ECOLOGICAL STUDIES OF A VILLAGE POND OF SIMILIYA, DISTRICT KOTA, RAJASTHAN

A Thesis
Submitted for the award of Ph.D degree

In Zoology
(Faculty of Science)

To the
University of Kota

By
Kamlesh Meena

Under the Supervision of
Dr. Prahlad Dube

Department of Zoology
Government College, Kota

UNIVERSIRTY OF KOTA, KOTA (RAJASTHAN)
2019

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Date:

Dr. Prahlad Dube
Research Supervisior
Associate Professor
Govt. College Kota,
Kota

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ABSTRACT

Water is the most precious substance on the earth. Life on the earth is not possible without water. Ponds have been a traditional source of water from ancient times for drinking purposes in villages. So, the present study is asses to quality of pond water of Similya Village Pond, District Kota, Rajasthan. The determinant of good water body is determined by physico-chemical characteristics. In the present study seasonal variation of physico-chemical characteristics were statically analyzed and graphically presented. The following ranges were obtained for the parameters evaluted atmospheric temperature 23.1-34.6 ˚c, atmospheric relative humidity 40.9-78.9 %, water temperatre 22-29 ˚c, transparency 13.43-83.55 cm, electric conductivity 120.76-391.96 µmhos/cm, total dissolved solids 57.8-128.9 mg/l, pH 7.11-8.9, free carbon dioxide 0.50-4.86 mg/l, total alkalinity 86.44-155.87 mg/l, dissolved oxygen 6.46-9.57 mg/l, chloride 26.80-145.61 mg/l,total hardness 86.80-198.33 mg/l, phosphate 0.86-1.98 mg/l and nitrate 0.16-0.56 mg/l. The qualitative study of plankton was observed. Phytoplankton species were more diverse and dominant than zooplankton communities. These were found to be present in the ratio of 6.4:3.6 (64 % phytoplankton 36 % zooplankton). The study concluded that the water of the village pond similiya showed variation in the various physico-chemical parameters in all the three seasons. Therefore, urgent need to take the important step towards the quality management plan in order to eliminate water pollution.

CANDIDATE'S DECLARATION

I, hereby, certify that the work which is being presented in the thesis entitled. ***Ecological, Studies of Village Pond of Similiya, District Kota, Rajasthan*** partial fulfillment of the requirement for the award of the Degree of Doctor of Philosophy, carried out under the supervision of Dr. Prahlad Dube and submitted to University of Kota, Kota represents my idea in my own words and where other ideas or words have been included, I have adequately cited and referenced the original sources. The work presented in this thesis has not been submitted elsewhere for the award of any other degree or diploma from any institution.

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This is to certify that the above statements made by Kamlesh Meena (Regd. No. RS/13/6/13) is correct to the best of my knowledge.

Date **Dr. Prahlad Dube**

Place Kota **Research Supervisior**

ACKNOWLEDGEMENT

I wish to express in deep sense of indebtedness and immense gratitude to my esteemed Supervisor ***Dr. PRAHLAD DUBE*** Associate Professor, Department of Zoology, Government College, Kota whose invaluable guidance and constant encouragement enabled me to carry out the present investigation. His guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better advisor and mentor for my Ph.D study.

My grateful thanks are extendwd to Head, Department of Zoology, Principal and Teaching and non teaching staff of Government College, Kota for their encoragment and help. I am also thankful to ***Dr. Usha Pancholi***, for her advice and assistance in keeping my progress on Schedule.

I acknowledge the people who mean alot to me, my parents, Mr**.** ***Brijraj Meena*** and ***Mrs. RamJanki Meena*** for showing faith in me and giving me liberty to choose what I desired. Also I express my thanks to my brother ***Mahaveer*** and cousins ***Vishnu, Anil, Avinash*** for their support.

I owe thanks to a very special person, my husband, ***Mr. Mahesh Kumar Meena*** for his continued and unfailing love, support and understanding during my pursuit of Ph.D degree that made the completion of thesis possible. He was always around at times I thought that is impossible to continue, you helped me to keep things perspective. I greatly value his contribution and deeply appreciate his beleif in me. I appreciate my baby ***Saanvi*** for abiding my ignorance and the pateince she showed during my thesis writing. Words would never say how grateful I am both of you. I consider myself luckiest in the world to have such a lovely and carrying family, standing beside me with their love and unconditional support.

My heart felt regard goes to my father in law ***Mr. Satyanarayan Meena*** and mother in law ***Mrs.Chhoti Bai*** for their love and moral support.

I thank the Almighty for giving me the strength and patience to work through all these years so that today I can stand proudly with my head held high.

Kamlesh Meena

M.Sc. NET

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INTRODUCTION

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INTRODUCTION

Ecology is the study of the relationship between living organism, including humans, and their physical environment, it seeks to understand vital connection between plants and animals and the world around them. Ecology is the multidisciplinary field extending across the physical, biological, and social sciences. Ecology was the practical interest early in human history. In primitive society, all individuals needed to know their environment –that is, to understand the forces of nature and the plants and animals around them- to survive. If we want to conserve and protect nature and prevent the extinction of species, we need to know how they all fit together, what their habitat requirement are, how they influence each other. Ecology derived from the Greek word Oikos meaning habitation, and logos meaning study, i.e. study of the habituation of organisms. This is the study of ecosystem, which describes the relation between the organisms with different habitats. The environment of an organism includes both biotic and abiotic factors. These two factors have to coordinate each other to share the resources that are present within the environmental ecosystem. To understand about this mutual relationship we study ecology. Human being is also the part of ecosystem.

Environment describes the biotic and abiotic factors. The biotic components of the ecosystem consist of 3 group's producers, consumerand decomposers. The producers are the organisms those are capable for photosynthesis i.e. plants. The consumers depend on the producers (all herbivores). The decomposers are the organisms that are rely on dead organisms for their existence (bacteria, virus and yeast). Abiotic factors includes the flow of energy necessary to maintain any organisms, the physical factor (climate, temperature, rain, snow, hills) that effect it and the supply of molecules required for its life functions (carbon, hydrogen, nitrogen, sulphur, phosphorus)

A unit that includes all the organisms i.e. the communities in a given area interacts with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity and material cycle (i.e. exchange of materials between living and non-living components) within the system, known as

an ecosystem. We may think of the earth, we live upon as a giant ecosystem where abiotic and biotic components are constantly acting and reacting upon each other bringing out structural and functional changes in it. This vast ecosystem biosphere is difficult to study for our convenience we study it in a subdivisions into units (*Terrestrial*- forest, desert, grassland*; man engineered* -cropland*; aquatic* -freshwater, marine etc).

Freshwater systems- lakes, wetlands, rivers and streams, have been critical to the establishment of civilizations throughout human history. From ancient times, civilizations have been established based on their proximity to water. Water bodies are essential to humans not only for drinking but also for transportation, agriculture, energy, production, industry and waste disposal. Contaminated runoff from expanding urban and agricultural areas, airborne pollutants and hydrologic modifications such as drainage of wetlands are just few of the many factors that continuing degrade surface waters. Determining which of these factors has the most significant influence on the quality of water body with its watershed and how the various inputs affect its physical, chemical and biological characteristics. One of critical sciences required to understand aquatic ecosystem interactions in called limnology.

Our inland waters are vital and important resources. They provide us drinking water, recreation, bird and wildlife viewing, fishing, land protection and so much more. Limnology is the study of structural and functional interrelationships of organisms of inland waters as their dynamic physical, chemical and biotic environment affect them. The word comes from the Greek *limne,* which means marsh or pond. Limnology covers all inland Limnology; need to be familiar with many different aspects of inland water system, including our atmosphere. Limnology incorporates many scientific disciplines into one including physics, chemistry, and biology. While the main thread of limnology is water system, these water systems are interconnected host plant and animal life, both influence and interact with weather patterns.

Our major branch of limnology is freshwater ecology. In fresh water ecology we study lentic (standing water) and lotic (running water). The Pond is a small body of standing water and the pond ecosystems complex interaction

between its biotic and abiotic components. Abiotic components of pond ecosystem are environmental factors (light, temperature, water), inorganic components **(O_2, CO_2, N_2,** nitrate, phosphates, carbonates etc.). Biotic factors are phytoplankton and zooplanktons.

CHAPTER 2

REVIEW OF LITRATURE

Chapter 2

REVIEW OF LITERATURE

Freshwater bodies had been under investigation for nearly two centuries and estimated physical-chemical and biological attributes of these water bodies. All these attributes have been studied throughly and ample amount of literature is available on this subject. Since water is vital to public health and agriculture therefore a continous and prolonged research atmost essential. To have an idea of historical account of published literature and for learning the review of literature is necessary.

Forel *(1841 – 1912)* was the founder of modern hydrobiology. He worked on different lakes found in Switzerland. The early fresh water stations yielded a mass of information, which made early groundwork of modern ecology. Elaborated investigations have been carried out during last few decades on limnology of different types of water resources. The study includes various aspects of lotic and lentic fresh water ecosystems, such as quality of water its physical, chemical and biological characteristics (phytoplankton, zooplanktons, macrophytes and animal of different taxonomic categories which has been reviewed and included in many research papers, dissertations, thesis, monographs and books (Dube, 2002 and Basavarajappa et al., 2014).

In the year 1989, Gautam has studied plankton ecology of Jait Sagar Lake. Definite correlation was obtained in the seasonal abundance of plankton and physico-chemical condition. In this investigation He found twenty-two genera which belonging chlorophyceae, bacillariophyceae, and cyanophyceae. These show two peak high concentrations in the year round study, in the month of September and May. The number of diatoms and chlorophyceae was great in September and in May blue green algae was in abundance. High pH in winter seasons to be responsible for luxuriant growth of diatoms and chlorophyceae and high temperature, alkalinity, calcium and chlorides are responsible for high growth of cyanophyceae. Maximum densities of zooplankton were recorded in summer. These include rotifers, cladoceran and copepods. All these groups were

found throughout the year but rotifers were in abundance every time. In the same year 1989, Gupta studied hydrobiology of Khandia Talab (Jhalawar).

Jakher *et al*. (1990) have been investigated on comparative limnology of Sambhar and Didwana lakes (Rajasthan, NW India). In this investigation they found maximum total alkalinities were 2162 mg l^{-1} and 2090 mg l^{-1}, respectively in Sambhar and Didwana lakes. Dissolved oxygen ranged from completely anoxic conditions to maxima of 11.68 and 7.29 mg 1^{-1}, respectively in Sambhar and Didwana lakes. Nutrient enrichment in the lakes was low. Sambhar Lake was reduced from an earlier reported 20 genera to only 11 (*Nostoc, Microcystis, Spirulina, Aphanocapsa, Oscillatoria, Merismopedia, Nitzschia, Navicula, Synedra, Cosmarium* and *Closterium*). Phytoplankton of Didwana was composed of only 9 genera including *Anabaena* and *Nodularia*.

Sharma (1991) has studied algae of Anasagar Lake of Ajmer during the present investigation 11 cyanophyceae, 18 chlorophyceae, and 3 euglenophyceae members were identified. Other factors, it has been observed that due to cloth washing activities huge amount of detergent is being added. In the same year 1991, Renu and Sharma have studied on trophic state of Anasagar lake Ajmer. Total 100 species identified in lake, which belonging to cyanophyceae (21), chlorophyceae (52), centric diatoms (3), pinnate diatoms (17), and euglenophyceae.

Ojha *et al.* (1992) investigated ground water quality in some arid regions of western Rajasthan. Nagor and Jalore, which are parts of arid districts, have some peculiar type of waters. In these districts, besides salinity, problems of high nitrates and fluorides have been extensively observed as also cases of skeletal fluorosis.

Sharma and Sharma (1992) have studied on diatoms of Anasagar Lake. 22 species belonging to 15 genera of diatoms were recorded from Anasagar Lake. Seasonal variation in diatom population may be correlated with changes in dissolved oxygen and carbon dioxide level along with other physico-chemical parameter of the lake. Diatoms species vary seasonally in both polluted and unpolluted sites. Maximum species of diatoms were recorded during winter. Comparatively higher number of diatoms species were recorded for polluted site

than unpolluted sites. Agrwal *et al.* (1993) have studied Plankton productivity of sewage fish pond and adjoining oxidation pond of Vallabh Gardans, Bikaner. Ojha and Sharma (1994) have studied algal diversity in Gandhi Sagar Lake of Bhilwara. Many physico-chemical parameters were recorded from polluted sites. Value of TS, TDS, TSS, phenolphthalein alkalinity, total alkalinity, phosphate, total hardness, Ca, mg, chlorides, salinity and DOM were recorded to be very high from polluted site as comparatively unpolluted sites. Salodia (1995) has described hydro biological studies of Jaitsagar Lake (Bundi district). Ranga (1995) has worked on the limnology of Anasagar Lake of Ajmer. Swarnlata and Rao (1997) have limnological studies of a semi-permanent pond. PH, bicarbonate, chlorides, dissolved oxygen and calcium are in moderate concentration with the average value of 8, 192.4, 194.7, and 6.4, 53.7 ppm respectively. Organic matter iron and phosphate were in low concentration whereas total hardness and silicates were in high concentration with average value of 269.1 and 6.4 ppm respectively. Temperature and total solids were responsible for a major change in the variation of blue greens. The highest peak of diatoms was attained during winter months and has shown a negative relationship with temperature.

Jain and Sharma (1997) have studied on relationship among water quality parameter of ground water. In this study the highest positive correlation is found between electrical conductivity and total dissolved solids. These indicate that electrical conductivity in the ground water of this region is mainly due to dissolved solids. The high correlation of electrical conductivity, total dissolved solids and total hardness with chloride, nitrate, sulphate, sodium, potassium and calcium is also observed. This indicates that the ground water of the region contains chloride, nitrate, and sulphate salts of sodium potassium and calcium. A positive high correlation between sodium and chloride is an indicative of sodium chloride in these waters. A good relation of total hardness with calcium, nitrate, and chloride indicate that hardness in the ground water is mainly due to chloride and nitrate salt of calcium. The highest negative correlation is observed between pH and magnesium. Bahura (1998) has investigated a study of physic-chemical characteristics of a highly eutrophic temple Tank, Bikaner.

Saluja and Jain (1998) have investigated physico-chemical analysis of Machna Annicut Dam. In this investigation they observed that pH was alkaline and specific conductivity was founding ranging from 318 to 680umho/cm. Chloride were found to be ranging from 66.5-198 mg/l. higher value of chloride at sampling point no.3 is mainly due to the sewage contamination in water. Nitrite and nitrate were found ranging from 1.55-4.84 mg/l. Similarly Ca and mg hardness were found ranging from 77.1-125.2.The percent sodium and electrical conductivity were in the range of 14.20 to 19.60 and 318-448 umhos/cm.respectively. It clearly indicates that the quality of water of the Machna Annicut Dam comes in excellent and good category. In this study he found that pH value from 7.3-8.2. Total solids range between 244mg/l to 500mg/l. TDS range from 170-399.5mg/l and TSS range between 60-109.5mg/l, value of total alkalinity were record between 84-164mg/l. the chloride and sulphate content of ground water varied from 29.82-200.35mg/l and 19.20-148.8mg/l. total hardness ranged between 230-704mg/l.

Bath and Kaur (1999) have studied the physico-chemical characteristics of water of Bundha-Nallah. In this study water temperature was recorded between 19 and 37·C, with high value during summers and low during winter. pH water was relatively high in winter and low in summer and monsoon. The high values of pH during winter are attributed to increased primary productivity where in carbonate; sulphates, nitrate, and phosphate are converted in hydroxyl ions. Dissolved oxygen was very low ranging between 0.3 to 2.4 mg/l. total alkalinity values fluctuated between 120 to 210 mg/l indicating that the water is hard. Chlorides values were recorded very high between 300 to 1220 mg/l with maximum concentration during summers. Thus the present study reveals that the water of Bundha-Nallah is severely polluted and is studied the alarmingly hazardous to the health of the inhabitants living in its vicinity. Jain (1999) has studies on diel variation in some water quality parameter at Hnumantal Lake. He found the pH of the entire sample collected during survey was to be constant. This may be due to the strong buffering capacity of carbonate and bicarbonate ions in water. Dissolved oxygen was decreased while bio-chemical oxygen demand was not varied significantly. The increase in chloride content was due to the dirt and sweat

of the bathers. This increased the alkalinity of the lake. Bahura (2001) has reported Diurnal cycle of certain abiotic parameters of fresh water lake, The Ganjar Lake Bikaner in Thar Desert of India.

Dube and Sharma (2001) have studied on breeding preferences and pH correlation of Amphibians in southeastern plateau of Rajasthan. In the same year (2001) Baruah and Das studied on plankton as indicator and index of pollution in aquatic ecosystem paper mill pollution. Physico-chemical characteristics of paper mill effluents revealed different organic and inorganic chemical made the effluents toxic and was able to change the quality of receiving water bodies. Fluctuation in the plankton population recorded in different seasons. The density of plankton was high in post-monsoon due to high water level and low density in winter. After analysis six species of blue green algae, seven of chlorophyceae, for each of protozoa, rotifera and desmids were recorded, five of diatoms, three of crustacea and one each of decapoda and cladoceran. Plankton species like oscillatoria, brachinous, pandorina and nitzschia were found to be the indicator of pollution.

Nanda and Tiwari (2001) have presented a survey of fish fauna in the Sambalpur. In this study they found of 18 variations of fish, belonging to 13 different species in this region. There are several rare species too but they have not been included in this preliminary survey. Verma *et al.* (2001) have studied the ecology of a perennial wetland. They have conducted physico-chemical characteristics study and biological study. Water temperature was recorded maximum in monsoon and minimum in winter. The dissolved oxygen concentration was high in surface water in comparison to deep water in all the seasons. Bicarbonate alkalinity was usually less in deep water compared to surface irrespective of seasons. Chloride content was always more in deep water. The phytoplankton community comprised of three major groups viz; myxophyceae, chlorophyceae, and bacillariophyceae. Protozoa, rotifera, copepoda and cladoceran represented the zooplankton community. Gupta *et al.* (2001) investigated the hydrochemistry of Udaipur Lake.Dube *et al.* (2002a) have studied on ecobiology of seasonal water bodies in southeastern plateau of Rajasthan with special reference to amphibians. Water samples were collected from three sites for

this study. In this observation the humidity level was higher which is favourable to the amphibians. Seven species of anurans belonging to three families were also recorded from all three study sites. These are *Bufo andersoni*, *B. melanostictus*, *Microhyla ornate*, *Rana breviceps, R. cyanophlyctis, R. limnocharis* and *R. tigrrina.*

Dube (2002b) described physico-chemical attributes of various ponds and temporary water bodies of southeastern plateau of Rajasthan (i.e. Kota, Bundi, Baran and Jhalawar district). Dube *et al.* (2002c) have studied spawning preference and pH correlation of amphibians in south eastern plateau of Rajasthan. In this report the *Bufo,Rana* and *Microhyla* tadpoles were found to be sensitive to pH for breeding preferences. Those areas having pH 7 –8.6 were preferred for spawning by all the three species. There was no spawning in the water bodies having pH below 4.0. Dube (2003) has study on amphibian fauna of southeastern Rajasthan with special reference to their ecobiology. The paper describes the ecology, habit, habitat and impact of environmental parameter on their life activities.

Srivastava *et al.* (2003) have studied of physico-chemical characteristics of water bodies around Jaipur. Water samples were collected from Jalmahal Lake, Nevta Lake, Amer Lake and Ramgarh Lake fore analyzed. They found that the water of Jalmahal Lake is most polluted due to high pH, hardness, alkalinity, free carbon dioxide, zinc content, and a low level of dissolved oxygen. Contrarily Ramgarh Lake is least polluted, as it has high dissolved oxygen and low pH, alkalinity, free carbon dioxide, hardness and zinc content.

In research, we find that it revolves mostly around investigations regarding, structure, functioning .If we look into various aspects of limnological and external influences on the water bodies. In reaction to increased anthropogenic nutrient loading into water bodies, a large number of studies have been conducted in the past 3 decades to study phytoplankton nutrient limitation.

In response to the increased nutrients, especially phosphorus, most of the shallow lakes have changed from transparent to the turbid state (Scheffer *et al*., 1993; Beklioglu *et al*., 2003). In Indian context, the following account includes review of available literature published in the present century e.g. Ghaffar *etal.*,

2002 studied the effect of two different doses of inorganic fertilizers (urea and SSP) in two water bodies and environmental changes were observed in the pond ecosystem when fertilized with different doses of inorganic fertilizers.

Littoral zone with submerged macrophytes reduces fish predation and enables refuge for the potential prey in pelagial such as large-bodied algaevorous *cladocerans* (Jeppesen *et al*., 1999; and Estlander *et al*., 2009). Seasonal requirement of plankton assemblages are closely linked to seasonal changes in temperature, external hydraulic, nutrient loads and light availability (Malten*et al.*, 1991). Singh and Singh (1999) observed a comparative study on the phytoplanktonic primary production in River Ganga and a Pond of Patna.

Nandini (1999) noted a variation in physico-chemical parameters and planktonic community structure in series of sewage stabilization ponds, showing plankton blooms. Mualidharan (2000) worked on organo chlorine residues in the water of Keoladeo National Park, Bharatpur.

Rao *et al.* (2001) worked on the quality of drinking water from ponds in the village of Kollere Lake region by analysing different physico-chemical parameters. Yadav and Rana (2001) observed effect of temperature is directly proportional to phytoplankton whereas transparency is inversely proportional to temperature.

Ecologically zooplanktons are important biotic components and play an important role in the aquatic ecosystem as they constitute the most import link in the energy transfer between phytoplankton and higher aquatic fauna (Iloba, 2002).

Moundotiya *et al., (*2004) studied the physical and chemical nature of water and its environment of the Jamwaramgarh wetland of Jaipur. The constituent's monitored include temperature, pH, and EC, TDS, DO, alkalinity, hardness and chloride ion. The pH of the Ramgarh lake water ranged from 6.8 to 8.5 which may be due to high buffering capacity of the system. The electric conductivity values ranged from 500 to700 micro mhos/cm with a maximum in summer and minimum in the monsoon season season. Alkalinity was high during the summer and a minimum in the monsoon season. Total alkalinity values fluctuate from 102.6 to 215 mg/l indicating that water is hard. They concluded

that if the present condition continued for long period Ramgarh Lake may soon become ecologically inactive.

Dube (2005a) has studied physicochemical characteristics of a semi-permanent pond at Baran Rajasthan, India. In the same year (2005b), Dube and Sharma have studied distribution pattern of amphibian biodiversity in southeastern plateau of Rajasthan, India in relation to ecology of the habitat and niche. In southeastern plateau of Rajasthan, Jhalawar, Baran district represent the rich amphibians' biodiversity. Mohamed (2005) studied the physical and chemical characteristics of saline water and in the range of brackish water. Water of Abu-za'baal ponds was studied to identify nature and quality of water. The present result reveals that the values of most physical and chemical parameters were higher than that of fresh water and lower than water of Abu-za'baal pond can be classified as brackish water.

Durve and Rao (2006) studied seasonal variation in primary productivity and its interrelationship with chlorophyll in the Lake Jaisamand near Udaipur (Rajasthan) which is one of the oldest man-made lakes in India. The primary productivity of the lake showed a bimodal pattern with a first peak of a higher magnitude in July (7.605 g/m_2) and the second of a lower magnitude (5.851 g/m_2) in December

A study of physico-chemical characteristics of some water ponds of Ayodhaya - Faizabaad was carried out by Chaurasiya and Pandey (2007). Water of Khirgali pond, Indira pond, Vidhya kund and Dantdhawan pond were analysed for various physico-chemical characteristics. TDS, BDO, alkalinity, total hardness and total phosphate are found to be beyond permissible standards while pH, DO, total nitrates was recorded within the limits. Khergali pond is most polluted of these ponds. According to the author these water bodies are suitable for domestic and drinking purposes, so that the possible remedial measure should be adopted for these water resources of Ayodhaya-Faizabaad. Zooplanktons influence all the functional aspects of an aquatic ecosystem such as food chains, food webs, energy flow and cycling of nutrients (Park and Shin, 2007).

The physico-chemical aspects and suggest applicable restoration measure for Pushkar lake Ajmer Rajasthan were assessed by Mathur *et al*., (2008) water of Pushkar lake exhibits low DO, high BOD, COD, Turbidity, Hardness, chloride, Phosphate, Nitrate etc.. Higher pH value indicates slightly alkaline nature of water. The pollution load is significantly high during Pushkar fair especially on the Kartik Poornima due to excess of religious activities on that day. The remedial measure suggested for the restoration of the prestigious lake, increasing the ground water level and improving the lake water quality, checking soil erosion, desilting the lake, established a water treatment plant and creating public awareness can be some of the constructive effects to revive this ancient religious and renewed lake of Pushkar. Macrophytes can significantly alter abiotic (temperature, oxygen concentration, light intensity) and biotic (food availability, competition, predation) factors in aquatic ecosystems (Cazzanelli *et al.*, 2008; Špoljar *et al.*, 2012).

Shallow lakes have an exceptional ecological significance (biodiversity of invertebrates, fish, water birds), but they are often neglected in limnological studies (Céréghino *et al*., 2008). Soil bank diversity and zooplankton emergence pattern of some recently dried water bodies in north Maharashtra region, comparing to that of neighbouring temporary pond and that permanent ponds studied by Gaikwad *et al*., (2008) the diversity in permanent pond was significantly higher (i.e. 19) than the diversity in the temporary ponds (i.e. 8). We have recorded 8 species of rotifera which are not present in the neighbouring permanent for ephemeral water bodies during that period. A total 19 species were recorded including copepoda 6 species, cladocera 5 species, and rotifera 8 species.

Kedar *et al*., (2008) studied the seasonal abundance of zooplankton population in Rishi Lake with physico-chemical parameters. The no. of zooplankton recorded in summer and lowest in rainy season. The inter-relationship between physico-chemical factors and zooplankton is that all parameters pH, DO, alkalinity, total hardness, chlorides, sulphates, nitrates, and phosphates were at peak in summer and minimum in rainy season. Total 61 species were identified during study period such as Protozoa (14sp.) Rotifera (29 sp.), Copepoda (6sp.), ostracoda (5sp.) and Cladocera (7sp.).

