnetic anomalies over Lonar lake, India: An impact crater in a basalt province. J. current science, Vol. 88:1836-1840.

Ramulu (2011): Phosphorus, potassium and total soluble salts in soil samples from fertilized and unfertilized Histosods. J. Environ. Qual. Vol. 1: 446-449.

Rao P. G. V. S. and M. S. Bhalla (1984): Lonar Lake: palaeomagnetic evidence of shock origin, Geophys. J. R. astr. SOC.Vol.77: 847-862

Rask M., A. Holopainen, A. Karusalmi, R. Niinioja, J. Tammi, L.Arvola, J. Keskitalo, Blomqvist I,, S.Heinimaa, C. Karppinen, K.Salonen and J.Sarvala. (1998): An introduction to the limnology of the Finnish Integrated Monitoring lakes. Boreal environment research Vol.3: 263–274.

Ravikumar M. S. Manijappa, B. R. kiran and E.T. (2005): Hydtochemistry of Ayyanakere Tank in Harpanhalli Town, Davanagere, Karnataka. J. Aqua. Biol. Vol. 20 (2): 117-120.

Roy U., B. K. Shaha, Kh. Mazhabuddin, M. F. Haque, and M. G. Sarower (2010): Study on The Diversity And Seasonal Variation of Zooplankton In a Brood Pond, Bangladesh. Marine.res. aqua.Vol. 1(1):30-37.

Saksena D. N., D.M. Gaidhane and H. Singh (2006): Limnology of Kharland (saline) ponds of Ratnagiri, Maharashtra in relation to prawn culture potential. Journal of Environmental Biology, Vol. 27(1): 49-53.

Saler S. (2009): Rotifers of Kepektas Dam Lake (Elazig-Turkey). Iranian Journal of Science & Technology, Transaction A, Vol. 33 (A1): 121-126.

Satpathy K. K., A. K. Mohanty, M. V. R. Prasad, U. Natesan, S. Bhaskar and K. E. Jebakumar (2008): Limnological Studies in A Brackish Water Lake Present in the Vicinity of Kalpakkam Coast, Tamil Nadu, Proceedings of Taal 2007: The 12th would Lake Conference 1672-1678.

Satyanarayan S., P.R. Chaudhari and S. Dhadse (2008): Limnological Study on Lonar Lake: A Unique Brackish Crater Lake in India Sengupta, M. and Dalwani, R. (Editors). Proceedings of Taal 2007: The 12th World Lake Conference: 2061-2066.

Segers H. and S. Babu (1999): Rotifera from high altitude lake in Southern India with a note on taxonomy of Polyarthra Ehrenberg 1834. Hydorbiologia., Vol. 405: 89-93.

Shah M. R., Y. Hossain., M. Begum., Z. F. Ahmed., J. Ohtomi., M. M. Rahman., M. J. Alam., M. A. Islam and B. Fulanda. (2008): Seasonal Variations of Phytoplanktonic Community Structure and Production In Relation To Environmental Factors of The Southwest Coastal Water of Bangladesh. J. of Fisheries and Aquatic Science Vol. 3 (2): 102-113.

Shaikh Y. H, J. M. Phathan, F. Maqdoom, A. R. Khan and S. H. Behere (2010): Application of Fractal Geometry to Lakes, Scholars Research Library Archives of Physics Research, Vol. 1 (2):147-170.

Sharma S., A. Siddique, K. Singh, M. Chouhan, A. Vyas,C.M.Solnki, D. Sharma,S. Nair and T. Sengupta (2010): Population Dynamics and Seasonal Abundance of Zooplankton Community in Narmada River (India).

Shannon C. E. and W. Weaver (1949): The mathematical Theory of Communication. University of Ilinois Press, Urbanaj, 177.

Sharma B. K. (1979): Rotifers from west Bengal III. Hydrobiologia, Vol. 64: 239-250.

Sharma B. K. (1980): Comtributions to the Rotifers fauna of Orissa. Hydrobiologia, Vol. 70: 225-233.

Sharma B. K. (1998): Rotifera. In Faunal Diversity in India, (Eds. J. B. B. Alfred, A. K. Das and A. K. Sanyal) ENVIS Centre, Zoological Society of India, Calcatta, 58-70.

Sharma B. K. (2011): Zooplankton diversity of two floodplain lakes (pats) of Manipur, northeast India. Opusc. Zool. Budapest, Vol. 42(2): 185–197.

Sharma K. K., Shvetambri, P. Verma and S. P. Sharma (2009): Taxonomy of Rotifer (Rotifera: Eurotatoria) From Two Perennial Freshwater Ponds of Jammu, Jammu (J and K) An International quaternary Journal of environmental science The Ecoscan. Vol. 3(3 and 4): 251-254.