Periodical ecological study of an urban pond near Vadodara Gujarat was studied by Soni and Bhatt (2008) with the physico -chemical, biological and microbiological parameters. The physico-chemical parameters show N max up to 3.4 mg/l, total phosphates 1.45 mg/l and BOD 33mg/l. The pond is full of algal growth. Microbiological analysis show positive result for *E. coli*, *Vibrio* species and many other pathogenic bacteria. These in water increase pollutants in terms of nutrients, organic matter and toxic substance in water bodies and disturb its ecosystem.

Zutshi *et al*., (2008) studied the anthropogenic impact on the lake ecosystem in Hi-tech city Bangalore, Karnataka. A Hi-tech city Bangalore originally had 290 lakes many decades ago and today about 81 are left and of these 21 are said to be live. Lakes in and around urban areas of Bangalore receive considerable effluents and sewage inflow. The result are very evident showing depletion in oxygen level, high level of chlorophyll 'a', TDS, BOD, phosphate, sulphates, ammonia and high alkalinity etc. which in turn has altered the nutrients concentration contributing to the formation of algal blooms causing high mortality of fishes. A few badly affected lakes in and around Bangalore city such as Bellandur, Varthur, Ulsoor, Byramangla, Madivala, Agra and Nagawalaare the one from where in even the hardy fish species like *Murrels*, *Clarias, singhi* etc. have completely disappeared.

Mishra *et al., (*2008) assessed the pollution load through estimation of physical-chemical parameters of aquaculture pond water discharged into Bhitarkanika mangrove ecosystem for a period of six months. The results of physico-chemical were compared with Bureau of Indian Standard and central and state pollution control board. The pH values (5.63-8.5), DO (3.0-8.3 mg/l) and Nitrate Total hardness, calcium, magnesium, phosphate and chlorine contents show variation within different sites. The study indicates that the aquaculture pond water at present do not possess any pollution problem for the mangrove ecosystem.

Selected physico-chemical factors such as temperature, DO, free carbon dioxide, pH, total alkalinity, turbidity and primary productivity of reservoir of fish culture of Thodga TQ Ahmedpur district Latur Maharastra was assessed by Patil

and Kulkarni (2008). Air temperature 31.84°C to31.84°C, water temperature 23.75◦C to 23.07°C, DO 8.27mg/l, pH 7.85 to 7.92, total alkalinity 6.04 mg/l, turbidity 39.71 to 41.42 cm, primary productivity 235.04 mgc/m productivity 235.04 mgc/m³/hr to 241.49 mgc/m³/hr. Physico-chemical values of this reservoir are under the permissible limits, this indicates that reservoir is productive and suitable for fish culture.

Kumar *et al., (*2008) evaluate the physico-chemical characteristics and diatom as indicators of trophic status of wetland namely Kishore Sagar Lake of Kota Rajasthan. The Diatom community comprised of 42 species representing 8 centric forms and 34 pennate forms. *Melosira granulata, Cocconies placentula, Diatoma elongatum, Fragilara crotoneinsis, Ghomphonema olivacium, Ghomphoneis herculum, Nitzchia sp. Navicula radios* and *Synendra ulna* were the most dominant species from this wetland. Highest population density of diatoms was observed in winter season. The abundance of diatoms in cold months is probably due to the fact that they are able to grow under the condition of weak light and low temperature. The dominance and abundance of diatoms the wetland is indicative of eutrophic nature of the water body. The water quality of the lake has detroited and is potential threat to human health as well as aquatic flora and fauna.

Monitoring of zinc, endosulfan and evaluation of physico-chemical parameters and zinc concentration of water bodies around Jaipur as Ramgarh, Nevta, Jalmahal and Amer and their impact on physiological functions was subsequently studied by Srivastava *et al., (*2009). The levels of zinc and endosulfan were highest in Jalmahal (1.324 to 0.197 mg^{-1}) and lowest in Ramgarh Lake (0.020 to 1.20 mg^{-1}) respectively. Anthropogenic sources and cultivation in dried up area of these lakes seems to contribute largely to pollution. Anthropogenic impacts frequently lead to the eutrophication and acidification of these habitats, and the introduction of invasive plants and animals results in reduced biodiversity (Kruk *et al.,* 2009).

According to fluorescence measurement it appears that the lake water quality is not directly influenced by the Geological characteristic but more likely by the flora and fauna and the combination of anthropogenic degradation sources.

The correlation between the fluorescence spectroscopy appears to the suitable for the evaluation and monitoring of the health of water system thus providing the opportunity for real time's meteorological and hydrological events (Guillermo, 2009).

Physico-chemical parameters and fauna of Kisan Sagar Pond Jhalawar were assessed by sen (2009). He reported 17 fish species. Kashyap (2009) studied fish production in Jhalawar district. Dubey (2009) studied the fish production in Kota district. He reported 16 species from six families. Paras (2009) were observed co-relation between temperature and plankton abundance. Shringi (2009) observed the planktons of water bodies. He investigates12 genera of phytoplankton and 10 genera of zooplanktons. Sharma (2009) assessed and compare the water quality source (River Chambal) and supply level (tap water) and observed that concentration of most of parameters under desirable norms prescribed bureau of Indian Standards. Bheel (2009) were studied the physico-chemical parameters of Pond and observed some parameters such as hardness, chloride, pH, and dissolved oxygen of the ponds were higher than the permissible limit of water. Sharma (2009) observed that in physico chemical parameters of Kisan Sagar Pond value of chloride was higher than the other parameters for survival and growth of fish. Sharma *et al.*, (2009) investigate 24 species of phytoplankton and 17 families related to 5 phyla. The highest plankton density occurred in summer season and beginning of monsoon season. Sharma *et al.*, (2009) assessed for a period of two years and 36 species of zooplankton were recorded.

Sharma (2010) analysed physico-chemical parameters in the Kishore Sagar Tank of Kota shows good plankton diversity and seasonal fluctuation. Makandar and Bhatnagar (2010) studied diversity of micro algal and cyanobacteria from different fresh water bodies of Jodhpur city. They compared variation in physic-chemical and diversity indices. 25 Samples were collected from 7 different water bodies and 84 forms were observed. There were 26 green algal belonging to 16 genera, 9 morph types of diatoms and 48 morph types of 13 cyanobacterial genera Shannon and wealler's Biodiversity Index is calculated

which varied from 0.655 to 1.189 indicating that generic diversity was high in green algae but morphotypic diversity in cyanobacteria.

Nutrient Status and Physico-Chemical analysis of surface and ground water of Bargarh District Orissa assessed by Mahananda *et al., (2010*). Various parameters like temperature, pH, Total suspended Solids, Total dissolved Solids, chemical Oxygen demand, Nitrate, Chloride, Magnesium, Phosphate, F, total Coli form etc. are analysed. Ground water in generally less susceptible to contamination and pollution when compared to surface water bodies. Also the natural impurities in rainwater which replenishes groundwater systems get removed while infiltration through soil strata. Thus the observation concluded that the water quality are below the pollution level for ground water which satisfy the requirement for the use various purposes like domestic, agricultural, industrial etc. But increase surface water the water quality of small pond is above the permissible level due to contamination by Sewage industrial effluents, agricultural runoff.

Dube *et al.,* (2010a) investigated on Community structure of zooplanktonic groups of Kishore Sagar Tank. In this investigation they recorded total 36 species of zooplankton which belong to 7 groups. Dube *et al*.,(2010b) have studied the occurrence and seasonal variation of the plankton in Kishore Sagar Tank, Kota, Rajasthan and a total 60 species of planktons (twenty four species of phytoplankton and thirty six species of zooplanktons) were recorded.

Zooplankton diversity responds rapidly to changes in the aquatic environment. Several zooplankton species are served as bio indicators (Ahmad *et al.,* 2011, Mola, 2011). Seasonal variation in abundances of nitrifying bacteria in surface and bottom water of fresh water ponds are examined with respect to temp., DO, pH as well as concentration of ammonia and nitrite was studied by Vibha Kumari *et al., (*2011). The most probable number (MPM) of ammonia Oxidised wire greatly reduced in summer and ranged from 435.05 ± 15.7 to 547.54 ± 2 2.12 ml^4 in bottom and 218.7 ± 7.3 to 368.4 ± 9.32 ml^4 in surface water. The abundance of nitrifies in surface and bottom water was highest in rainy season followed by winter and modest in summer.

Evaluation of Primary productivity and physic-chemical parameters of Ana Sagar lake Ajmer was studies by Koli and Ranga (2011). GPP value ranged

b/w 1.93 and 6.24 gc / m^2 / day HPP ranged between 0.72 and 4.99 gc / m^2 / day and community respiration ranged from 0.26 to 3.6 gc / m^2 / day. Water temp varied from 16.4ºC – 31.2ºC. PH and transparency ranged b/w 6.7 to 10.2 and 34 and 65 cm respectively. Variation in DO was from 6.7 to 16.7 mg lt. BOD & alkalinity varied from 9.2 – 25.2 mg / t and 176 – 264 mg / t. Concentration of nutrients, Chloride, Nitrate and phosphate also varied independently. Primary productivity and physical chemical values of the lake were found high, mainly due to sewage discharged industrial effluent and the agricultural run of by surrounding city population. High values of productivity and nutrients also exposed its eutrophic condition.

The seasonal influence of physic-chemical parameters of water on the diatom population species composition and community organization in Mawatha lake Jaipur was assessed by Singh *et al., (*2011). In study period 30 diatom species were recorded. These taxa belong to 19 genera Total diatom diversity showed significant positive correlation with electrical conductivity total dissolved solids, chemical oxygen demand. Shannon – wiener diversity index (h) value (1.372) and Events (T) value (0.903) were found to the highest during winters while Birger – Parker index of dominance (0.147) was highest in monsoon. Water quality of several lakes other process acting on as time periods on days to week, like Bucharest city area on the comparison of standard and florescence measurement was studied (Gheravase *et al., 2011*).

The pollution status of whole stretch of river Gomti in U.P. in terms of Physico-chemical characteristics and level of Sewage pollution indicator bacteria was studied by Anukool andShyani (2011). Eight water samples are subjected to physico-chemical analysis like water temp., total solids, Total dissolved solids, and Total suspended solid, conductivity, and pH, COD, BOD and DO. The bacteriological study of these samples included bacteriological parameters, like total Coli (TC), Faecal Coli (FC) and Faecal Streptocoli (FS) has given the information regarding the suitability of the water for various uses like drinking and other domestic application. Water quality of River Gomti from, upstream to downstream be found to the more polluted with references to bacteriological

parameters rather than all physic-chemical parameters. The high values of Sewage pollution indicator bacteria detected revealed the microbiological quality of water of River Gomti was very poor, unsafe and not accepteable for any purposes especially in Lucknow and Barabanki districts. The main cause of the coliform pollution is the total absence of wastewater treatment system for all cities situated along side of Gomti River.

Kumara and K.M. (2011) evaluate the physico-chemical parameters of four selected sites of mangrove ecosystem of Kundapura Udapi district Karnataka. A seasonal variation in physico-Chemical parameters was observed and comparison was made as monsoon, pre monsoon and post-monsoon. The seasonal variations in the water quality as well as the biological components of these systems are influenced heavily by anthropogenic stress exerted by the developmental activities carried along the coast. There is a fluctuation in the physical chemical character of the water this will be due to ebb and flow and change in the temperature and salinity as season changes.

Mondal *et al*. (2011) Studied the physical parameter (air and water temp.), chemical parameters (pH, Cl, hardness, alkalinity, phosphate) and Sediments parameter (pH, available nitrogen and phosphate of water Burdwan municipality, Burdwa, West Bengal to identify the nature and quality of water. There is partial relationship exists between water parameter. But water pH has a definite relationship with sediment pH, Phosphate and Sediment available nitrogen. The alkalinity of pond depends on many factors among them availability of carbonate and bicarbonate is one of the main factor. Moreover regression statistics indicates that the quality of ponds positively related with air temp., Surface water temp, pH of water, pH of Sediments.

Waghmare *et al., (*2012) studied the seasonal variations of Physico-chemical characteristics of Jamgavan dam water of Hingoli district (M.S.) India. Physico-Chemical parameters of the water of Sawa pond Vadodara city Gujarat is studied by Parikh and Mankodi (2012).Significant Seasonal variation was observed during the study for various parameters. Alkaline pH was observed during the entire study period. The alkalinity was high during summer in first year while it was highest in monsoon during second year. During first years Calcium

hardness was highest in monsoon while Mg hardness was lowest. Highest values of total solids are recorded in Seminar during both the years. DO was in normal range in both the years. Nitrate was high in summer while phosphorous was comparatively less in winter of both the years.

The ecological study of the sewage Pond of H. E. C. industrial area Ranchi has been studies by Kumar and Sahu (2012). Studies were conducted to determine the occurrence and abundance of cynobacteria in relation to Physical-Chemical characteristics of Sewage Pond. This study indicates the maximum occurrence and abundance of *Microcys oscillatoria*, a Phormidium spp. in all the sites of Sewage Pond. The physico - chemical parameter show maximum nitrogen up to 35.4 mgl^2, 4.8 mgl^1, Phosphate 147.131 mgl^1 Cl and alkaline nature of water throughout the year favour the growth of *cyanophean* members and promote algal bloom formation of *Microcysis aeruginosa, O. princeps* and otenus in pond. The algal diversity of the Sewage pond is bio indicator of organic pollution.

Tidame and Shinde (2012) studied the zooplankton diversity in the temple Pond of Nasik District. Different Zooplanktons were noticed during the study period, amongst them rotifers are more dominant. Total 17 genera were reported from rotifers and genus *Brachionus* in abundant and more common to both the Ponds. In Amrut kund 21 species of rotifers were recorded belonging to 15 genera while in Pond Ram Kund 23 species to 14 genera. The maximum diversity of rotifers was observed in the monsoon season in both Amrit Kund and Ram Kund Pond.

Primary productivity of the aquatic macrophytes of Kharungpat Lake of Manipur was assessed by Singh and Sharma (2012). Daily and annual not primary productivity of the dominant macrophytic vegetation were determined for a period of two years. The daily Net Primary Productivity of all species varied from 0.03 to 6.10 sm^2 day^1 and 0.15 to 8.42 gm^2 day^1 in the first and second year. The total annual MP of all species varied from 682.64 to 891.13 gm^2 yr^1 and 702.49 to 840.45 sm^2 yr^1 in the first and second year. The lake found to the markedly polluted and hence it may be inferred that the lake in the present study is in Eutrophic state. Assessment on Diurnal variation of Physico-chemical status of Khanpura Lake Ajmer India was studied by Tiwari and Ranga (2012). The lake

water contains high values of TDS, BOD, COD, alkalinity, hardness and chloride which were beyond safe limits indicating severe degradation of water quality. A suitable correlation was also established between degradation index and environmental protection cost which may be used a regulation measures for pressuring perennial and seasonal wetlands of Ajmer.

Macrophytes can significantly alter abiotic (temperature, oxygen concentration, light intensity) and biotic (food availability, competition, predation) factors in aquatic ecosystems (Cazzanelli *etal.*, 2008; Špoljar *et al.*, 2012). Concurrently, macrophytes increased habitat diversity, provided plenty and diverse food resources and refuge from predators (larvae and adult fish insects) for the zooplankton and benthic invertebrates (Estlander *et al*., 2009; Špoljar, 2013).

The Physico-Chemical parameter of Satak reservoir situated in Khargone district, Madhya Pradesh, India were analysed by Yadav *et al.*, (2013**).** The nutrients including Nitrogen and Phosphate are in sufficient quantities for the growth of aquatic animals. The reservoir is under the category of mesotrophic water body slightly inclined towards eutrophication.

Hydrological status of Danteshwar Pond Vadodara, Gujarat, India was studied by Neelam and Mankodi (2013). All the parameters were within permissible limits for potable water standards of W H O except water, temperature and pH. The chloride concentration showed that the Pond was polluted. Water temp showed high significant Phosphate showed negative correlation with most of all parameters except acidity and dissolve oxygen. Nitrate show negative correlation with most of all parameter except water temps phosphate. It also showed significant negative correlation with total hardness.

Devi et al., (2013) deals with the analysis of water and soil samples in aquaculture ponds in west Godavari region Physical and chemical analysis of water and soil in culture practices throw light on the development of plankton directly and growth of fish and fishery indirectly.

Veronica *et al., (*2014) studied the effect of water quality on phytoplankton abundance in Hampalam River and fish Pond of Batanjung village.

In the River Hampalam, 60 genera of phytoplankton were found in the River and Pond with the highest abundance of Pluerosigma belonging to *Chrysophyra* in the river and *Euglena* species belonging to Euglenophyta in the Pond.

Physico-chemical analysis of fish pond of Bayelsa state Nigeria was studied byKeremah *et al*.,(2014). The values for NH_3-N were higher than expected values for fish culture while other parameters favoured good fish production.Nag and Gupta (2014) studied the physico-chemical analysis of pond in and around Santineketan. Result is varied from Pond to Pond correlation analysis indicated high significant relationship ($P<0.001$, $P<0.01$) and also significant negative relationship ($P<0.05$) among the different parameters. Darasing and Laxmi (2014) compare the physico-chemical parameters of Sitapat Pond with tap water quality Dhar town .The result show severe deterioration in the quality of Pond water and tap water.

Banerjee *et al*., (2014) analyzed zooplankton abundance in Ponds under different fish farming system in west Bengal. The identified zooplanktons were under 4 orders namely Copepoda, Rotifera, Cladocera and Diatoms. Among these four orders Copepoda and Cladocera were dominant and represented by *cyclops* species and daphnia species respectively.

Mishra *et al*., (2014) evaluate the physico- chemical parameters of pond at Varanasi under anthropogenic influences. The water quality parameters which were assessed were nitrate 52 mg/L, BOD 2.5 mg/L, TDS 2420 mg/L and phosphate 7.5 mg/L were very high as compared to the permissible limit of drinking and irrigation water quality standard. Water quality status of Loktak Lake assessed byLaishram and Dey (2014).It was observed that air temperature ranged between 11-33 ˚c , water temperature between 16-32 ˚c, pH ranged between 6.05-9.10, dissolved oxygen 4.05-14.18 mg/L, Biochemical oxygen demand 1.51-10.65 mg/L , free carbon dioxide 0-35 mg/L, total dissolved solids 50-150 ppm.

Diversity and distribution of zooplankton of freshwater body of Aligarh region was studied by Ansari and Khan (2014). During study zooplanktons were observed were Cladocera, Rotifera, Copepoda and Ostracoda. Zooplankton show negative correlation with water and temperature and positive correlation with pH

and dissolved oxygen. Ansari *et al*. (2015) assessed the phytoplankton diversity and water quality assessment of ONGC pond Hazira. The study reveals that 73 genera of phytoplankton belonged to four classes' viz. Euglenophyceae, Chlorophyceae, Bacillareophyceae and cyanophyceae were identified. Among four classes Chlorophyceae group was dominant. Presence of more phytoplankton werebthe indicator of pollution.

Physico-chemical parameters of four pond of Tirunelveli district was assessed by Selvamohan *et al*., (2014). Parameters which were analyzed were appearance, colour, turbidity, total dissolved solids, total hardness, iron, fluoride, sulphate, phosphate, pH, electrical conductivity, nitrate, calcium, chloride, magnesium and potassium. Bisht and Bhatt (2014)studied the physico-chemical parameters of three water bodies' viz. earthen pond, cemented Pond and Lake located at Bhimtal Nanital Uttrakhand. The parameters which were analysed were air temperature, pH, DO, free Carbon Dioxide, total alkanity. Verma*et al*. (2014) studied the seasonal variation of the phytoplankton biodiversity of Chandlodia Lake. Numbers of phytoplankton were reported viz. Cylinderospermum species, Microcystis species, Phormidium species, Oscillatoria species, Chlorella species. Presences of more phytoplanktons were the indicator of pollution.

Kumar *et al*., (2015) studied the phytoplankton diversity in relation of primary productivity of Lake Udai sagar Udaipur. The mean primary productivity (GPP) was to be 0.50 $gcm^{3}h^{-}1$ in surface. Similarly, Verma and Khan (2015)analysed the physico chemical parameters of Fateh sagar talab in Bagar, Jhunjhunu district of Rajasthan. Temperature, pH, electric conductivity, total hardness, alkalinity, TDS, chloride, DO was analysed and found that there is considerable variation in the values of these parameters during all seasons.Bhupender and Kumar (2015)studied the phytoplankton diversity of desert village pond in Bikaner Rajasthan. The reported species of phytoplankton were the members of three algal groups namely Cholorophyceae, Cynophyceae and Bacillariophyceae were observed. The species *Cladocera, crucigenia, murospora, chara, spirogyra* (5 green), *Navicula, Nitzchia, synedra, diatom, coscrnodiscus* (5 diatoms), *Spirulina, Nostoc, Anabaena, Oscillatoria* (4 blue green algae) were recorded from pond.

A seasonal change in phytoplankton community of Lake Ramgarh was studied by Maheshwari*et al*., (2015) correlation between various physico-chemical parameters, productivity and plankton groups were calculated according to Karl Pearson's formula. During summer gross and net primary production were high and low during the winter season. Bacillareophyceae (43.58%) > chlorophyceae (33.41 %) > Cyanophyceae (23 %) were three major groups according to their density. *Nitzchia, synedra* and *Naviculla* were the main contributors of Bacillariophyceae, *Closterium* and *chlorella* was from the group Cholorophyceae, Cynophyceae was dominated by *spirullina, Anabaena, microcystis*.

Ansari *et al*., (2015) assessed the diversity of phytoplankton and physico-chemical parameters of ONGC pond Hazira. During the time period of study 73 genera belonged to 4 classes' viz. Euglenophyceae, Cholorophyceae, Bacillariophyceae and Cyanophycea were identified. Among the four classes Cholrophyceae group was dominating class. Level of various physico-chemical parameters are as follow oxygen (5.678±0.218 mg/L, nitrate (4.089±0.926 mg/L), phosphate solids 143.8-159.5 mg/L, conductivity 290.8-391.5 µmhos, salinity 0.11-0.19 %,dissolved oxygen 0.7-1.8 mg/L, and alkalinity 0.8-1.7 mg $CaCo_3$ mg/L, five families of phytoplankton are identified at the time of study Cyanophyceae, Colorophyceae, Euglenophyceae, Bacillirophyceae and dinophyceae. Three groups of zooplanktons are also identified namely copepods, Cladocerons and Rotifers. Pond is likely polluted as some pollution indicator species are present such as *Microcystis, phacus, Oscillatoria, Anabeana, Euglena.*

Physico-chemical parameters and plankton diversity of Konda (open pond) Pond of Bharatpur is studied by Singh (2015). Physico-chemical parameters of pond are water temperature 24-25.6 ˚c, transparency 0.2-0.4 m, pH 7.3-7.4, total dissolved (0.257±56.786 mg/L) and silicate (0.218±0.029 mg/L). Physico-chemical parameter shows direct relationship. Sharma *et al*.,**(**2015) studied the diversity of zooplankton and macro benthic invertebrates in Jhakhand Dilli pond. 29 species of zooplanktons were identified viz. Protozoan, Rotifers, Cladocerons, Copepods and Ostracods.

Physico-chemical parameters of Srisanishawaran temple Pond of Tirunallar was analysed by Ganesh *et al*., (2015). Physico-chemical parameters

which were analysed such as pH, electrical, conductivity, total hardness, calcium hardness, BOD, total dissolved solids, suspended solids, oil and grease were varied. Bacterial load was more after mass bathing than in before mass bathing.

Dixet *et al.*, (2015) analysed physico- chemical parameters of different pond of Biaspur district of Chhattisgarh India. The physico-chemical parameters which were studied during research were pH ranged from 6.50-9.69, electrical conductivity ranged from 118.7-206.6 µmhos/cm, TDS ranged from 165.5-254.8 ppm, temperature ranged from 20.9-33.8 ˚c, salinity ranged from 5.1-6.9 ppt, dissolved oxygen ranged from 2.41-4.8 mg/L. Correlation coefficient (r) was found significant at <0.05 level for tested parameters.Presence of more phytoplanktons was the pollution indicators.

Mahish (2015) analysed the physico-chemical analysis of pond water municipal sewage and industrial effluent of Rajnadgaon (Chhattisgarh). the maximum values were recorded were as follow temperature 22.67 ±0.33, pH 7.53±0.2 , turbidity 248.67 ±7.40 ,fluoride 2.70±0.17 mg/L, nitrate 2.36 ± 0.16 mg/L, chloride 53.33±3.33 mg/L, iron 0.46±0.02 mg/L, hardness 553.33±13.02 ,arsenic 0.05±0.02 mg/L, DO 9.33±0.32 mg/L , BOD 163±3.78 mg/L and COD 347±15.89 mg/L.

Biswas (2015) studied the relationship between the physico- chemical properties and zooplankton in Dhakuria Lake. 31 species of zooplankton comprising of 4 groups were reported viz. Rotifera (17 species), Cladocera (10 species), Copepoda (3 species), Ostracoda (1 species). copepodes were dominant. There is positive relationship between high level of physico-chemical parameters such as total hardness, Do, BOD, COD, sulphate and phosphate with the abundance of Cladocera, Copepoda and total zooplankton population.

Manikam *et al.,* (2015) studied the zooplankton diversity and physico-chemical parameters of Barur Lake, Krishnanagri district Tamil Nadu. 47 species of zooplankton were reported of which18 species of Rotifers, 11 species of Cladocera, 11 species of Copepoda and 7 species of Ostracoda were observed. Rotifera was dominating group among all species.

Seasonal variation of zooplankton diversity of Majalgaon reservoir Maharashtra was assessed by Pawar (2016). During the study period 23 species were recorded among them Rotifers (8 species), Cladocera (6 species), copepod (5 species), Ostracod (2 species) and Protozoa (2 species). During summer season number of zooplankton were highest and lowest during winter season.

Saidu *et al*., (2016) studied the species distribution of phytoplankton in Balanga Dam. 21 species were identified belonging to about 7 taxa. Cholorophyceae were dominating about 28.6%, followed by Bacillariophyceae 19%, Cyanophyceae (19%), Desmidiaceae (14.3%) and Chrysophyceae (9.5%) respectively. Pahl *et al*., (2016) studied the phytoplankton of Chakhan Lake District Dadu, Sindh Pakistan. Phytoplankton algal species belonging to genera Anabaenospsis, *Anabaena*, *Nostoc* of family Nostocaceae were reported. Numbers of phytoplankton were reported viz. Cylinderospermum species, Microcystis species, Phormidium species, Oscillatoria species, and Chlorella species.

Physico-chemical parameters of pond water at Athiyannor Panchyath Kerala was analysed by Sajitha and Vijayamma (2016). The result were evaluated and compared with WHO and BIS water quality standards. Yadav *et al.*, (2016) analysed the physico-chemical parameters of urban pond in Raipur, Chhattisgarh. Ponds of urban area were severely contaminated with surfactant and microbes due to anthropogenic activities. The concentration of surfactant in the term of Sodium lauryl sulphate (SLS) in water is ranged from 7.0 -27 mg/L and microbes i.e. Bacteria, algae, fungi were reported. Swarnkar and Choubey (2016) assessed physico-chemical parameters of pond water in Raipur city. Various physico-chemical characteristics were turbidity; pH, total dissolved oxygen, biological oxygen demand (BOD) and total coliform were analysed.

Seasonal water quality assessment for fish farming is studied by Kumar *et al*., (2017). The water samples were analysed for various physico-chemical characteristics like colour, turbidity, temperature, ,pH, DO, BOD, COD, carbon dioxide, salinity, total alkanity and total hardness etc. Levels of physico-chemical parameters were obtained pH (7.1-8.5), temperature (2.69-31.9 ˚c), electric conductivity (290.30-405.10 µs/cm), dissolved oxygen (6.5-7.9 mg/L), BOD (4.5-6.0 mg/L), carbon dioxide (4.2-5.9 mg/L), calcium 7(78-108 mg/dl), magnesium

(58-73 mg/dl), salinity (10-19 ppt), total alkanity (68-95 mg/L), nitrate (3.0-4.1 mg/L) and chloride (15.3-39.8 mg/L).

Lucas *et al*.,(2017) studied the microbiological and and physico-chemical parameters of water bodies of Desiroto de los leones National Park located in central region of the Mexico city. They identified five bacterial genera (*Escherichia, Pseudomonas, Klebsiella, Shigella and Salmonella*). Result oftesting of water is as follow: pH 5.5-5.9, turbidity 10.7-32.3, Nephlometric turbidity units (NTU's), chemical oxygen demand (COD) 106-450 mg/L, total coliforms 98-956 colony forming units (CFU'S), faecal coliforms 78-807 CFU'S, 90% isolated bacteria were resistant to ampicillin while 25% resistant to ciprofloxacin.

Yadav and Singh (2017) studied the zooplankton diversity of Chhapakaiya pond Birgunj Nepal. A total 27 taxa from different classes of zooplankton were identified. The zooplankton were reported maximum (774.4 unit/L) during summer and minimum (539.2 unit/L) during rainy season in Chapakaiya pond.

Triest and Stier (2017) studied the impact of non-native plant species on phytoplankton and zooplankton communities in temperate pond. Investigation shows the relationship between the three aquatic non-native invasive species (*Hydrocotyle, ranunculoides, Ludwigia randiflora* and*Myriophyllum aquaticum*), zooplankton and phytoplankton density.

Zebek and Szymansk (2017) assessed the differences in phytoplankton abundance, biomass structure and the environment requirement of dominant species of pond of Warmia Mazury region of north-east Poland.Pandiammal *et al.*(2017) studied on the diversity of phytoplankton and seasonal fluctuation in temple pond at Thiruvottiyur Chennai. Totally 5 groups of phytoplankton taxa were identified which were chlorophyceae 10, Bacilliariophyceae 11, Cyanophyceae 6, Euglenophyceae 3, Dinophyceae 2.

Joseph(2017) studied the diversity and distribution of phytoplankton in an artificial pond. Phytoplankton species cyanophyceae (39%) was the dominating group followed by Cholrophyceae (34%), Bacillariophyceae (235%) and euglenophyceae (4%).Jacob *et al*. (2017) studied the odanata (dragonflies and

damselflies) as bio indicators of water quality in 30 ponds of Maanachil taluk of Kottayam district Kerala. The water quality index, Simpson's diversity index and species abundance values were calculated. Bradinopyga germinata and Trithemis festiva species were fresh water indicator species whereas Zyxomna petiolatum and Ceriagrion cerinorubellum were indicates the polluted water.

Seasonal variation of zooplanktons of pond at Lake Kollore region of Andhra Pradesh was assessed byKrishna and Kumar(2017). Zooplankton richness, evenness and diversity were observed. A total number of 16 species recorded with 9 rotifers, 3 cladocera and 4 copepods. In the rotifers genus Branchionus was the dominating group.Seasonal succsesion and role of temperature on zooplanktons of Talpad pond and Jonu pond, Udhampur city assessed byDevi **(**2017**).** Total 34 genera were identified belonging to 5 groups Protozoa (6 genera), Rotifera (12 genera), Copepoda (6 genera), Cladocera (6 genera) and Ostracoda (2 genera).

Chakaborty *et al*. (2017) studied the physico-chemical parameters of four fish inhabiting water bodies around Kokrajhar, BTAD Assam. Temperature, pH, total dissolved solids (TDS), total alkanity, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), turbidity and salinity parameters were tested. DV and HL (2017) studied the physico-chemical parameters of Nizam Sagar dam for fish production, phytoplankton and zooplankton. Water temperature, pH, total alkanity, dissolved oxygen and carbon dioxide were investigated. The pH shows alkaline trend in Nizam Sagar dam which is more suitable for fish culture.

Physico-chemical parameters and zooplankton diversity of a perennial lake, Dharampuri Tamil Nadu studied byDhanasekaran *et al*.,(2017). Total 29 zooplankton species were identified during the period of study among them 10 species of Rorifers, 8 species of Cladocera, 6 species of Copepoda and 5 species of Ostracoda. There is positive co-relation between physico-chemica parameters and zooplankton species.

Kangabam *et al*.(2017) studied the water quality index for the Loktak Lake. All the phycico-chemical parameters were analyzed using the standard procedures. The WQI values ranges from 64 to 77 indicating that Loktak lake water was not fit for drinking purpose.

Abbai (2017) assessed the zooplankton diversity of Sogal pond in Belagavi district of north Karnataka. Total 16 species were identified belonging to 3 different groups 43% Rotifera, 36% Cladocera, and 21% of Copepoda. In winter season density of zooplanktons were high and low during summer.

Diversity of zooplankton in municipal waste water contaminated urban pond of the lower gangetic plains were studied byAdhikari *et al*., (2017). 22 species of zooplankton were identified ,14 species of Rotifera, 3 species of copepoda, 4 species of Cladocera and single species of Ostracods , which suggest that municipal waste water loaded with various nutrients has influenced the zooplankton diversity and abundance.In recent years, limnology of different water bodies of Rajasthan was studied byseveral workers and total 144 zooplanktonic forms were reported belonging to 3 phyla, 27 families, 64 genera and 105 species. Protozoa (13), Rotifera (39), Copepoda, Cladocera and Ostracoda were represented by 13, 39, 22 and 6 forms respectively. Biodiversity in the zooplankton has been calculated in the Menhinick's index and values have been discussed in relation to physico-chemical characteristics and primary productivity.

Manickam *et al., (*2018) studied impact of seasonal changes on zooplanktonbiodiversity was conducted in the Ukkadam Lake (Lat 10° 59′N and Long 76° 57 ′ E), at Coimbatore city, Tamil Nadu,India. The population density of various group of zooplanktonwas observed, and it was found to be following order Rotifera> Copepoda > Cladocera > Ostracoda. The high and lowpopulation densities were recorded in summer and earlymonsoon season respectively. This higher zooplanktonpopulation density in summer might be due to the temperatureacceleration in the Ukkadam Lake. It indicates that thetemperature has influence on the zooplankton diversity.Therefore, increased temperature due to global climate changemight have influence on the zooplankton production. Meena and Dube(2018) critically reviewed literature ofzooplankton of Lentic Water Bodies in India. Zooplanktons arethe plankton consisting animals and the immature stages oflarger animals. Due to their large densities they are being used as the indicator organisms of physical, chemical, andbiological process of aquatic system.

Karra *et al*., (2018) reviewed the studies of Phytoplankton in Lotic Water of India. Phytoplanktons are microscopic creatures mainly algae contain chlorophyll and live near the surface of water where there is sufficient light, producing their own food and thus providing meals for countless other aquatic dwellers. They play important role in maintaining the equilibrium between living organism and abiotic factors. The density and diversity of phytoplankton and their association as biological indicator is significant in the assessment of water quality. Sharma and Dube (2018) assessed a review of literature on zooplanktons in India. Zooplankton population is very useful indicator for biological, physical and chemical process of aquatic system because they are strongly affected by environmental conditions and respond quickly to changes in water quality. Sharma *et al*., (2018) critically reviewed the literature on diversity and seasonal variation of phytoplankton.The important components of phytoplankton are Diatoms (Bacillariphyceae), Dinoflagellates (Xanthophyceae, Chrysophyceae, Haptophyceae, Cryptophyceae) and Nanoplankters (*Chlorella, Nannochlorpsis*, etc.). In addition to these, two other classes namely Silicoflagellates and Coccolithophores also belong to the category of phytoplankton.

The relationship between phytoplankton abundance and five important physicochemical parameters were studied by Das *et al*.,(2018) showing different rich waste water supports the diversity and abundance of phytoplankton. Physicochemical analysis of pond water was assessed by Ghosh (2018) and in this she analyzed the air temperature ranges from 19°C to 34°C where as water temperature ranges to 16°C to 31.8°C. pH ranges from 8.2 (September) to 9.5 (August). Lowest value of DO was observed in April (4.1mg/l) and highest value was observed in December (13.1mg/l). Free carbon di oxide varies from 2.4mg/l to 10.2mg/l. Chloride content ranges from 70mg/l to 165mg/l. Alkalinity level ranges from 82mg/l to 165.5mg/l where as phosphate level was in between 0.40 mg/l and 0.86mg/l. Physico-chemical parametersof freshwaterlake studied by Gowri and Bannerjee (2018).

Limnological characteristic, planktonic diversity and ichthyofauna studied by Gothwal and Gupta (2019) and found that some physico-chemical parameters show seasonal fluctuation. The Limnological parameters of Sant-Sarover Pond

showed low mean values including hardness (104.83 mg/l) and TDS (142.0 mg/l)) with optimum alkaline water (pH 7.12), and alkalinity of (98.50 mg/l) Secchi Depth of 80 cm. The average nitrate and sulphate levels were 28.57 mg/l and 122.28 mg/l while average dissolved oxygen levels were at 5.45 mg/l respectively. Meena and Dube (2019) assessed a reviewphytoplankton of lentic bodies of India which shows that there is very important to investigate fresh approaches in the field of diversity. Choudhary *et al*., (2019) studied physico-chemical analyzed Physico chemical parameters i.e temperature, pH, dissolved oxygen, Total alkalinity, Free carbondioxide, transparency, Hardness, total dissolved solids, Conductivity and biological oxygen demand has been studied and correlated with ideal condition for fish culture. Abhijet and Arjun (2019) studied the ecological and polltion status of freshwater reservoir. Rao B. *et al.,* (2019) investigate the status of pond and measured pH, turbidity, acidity, and few more physical properties. Meena and Dube (2019) studied the diversity and seasonal variation of Similiya Village Pond which shows variation in the various physic chemical parameters and phytoplankton species were more diverse and dominant than zooplankton communities.

This review clearly indicates the pockets where such research is necessary and emphasis the urgency of present work therefore present study was undertaken to fill this gap and to generate primary scientific dats for village pond of Similiya whih is being used for many human purposes in Similiya village, district Kota, Rajasthan.

CHAPTER 3

MATERIALS AND METHODS

Chapter 3

MATERIALS AND METHODS

1. STUDY AREA AND SAMPLING SITES

1.1 Study Area

Similiya pond is a local water body in Similiya village located in Sultanpur tehsil of Kota district, Rajasthan, India. It is 28 KM towards east from district headquarters Kota on national highway number 27. Its Geographical location is at longitude 76˙11 N and latitude 25˙17 E. The pond was constructed by Maharao of Kota Ummed Singh ji in 1900 for drinking water purpose. The pond is rich in flora and fauna.Pond water is used for pisciculture, drinking and bathing. Pond water is not used for irrigation. Its area is about 40 bigha. In the east two ghats are constructed for bathing and two tubewells are also located .Water of tubewells is used for drinking purpose.

1.2 Sampling Sites

To carry out the study ECOLOGICAL STUDY OF SIMLIYA VILLAGE POND, DISTRICT KOTA RAJASTHAN (INDIA) water sample will be collected twice in a month for a period of two years from selected sites:

Site 1: - Two Ghats are located in towards East. These Ghats are used for human activity such as bathing, washing clothes.

Site 2: - One Hanuman temple is situated in the eastern side of the pond, which conveys waste into the pond.

Site 3: - National highway no. 27 is passing near the tank towards the south.

Site 4:- Northern undisturbed area.

Plate No. 1:- Map of India

Plate No. 2:- Map of Rajasthan and Kota district

Plate No.3:- Map of Similiya Pond

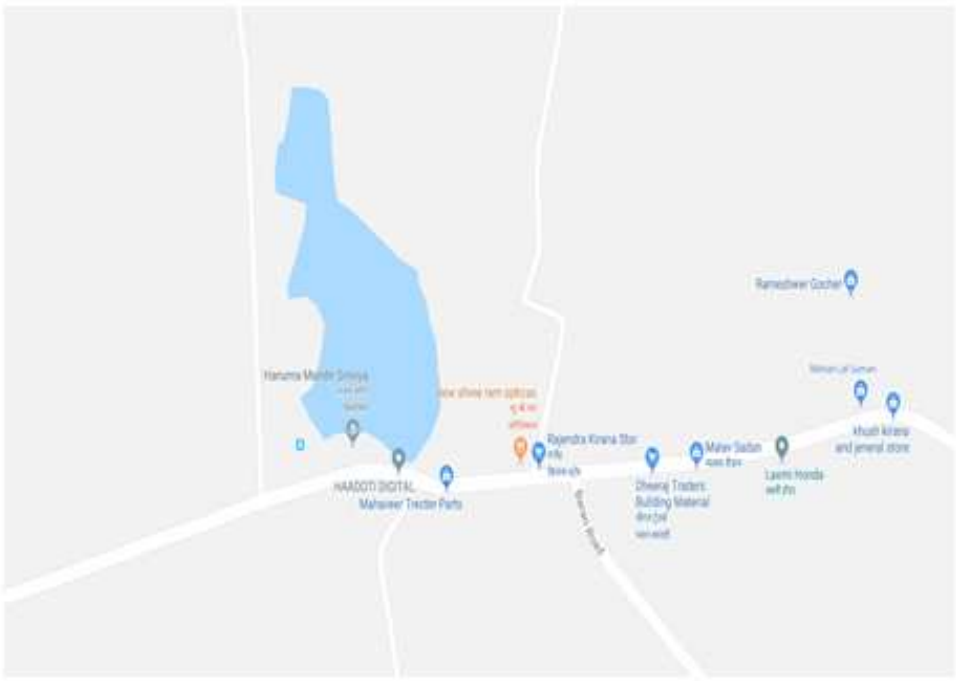


Plate No.4: Site 1- Two Ghats are located towards East. These Ghats are used for human activity such as bathing, washing clothes.

Plate No. 5- Site 2- Near Hanuman Temple that is situated in the Eastern side of the Similiya Village, Pond, which conveys waste into the Pond.

Plate No. 6- Near Road passing near the Pond towards South of Similiya Village Pond.

Plate No. 7 - Site 4 Northern undisturbed side of Similiya Village Pond.

The samples will be analysed on the spot for some parameters (such as Temperature, depth etc.) and will be brought in the laboratory for further analysis. The following parameters will be studied from the sample collected (twice a month) from Simliya village pond (study sites): -

1) Atmospheric Temperature: - temperature will be measured by standard mercury thermometer (least count 0.1^{o} C) at sampling sites.
2) Atmospheric Relative Humidity
3) Water Temperature
4) Turbidity: - turbidity will be determined with the help of sacchi disc at sample sites. Water sample will be brought in the laboratory and turbidity will be measured with the help of digital turbidity meter (NTU).
5) pH: - the pH will be estimated by pH strips in the field and by digital pH meter in the laboratory.
6) Alkalinity: - Alkalinity will be measured by titration method (APHA, 2005) in the laboratory. The water sample will be titrated against 0.1N HCl.

7) Hardness: - Hardness will be measured by titration method (APHA, 2005) in the laboratory. The water sample will be titrated against 0.1N EDTA solution.
8) Free carbondioxide: - free carbon dioxide will be measured by titration method (APHA2005) in the laboratory. The water sample will be titrated against N/44 NaOH solution.
9) Dissolved oxygen: - dissolved oxygen will be determined by modified Wrinklers (volumetric) method (APHA, 2005).
10) Chloride: - Chloride will be measured by titration method (APHA, 2005) in the laboratory. The water sample will be titrated against 0.02N AgNo□□solution.
11) Total dissolved solids (TDS): - total dissolved solids will be determined by evaporating method (APHA, 2005).
12) Nitrate: - APHA, 2005.
13) Phosphate: - APHA, 2005.
14) Conductivity:- APHA, 2005.

The standard APHA, (2005) methods were followed for estimation of physical, chemical and biological parameters. Details are given as under:

Methods used for physical parameters were:-

(a) Atmospheric Temperature -

Temperature affects the solubility and in the turn the toxicity of many other parameter. The solubility of solid increase with increasing in temperature, while gases tend to be more soluble in cold water.

The instrument used to record temperature :-

A thermometer was with a least count of 0.5 C. The thermometer was immersed in a thoroughly shaken water sample put in a clean and dry beaker and reading (in C) were noted down upto one place after decimal.

(b) Atmospheric Relative Humidity -

(c) Water Temperature -

(d) Turbidity –

Principle – Turbidity is the cloudiness of a fluid caused by individual particles that are generally invisible to the naked eye, similar to smoke in air. The

measurement of turbidity is the key test of water quality. The WHO, establishes that the turbidity of drinking water should not be more than 5 NTU, and should not be less than 1 NTU. Nephelometer is employed to determine turbidity; measures the intensity of light passes through a water sample. Causative factor – non settle able suspended matter (colloidal) e.g., clay, silt, finely divided organic matter or plankton.

Reagents –

Solution –I, Dissolve 1 g Hydrazine sulphate and dilute to 100 ml.

Solution – II, Dissolve 10 g hexa methylene tetramine and dilute to 100 ml.

Solution III- Mix 5 ml of I with 5 ml of II. Allow to stand for 24 hours and dilute to 100 ml. This solution should have turbidity of 400 NTU.

Solution IV - Dilute 25 ml of solution III to 100 ml to have solution having turbidity of 100 NTU.

Procedure – Calibrate the instrument (Nephleometer) at the desired range with the help of the 100 ml distilled water and then with the help of 100 ml standard solution of 100 NTU.

Now, take sample 100 ml and determine its turbidity by direct reading on the Nephleometer. Report the readings in NTU turbidity unit.

Methods involved for testing chemical parameters like.

(a) pH
(b) Free Carbon Dioxide
(c) Total hardness
(d) Total Dissolved Solids
(e) Chloride
(f) Dissolved Oxygen
(g) Total Alkalinity
(h) Electrical Conductivity
(i) Nitrate
(j) Phosphate

(a) *pH*

Principle – The pH value of water indicates the logarithm of reciprocal of hydrogen ion concentration present in water. Since the pH is the log of reciprocal of H^+, the higher values of pH means lower H^+ concentrations, and thus represent alkaline solutions, whereas, the lower values of pH means higher hydrogen ion concentrations & thus represent acidic solutions.

Neutral water will, have a pH equal to:

The pH value of water can be measured quickly & automatically with the help of p^H meter, which measures the electrical potential measured exerted by H^+ and thus indicating their concentration.

Apparatus **-** pH meter: Many makes and models with separate /combined electrodes are commercially available. For their satisfactory operation the manufacturer's instructions must be followed. For many purposes reporting p_H values to 0.1 pH is adequate and a pH meter accurate to +0.05 unit will suffice. pH meter should be equipped either by manual or automatic temperature compensation. Buffer Solutions in p^H meters are usually standardized with standard buffer solutions.

REAGENTS -The preparation of some normally required buffers are given below.

- pH 4.01 buffer solution at 25^0C- Dissolve 10.21 g anhydrous potassium bipthalate, $KHC_8H_4O_4$, in distilled water and dilute to 1000 ml in a volumetric flask .
- pH 6.86 buffer solution– dissolve 10.21 g anhydrous potassium dihydrogen phosphate KH_2PO_4 and 1.42 g anhydrous disodium hydrogen phosphate Na_2HPO_4 (both of which have been dried at 110-150^0C for 2 hrs) in distilled water and make upto 1000 ml in a volumetric flask. Use distilled water which have been boiled for 15minutes and cooled at room temperature.

- pH 9.18 buffer solution at 25^0C – dissolve 3.8 g sodium borate ahydrate (borex), $Na_2B_4O_7$. $10H_2O$ in distilled water which have been boiled for 15 minutes and cooled to room temperature. Dilute to 1000 ml. Store the buffer solutions in polythene containers.

***Procedure*– Standardizes** the p^H meter by using a buffer solution of known pH approaching that of the sampleadjusts the temperature correction. Standardization may be counter checked by the buffer solution of a known value. Prepare the electrodes as per the manufactures instructions; insert the electrodes in the water sample. Read the reading directly on the dial of the instrument.

(b) *FREE CARBON DI-OXIDE*:

Free CO_2 refers to carbon dioxide gas dissolved in water. The term is used to distinguish a solution of gas from the combine CO_2 present in bicarbonate ion aquatic plant life depends upon CO_2. CO_2 utilize in the photosynthesis of plant materials.

Free CO_2 reacts with sodium hydroxide to from sodium bicarbonate. Complication of reaction is indicated by the development of colour of the phenolphthalein indicator. This method is based on this simple principle. All reagents were prepared in water freshly boiled at least for 15 minutes.

1. **Phenolphthalein indicator solution: 5g** phenolphthalein disodium salt was dissolved in 1 liter distal water.
2. **Standardized 0.0227 N NaOH titrant:**22.7 ml 1N NaOH was dilute to 1 liter with distilled water. Standardized it against standarded 0.02N using H_2SO_4 phenolphthalein indicator solution. Prepare the reagent daily and protect from atmosphere Co_2 in a pyrex bottle.

   1 ml = 1.00 mg CO_2

Sample collection:-

The sample was collected by means of rubbing discharging at the bottom of a 100ml graduated cylinder. The sample was allowed to overflow for a few minutes

and the tubing withdrawn while the sample is flowing. Flick the cylinder to throw off the excess sample above 100ml mark.

Procedure:

5-10 drops of phenolphthalein indicator was added to 100ml of water sample. It the sample turns pink, free Co_2 is absent. If the sample remains colourless, titrate rapidly into the cylinder with standard alkali solution stirring gently with a stirring rod until a definition pink colour persists for 30 second.

Calculation:-

$$Co_2 \text{ (mg/l)} = \frac{A * N * 4000}{ml.of\ sample}$$

Were,

A = ml titration for sample and,

N = Normality of NaOH

(c) Total Hardness

Principle **- Hardness** in water is that characteristic which prevents the formation of sufficient lather or foam when such hard waters are mixed with soap. It is caused by the presence of certain salts of calcium and magnesium dissolved in water which form scum when reacts with soap. Hardness is defined as $CaCO_3$ equivalent of Ca & Mg ions present in water and expressed in mg/lit or ppm. Here, principle involved is when a small amount of Solo chrome Black-T is added to aqueous solution containing Ca^{+2} and Mg^{+2} at pH 10 ± 0.1, the solution becomes wine red in colour. When the solution is titrated with EDTA the Ca and Mg are complexes and at the end point the colour changes from wine red to blue, the sharpness of the endpoint increases with increasing pH but Ca and Mg may be precipitated if pH is too high.

Causative factors – Divalent metallic cations.Eg.Ca^{+2}, Mg^{+2}, Fe^{+2}, Mn^{+2}, Ba^{+2} etc.

Reagents -

(i) Solo chrome Black T – 1 mg

(ii) standard EDTA Solution– N/100 or 0.01 N – Dissolve 3.723 g EDTA in 1000 ml distilled water. Standard EDTA solution is stored in polythene bottle.

(iii) Ammonium buffer solution – 1 ml.

Procedure – To 10 ml water sample add 1 ml of buffer solution and mix well.. Add 1 mg of Solo Chrome Black T Indicator. We get reddish wine colour.

Then titrate with N/100 EDTA solution and at end point reddish wine colour changes to sky blue colour.

Formulae –

$$\text{Total Hardness (Mg/lit)} = \frac{\text{Volume of 0.01N E DTA (ml) x 1000}}{\text{Vol. of samples (ml)}}$$

(d) TDS (total dissolved solids)

(1) Principle – The total amount of solid present in water sample can be determined by finding the conductivity of water sample.

TDS = Conductivity x Correlation factor

Procedure – The determination of electrical conductivity provides a rapid and convenient means of estimating the concentration of total dissolved solids in water. If conductivity and dissolved solids concentration of the same water sample us found out separately and a correlation factor is found out previously, dissolved solids need not to be determined in future it can be completed by multiplying conductivity with the correlation factor.