Sharma R., M. S. Sharma, V. Sharama and H. Malara (2008): Study of Limnology and microbiology of Udaipur Lakes. Proceedings of Taal 2007: The 12th would Lake Conference. 1408-1504.

Sharma S., A. Siddique, K. Singh, M. Chouhan, A. Vyas, C.M.Solnki, D. Sharma,S. Nair and T. Sengupta (2010): Population Dynamics and Seasonal Abundance of Zooplankton Community in Narmada River (India). Researcher Vol. 2(9): 1-9.

Sharma B.K. (2009): Composition, abundance and ecology of phytoplankton communities of Loktak Lake, Manipur, India. Journal of Threatened Taxa.Vol. 1(8): 401-410.

Shayestehfar A., M. Noori and F. Shirazi (2010): Environmental factor effects on the seasonally changes of zooplankton density in Parishan Lake (Khajoo Spring site), Iran Asian J. Exp. Biol. Sci. Vol. 1(4): 840- 844.

Shinde S. E., T. S. Pathan, K. S. Raut and D. L.Sonawane (2011): Studies on the physic-chemical parameters and correlation coefficient of Harsool-savangi dam, district Aurangabad, India. Middle-East Journal of Scientific Research Vol. 8(3): 544-554.

Shinde V. A. and S.M. More (2013): Study of physicochemical characterization of lonar lake effecting biodiversity lonar lake, maharashtra, india. J. International Research Journal of Environment Sciences. Vol. 2(12):25-28.

Shrivastava C.B.L. (1999): A text book of fishery science and Indian fisheries. Kitab Mahal ageancies Allahabad, 17-18.

Siddiqi S.Z. (2008): Limnological profile of high-impact meteor crater Lake Lonar, Buldana, Maharashtra, India, an extreme hyperalkaline, saline habitat. Proceedings of Taal2007: The 12th World Lake Conference: 1597-1613.

Sitare S. R. (2013): Zooplankton Biodiversity in Ghotnimbala reservoir in Bhadravati Tehsil of Chandrapur district.www.oiirj.0rg. Vol. 3(1).

Slusarczyk A. (2003): Limnological Study of a Lake Formed in Limestone Quarry (Kraków, Poland). I. Zooplankton Community. Polish Journal of Environmental Studies Vol. 12(4): 489-493.

Smith V. H. (2006): Eutrophication of freshwater and marine ecosystems. J. Limnol. Oceanogr.Vol.51: 351–355.

Somani V. U. and M. K. Pejaver (2004): Rotifer Diversity in Lake Masunda, Thane (Maharashtra). J. Aqua. Biol.,Vol. 18(1): 23-27.

Son T.H. and C. Koeberl (2007): Chemical variation in lonar impact glasses and impactities, GFF Vol. 129: 161-176.

Sontakke G.K. and S.S.Mokashe (2014): Ostracod Density of Two Freshwater Lakes in India: A Comparative Study.Indian Journal of Applied Research Vol.4 (10).

Soranno P. A., K. S. Cheruvelil, K. E. Webster, M T. Bremigan, T. Wagner, And C. A. Stow (2010): Using Landscape Limnology to Classify Freshwater Ecosystems for Multi-ecosystem Management and Conservation. J. BioscienceVol. 60(6): 440-454.

Sprules W. G. and M. Munawar (1991): Plankton community structure in Lake St. Clair. HydrobiologiaVol. 219:229-237.

Suarez-Morales E. and A. Vazquez-Mazyy (1993): On the zooplankton community of a Mexican Etrophic Reservoir, A seasonal survey, J. Hidrobiologica Vol. 3 (1-2): 71-80.

Subhashini S. and N. Saradhamani (2003): Hydrobiology of Aliyar reservoir-Coimbatore District, India. In:S. B. Nangia, Fundamentals of Limnology, APH Publishing Corporation, New Delhi. 57-61.

Sundri M. L. and M.T. Gomoiu (2009): Qualitative and Quantitative Structure of Zooplankton Associations in the Danube Thermal Discharge Area of Nuclear Power Plant Cernavoda. J. GEO-ECO-MARINA, 123-130.

Sunkad B. N. and H. S. Patil (2004): Water quality assessment of Fort Lake of Belgaum (Karnataka) with special reference to zooplankton, J. Envi. Bio., Vol.25(1): 99-102.

Tambekar D H and V R Dhundale (2012): Studies on the physiological and cultural diversity of bacilli characterized from lonar lake (MS) India.J. Bioscience Discovery.Vol. 3(1): 34-39.

Tambekar D. H., S. D. Tale and P.R. Borkar (2013): Bioremediation of phenol by haloalkaliphilic microorganisms isolated from Lonar lake. J. International Journal of Science, Environment and Technology, Vol. 2(3): 434 – 441.