Formulae - TDS = Conductivity x Correlation factor (0.4)

(e) Chloride –

Principle– **Chloride** occurs in natural waters in widely varying concentrations in the form of sodium chloride. Their concentrations above 250 mg/liter produce a noticeable salty taste in drinking water & are thus objectionable .The chloride concentrations of raw waters being used for public supplies should be tested regularly, so as to immediately detect any sudden increase in its chloride content and the possibility of any organic pollution of water. Here, principle involved is –Mohr method in which silver nitrate is used as a titrate and potassium chromate as indicator. In neutral or slightly alkaline solutions (pH 7 to 8) as the solubility product of AgCl is more (K_{sp} = 3 x 10^{-10}) than the solubility product of Ag_2CrO_4 (K_{sp} = 5 x 10^{-12}), therefore, the AgCl quantitatively gets precipitated before, red Ag_2CrO_4 is formed.

$Ag^+ + Cl^- = AgCl$

If $P^H > 8.3$ – $Ag(OH)_2$ is precipitated.

$P^H < 8.3$ Cr_2O_4 is precipitated

Reagents –

(i) Silver nitrate standard solution (0.0282 N)

(ii) K_2CrO_4 (Potassium chromate) indicator.

Procedure – To 10 ml sample add 2-3 drops of potassium chromate indicators. Yellow colour appears. Then titrate with standard silver nitrate solution. At the end pt. Orange red colour appears.

Formulae -

$$\text{Chloride (mg/lit)} = \frac{\text{Vol. of titrate (ml)} \times 1000}{\text{Vol. of sample (ml)}}$$

(f) DISSOLVED OXYGEN:

Dissolved oxygen is one of the most important parameter in aquatic system. The gas is an absolute requirement for the metabolism of aerobic organism and also influences inorganic chemical reaction. Therefore knowledge of the solubility and dynamics of oxygen distribution is essential to interpreting both biological and oxygen get into water by diffusion from the surrounding air, by aeration and as a waste product of photosynthesis. The amount of dissolve oxygen gas is highly dependent on temperature. Atmospheric pressure also has as effect on dissolved oxygen the amount of oxygen that dissolved in pure water is inversely proportional to the temperature of water. The warmer the water, the less dissolved water oxygen.

Much of dissolve oxygen in water comes from the atmosphere due to wind action. Algae and rooted aquatic plant also give out oxygen into water through photosynthesis.

Reagent:

1. $MnSO_4$:

Dissolve 480g of manganous sulphates $MnSO_4$. $4H_2O$ or 400g $MnSO_4$. $2H_2O$ or 364g $MnSO_4$. H_2O in distilled water, filter and dilute to 1L. the solution should not liberate not more than a trace of iodine when added to an acidified solution of KI.

2. alkali-Iodide Azide reagent:

Dissolved 500g NaOH (or 700g KOH) and 135g of NaI (or 150g KI) in the distilled water and dilute to 950ml. dissolve 10g sodium azide in 40ml of distilled water and add to 950 ml of the first solution with constant stirring. The reagent should not give starch solution when diluted and acidified.

3. Standard sodium thiosulphate solution (0.025N).

Dissolved 6.250g of $Na_2S_2O_3$. $5H_2O$ in distil water boil, cool and make the volume to 1L. Standardize against std. potasium dichromate solution (0.1N).

4. Standardizations of sodium thiosulphate using std. potassium dichromate:

Dissolve 1.2257g potassium dichromate (previously dried at 103C for 1hour) in distilled water and make upto 250 ml in a volumetric flask. This is exactly 0.1N solution. Place 100Ml boiled cooled distilled water in a 500ml iodine flask. Add 3g KI_2g $NaHCO_3$ and shake until the salts dissolved. Add 6.0ml concentrate HCI. Pipet of 10ml and 0.1N potassium dichromate solution is taken to the flask. Cover the flask with watch glass and kept in dark for 5 minute. Rinse the watch glass and dilute the solution in the flask to 250ml with boiled and cooled distile water (free from oxygen). Titrate the liberated iodine with the sodium thiosulphate solution in the burette. When the solution acquire yellowish green colour, add 1ml starch indicator solution. Now a blue shade appears, rinse the side of the flask and contain the titration until one drop changes the colour to light green. Calculated normality of sodium thiosulphate solution is:

1ml of 0.025N sodium thiosulphate = 0.2mg oxygen.

5. Starch solution:-

Dissolve 1 g starch in a little water with the help of glass rod, make a thin paste. Pour this paste in about 100ml boiling distil water and contain boiling for 2 minutes. Add cool and prepare daily fresh solution.

Procedure:

Add 2ml of $MnSO_4$ solution in sample bottle followed by 2ml of iodide azide solution well below the surface of the liquid. Stopper with care to exclude air bubble if any completely and mix by inverting the bottle severalties. When the precipitate settles leaving a clear supernatant above the manganous hydroxide, repeat shacking second time. When setting has produced at least 100ml of clear supernatant carefully remove the stopper and immediately add 2ml of conc. MnSO4, allowing the acid to run down the neck of the bottle. Re stopper and mix by gently inversion. This should correspond to 200ml of original sample after correction has been made for loss of sample by displacement with the reagent. Thus when the total of 4ml each of MnSO4 and the iodide azide reagent is added to a 200ml bottle, volume taken for titrate should be 203ml.

Titrate with sodium thiosulphate solution to a pale yellow colour, add 1 to 2 ml of starch solution and contain the titrate until the first disappearance of blue

colour. Subsequent recoloration due to catalytic effect of nitrites or to the presence of traces of ferric salts which have not formed complexes should be disregarded.

Reations:-

$MnSO_4$+ 2KOH→$Mn(OH)_2$+k_2SO_4 white ppt.

$2Mn(OH)_2$ +O_2 (Do) → $2MnO(OH)_2$ brown ppt.

In absence of Do, brown colour does not appear

$MnO(OH)_2$ +2KI+$2H_2SO_4$ → $MnSo_4$+$2H_2o$+2KOH + I_2

Where $I_2 = O_2$

$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$

Calculation:-

Because 1ml of 0.025N $Na_2S_2O_3$ titrant is equivalent to 0.2mg Do, each ml of $Na_2S_2O_3$ titrant used is equivalent to 1mg/1Do if a volume equal to 200ml of original sample is tirated.

$$DO = \frac{(ml.*n)of\ sodium.this.sulphate*8*1000}{v_2(v_1 - v/v_1)}$$

(g) Alkalinity (Total alkalinity by methyl orange indicator)

Principle – Highly alkaline waters are not potable, Alkalinity value provide guidance in applying proper doses of chemicals in treatment processes particularly in deflouridation, coagulation, softening and operational control of anaerobic digestion. Here, principle involved is that the titration of the sample with N/50 H_2SO_4 to p_H 4.5 or sharp change from yellow to orange of methyl orange indicator will indicate total alkalinity.

Causative factors – The major portion of the alkalinity in natural waters is caused by hydroxide, carbonates and bicarbonates.

Reagents –

(i) Prepare the reagents in distilled water freshly boiled for 15 minutes.

(ii) Methyl arrange indicator – Dissolve 0.5 g in 1 litre of distilled water.

(iii) N/50 H_2SO_4 solution – Prepare approximately 0.1 N H_2SO_4 by diluting 3 ml conc. H_2SO_4 to 1 litre. Dilute 200 ml of this solution to 1 litre.

PROCEDURE – Take 10 ml of sample and add 2-3 drops of methyl arrange indicator. Titrate it with N/50 H_2SO_4 (0.02 H_2SO_4) solution, colour changes from yellow to orange.

Formula -

$$\text{Total alkalinity (mg/lit)} = \frac{\text{ml of titrate to reach the end point} \times 1000}{\text{Ml of sample}}$$

(h) CONDUCTIVIY:-

Conductivity is a numerical expression of the ability of an aqueous solution to carry electric current. This ability depends on the presence of ions, their total concentration mobility valence and relative concentration and on the temperature of measurement.

Conductivity measurements can be used to calculate total hardness solids by multiplying conductivity (in us/cm) by an empirical factor, which vary between 0.55 to 0.9 depending an the soluble components of the water and the temperature of measurement.

The determination of electrical conductivity provides a rapid and convenient means of estimating the concentration of total dissolved solids in water. If conductivity and dissolved solids concentration of the same water sample is found out separately and correlation factor is found out previously, dissolved

solids need not be determined in future as it can be computed by multiplying conductivity with the correlation factor. With waters of variable proportions of neutral salts the factor also varies. Conductivity measurements are made after proper temperature Compensation.

Conductivity = Dial reading x multiplier reading micromhos.

Sp. Conductivity = dial reading x multiplier reading x cell constant micromhos cell constant.

Then cell constant. = $\frac{sp.conductivity\ of\ the\ solun.}{measured\ conductivity}$

At 25^0c the specific conductivity of 0.01 N KCI solutions is 1405 mcromhos. This solution is suitable for cell constant between 0.1 to 10.

Example:-

T.D.S. of a water sample determined by evaporation method is 645; the dial reading of the same water sample is say 1.1×10^3

Factor for this particular water sample is 645 / 1100 = 0.586.

The conductivity of all the ions varies; therefore a universal factor cannot be applied to all the water samples. However where one does not mind the accuracy and work load is heavy the factor for very rough estimation can be determined by estimating the T.D.S. value with the evaporation method along with the conductivity measurement. At least 50 samples of low as well as of high TDS values from different areas should be analyzed by this way. By determining the factor of each water sample and taking out the average of all the factors, a calculation factor for determining T.D.S. value by conductivity measurement can be worked out.

(i) Nitrate

Principle **-** The nitrate represents fully oxidized organic matter and such waters may not be harmful. However, the presence of too much of nitrate in water may adversely affect the health of infants causing a disease called

mathemoglobinemia. The nitrate concentration in domestic water supplies is generally limited to 45 ppm.

Here, principle involved is – the yellow colour produced by the reaction between nitrate and phenol disulphonic acid obeys Beer's law up to at least 50 mg/lit at a wavelength of 410 nm when a light path of 1 cm is used.

$$C_6H_5OH + 2H_2SO_4 = C_6H_3(OH)(SO_3H)_2 + 2H_2O$$

$$C_6H_3(OH).(SO_3H)_2 + HNO_3 = C_6H_3(OH)(SO_3H)NO_2 + H_2O$$

Colourless compounds

$$C_6H_3(OH)(SO_3H)_2NO_2 + NH_4OH = C_6H_3(OH)(SO_3H)_2NO_2NH_4$$

Yellow coloured salt

Reagent – (i) Standard silver sulphate solution – Dissolve 4.40 g Ag_2SO_4 in 1 L distilled water (1 ml = 1 mg Cl)

A. ***Phenol disulphonic acid reagent*** – Dissolve 25 g phenol in 150 ml conc. H_2SO_4 + 75 ml fuming H_2SO_4. Stir and heat for 2 hrs and hot water bath.

B. Ammonium hydroxide – Concentrated

(3) Procedure – In 10 ml sample add standard silver sulphate solution in the amount equal to the amount of silver nitrate solution consumed in chloride list. Now evaporate at water bath. Coal it and add some distilled water. Now add 2 ml phenol disulphonic acid. Add 10 ml ammonium hydroxide. If yellow colour appears, nitrate is present & otherwise absent.

(j) PHOSPHATE

Phosphorous was determined by spectrophotometer. Samples were taking in Erylenmeyer flask and evaporate to dryness. Titrate with sodium hydroxide solution and ammonium molybdate solution.

PHYTOPLANKTON

Collection and identification of phytoplankton

According to size, phytoplankton are classified as ultra-plankton 0.5 to 10 µm, nanno plankton 10 to 50 µm, micro plankton (net plankton) 50 to 500 µm and macroplankton 500 µm. larger phytoplankton collected by filtering a known amount of water through a plankton net made by bolting silk (no. 25 mesh size 55 µm).Take one litre of water sample in a wide mouth glass bottle. Add 10 ml of Lugol's iodine solution per litre of sample. Lugol's iodine solution speeds up the rate of sedimentation of phytoplankton, provides them stain, and preserves their flagella and cilia. For complete sedimentation sample were allowed to stand for a day. Through pippete clear sediment is removed and is examined and identified under a Nikon microscope, preferably an inverted plankton microscope using pertinent literature.

ZOOPLANKTON

Collection and identification of zooplankton

Zooplankton were collected by filtering a known volume of water through zooplankton made up of bolting silk (no.25; mesh size 55µ) the surface water was collected with the help of aplastic bucket or a jug of known volume. Zooplanktons were collect and identified under a Nikon binocular microscope, using pertinent literature.

CHAPTER IV

OBSERVATION AND RESULTS

CHAPTER IV

OBSERVATION AND RESULTS

STUDY OF PHYSICO-CHEMICAL FEATURES OF WATER

PHYSICO-CHEMICAL FEATURES OF WATER:

Water is the most essential resource for life. Water plays an array of vital roles in ecosystem across planet. Although many other substances are necessary for life and for ecosystem to exist, without water nothing else would function to produce life as we know it. From the time Forel (1841-1912) who was regarded as the founder and father of limnology. Freshwater phenomenon was observed "Good quality of water is necessary for the survival of living organisms". Quality of water is determined by studying of its physico-chemical characters. The physico-chemical characteristics of water, that include pH, total alkalinity, dissolved oxygen, chloride (salinity), phosphate, water temperature, atmospheric temperature etc. mainly influence the quality of water.

During the investigation, Similiya pond was selected keeping the aim of study monthly sample from July 2015 to June 2017 was taken. At least four water samples were collected every month from each site. In spite of monthly variations, seasonal variation was also calculated and illustrated in tables. Statistical tool, two way analysis of variance (F-test) was applied to see if there was any significant differences between sites and seasons or not and discuss them with relevant parameters.

RESULTS

Atmospheric Temperature:

The atmosphere and the earth's ecosystem are parts of a coupled system. During the study period the atmospheric temperature was minimum 23.1˙C in the year 2017 and maximum 36.6 ˙C in the year 2016. (Table 1 and Graph 1). During the period of study, it was observed that the air in Similiya pond was coolest in winter and hottest in summer.

Atmospheric Relative Humidity:

The humidity amount of water vapors present in the air. Seasonally the atmospheric relative humidity varied from minimum 39.2% and maximum 79.7% in the year 2017. In rainy season humidity is observed highest and lowest in summer season.(Table 2 and Graph 2)

Water Temperature:-

During the study period seasonally water temperature was minimum 21.7 ˙C in winter season and maximum 29˙c in rainy season. (Table 3A, 3 B)(Graph 3, 4).The maximum and minimum water temperature ranges from 33˙c to 16˙c.

Transparency:-

Transparency of water relates to the depth that light will penetrate water. The maximum light penetration is 83.55 cm and minimum 13.43 cm. (graph 5) (Table 4 A). There was more clear water in the winter season 74.54 cm in the year 2017 and most turbid in summer season 31.42 cm. The analysis of variance showed that the calculated values between station and season were 0.97 and 3046.15 (Table 4B and graph 6).

Conductivity:-

Electrical conductivity is the ability of an aqueous solution to conduct the electric current. Electric conductivity ranged from 120.76 to 391.96 micro mhos/ cm (Table 5 A and Graph 7, 8). During the study maximum conductivity was seen

in summer season andminimum in the rainy season. According to seasonal variation the lowest values were observed in rainy season 172.14 micro mhos/ cm in the year 2017 and highest value in summer season 371.59 micro mhos/cm in year 2016. The analysis of variance showed that the calculated value between station (3.65) and between season it was (112201.1) (Table 5 B).

Total Dissolved Solids:-

In the present study it was observed that value of total dissolved solids ranged from maximum to minimum was 128.96 to 57.80 (mg/L) (Table 6 A and Graph 10) Seasonally the Total dissolved solids was highest in summer season (123.33 mg/L) in the year 2016 and lowest in rainy season (76.90 mg/L) in the year 2015 (Graph 9). The analysis of variance showed that the calculated value between stations was 1.64 and between seasons were 452.15 (Table 6 B).

Hydrogen ion concentration (pH):

From the above experimentation it was observed that among the four sites of Similiya pond pH is ranged from 7.11 to 8.92. Seasonally maximum pH was recorded rainy season 8.60 in the year 2016 and minimum in summer season 7.82 in the year 2015 (Table 7 A and Graph 11, 12). The analysis of variance showed that the calculated value between stations was 0.65 and between the seasons were 0.26 (Table 7 B).

Free Carbon Dioxide:-

Seasonal variation of Free Carbon Dioxide ranged between 0.50 - 4.86 mg/L. With the relation to experimental sites the maximum (5.04 mg/L) Free Carbon Dioxide was noted in the year 2017 in winter season and followed by minimum (2.14 mg/L) in the year 2017 in rainy season (Table 8 A and Graph 13, 14). The analysis of variance between station and between seasons was 1.65 and 0.15.

Total Alkalinity:

Total alkalinity is a measure the ability of water is neutralized or assimilates acids. High value of alkalinity was 155. 87 and lowest value is 86.44 (Table 9 A and Graph 15, 16). In summer season maximum (141.42 mg/L) value of total alkalinity was found in 2015 and minimum (92.9 mg/L) in rainy season in 2015. The value of variance between station and seasons was 0.65 and 3470.15 (Table 7 B).

Dissolved Oxygen:

The presence of dissolved oxygen is essential to maintain the higher forms of biological life and to keep proper balance of various pollutions thus making the water bodies healthy. In the present investigation Dissolved Oxygen ranged maximum 9.57 mg/L and minimum 6.46 mg/L. Dissolved Oxygen is highest in the winter season 8.84 mg/l in year 2016 and lowest in summer season 6.92 mg/L in year 2015 (Table 10 A and Graph 17, 18). The analysis of variance between stations was 0.25 and between seasons was 5.55 (Table 10 B).

Chloride (salinity):

Salinity is the saltiness or dissolved salt content of a body of water. The ecological significance of chloride lies in its potential to regulate salinity of water. In the present study Similiya Pond water salinity ranged between 26.80 to 145.66 mg/L which shows seasonally fluctuation i.e. maximum in summer season (141.52 mg/l) and minimum in rainy season (28.93 mg/l) in the year 2015 (Table 11 A and Graph 19, 20). The value of variance between stations and seasons were 2.22 and 143.15 (Table 11 B).

Total Hardness:

Seasonally variation of Total Hardness was maximum in summer season (172.54 mg/L) in the year 2017 and minimum in rainy season (102.90 mg/L) in the year 2015 (Table 12 A). The highest value was 196.56 mg/L and lowest value was 86.80 mg/L (Graph 21, 22). The analysis of variance showed that the

calculated value between stations was 1.02 and between seasons were 34.25(Table 12 B).

Phosphate:

Phosphate is one of the most important nutrients in aquatic ecosystem. The amount of Phosphate is maximum 1.98 and minimum 0.86 mg/L. There is continuous increase in values in summer season (2.54) and in rainy season (1.27) and it declines in winter season (1.05) (Table 13 A and Graph 23, 24). The analysis of variance calculated between stations was 5.02 and between seasons were 24.35 (Table 13 B).

Nitrate:

Seasonal variation of Nitrate was maximum in summer season (0.39 mg/L) in the year 2015 and minimum in winter season (0.22 mg/L) in the year 2015 (Table 14 A).The highest value was observed at site 0.56 mg/L and lowest value was 0.16 mg/L (Graph 25, 26). The analysis of variance was calculated between Stations was 1.32 and between seasons were 1.15(Table 14 B)

PLANKTONS:

The term "Plankton" refers to those minute aquatic forms which are non-motile or insufficiently motile to overcome the transport by currents and living suspended in the open or pelagic water. The planktonic plants are called phytoplankton and planktonic animals are called zooplankton (APHA 1985).

Planktons are found throughout the oceans, seas, and lakes of the world. However the local abundance of plankton varies horizontally, vertically and seasonally. All plankton ecosystem are driven by the input of solar energy and to geographical region and seasons when light is abundant. A secondary source of variability is that of nutrient availability.

The present study highlights good plankton diversity in the Simaliya village pond, Kota district, Rajasthan. Total fifty species of planktons belonging to phytoplanktons (21) and zooplanktons (29) were recorded (Table 15 and Table

16). High densities of planktons were recorded in summer and beginning of monsoon.

PHYTOPLANKTONS:

Phytoplanktons are the base of aquatic food webs and energy production is linked to phytoplankton primary production. Excessive nutrient and organic inputs from human activities in lakes and their watersheds lead to eutrophication, characterized by increases in phytoplankton biomass, nuisance algal blooms, loss of water clarity from increased primary production and loss of oxygen in bottom waters. Phytoplankton is the base of food web which affects the food production. Diatoms have been used by ecologists to indicate pollution in water body and other variation of ecological conditions.

Chlorophyta was dominating group and cyanophyta was second dominate group. In the pond the contribution of chlorophyta and cyanophyta to total biomass was higher than 90%. Phytoplankton biomass reached the value many times higher. (Table 15 A, 15 B) (Graph 27)

ZOOPLANKTONS:

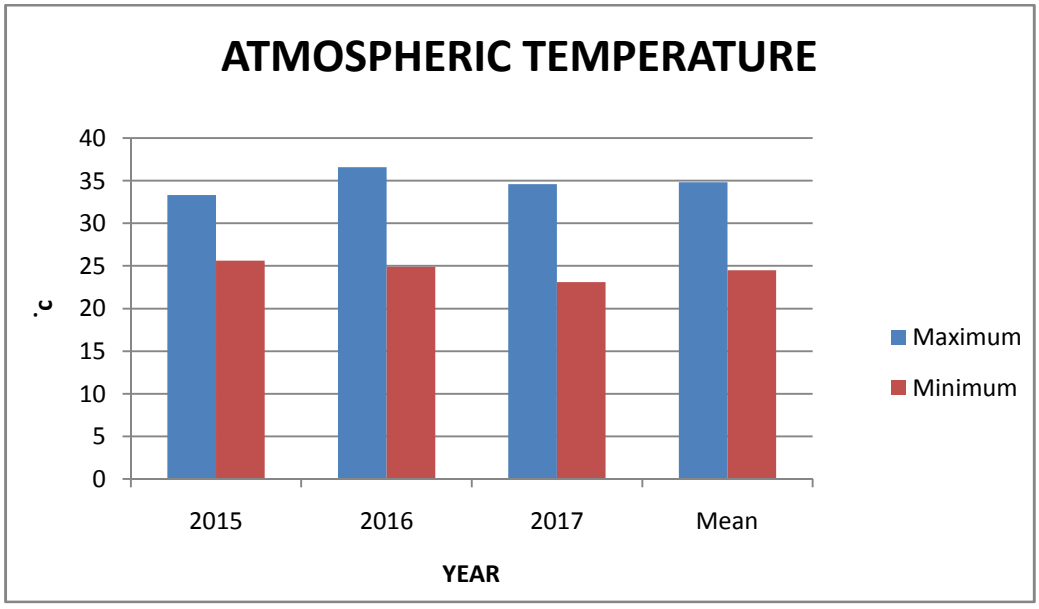
Zooplanktons are the central trophic link between primary producers and higher trophic levels. The freshwater zooplankton comprise of Protozoa, Rotifers, Cladocerans, Copepods and Ostracods. Most of them depend to a large extent, on various bacterioplankton and phytoplankton for food. Many of the larger forms feed on smaller zooplankton, forming secondary consumers. Some of them are detritivore feeders, browsing and feeding on the substrate attached organic matter, phytoplankton or concentrating on the freely suspended organic matter particles or those lying on the bottom sediment. Many of these organisms are also fish food organisms and are consumed by the other aquatic macrofauna.

The present study highlights good zooplankton diversity in the Simaliya village pond, Kota district, Rajasthan. Twenty nine species of zooplanktons representing seven groups of namely- Rotifera, Cladocera, Copepoda, Ciliata,

Ostracoda and Branchiopoda were reported. Rotifers included 8 species, Cladocera 4 species, Copepoda 7 species, Ciliata 6 species, Ostracoda 2 species and Branchiopoda 2 species (Table 16 A, 16 B) (Graph 28).

Table 1- Mean values of Atmospheric Temperature (˚c) from July 2015 to June 2017

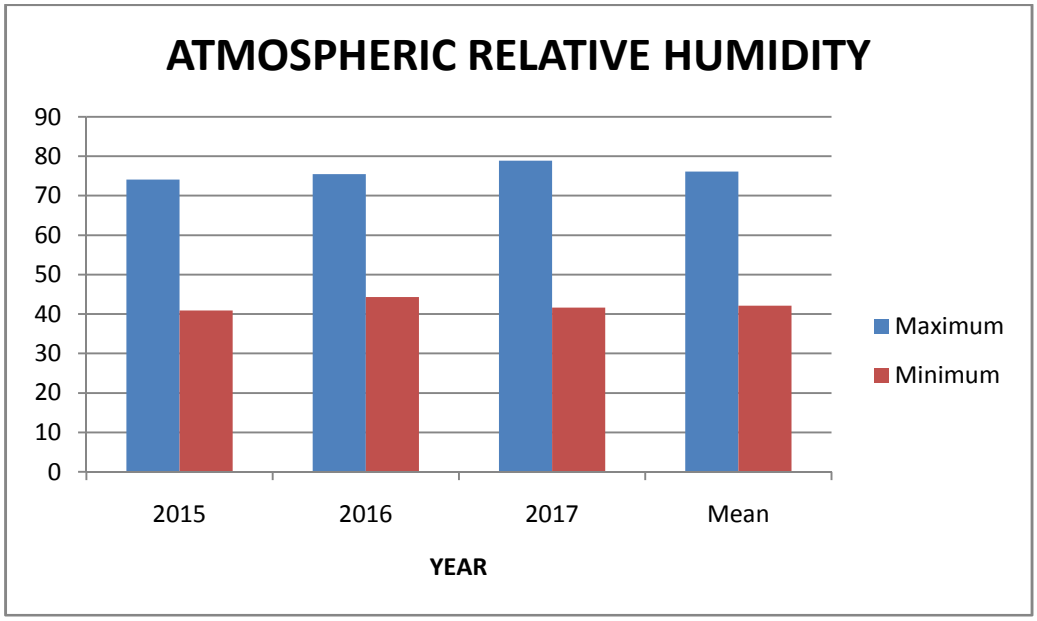
Year	2015	2016	2017	Mean
Maximum	33.3	36.6	34.6	34.8
Minimum	25.6	24.9	23.1	24.5



Graph 1:-Showing Maximum and Minimum values of Atmospheric Temperature of Similiya village Pond, Kota (July 2015-June 2017).

Table 2- Mean values of Atmospheric Relative Humidity (%) from July 2015 to June 2017

Year	2015	2016	2017	Mean
Maximum	74.1	75.45	78.9	76.15
Minimum	40.9	44.3	41.6	42.1



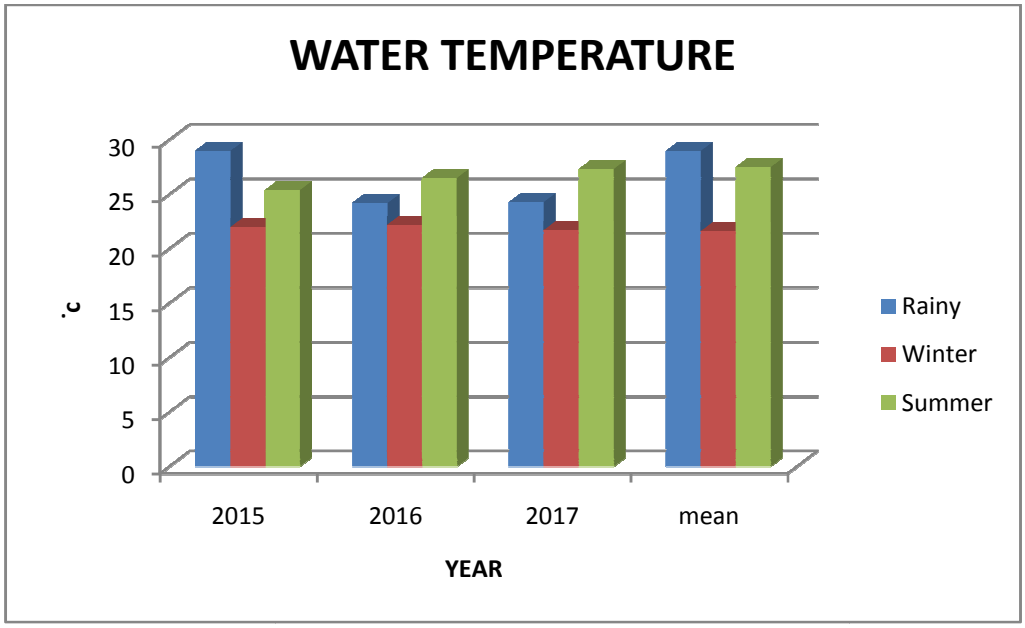
Graph 2:- Showing Maximum and Minimum values of Atmospheric Relative Humidity (%) of Similiya village Pond, Kota (July 2015-June 2017).

Table 3 A- Mean values of seasonal variation of Water Temperature from July 2015 to June 2017

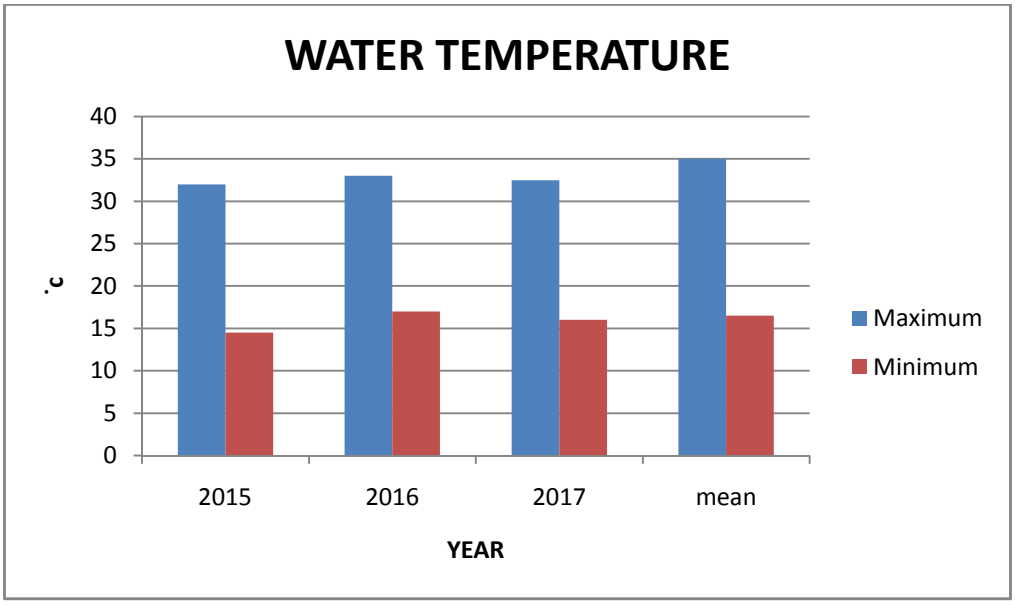
1	Rainy	29	24.2	24.3	29
2	Winter	22	22.2	21.7	21.6
3	Summer	25.4	26.5	27.33	27.5
	Maximum	32	33	32.5	35
	Minimum	14.5	17	16	16.5

Table 3 B – Analysis of Variance for Water Temperature

Source of variation	Degree of freedom	Calculate d F	Tabulated F	Probablity level	Significant level
Between station	2 &6	0.29	5.1	0.05	NS
Between season	3&6	42.77	4.4	0.05	NS



Graph 3:- Showing yearly seasonal variation and mean of Water Temperature (^{o} C) of Similiya village Pond, Kota (July 2015-June 2017)



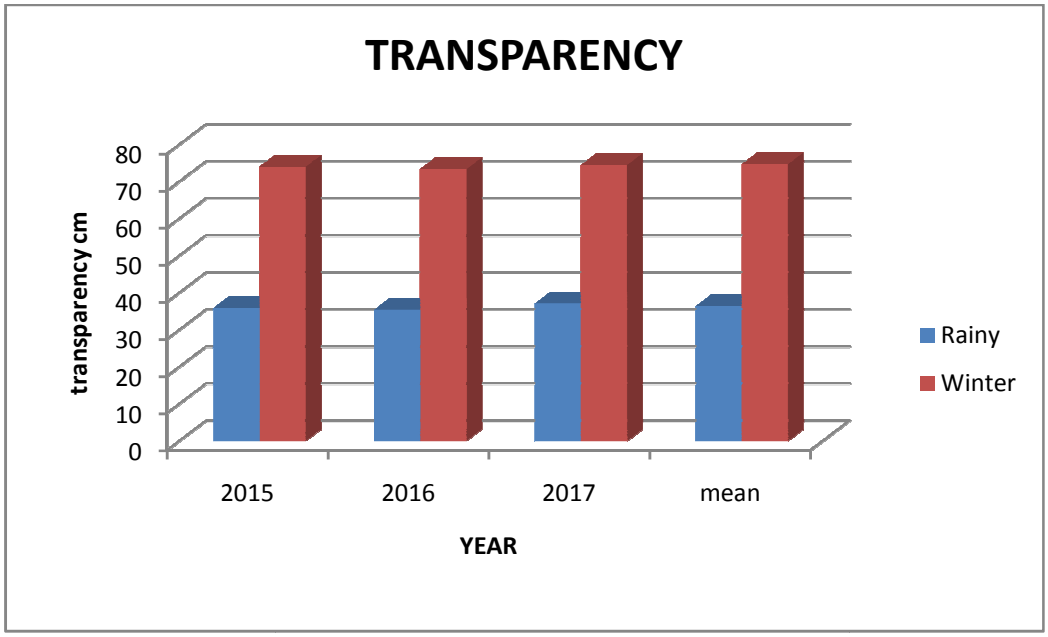
Graph 4:- Showing Maximum and Minimum values of seasonal variation of Water Temperature (^{o} C) of Similiya village Pond, Kota (July 2015-June 2017).

Table 4 A – Mean values of seasonal variation of Transparency from July 2015 to June 2017

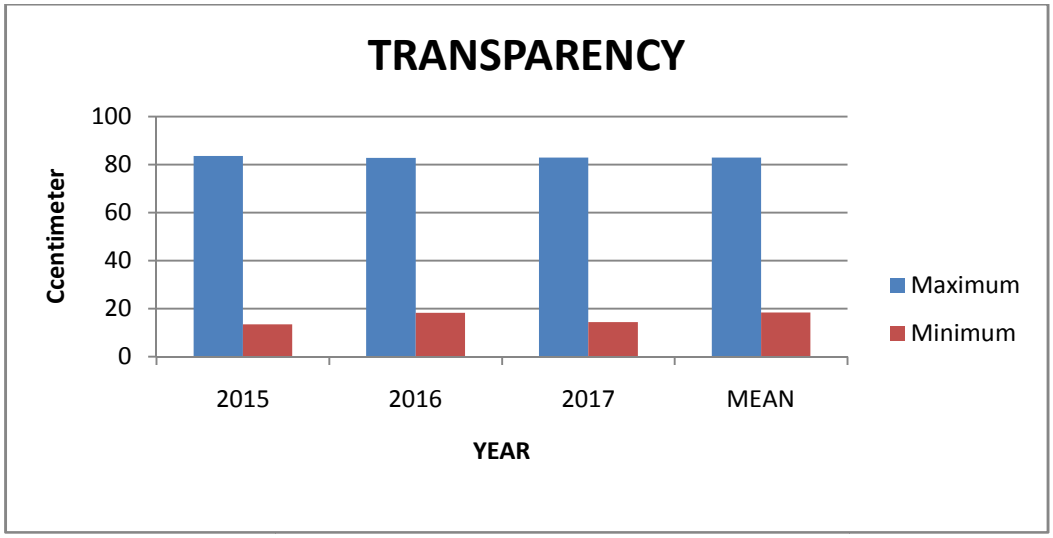
1	Rainy	35.90	35.47	37.14	36.44
2	Winter	74.06	73.44	74.54	74.77
3	Summer	31.42	32.23	31.59	31.66
	Maximum	83.55	82.76	82.87	82.92
	Minimum	13.43	18.32	14.36	18.45

Table 4 B - Analysis of variance for Transparency

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	0.97	5.1	0.05	NS
Between seasons	3&6	3046.15	4.4	0.05	



Graph 5:- Showing yearly seasonal variation and mean of Transparency of Similiya village Pond, Kota (July 2015-June 2017).



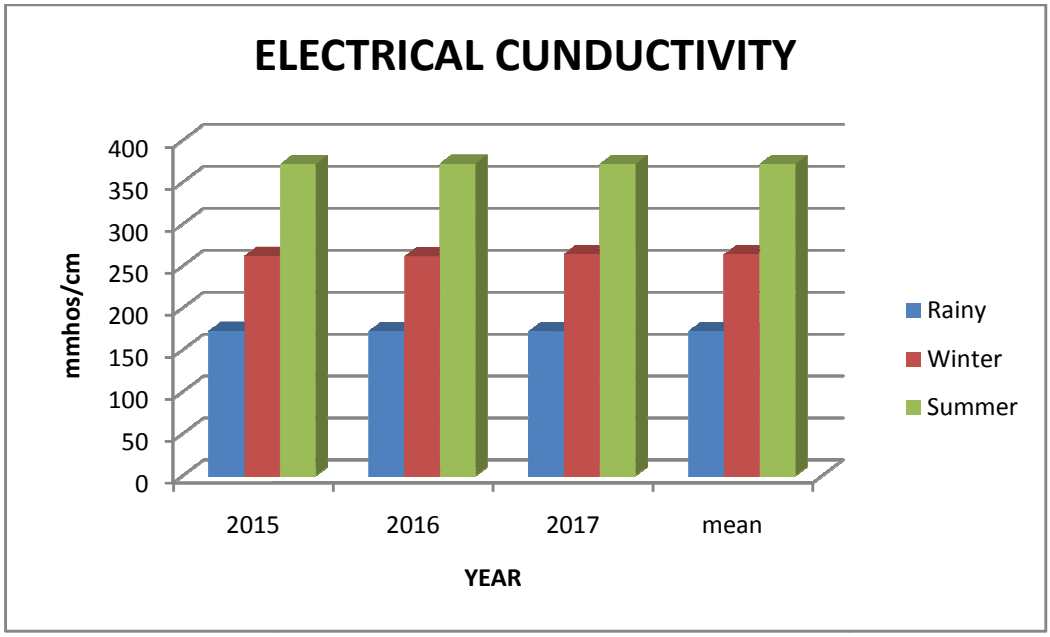
Graph 6:-Showing Maximum and Minimum values of seasonal variation of Transparency of Similiya village Pond, Kota (July 2015-June 2017).

Table 5 A – Mean values of seasonal variation of Electrical Conductivity (EC) from July 2015 to June 2017

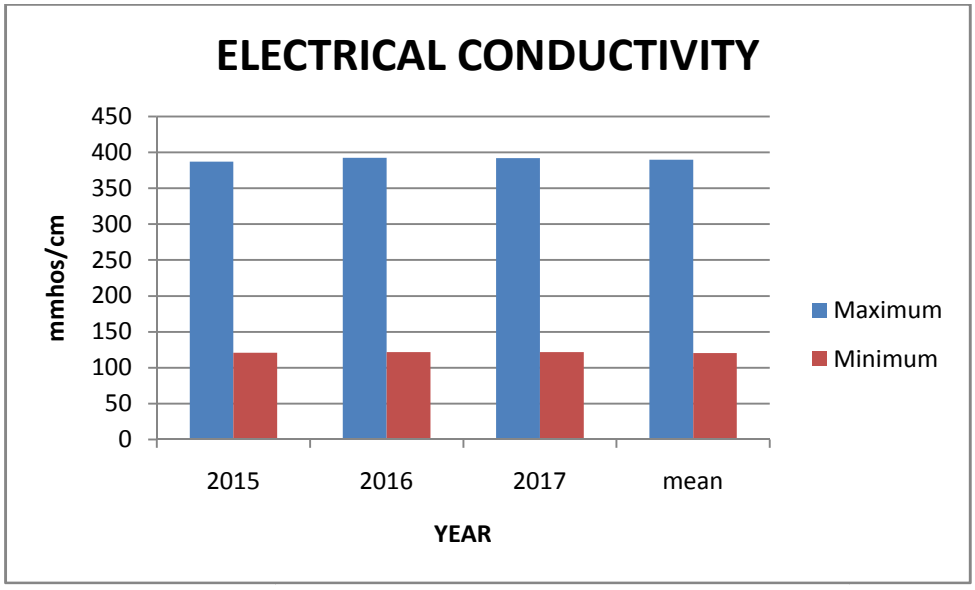
1	Rainy	172.90	172.47	172.14	172.44
2	Winter	262.06	261.44	264.54	263.77
3	Summer	371.42	372.23	371.59	371.66
	Maximum	387.24	392.67	391.96	389.65
	Minimum	120.76	121.92	121.65	120.60

Table 5 B - Analysis of variance for Electrical Conductivity (EC)

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	3.65	5.1	0.05	NS
Between seasons	3&6	112202.15	4.8	0.05	NS



Graph 7:- Showing yearly seasonal variation and mean of Electric Conductivity of Similiya village Pond, Kota (July 2015-June 2017).



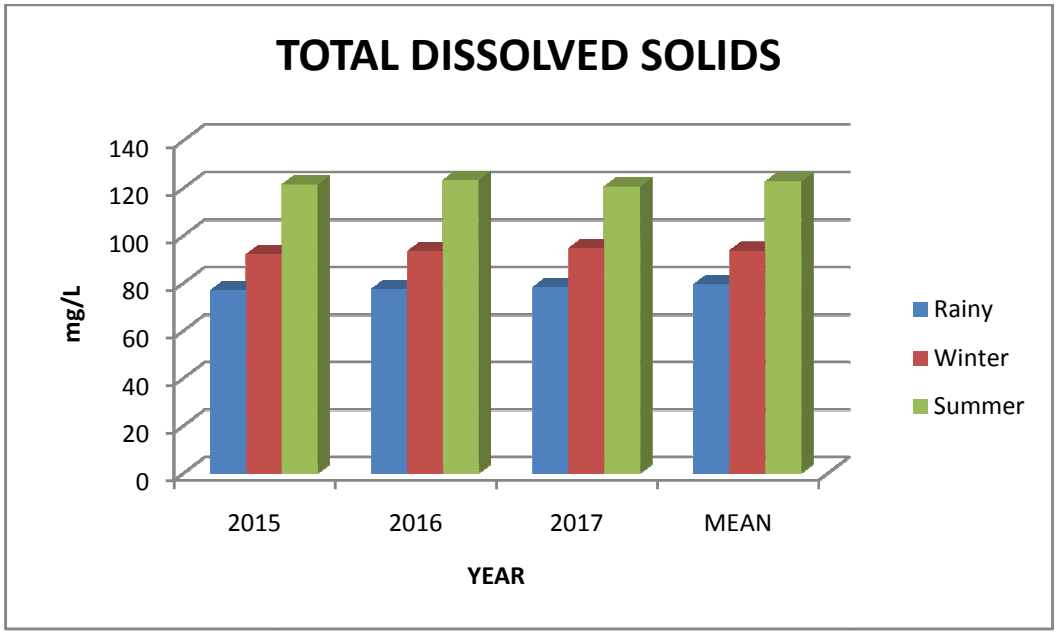
Graph 8:-Showing Maximum and Minimum values of seasonal variation of Electric Conductivity of Similiya village Pond, Kota (July 2015-June 2017).

Table 6 A – Mean values of seasonal variation of Total Dissolved Solids (T. D. S.) from July 2015 to June 2017

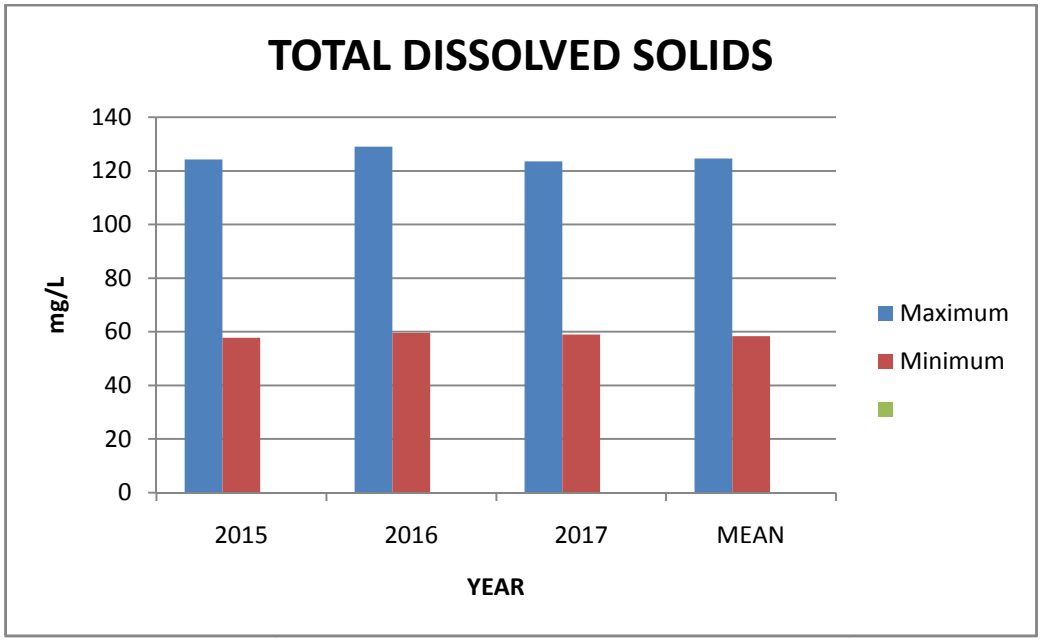
1	Rainy	76.90	77.47	78.14	79.44
2	Winter	92.06	93.34	94.54	93.57
3	Summer	121.42	123.33	120.59	122.66
	Maximum	124.21	128.96	123.56	124.65
	Minimum	57.80	59.50	58.94	58.31

Table 6 B - Analysis of variance for T. D. S.

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	1.64	5.1	0.05	NS
Between seasons	3&6	452.15	4.8	0.05	NS



Graph 9:-Showing yearly seasonal variation and mean of Total Dissolved Solids of Similiya village Pond, Kota (July 2015-June 2017).



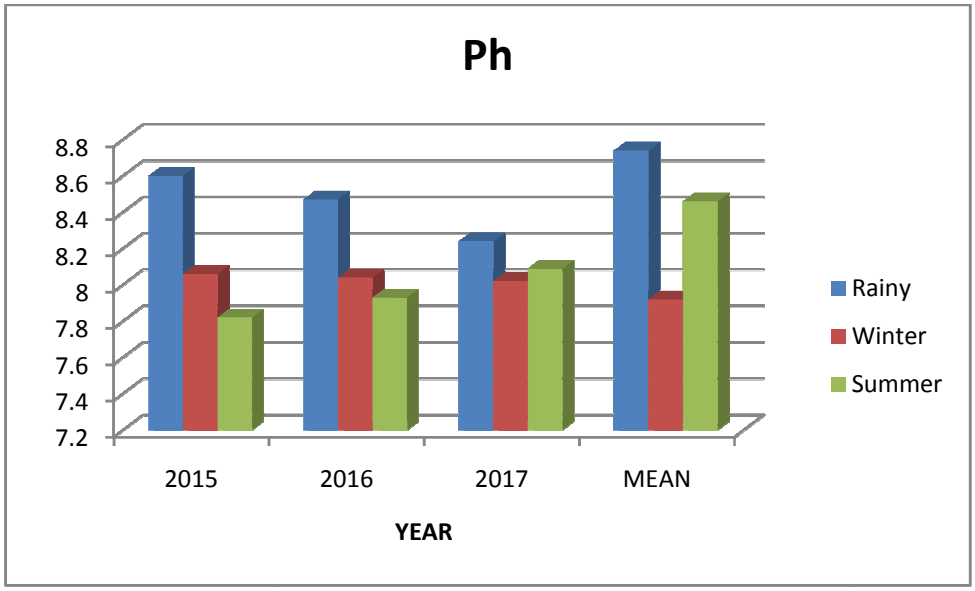
Graph 10:-Showing Maximum and Minimum values of seasonal variation of Total Dissolved Solids of Similiya villagePond, Kota (July 2015-June 2017).

Table 7 A – Mean values of seasonal variation of pH from July 2015 to June 2017

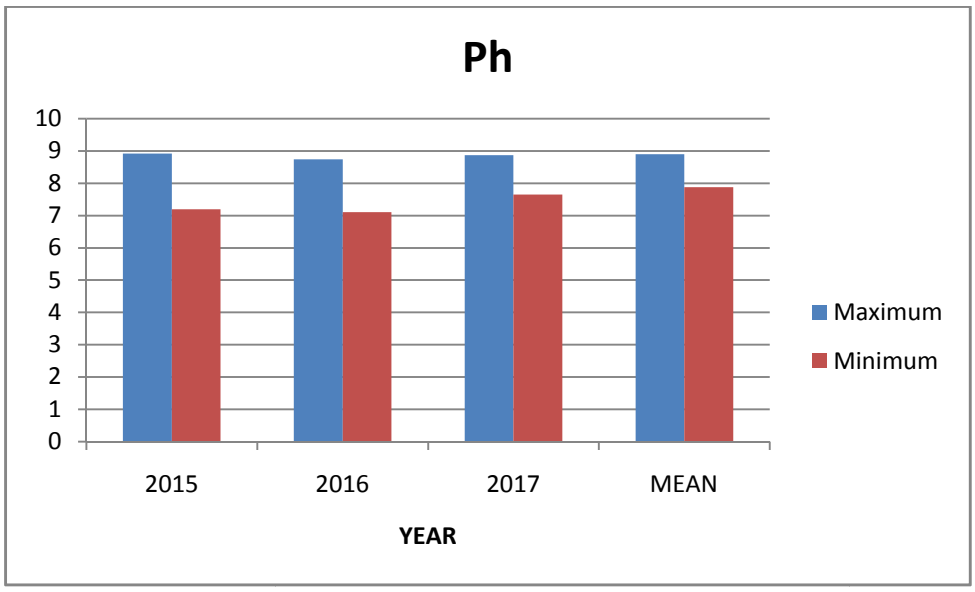
1	Rainy	8.60	8.47	8.24	8.74
2	Winter	8.06	8.04	8.02	7.92
3	Summer	7.82	7.93	8.09	8.46
	Maximum	8.92	8.74	8.87	8.90
	Minimum	7.20	7.11	7.65	7.88

Table 7 B - Analysis of variance for pH

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	0.65	5.1	0.05	NS
Between seasons	3&6	0.26	4.8	0.05	NS



Graph 11:- Showing yearly seasonal variation and mean of pH of Similiya village Pond, Kota (July 2015-June 2017).



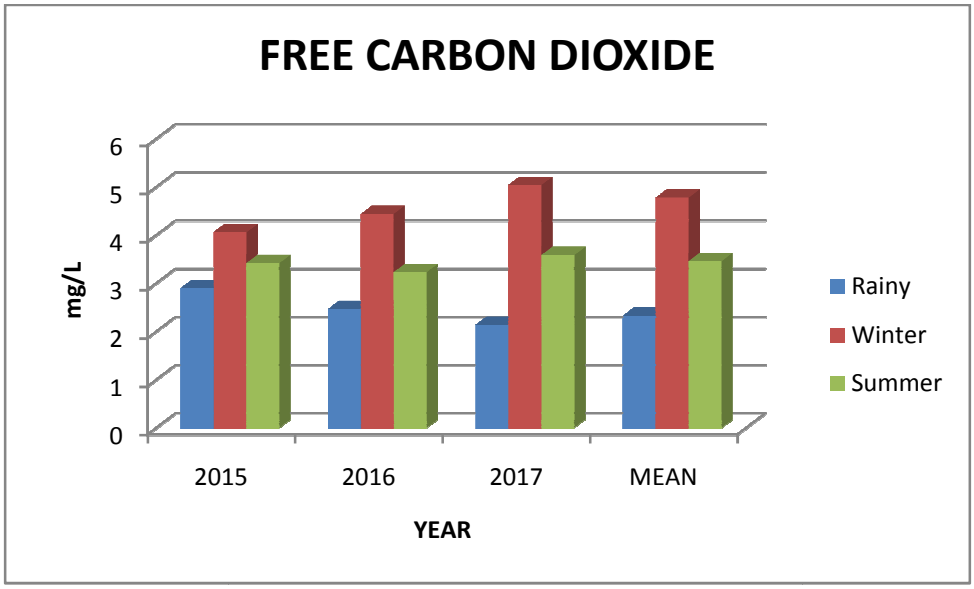
Graph 12:-Showing Maximum and Minimum values of seasonal variation of pH of Similiya village Pond, Kota (July 2015-June 2017).