Tambekar D.H. and Tambekar S.D. (2011): Partial characterization and opetimization of protease production from newly isolated Cohnella thermotolerans from Lonar lake. Journal of Research in Biology.Vol.4: 292-298.

Tambekar S.D. and D.H. Tambekar (2012): Partial characterization and optimization of alkaline protease production of bacillus pseudofirmus from lonar. J. Int J Adv Pharm Biol Sci Vol.2: 107-115.

Tambekar S.D. and D.H. Tambekar (2012): Physico-chemical properties and production dynamics of alkaline protease of bacillus odysseyi (jq337959) isolated from Lonar lake. J. Int J Adv Pharm Biol Sci Vol.2(2): 161-170.

Tayade S. N. (2012): Studies on Zooplankton Communities of Rotarians in Relation to Water Chemistry of Ephemeral Ponds in Washim Region of Maharashtra, PhD Thesis submitted to S.G.B. Amravati University, Amravati.

Telesh I. V. (1999): Species diversity and spatial distribution of thesummer rotifer assemblages in Lake Ladoga. J. Boreal Environment Research Vol. 4: 257–262.

Thakker C.D. and D. R. Ranade (2002): An alkalophilic methanosarcina isolated from lonar crater. J.Current Science, Vol. 82, (4): 455-459.

Tijare R. V. and M. R. Thosar (2008): Rotifer Diversity in three Lakes of Gadchiroli, a Tribal District of Maharashtra (India). Proceedings of Taal 2007: The 12th World Lake Conference: 480-483.

Tilahun L. (2010): A thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfilment of the Degree of Master of Science in Biotechnology.

Tilahun L. (2010): Diversity of culturable alkaliphilic denitrifying bacteria in four soda lakes of Ethiopia.

Tiwari K. K. and B. K. Sharma (1977): Rotifers in the Indian Museum Tank, Calcatta, Sci., Cult., Vol. 43: 280-282.

Torres L. E. and K. Rylander (2006): Diversity and abundance of littoral cladocerans and copepods in nine Ecuadorian highland lakes Int. J. Trop. Biol. Vol. 54 (1): 131-137.

Toyosi I. R.and G. U.Ngamarju (2011): Rotifer fauna in Lake Alau, Arid Zone of Nigeria in West African. J. Nature and Science, Vol. 9(8): 261-267.

Vanjare A. I., S. M. Padhye and K. Pai (2010): Zooplankton from a polluted river, Mula (India), with record of Brachionus rubens (Ehrenberg, 1838) epizoic on Moina macrocopa (Straus, 1820).Opusc. Zool. Budapest, Vol. 41(1): 89–92.

Vasisht H. S. and S. K. Bathish (1971): Rotifer fauna of North India, Res. Bull. (NS), Punjab Univ. Vol. 22: 331-337.

Verma S. R. and P.R. Chaudhari (2013): Limnological studies on indian brackish water Lonar lake with special reference to trophic status and potential public utility. J. Research Journal of Chemistry and Environment.Vol.17 (4): 49-55.

Walsh A. M., K. E. Holloway, P. Habdas and J. R. D. Bruyn (2003): Morphology and scaling of impact craters in granular media, Phys. Rev. Lett., Vol. 91: 104301-104304.

Wani A.A., V. P. Surakasi, J. Siddharth, R. G. Raghavan, M. S. Patole, D. Ranade, Y. S. Shouche. (2006): Molecular analyses of microbial diversity associated with the Lonar soda lake in India: An impact crater in a basalt area. J. Research in Microbiology Vol. 157: 928–937.

Weber C. A. (1907): Aufbau und Vegetation der Moore Norddeutschlands. Bot. Jahrb. Beibl.Vol. 90: 19–34.

Weiss B.P., S. Pedersen, I. G. Bethell, S. T. Stewart, K. L. Louzada, A. C. Maloof, N. L. Swanson-Hysell (2010): Paleomagnetism of impact spherules from Lonar crater, India and a test for impact-generated fields.J. Earth and Planetary Science Letter.Vol.298: 66–76.

Wetzd R. G. (1983): Limnology 2nd edition, Saunders College Publishing Philadelphia. 753.

Wetzell, R. G. (2001): Limnology: Lake and river Ecosystem, 3rd ed. Academic Press.Vol.1.

Wulfert K. (1966): Rotatorien aus Stausee Azwa under Trinkwasser Aufbereitung der Stadt Baroda (Indian), J.of Limnologica., Vol. 4: 53-93.

Yannawar V.B. and A. B. Bhosle (2013): Cultural eutrophication of lonar lake, maharashtra, india. J. International Journal of Innovation and Applied Studies. Vol. 3 (2):504-510.

WEBSITES

www.protectingusnow.org

http://www.isslr.org/news/newsone.asp?qnewsid= 188

http://wldb.ilec.or.jp/data/ilec/WLC13_Papers/S7/s7-7.pdf