Table 8 A – Mean values of seasonal variation of Free Carbon dioxide from July 2015 to June 2017

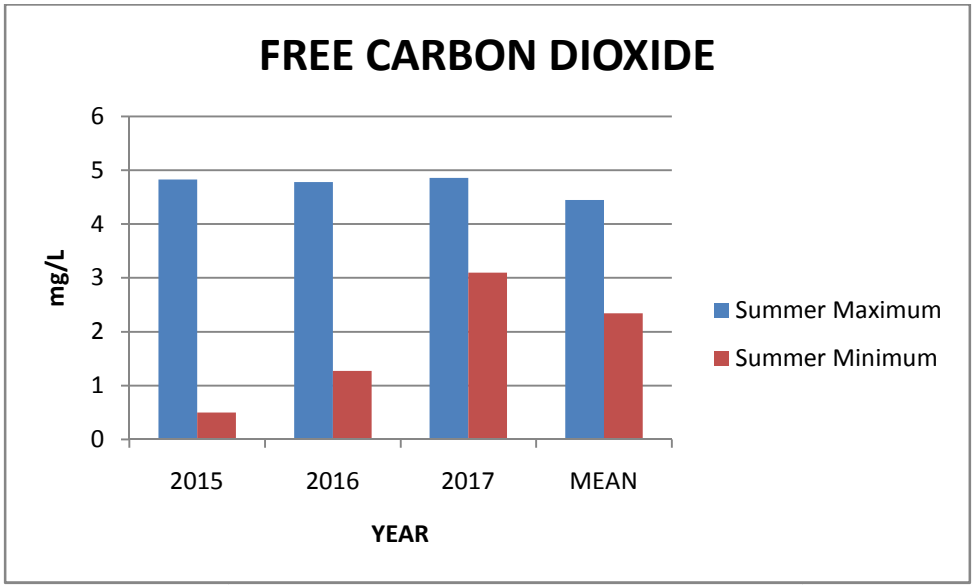
1	Rainy	2.90	2.47	2.14	2.33
2	Winter	4.06	4.44	5.04	4.78
3	Summer	3.42	3.23	3.59	3.46
	Maximum	4.83	4.78	4.86	4.45
	Minimum	0.50	1.27	3.10	2.34

Table 8 B - Analysis of variance for Free Carbon dioxide

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	1.65	5.1	0.05	NS
Between seasons	3&6	0.15	4.8	0.05	NS



Graph 13:- Showing yearly seasonal variation and mean of Free Carbon Dioxide of Similiya village Pond, Kota (July 2015-June 2017).



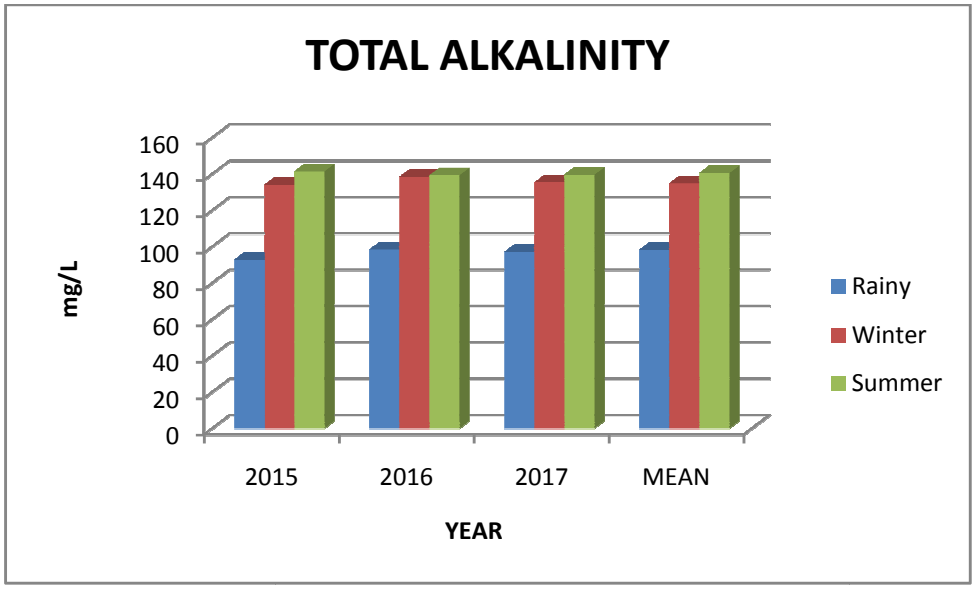
Graph 14:-Showing Maximum and Minimum values of seasonal variation of Free Carbon Dioxide of Similiya village Pond, Kota (July 2015-June 2017).

Table 9 A – Mean values of seasonal variation of Total Alkalinity (mg/l) from July 2015 to June 2017

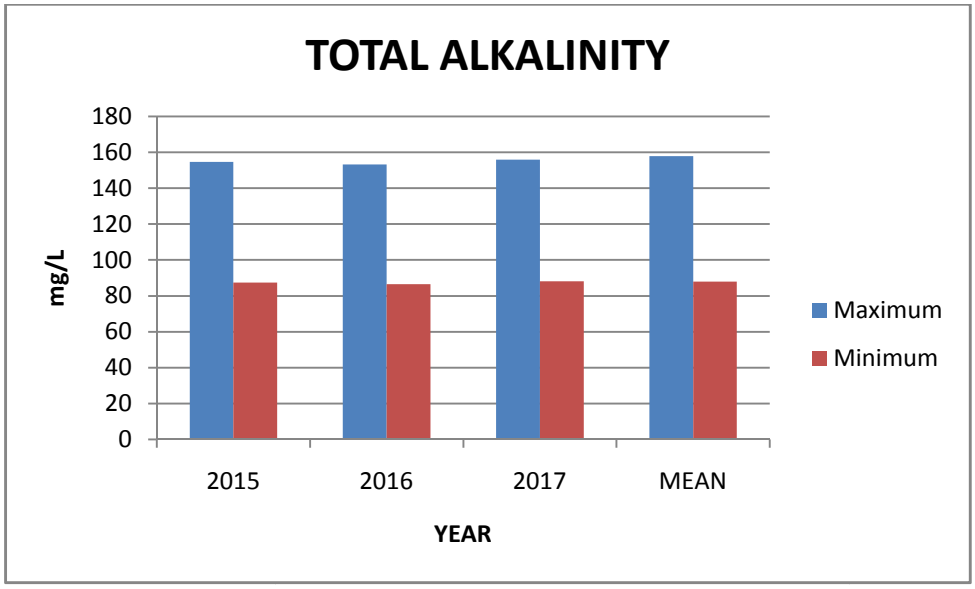
1	Rainy	92.90	98.47	97.14	98.33
2	Winter	134.06	138.44	135.34	134.78
3	Summer	141.42	139.23	139.59	140.46
	Maximum	154.67	153.23	155.87	157.87
	Minimum	87.50	86.44	88.13	87.97

Table 9 B - Analysis of variance for Total Alkalinity

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	0.65	5.1	0.05	NS
Between seasons	3&6	3470.15	4.8	0.05	NS



Graph 15:- Showing yearly seasonal variation and mean of Total Alkalinity of Similiya village Pond, Kota (July 2015-June 2017).



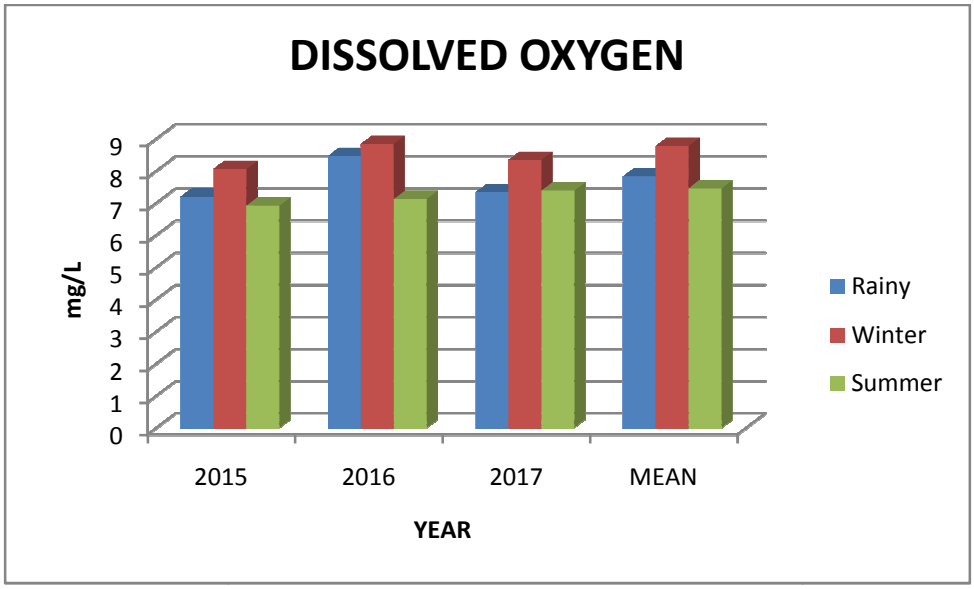
Graph 16:- Showing Maximum and Minimum values of seasonal variation of Total Alkalinity of Similiya village Pond, Kota (July 2015-June 2017).

Table 10 A – Mean values of seasonal variation of Dissolved Oxygen (mg/l) from July 2015 to June 2017

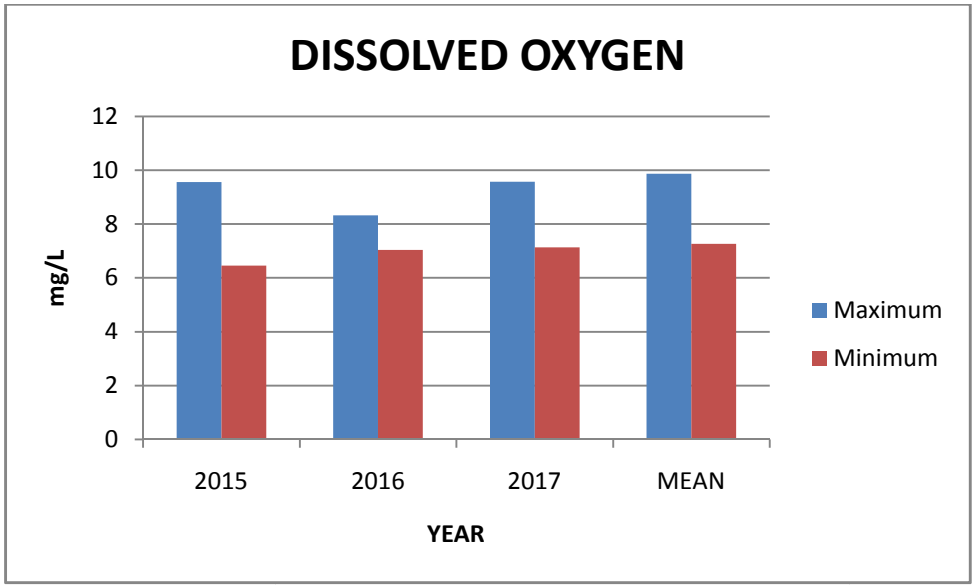
1	Rainy	7.20	8.47	7.34	7.83
2	Winter	8.06	8.84	8.34	8.78
3	Summer	6.92	7.13	7.39	7.46
	Maximum	9.56	8.33	9.57	9.87
	Minimum	6.46	7.04	7.13	7.27

Table 10 B - Analysis of variance for Dissolved Oxygen

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	0.25	5.1	0.05	NS
Between seasons	3&6	5.55	4.8	0.05	NS



Graph 17:-Showing yearly seasonal variation and mean of Dissolved Oxygen of Similiya village Pond, Kota (July 2015-June 2017).



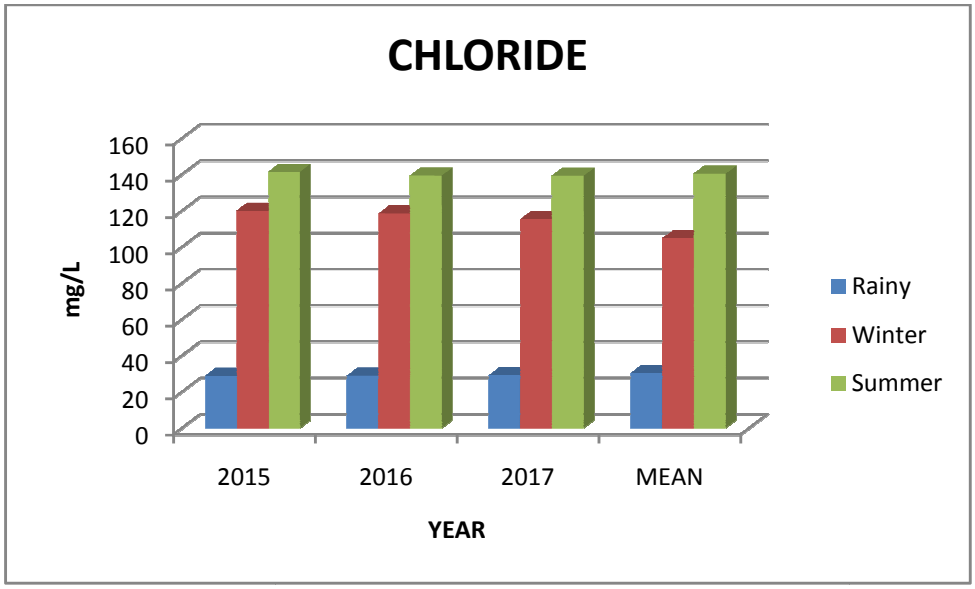
Graph 18:- Showing Maximum and Minimum values of seasonal variation of Dissolved Oxygen of Similiya village Pond, Kota (July 2015-June 2017).

Table 11 A – Mean values of seasonal variation of chloride (mg/l) from July 2015 to June 2017

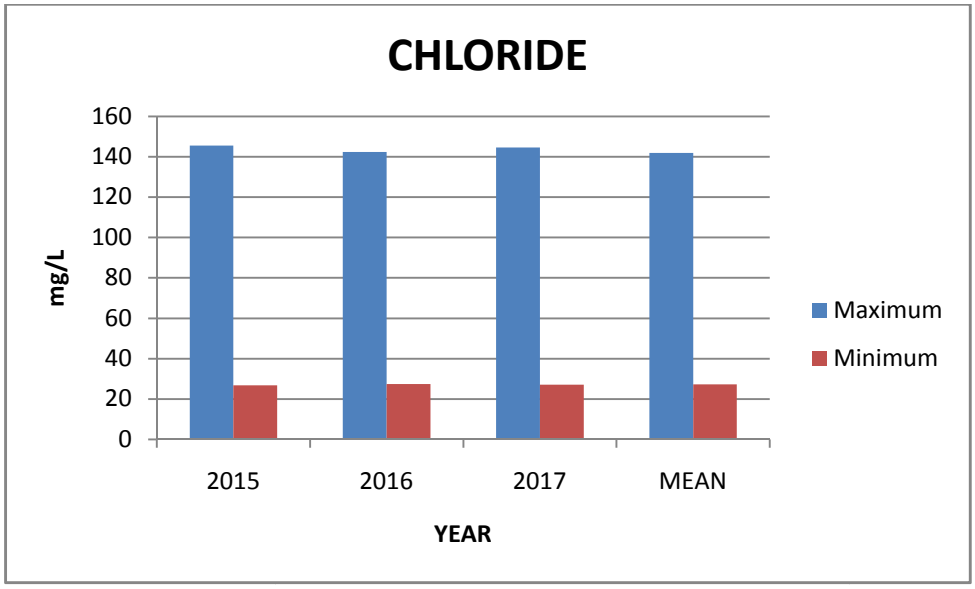
1	Rainy	28.93	28.97	29.14	30.35
2	Winter	120.06	118.44	115.34	104.78
3	Summer	141.52	139.43	139.39	140.48
	Maximum	145.61	142.33	144.57	141.87
	Minimum	26.80	27.44	27.13	27.27

Table 11 B - Analysis of variance for chloride

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	2.22	5.1	0.05	NS
Between seasons	3&6	143.15	4.8	0.05	NS



Graph 19:- Showing yearly seasonal variation and mean of Chloride of Similiya village Pond, Kota (July 2015-June 2017).



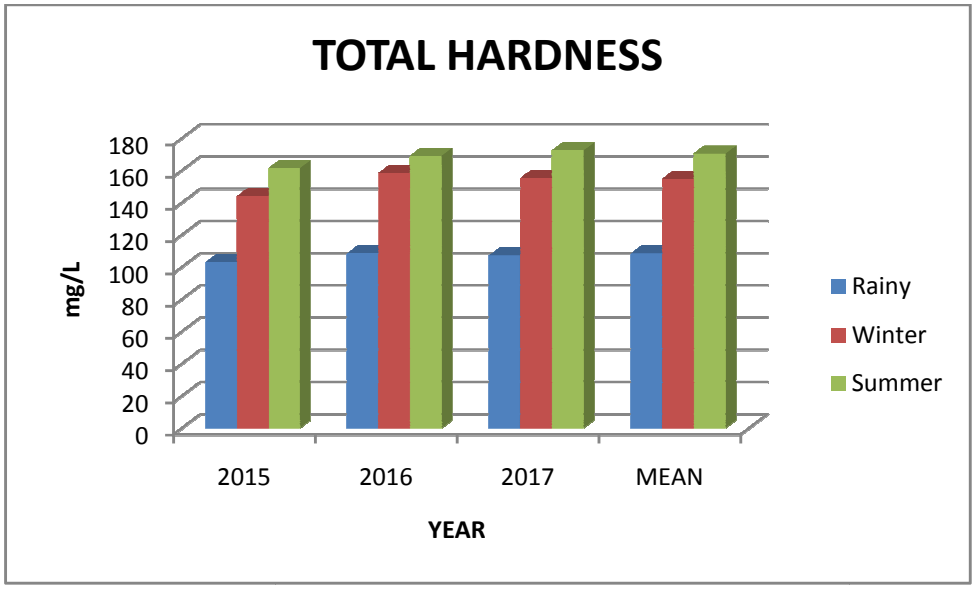
Graph 20:-Showing Maximum and Minimum values of seasonal variation of Chloride of Similiya village Pond, Kota (July 2015-June 2017).

Table 12 A – Mean values of seasonal variation of Total Hardness (mg/l) from July 2015 to June 2017

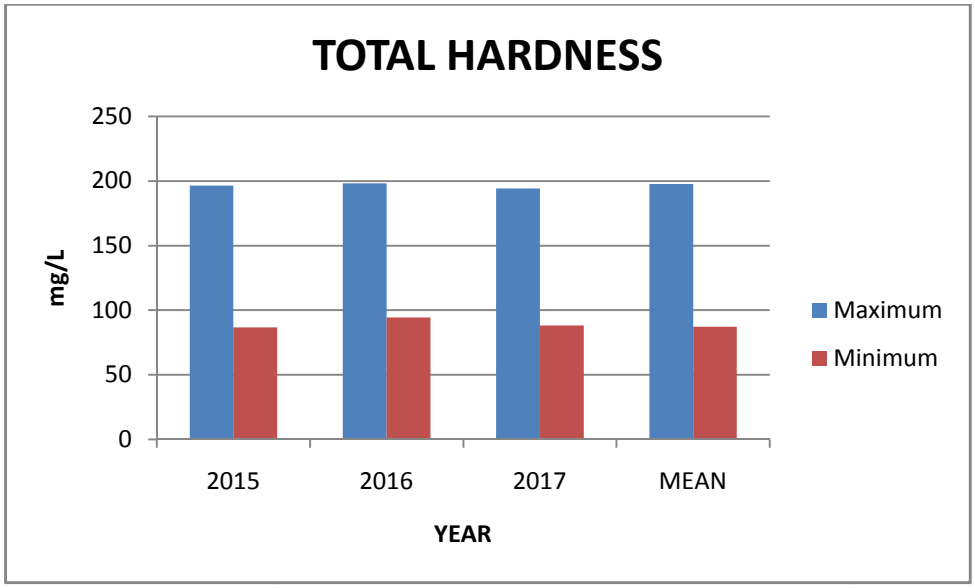
1	Rainy	102.90	108.48	107.24	108.43
2	Winter	144.06	158.44	155.34	154.78
3	Summer	161.42	169.23	172.54	170.56
	Maximum	196.56	198.33	194.37	197.67
	Minimum	86.80	94.44	88.13	87.27

Table 12 B - Analysis of variance for Total Hardness

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	1.02	5.1	0.05	NS
Between seasons	3&6	34.25	4.8	0.05	NS



Graph 21:- Showing yearly seasonal variation and mean of Total Hardness of Similiya village Pond, Kota (July 2015-June 2017).



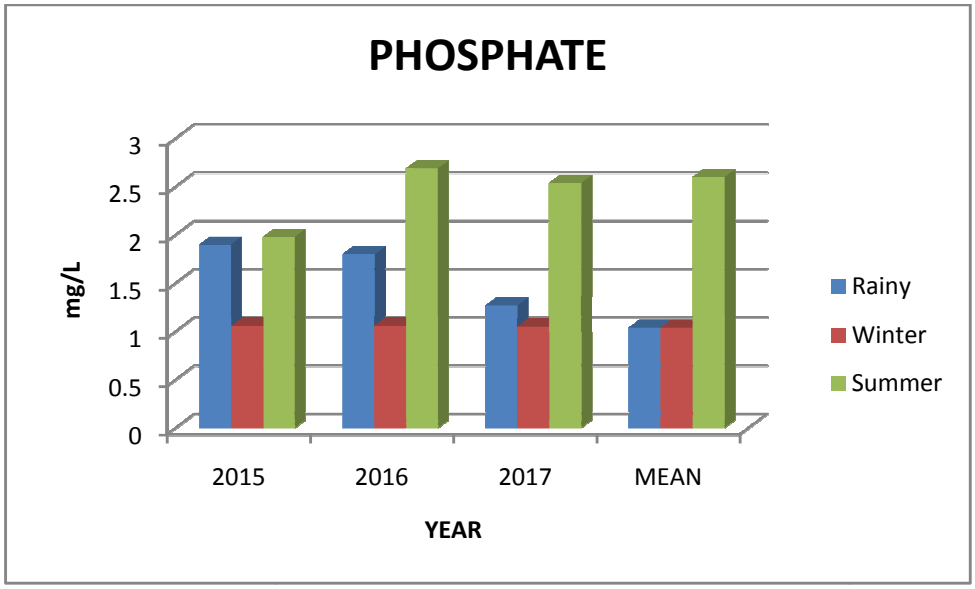
Graph 22:-Showing Maximum and Minimum values of seasonal variation of Total Hardness of Similiya village Pond, Kota (July 2015-June 2017

Table 13 A – Mean values of seasonal variation of Phosphate (mg/l) from July 2015 to June 2017

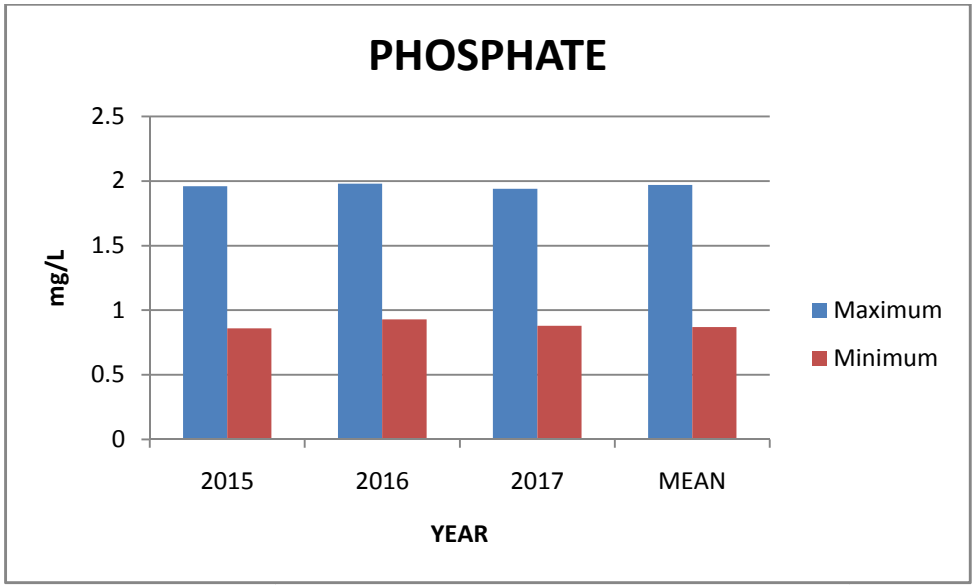
1	Rainy	1.90	1.80	1.27	1.04
2	Winter	1.06	1.06	1.05	1.04
3	Summer	1.98	2.69	2.54	2.60
	Maximum	1.96	1.98	1.94	1.97
	Minimum	0.86	0.93	0.88	0.87

Table 13 B - Analysis of variance for Phosphate

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	5.02	5.1	0.05	NS
Between seasons	3&6	24.35	4.8	0.05	NS



Graph 23:- Showing yearly seasonal variation and mean of Phosphate of Similiya village Pond, Kota (July 2015-June 2017).



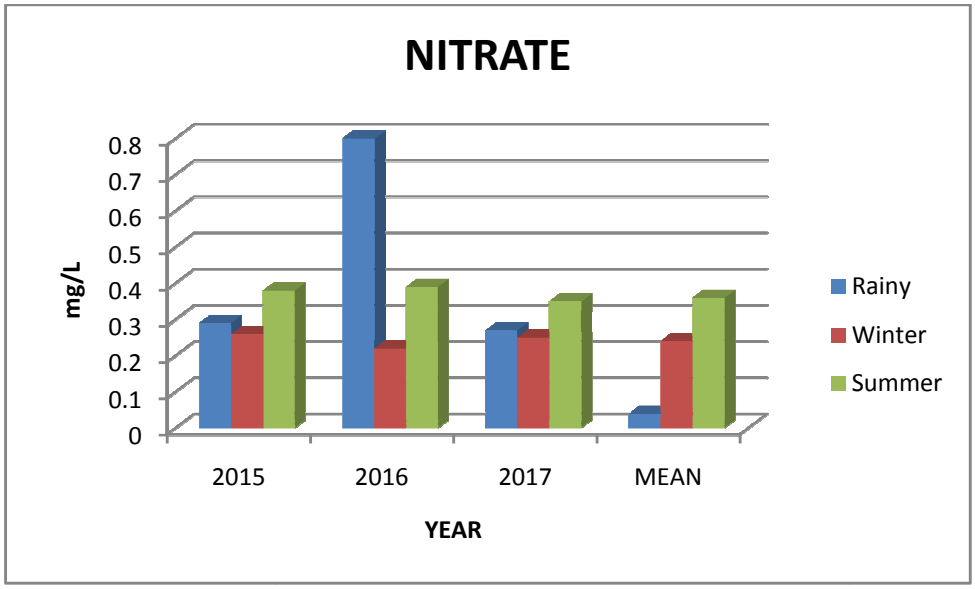
Graph 24:-Showing Maximum and Minimum values of seasonal variation of Phosphate of Similiya village Pond, Kota (July 2015-June 2017).

Table 14 A – Mean values of seasonal variation of Nitrate (mg/l) from July 2015 to June 2017

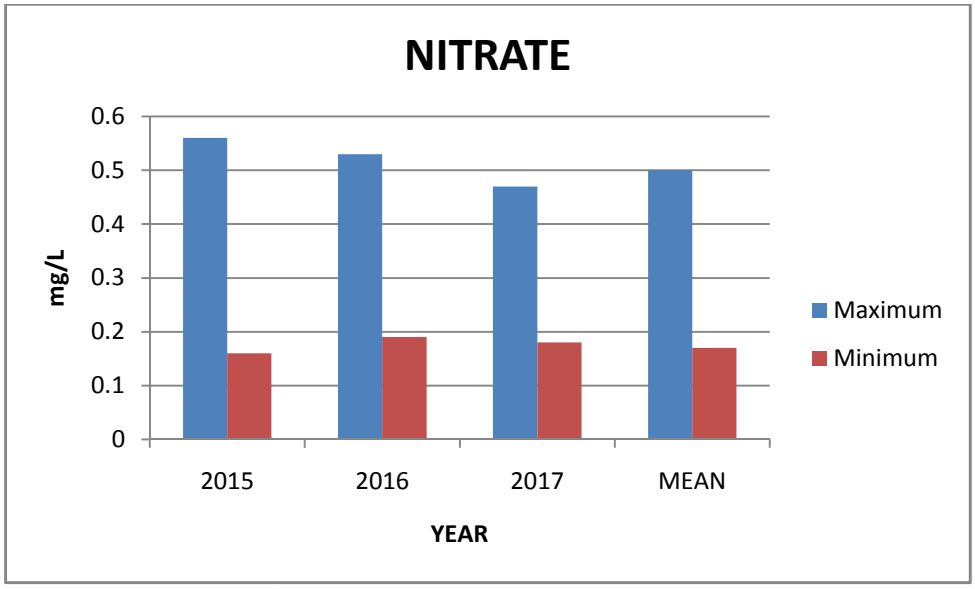
1	Rainy	0.29	0.80	0.27	0.04
2	Winter	0.26	0.22	0.25	0.24
3	Summer	0.38	0.39	0.35	0.36
	Maximum	0.56	0.53	0.47	0.50
	Minimum	0.16	0.19	0.18	0.17

Table 14 B - Analysis of variance for Nitrate

Source of variation	Degree of freedom	Calculated F	Tabulated F	Probability level	Significance level
Between stations	2&6	1.32	5.1	0.05	NS
Between seasons	3&6	1.15	4.8	0.05	NS



Graph 25:- Showing yearly seasonal variation and mean of Nitrate of Similiya Pond, Kota (July 2015-June 2017).



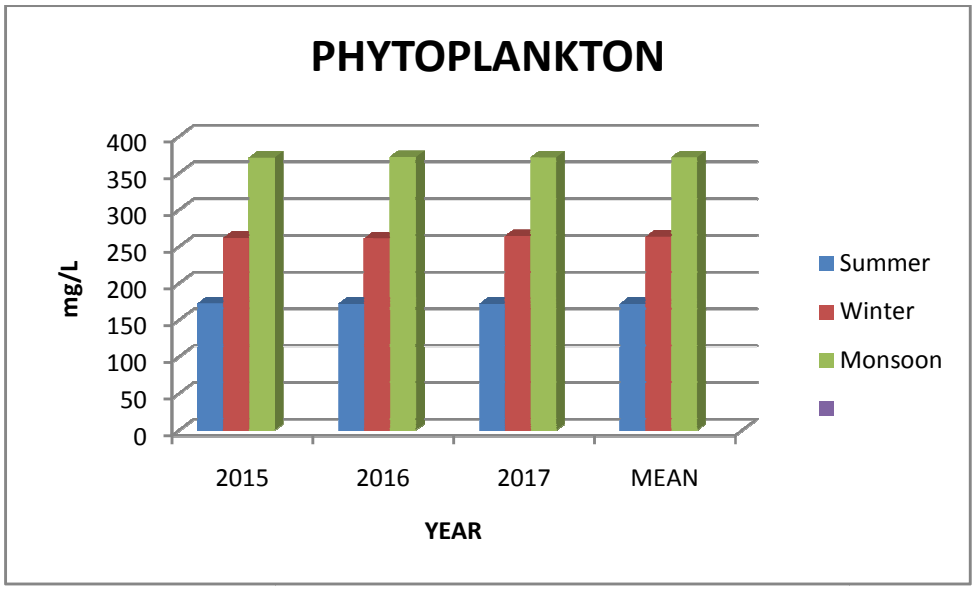
Graph 26:-Showing Maximum and Minimum values of seasonal variation of Nitrate of Similiya village Pond, Kota (July 2015-June 2017).

Table 15 A - Qualitative estimation of Phytoplanktons of Similiya village pond, Kota district, Rajasthan.

Phylum	Class	Family	Genus and species
Chlorophyta	Chlorophyceae	Chlamydomonadaceae	*Chlamydomonas eugametos*
Chlorophyta	Chlorophyceae	Volvocaceae	*Volvox globater*
Chlorophyta	Chlorophyceae	Oedogoniaceae	*Oedogonium nodulosum*
Chlorophyta	Chlorophyceae	Desmediaceae	*Closterium*
Chlorophyta	Chlorophyceae	Zygnemaceae	*Zygnema*
Chlorophyta	Chlorophyceae	Hydrodictyaceae	*Pediastrum duplex*
Chlorophyta	Chlorophyceae	Chaetophoraceae	*Draparnaldiopsis*
Chlorophyta	Chlorophyceae	Chlorellaceae	*Chlorella vulgaris*
Chlorophyta	Chlorophyceae	Zygnemaceae	*Spirogyra karnalae*
Chlorophyta	Chlorophyceae	Zygnemaceae	*Spirogyra varians*
Chlorophyta	Chlorophyceae	Zygnemaceae	*Spirogyra jogensis*
Bacillariophyta	Bacillariophyceae	Melosiraceae	*Melosira varians*
Bacillariophyta	Bacillariophyceae	Pinnulariaceae	*Pinnularia viridis*
Cyanophyta	Cyanophyceae	Chroococcaceae	*Chroococcus turgidis*
Cyanophyta	Cyanophyceae	Oscillatoriaceae	*Oscillatoria princeps*
Cyanophyta	Cyanophyceae	Nostocaceae	*Nostoc muscoru*
Cyanophyta	Cyanophyceae	Scytonemataceae	*Scytonema simplex*
Cyanophyta	Cyanophyceae	Rivulariaceae	*Gloeotrichia indica*
Cyanophyta	Cyanophyceae	Microcystaceae	*Microcystis aeruginosa*
Cyanophyta	Cyanophyceae	Microcystaceae	*Microcystis flosaquae*.
Xanthophyta	Xanthophyceae	Botrydiaceae	*Botrydium granulatum*
Xanthophyta	Xanthophyceae	Vaucheriaceae	*Vaucheria geminata*
Euglenophyta	Euglenophyceae	Euglenoidae	*Euglena viridis*

Table 15 B – Mean values of seasonal variation of Phytoplankton

1	Summer	172.90	172.47	172.14	172.44
2	Winter	262.06	261.44	264.54	263.77
3	Monsoon	371.42	372.23	371.59	371.66



Graph 27: -Showing yearly seasonal variation and mean of Phytoplankton of Similiya village Pond, Kota (July 2015-June 2017).

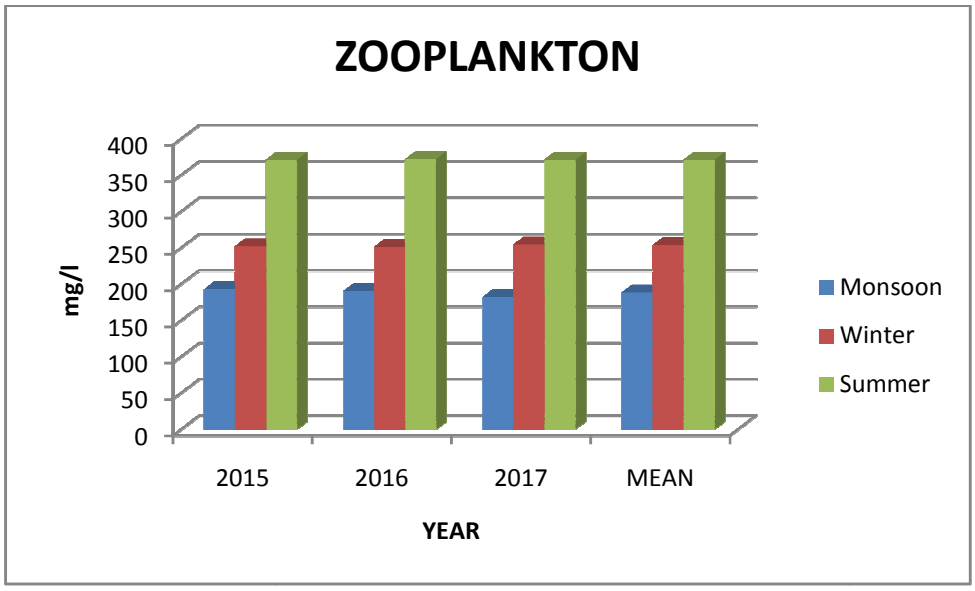
Table 16 A - Qualitative estimation of Zooplanktons of Similiya village pond, Kota district, Rajasthan.

Phylum	Class	Family	Genus and species
Protozoa	Ciliata	Parameciidae	*Paramecium caudatum*
Protozoa	Ciliata	Vorlicelldae	*Vorticella campanula*
Protozoa	Ciliata	Oxytrichidae	*Oxytricha ovalis*
Protozoa	Ciliata	Tracheliudae	*Trachelius ovum*
Protozoa	Ciliata	Enchelyidae	*Lacrymaria olor*
Protozoa	Ciliata	Ophryoglenidae	*Ophryoglena flava*
Rotifera	Monogonata	Brachionidae	*Brachionus calcyflorus*
Rotifera	Monogonata	Brachionidae	*Bbrachionus forficula*
Rotifera	Monogonata	Brachionidae	*Kertella tropica*
Rotifera	Monogonata	Brachionidae	*Kertella procurva*
Rotifera	Monogonata	Brachionidae	*Notholca sp.*
Rotifera	Monogonata	Lacanidae	*Lecane sp.*
Rotifera	Monogonata	Lacanidae	*Monostyla bulla*
Rotifera	Monogonata	Notommatidae	*Scaridium longicaudum*
Arthropoda	Crustacea	Streptocephalidae	*Streptocephalus dichotomus*
Arthropoda	Crustacea	Triopsidae	*Triops longicaudatus*
Arthropoda	Crustacea	Daphinidae	*Daphnia carinata*
Arthropoda	Crustacea	Daphinidae	*Moina dubia*
Arthropoda	Crustacea	Daphinidae	*Simocephalus sp.*
Arthropoda	Crustacea	Daphinidae	*Ceriodaphnia sp.*
Arthropoda	Crustacea	Cypridinidae	*Ostracode*
Arthropoda	Crustacea	Cypridinidae	*Heterocypris*
Arthropoda	Crustacea	Diatomidae	*Heliodiaptomus viduus*
Arthropoda	Crustacea	Diatomidae	*Phyllodiaptomus annae*
Arthropoda	Crustacea	Diatomidae	*Spicodiaptomus chelospinus*
Arthropoda	Crustacea	Canthocamptidae	*Cletocamptus albuquerquensis*

Arthropoda	Crustacea	Cyclopidae	*Mesocyclops leuckart*
Arthropoda	Crustacea	Cyclopidae	*Mesocyclops hyalinus*

Table 16 B- Mean values of Seasonal variation of Zooplankton

1	Monsoon	192.90	190.47	182.14	188.44
2	Winter	252.05	251.44	254.54	253.77
3	Summer	371.42	372.23	371.59	371.55



Graph 28: - Showing yearly seasonal variation and mean of Zooplankton of Similiya village Pond, Kota (July 2015-June 2017).

CHAPTER V

DISCUSSION

Chapter 5

DISCUSSION

Water is precious for living organisms on this earth. The available freshwater to man is hardly 0.3 to 0.5 % and therefore its judicious use is imperative. In today's scenario, unplanned urbanization, rapid indiscriminate use of artificial chemicals causes of heavy varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic fauna. Deterioration of the water quality is now a global problem (Mahananda et.al. 2010). The physico-chemical parameters have important significance in determining the water quality of aquatic habitat (Sharma 2009). Current study was under taken to investigate water quality of Similiya pond because of its importance in ground water recharging, irrigation and drinking purpose. Among physico-chemical factors influencing the aquatic productivity, temperature, pH, alkalinity, DO, CO_2, conductivity and dissolved inorganic nutrients like phosphate are considered to be important.

Atmospheric Temperature:-

Temperature is one of the most important factors in an aquatic environment. Temperature affects the physiology of living things as well as the density and state of water. It exerts an important influence on living organisms because few can survive at temperature below 0 ˚C (32 ˚F) due to metabolic constrains. Changes in an air temperature affect the water temperature (Kumar 1997). The Atmospheric Temperature in the present study ranged between from 23.1 to 36.6 ˚C. similar results were found by Laishram and dey (2014) in the study of Loktok Lake Manipur. Kaushik and saksena (1999) also noted the same results at Motijheel 12 ˚C to 43.8 ˚C.

Atmospheric Relative humidity:-

Relative humidity is the ratio of the partial pressure of water vapour to the equilibirium vapor pressure of water at a given temperature. The mean lowest humidity was 40.9 % and highest was 78.9 %.

Water Temperature:-

Water temperature plays an important role in the ponds. The variation in the temperature was influenced by the factors such as air temperature, humidity, and solar energy. Temperature fluctuation also affects the zooplanktons and phytoplankton. Due to shallowness of the ponds and influx of the channel water, the temperature varies diurnally and seasonally. The temperature value is determined by the amount of solar energy absorbed by the mass of water and by soil and air surrounding it as well as by evaporation on its surface. Temperature plays and important role in the biological balance and the solubility of oxygen and mineral salts. In the present study temperature was found ranging from 21.7 ˚C to 29 ˚C. Many researchers observed similar trends while working on the different ponds (Tidame & Shinde 2012) water temperature is very important because it influence the biota in a water body. All the metabolic and physicochemical activities of life process are greatly influenced by temperature. The atmospheric temperature is always higher than the water temperature (Verma & Khan 2015, Kangabham et. al. 2017). Temperature can be considered as the controlling factor for the nutrientavailability as well as the pattern of life growth of zooplanktons (Devi 2017). Similar results were found by Kiran (2010) water temperature ranged from 27.8 ˚C to 31.9 ˚C (Kumar et al. 2017). Dixit et al. 2015 reported range of temperature 20.9 ˚C to 33.8 ˚C.

Transparency:-

Light penetration into a water body is influenced by turbidity and the extent of light penetration determines depth of euphotic zone in a water body. The depths of visibility give firsthand information regarding water quality . In the present study, the depth of visibility varied between 13.43 cm to 83.55 cm which is maximum in winter season and minimum summer season.

Transparent water allow more light penetration which has for reaching effects on all aquatic organisms including their development, distribution and behavior (Kaushik & Saxena 1999). Transparency was found to be higher in winter is due to better penetration of light while it is low in pre monsoon season

because of the abundance of floating plankton on the surface water (Khan & Choudhary 1994) reported higher value of transparency during winter season.

Conductivity:-

Conductivity is defined as the ability of a substance to carry electrons. In the water this capacity is influenced by the amount of dissolved salts and the temperature (Lucas et. al. 2017). The conductivity ranged from 120.60 to 392.67 micro mhos / cm. Electric conductivity shows significantly negative relation with chlorine and salinity (Nag and Gupta 2014). The conductivity of water is affected by the presence of inorganic solids such as chloride, nitrate, sulfate, phosphate anions or sodium, magnesium, calcium, iron and aluminum cations (Mishra et.al. 2014) (Dixit et.al. 2015). Electric conductivity is a useful tool to evaluate the purity of water (Acharya et. al. 2008). The source of electric conductivity may be abundance of dissolved salts due to poor irrigation management, minerals from rain water runoff or other discharges (Sajitha et. al. 2016). The value fall within the WHO limits, so the water would be regarded safe.

Total Dissolved Solids (TDS):-

Total dissolved solids denote mainly the various kinds of minerals present in the water. TDS indicate the salinity behavior of ground water (Gohar 2002). TDS ranged between 57.80 to 128.96 mg/L maximum in summer season and minimum in rainy season. A similar result was found by Darasingh and Laxmi (2014). A high content of dissolved solids elevates of fresh water and regulates osmoregulation of freshwater organisms. TDS enriches the nutrients states of water body which leads to eutrophication of the aquatic system (Ganesh et. al. 2015). In water TDS are composed mainly of carbonate, bicarbonates, chloride, phosphate, and nitrate of calcium, magnesium, organic salts and other particles (Mahananda et.al. 2010). High TDS values imply the increased nutrients status of water body which leads to eutrophication of aquatic bodies reported by Swarnalatha et al. (1998) (Singh et.al. 2005). Total dissolved Solids value was under the permissible values of Indian standard (500-2000) and WHO (500).

pH :-

The pH of a solution refers to its hydrogen ion activity and is expressed as the reciprocal of the hydrogen ion activity at a given temperature. pH is an important factor in determining of productivity of an ecosystem (Singh et. al. 2009). In the present study highest value of pH was recorded 7.11 to 8.92. High pH value was recorded in rainy season because of pH shows highly significant positive relationship with chlorinity, salinity and COD (Nag and Gupta 2014). Utilization of bicarbonate and carbonate buffer system due to evaporation of water (Darasingh and Laxmi 2014). The low pH indicates acidity nature which is due to the deposition of acid forming substance. pH as a sink for nutrients and play an important role in phytosanitation (Kangabam et. al. 2017). Similar results were observed by (Bisht et al. 2014). (D.V. and H.L. 2017) considered pH as an indicator of overall productivity. The changes of Ph values indicate the alkaline nature of water might be due to high temperature that reduces the solubility of carbon dioxide in water (Mahananda et al. 2010). Similar results (Tidame and Shinde 2012). pH limits laid by Indian standard (6.5- 8.5) and WHO standard (7-8).

Free CO_2:-

CO_2 is vital for the life of plant and microorganisms. It is produced as a result of respiration of aquatic organisms. As CO_2 is highly soluble in water, it is found to be in larger amount in polluted water as compared to fresh water bodies. A part from its important role in photosynthesis of primary fish food organisms free CO_2 has interdependence with pH and bicarbonate- carbonate equilibrium. However if present in higher concentration, it may exert adverse effect on respiration and other physiological functions of aquatic life (Chattopadhyay 1998). Ellies (1937) stated that the water supporting good fish population usually contain less than 5 ppm free CO_2. In the present investigation free CO_2 is recorded 0.50 to 4.86 mg/l. Highest in the winter season and lowest in rainy season. DV and HL (2017) found free CO_2 from 3.81 to 6.81 mg/L. Kumar et al. (2017) found similar results. Free CO_2 recorded its presence in some winter months (November and January) which may be associated with low temperature, decrease water level.

Dwivedi and Pandey (2002) found the free CO_2 high in pre-monsoon and monsoon period and low in winter season. Rain also absorbs small amount of gas and delivers it to the water on which it falls (Kaushik and saksena 1999). The high value of free CO_2 in monsoon may be due to high rate of composition of organic matters by bacteria resulting in rapid production of CO_2 (Pandey et al. 1999). Kosygin et al.2007 also observed highest value of free CO_2 in monsoon and lowest in winter.(Kiran 2010)

Total Alkalinity:-

The alkalinity of surface water is primarily a function of carbonates hydroxide content and also includes the contributions from borates, phosphates, silicates and other bases. Alkalinity is a measure of the capacity of water to neutralize a strong acid (Wetzel 1983). Alkalinity is influenced by the pH the general composition of water, the temperature and the ionic strength. Total alkalinity of the water sample ranges 86.44 to 157.87 mg/L. The alkalinity values were maximum during summer and minimum in monsoon. The values obtained were low than the Indian Standard (200-600) and WHO Standard (100-200). The decrease in alkalinity was due to dilution caused by the rain water during monsoon (Verma and Khan 2015). The results is also in close conformity with the findings (Mishra et. al. 2013) (Darasingh and Laxmi 2014) (Laishram and Dey 2014). According (Yadav et. al. 2013) (Chakraborty et. al. 2017) alkalinity is most natural water estimates the amount of carbonates and bicarbonates whose salts get hydrolyzed in solution and produced hydroxyl ions. pH is an important factor in determining the productivity of an ecosystem (Singh et. al. 2009).

Dissolved Oxygen:-

Dissolved Oxygen is one of the parameter in water quality assessment .It's presence is essential to maintain the higher form of biological life in the water. The wastewater is largely determined largely by the oxygen balance in the system. Oxygen is formed by the absorption from the atmosphere at the surface of pond and by photosynthesis of the chlorophyll bearing organisms inhibiting in water body. Dissolved oxygen is very important component to break down man made

pollutants. The presence of dissolved oxygen is vitally essential to maintain the higher forms of lives balancing different pollutions which make the aquatic bodies' healthy (Dixit et. al. 2015). The dissolved oxygen is obtained from this study had ranged between 6.46 to 9.87 mg/L. Highest values in winter season and lowest in summer season. Results of the present study were similar to other (Laishram and Dey 2014).

Dissolved Oxygen was found to be higher in winter season (Dhanasekaran et. al. 2017). The high value of dissolved oxygen during winter season may be due to growth of large quantity of aquatic plants and the low value of oxygen for metabolic activities by the increasing growth of bacteria (Pandey et al. 1999). The low level of dissolved oxygen in water bodies in winter season reflects the richness of organic matter which consumes large amount of dissolved oxygen in the process of decomposition (Bisht et al. 2014). A significant positive correlation between dissolved oxygen and phytoplankton density may be due to its evolution from the latter through photosynthesis (Maheshwari et al. 2015).

Chloride:-

Chloride is an anion occurs in all natural waters in widely varying concentration. The origin of chloride in surface water is from weathering and leaching of sedimentary rocks, domestic and industrial waste discharge, municipal influence etc. In the present investigation the values of chloride recorded were as 26.8 to 145.61 mg/L. Concentration of chloride was highest in summer season and lowest in rainy season. The values obtained were low than the Indian Standard (250-1000) and WHO Standard (250). Concentration of chloride ions is maximum in winter season and minimum in rainy season. Similar results were recorded (Sajitha et .al. 2016).

The chloride content was its peak in summer and occurs down during rainy season (Verma and Khan 2015). The higher chloride in summer is due to the discharge of domestic sewage from the surrounding area (Qureshimata et. al. 2015) (Ganesh et. al. 2015) (Kumar et. al. 2017).

Chloride is an important indicator of organic pollution (Swarnkar and Choubey 2013) (Selvomohan et.al. 2014). The ecological significance of chloride lies in its potential to regulate salinity of water. Most of the water soluble salts in a pond environment generally remain in chloride form and hence the amount of chloride ions in pond waters very closely the amount of soluble salt presents (Nag and Gupta 2014).

Total Hardness:-

Total Hardness of water the parameters used to describe the effect of dissolved minerals. Hardness is generally governed by calcium and magnesium salts which largely combines with bicarbonates and carbonates giving temporary hardness and with the sulphates, chlorides and other anions of a mineral acids causing permanent hardness. In the present investigation the total hardness was recorded in the range of 86.80 to 197.67 mg/l. On the basis of observation the value of total hardness was under the permissible valueof Indian Standard (187-500) and more than the WHO Standard (100). Value of Total Hardness in summer season is high and low in rainy season. Similar results were found by Verma and Khan (2015). High values of hardness during summer can be attributing to low water level and high rate of water evaporation.

Phosphate:-

Phosphates are essential nutrients which are known to contribute in the process of eutrophication when these are present in excessive amount. In the present study maximum phosphate content was 0.86 to 1.97 mg/l. Higher values of phosphate in summer may be an account of reduced volume of water due to evaporation, the increased density of biota, which produce metabolic waste, high temperature and high biodegradation releasing this nutrients from the sediment (Darasing and Laxmi 2014).

Phosphate varied from 0.0 (september-november, january-febuary) to 0.0564 mg/L (may). A very low value of phosphate recorded in winter and spring resulted from its utilization by the algal plankton for photosynthesis. The high

value of phosphate 2 to 7 mg/L was due to discharge of domestic sewage or leaching of fertilizers used in nearby agricultural field (Mishra et. al. 2014) (Selvamohan et. al. 2014).(Kiran 2010) found phosphate level 0.51 to 1.28 mg/L. The phosphate is added to ponds from the domestic waste.

Nitrate:-

Nitrate is an essential nutrient but also a good indicator of contamination from natural and human activities. It also plays an important role in primary production. Nitrate concentration in groundwater and surface water is normally low but can reach high levels as a result of agricultural runoff or contamination with human or animal waste (Nas B 2006).Nitrates are important nutrients governed by geological conditions, organic load and rate of mineralization in water body. Nitrates are the highest oxidized form of nitrogen. Nitrate plays and important role in the process of eutrophication and is enriched by domestic sewage and agricultural runoff coming catchment area. High concentration of nitrate beyond 40 ppm is toxic.In the present study the value nitrate was 0.16 to 0.56 mg/l which is maximum in summer season and lowest in rainy season.The nitrate level was maximum during pre-monsoon season and post-monsoon (Kumar et. al. 2017) (Devi et. al. 2013).

The highest amount of nitrate concentration was known to support the formation of bloom's (Solanki 2001). The highest amount of nitrate was recorded during the summer season was 9.31 mg/L because of high vegetation which supported the growth of plankton and forming blooms during summer (Shastry et. al. 1970)**.**

PLANKTONS

Aquatic ecosystem harbours a variety of plankton communities which constitute characteristics and functioning of the ecosystem in terms of maintaining productivity and food chain. The density and diversity of plankton could be used as indication of quality of water with reference to pollution.

PHYTOPLANKTONS

Phytoplankton plays an important role as primary producers in the fresh water ecosystem. Phytoplankton represent more comprehensive index of the environmental conditions. During the present investigation 22 genera of phytoplankton were recorded from four divisions namely Cyanophyceae, Chlorophyceae, Bacillariophyceae and Euglenophyceae. Chlorophyceae was the dominant group. Maximum phytoplankton was observed in the May, September and October. Gautam (1989) and Razzaque *et al*. (1995) also observed similar findings.. Kumawat and Jawle (2003) recorded 59 genera of phytoplankton from a fish pond at Anjale. Ranga *et al*. (2006) recorded 93 species of phytoplankton in Pushkar Srovar.

Diversity of plankton population is fairly dependent on quality of water and climatic factors. Various physico-chemical and biological characteristics are to be simultaneously taken into consideration for understanding the fluctuation of plankton population. Tripathy and Panday (1990) reported that high water temperature, phosphate, nitrate, low dissolved oxygen and free carbon dioxide supported the growth of Euglenophyceae.. However, Zafar (1964) relates the growth of Chlorophycean with increased organic matter supplied in rainy season and high dissolved content. During the present investigation maximum diversity of phytoplanktons were recorded in summer season. The chlorophyceae forms started increasing in summer and persisted up to the end of rainy season. Most of studies have reported similar behavior of chlorophyceae (Zafar, 1964). Hutchinson (1975) observed that blue green algae generally found in eutrophic water.Vyas (1968) recorded the lowest diversity of green algae during the rainy season in a lake of Udaipur. Sharan *et al.* (2004) observed seasonal variation of phytoplankton in tropical fresh water.

ZOOPLANKTONS

In aquatic ecosystem zooplanktons play a critical role only in converting plant food into animal food but also they themselves serve as source of food for higher organisms. Zooplanktons provide the main food for fishes and can be used as indicators of the trophic status of water bodies (Verma and Munshi, 1987).

During the present investigation 30 genera of zooplanktons were recorded, which were represented by groups of Rotifers, Cladocerans, Copepods, Protozoans and Ostracods. Moitra and Bhowmik (1968) observed members of three main zooplnaktonic group, Rotifera, Cladocera and Copepoda, which dominant in fresh water fish pond in Kalyani, west Bengal. Agrarwal (1978) reported five genera amongst zooplankton population of Janaktal at Gwailor. In Ramaua Reservoir four genera of rotifera and cladocera and two genera under copepoda were observed by Agarwal (1980).

Maruthanayagam *et al*. (2003) studied the season specific zooplankton diversity in Thirukkulam pond, Mayiladuthurai, Tamilnadu, India. Jha and Barat (2003) carried out a qualitative analysis of zooplankton in Lake Mirik in Darjeeling, Himalayas. However, Pathak and Mudgal (2004) observed five genera of rotifers, three genera of cladocerans and otracodes and two genera each in respect of protozoans and copepods in Virla reservoir, Madhya Pradesh.

Rotifers was found prominent group among the zooplanktons. These findings are in agreement with Jana and Sarkar (1971), Chakroborty ans Asthana (1989), Kohli *et al.* (1982) and Balkhi *et al.* (1987). High incidence of rotifers in summer season indicating the influence of temperature was noticed by Sinha and Sinha (1983), Kaushik and Sharma (1994). Takamura *et al*. (1989) reported growth of rotifers in lake and reservoir indicating eutrophic condition. Similar finding were finding were observed in the present investigation. Pathak and Mudgal (2004) noticed dominance of rotifers followed by copepods in Virla reservoir at Madhya Pradesh. In the present study larvae of copepods (Nauplius) were available round the year and adults were maximum in the summer season.

These authors suggested that the high diversity of zooplankton in the pond is not due to the absence of organism of higher trophical level.

During present study zooplanktons were abundant during summer season and lower during rainy season. This might be attributed to the high water temperature. Similar findings were observed by Singh (1990) and Srivastava *et al.* (1990).

CHAPTER VI

CONCLUSION

Chapter 6

CONCLUSION

1. Ecological study of Similiya Pond, Kota, Rajasthan, India, was conducted.
2. The study was conducted on the physico-chemical and biological parameters of the Pond under study.
3. Investigation shows that there is significant amount of pollution in the tank under study and analysis of data obtained revealed that this tank is eutrophic in nature.
4. The physico-chemical factors showed considerable variation both monthly and seasonly.
5. The investigation of biological cherecteristics includes the qualitative estimation of phytoplankton, zooplanktons and macroinvertebrates.
6. Qualitative estimation of zooplanktons showed that 29 genera are represented by groups of Rotifers, Cladocerans, Copepods, Protozoans and Ostracods.
7. The data regarding physico-chemical factors were subjected to statistical analysis. Correlations between various physico-chemical factors were calculated and it was found that most of the parameters are correlated with each other significantly.

SUGGESTIONS AND RECOMMENDATIONS

The researcher feels at this juncture that it is right time for making some common efforts (government and public) for this important and historical Similiya Pond of Kota.

Certain suggestions and recommendations are being recorded in the following points for the betterment of the tank.

1. The domestic sewage and garbage which is being dumped into the pond presently should be diverted to some place far away from the tank to avoid the contamination of water.
2. It is also desirable that a certain water level should be maintained in the pond round the year
3. In the summer season usually the surface the water of the pond is covered by water hycynth and algal blooms. Measures should be taken to avoid this situation.
4. It is a common observation that all the religious festivals immerse some or other objects into the Similya Pond, which causes pollution of various kinds. This

should be stopped with the awareness and people's participation and awareness for better health of the tank.

5. Generally, fishing may be prohibited round the year so as to maintain the ecosystem of the water body.

Chapter VII

SUMMARY

Chapter VII

SUMMARY

ECOLOGICAL STUDIES OF A VILLAGE POND OF SIMLIYA, DISTRICT KOTA, RAJASTHAN

Ecology is the study of the structural and functional interrelationships of organisms and surrounding dynamic physical, chemical and biotic environment. An ecological study of a small village pond, near Village Simliya, District Kota, Rajasthan was conducted for three years from 2014 to17 covering all three prevailing seasons (Summers, Monsoon and Winters. The Simliya village pond is in a transitional stage between conditions of a perennial and temporary (empirical) aquatic ecosystem. The physical, chemical factors were analysed and biological factors were studied.

(1). STUDY SITE AND SAMPLING SITES

1. The Simaliya village pond is a natural pond located in south of Kota District headquarters at a distance of 35 km on NH 27.
2. Main objectives of the Research were to put on record benchmark data regarding ecological aspect of the pond selected for study by:-
    - ❖ Collection and analysis of samples of water for analysis of its attributes.
    - ❖ Recording seasonal variations in Physico-chemical attribute.
    - ❖ Identification of planktons and other fauna.
    - ❖ Statistical analysis of the obtained data.
3. For collection and analysis standard APHA-AWWA Methods (2005) were followed.
4. To carry out the study, surface water samples were collected seasonally for a period of three years from selected sites:

    Site 1: - Two Ghats are located in towards East. These Ghats are used for human activity such as bathing, washing clothes.

    Site 2: - Near Hanuman temple that is situated in the eastern side of the pond, which conveys waste into the pond.

    Site 3: - Near Road passing near the tank towards the south.

Site 4:- Northern undisturbed area.

(2). METHODOLOGY

- For collection, transport, preservation and Physico-chemical analysis of water samples standard APHA-AWWA Methods (2005) were followed.
- Plankton studies: - collection of planktons using plankton nets (No. 25) was done followed by their preservation in 5% formalin. The identification of plankton was made with the help of standard taxonomic keys, which are available in literature.
- For photography Nikon 35 SLR camera was used.

(3). RESULTS OF THE STUDY

I. The water quality data for physical and chemical parameters were analysed and mean values were recorded.

II. Resultant data obtained were tabulated accordingly and presented diagrammatically.

III. The findings of the current investigation can be summarized as follows:

1) The study was carried out for Three years over three well marked seasons that is, summer, winter and monsoon.
2) The seasonal variations in physico-chemical parameters were statistically analysed and diagrammatically presented. The minimum and maximum values were also recorded.
3) A gradual fall in the water level from November onwards. Its level was minimum in the month of June and with the start of monsoon water level started increasing gradually and is maximum in the month of August.
4) Sacchi disc depth showed a well-defined pattern of fluctuation. Similar fluctuations in the values of other physical factors such as conductivity, water temperature, pH etc. were also observed and put on record.

5) Fluctuations in the values of other chemical factors such as alkalinity, free CO_2, dissolved O_2, hardness, TDS, different ions, nitrate, phosphate, etc. were also observed and put on record.
6) The variations in the values of various physico-chemical parameters were statistically significant between stations in different seasons.
7) The qualitative study of plankton in the surface water samples collected from different sampling sites was under taken. It was observed during the period of investigation that phytoplankton species were more diverse than the zooplankton species. Phytoplankton communities were found to be dominant over the zooplankton communities. These were found to be present in the ratio of 6.4:3.6 (64% phytoplankton and 36% zooplankton).
8) Phytoplankton was represented by the following families: Chlorophyceae, Dinophyceae, Euglenophyceae, Charophyceae, and BGA.
9) Zooplankton were represented by Protozoan, Coelenterata, Crustaceans, Copepoda, Rotifera, larval forms of many animals especially helminths, insects, molluscs and some other groups of animals.
10) The annual values of percentage composition among the different groups of Phytoplankton and zooplankton were found to vary considerably.
11) The diversity of fish-fauna is represented by three types of fishes: major carps, minor carps and cat fishes. These were recorded and presented in the form of table.
12) Other vertebrates (Amphibians and Reptiles) were also observed and recorded in the table form.
13) A list of periphyton was also prepared which were seen growing during different seasons around the Simaliya village tank.
14) Attempt was made to identify coliform bacteria by culture method and in some samples of sites 1, 2 and 3 were reported. This field needs more intensive study.

In the end, it may be concluded that the water of the village pond Simaliya showed variations in the various physic chemical parameters in all three seasons. The Phytoplankton and Zooplankton were also showing seasonal variations. The presence of the Periphytons and other vertebrates make it a complete, self-sustained fresh water lentic ecosystem. The values of certain chemical parameters, presence of coliform bacteria and few diatom species are giving us an alarm towards its pollution. With the increasing population and anthropogenic factors there is urgent need of its continuous monitoring and scientific management.

Plate 8:- Typha (Elephant Grass)

Plate 9:- close up of Typha Grass.

Plate 10:-Lotus Leaves

Plate 11:- Lotus flowers

Plate 12:- human activity

Plate 13:- Human Activity washing clothes

Plate 14:- Plankton bloom (green water)

BIBLIOGRAPHY

.

- Abbai, S.S., 2017. A study on zooplankton diversity of sogal pond in Belagavi district, north Karnataka.IJIRSET .6(9):19071-19074.
- Acharya GD, Hathi MV, Patel AD, Parmar KC. 2008. Chemical properties of groundwater in BhilodaTaluka Region, North Gujarat. India. E-Journal of Chemistry, 5(4): 792-796.
- Adikari, S., A.R. Goswami and S.K. Mukhopadhyay, 2017. Diversity of zooplankton in municipal wastewater contaminated urban pond ecosystem of the lower gangetic plains. Turkish journal of zoology. 41:464-475.
- Agarwal, S.S. 1978: Hydrobiological survey of Janaktal Tank, Gawlior (M.P.) India. *Proceeding of All Indian Seminar on Ichthylogy* pp. 20-26.
- Agarwal, S.S. 1980: Some aspects of limnology of Ramaua Dam with special references to Phytoplankton and Zooplankton. *Ph.D. Thesis, Jiwaji University*, Gwalior.
- Agrwal R., Bahora C. K. and Saksena M. M. 1993: Plankton productivity of sewagw fish pond and adjoining oxidation pond of Vallabh Gardans, Bikaner, *J. Ecta. Ecol*. **15(1)** pp 58-61.
- Ahamad, V., Parveen, S., Khan, A.A., Kabir, H.A., Mola, H.R.A. and Ganai, A.H. 2011: Zooplankton population in relation to physiochemical factors of the sewage fed pond of Aligarh (U.P) India. Biol. Medic., 3: 336-341
- Anikool S. and Shivani S. 2011: Assessment of Physico-chemical properties and sewage pollution indicator bacteria in surface water of River Gomti in Uttar Pradesh. International Journal of Enviromental Sciences 2 (1)
- Ansari, E., M. Gandhia and N. C. Ujjania 2015. Phytoplankton diversity and water quality assessment of ONGC pond, Hazira .International Journal of Research in Enviromental Sciences. 1(1): 1-5.
- Ansari, S., A. A. Khan 2014. Diversity and distribution of zooplankton in freshwater body of Aligarh Region. Ind. J. Sci. Res. and Tech. 2(1):73-82.
- APHA 2005. Standard Methods for examination of water and waste water.21st ed. American Public Health Association, Washington, D. C.

- Arjun B. and Abijit K. (2019). Comparative studies on BOD and COD in Relevance to pollution impact of freshwater Reservoir. International journal of Research in Advent Technology 7(1).
- Bahura C. K. 1998: A study of physic-chemical characteristics of a highly eutrophic temple Tank, Bikaner, J. Aqua. Biol. 13(1&2) pp 47-57.
- Bahura C. K. 2001: Diurnal cycle of certain abiotic parameters of fresh water lake, The Ganjar Lake Bikaner in Thar Desert of India. J. Aqua. Biol. 16 (1&2) pp 45-48.
- Balkhi, M.H., Yousuf, A.R. and Quadri, M.R. 1987; Hydrobiology of Anchar Lake, Kashmir. *Comparative Physiology and Ecology* **12** pp. 131-139.
- Banerjee, S., R. Nur and S. Barat 2014. Study on the zooplankton production in ponds under different fish farming system in west Bengal. J. krishi Vigyan. 3(1):79-83.
- Baruah B.K. and Das M.2001: Study on plankton as indicator and index of pollution in aquatic Ecosystem receving paper mill efluents Indion *J. Environ. Sci*. **5(1)**: 41-46.
- Basavarajappa, S. H., Raju N. S., and Hosmani S. P. (2014).Limnological: Critical Review. Current World Enviroment, 9(3):741-749.
- Bath, Kaur (1999): Studies on physico-chemical characteristics of water of Bundha-Nallah. Indion J. Environ. Sci. 3(1) 27-30.
- Beklioglu, M., Ince, O., Tuzun, I. (2003): Restoration of the eutrophic lake Eymir, Turkey, by biomanipulation after a major external nutrient control I. Hydrobiologia. 490:93-105.
- Bheel, S. K. 2009. A Study of certain aspects of limnological parameters of Chandra Sarower Pond, Jhalawar. M.Phil. Dissertation, University of Kota, Kota.
- Bhupender, J. and K. A. Kumar 2015. Phytoplankton diversity of a desert village pond in Bikaner Rajasthan, India. International Research Journal of Environmental Sciences. 4(2):43-45.
- BIS (Indian Bureau of Standards), Specification for drinking water quality Indian standards institution New Delhi, India, (1991).

- Bisht, A .S. and A. B. Bhatt 2014. Physico-chemical analysis of three different water bodies of sub-tropical Himalayan region of India. Elixir International Journal. 75: 27712-27715.
- Biswas, M. 2015. Seasonal abundance of zooplankton in physico-chemical features in Rabindra Sarobar, Kolkatta. International Journal of Interdisciplinary and Multidisciplinary Studies. (5):56-72.
- Cazzanelli, M., Warming, T. P., Christoffersen, K. S. 2008.Emergent and floating-leaved macrophytes as refuge for zooplankton in a eutrophic temperate lake without submergedvegetation. Hydrobiologia, 605:113-122.
- Céréghino, R., Biggs, J., Oertli, B., Declerck, S. (2008): The ecology of European ponds: defining the characteristicsof a neglected freshwater habitat. Hydrobiologia, 597,1-6
- Chakraborty, N.M. and Asthana, A. 1989: Plankton succession and ecology of a sewage treated pond in West Bengal. *Eniv. And Ecology* **7** pp. 549-554.
- Chakraborty, S., M. A. Kausar, A. K. Goyal, A. K. Basumatary and B. K. Brahma, 2017. Studies on physico-chemical parameters of fish inhabiting water bodies in the vicinity of Kkrajhar, Btad, Assam. International Journal of Applied Chemistry. 13(3):409-420
- Chattopadhyay, G.N. (1998), Chemical Analysis of Fish Pond Soil and Water. Daya Publishing House, Delhi- 110035. pp 13-66.
- Chaurasia, M. and G.C. Pandey (2007). Study of physico-chemical characteristics of some water ponds of Ayodhya – Faizabad. Indian J. of Environmental Protection. 27(11):1019-1023.
- Choudhary J., Kumari J., Kumari A., Singh R.K. (2019). Physico-chemical Status of Rural Pond Sasaram of Bihar in respect of Fish Culture. International journal of science and technology 8(2): 289-297.
- Darasingh, W. and B. Laxmi 2014. Physico-chemical analysis of Sitapat pond and its comparison with tap water quality of Dhar town for potability status. Res. J. Animal, Veterinary and fishery Sci. 2(12): 8-13.
- Das D., Pathak A., Pal S. (2018). Diversity of phytoplankton in some domestic wastewater fed urban fish pond ecosystems of Chotanagpur Plateau in Bankura, India. Applied Water Sciences 8:84.

- Devi, P. D. Sirisha and N Gandhi (2013). Study of the Quality of water and soil from fish pond in around bhimavaram, West Godavari District, A.P., India. International Research Journal of Environmental Sciences. 2(1):58-62.
- Devi, S. 2017. Role of temperature for the zooplankton growth and seasonal fluctuations. International Journal of Advance Research in Science and Engineering. 6(90):337-346.
- Dhanasekaran, M., P. S. Bhavan, N. Manickam and R. Kalpana, 2017. Physico-chemical characteristics and zooplankton diversity in a perennial Lake at Dharampuri, Tamil nadu India. Journal of Entomology and Zoology Studies. 5(1):28.
- Diwedi BK and GC Pandy (2002) Physico-chemical factors and algae diversity of two ponds (Girija Kund and Maqbara pond). Faizabad, India. Poll. Res. 21 (3): 361-370.
- Dixit, A. K., S .K. Pandey, R. Mehta, Niyazahmad, Gunjan and Jyotipandey 2015.study of physico-chemical parameters of different pond water of Bilaspur District, Chattisgarh India. Environmental Skeptics and Critics. 4(3):89-95.
- Dube P. 2002a: Ecobiology of seasonal water bodies in southeastern plateau of Rajasthan with special reference to amphibians. Indian J. Eniron. Sc. 6(2) pp 135-139.
- Dube P. 2002b: Physico-chemical attributes of various ponds and temporary water bodies of southeastern plateau of Rajasthan (i.e. Kota, Bundi, Baran and Jhalawar district).
- Dube P. 2002c: Spawning preference and pH correlation of amphibians in southeastern plateau of Rajasthan.Indian J. Environ. Sci. 6(1) pp. 73-76.
- Dube P. 2003: Amphibian fauna of southeastern Rajasthan with special reference to their ecobiology. Abstract in Proc. All India Congress of Zoology pp. 104-105.
- Dube P. 2005a. Physicochemical characteristics of a semipermanent pond at Baran Rajasthan, India. Abstract in Proc. All India Congress of Zoology : 69
- Dube P. and Sharma K.K. 2001: Breeding preferences and pH correlation of Amphibianes in southeastern plateau of Rajasthan. Abstract Proc. National Symposium on status of India's Diver. And Environ. pp 21-22.

- Dube P. and Sharma K.K. 2005b. Distribution pattern of amphibian biodiversity in south eastern plateau of Rajasthan, India. Indian j. Environ. Sci. **9(1)**: 35-38.
- Dube P. Garg, V. and Sharma S. 2010a: Community structure of zoo planktonic groups of Kishore Sagar Tank, Kota, and Rajasthan. Life Sci. Vol. 6(3): 451-453.
- Dube P. Garg, V. and Sharma S. 2010b. The occurance and seasonal variation of the plankton in Kishore Sagar Tank, Kota, Rajasthan. Life Sci. Bull. 6(3): 327-330.
- Dube, P. 2002. Ecobiological studies of amphibians around south eastern plateau of Rajasthan. Ph.D. Thesis, M.D.S. University, Ajmer.
- Dube, P., Garg V., Sharma S. 2009. Community structure of zoo planktonic groups of Kisore Sagar Tank, Kota, Rajasthan. National Journal of life science, 6 (3):451-453.
- Dube, P., Garg V., Sharma S. 2009. The occurrence and seasonal variation of the plankton in Kishore Sagar Tank, Kota, Rajasthan. Life Science Bulletin, 6(3): 327-330.
- Dubey, A. K. 2009. Production and marketing studies of freshwater fishes in Kota district: A Bio economic Study. M.Phil. Dissertation, University of Kota, Kota.
- Durve V. S, Rao P. S. 2006.Variation in Primary Productivity and its Interrelationship with Chlorophyll in the Lake Jaisamand (Rajasthan, India). J. Acta Hydrocimicha et Hydrobiologia **15(4):** 379-387.
- Ellis, M.M (1937), Detection and measurement of Stream Pollution. Bull 22, US Bureau of Fisheries.Environmental Science, 9, pp 57-61.
- Estlander, S., Nurminen, S. L., Olin, M., Vinni, M., Horppila, J. (2009): Seasonal fluctuations in macrophyte cover and water transparency of four brown-water lakes: implicationsfor crustacean zooplankton in littoral and pelagichabitats. Hydrobiologia, 620, 109-120
- Gaikwad, S.R., K.M. Ingle and S.R. Thorat (2008). Study of Zooplankton emergence pattern and resting egg diversity of recently dried waterbodies in North Maharastra Region. Journal of Environmental Biology. 29 (3):353-356.

- Ganesh, K. S., R .L. Xavier, M. Nagarajan and P. Sundaramoorthy 2015. Physico-chemical properties of sri-sanishwaran temple pond water Tirunallar. World Scientific News. 21:1-11.
- Gautam P.C. 1989: Plankton ecology of Jait sagar lake (Bundi). *Acta. Ecol.***11(1)** PP 17-21.
- Ghaffar, A., M. Afzal and M. Iqbal (2002). Fish Pond Fertilization: Comparison of ecological conditions under different fertilizers refiners. Journal of Biological Sciences. (9): 620-622.
- Gheravase, L., C. Ioja, E.M. Carstia, L. Niculita, D. Savastra, G. Pavelescu and G. Vanau: (2011) Evaluation of Biotic ecosystem from Bucharest city. International Journal of Energy and Environment. Vol. 5(2), P. 183-192.
- Ghosh B. B. (2018). Physico-chemical analysis of pond water in Purba Barddhaman, West Bengal, India. International Research Journal of Environmental Sciences.7 (2):54-59.
- Goher MEM 2002. Chemical studies on the precipitation and dissolution of some chemical element in Lake Qarun, Ph.D. Thesis faculty of sciences, Al-Azhar University, Egypt.
- Gothwal R. and Gupta G. K. (2019). Limnological planktonic diversity and Ichthyofauns of Sant- Sarover Pond: Mount Abu (Rajasthan), India. World News of Natural Sciences 22: 129-138.
- Gowri P. and Benarjee G. (2018). Assessment of water quality using physico-chemical parameters – A study of freshwater lake in Warangal District, Telangana state, India. International journal of current trends in sciences and technology 8(05): Zo 20244-20253.
- Guillermo, C. 2009. The use of phytoplankton patterns of diversity for algal bloom ***I*** W. 2003. Zooplankton, phytoplankton and the microbial food web in two turbid and two clear shallow lakes in Belgium. Aquat. Ecol., 37:137-150.
- Gupta S.C. and Rathore G.S. Mathur G.C.D. 2001: Hydro-chemistry of Udaipur Lake. *Indian Environ. Hlth. Vol.***43(1)** PP 38-44.
- Gupta S.N. (1989): Studies on the hydrobiology of Khandia Talab. Ph.D. Thesis, Jaipur.
- Hutchinson, G.E. 1975: A treatise on limnology 1(2).

- Iloba, K.I. 2002. Vertical distribution of Rotifera in the Ikpoda reservoir in southern Nigeria. Tro. Fres. Bio, 11: 69-89.
- Jacob, S., A .P. Thomas, E. K. Manju 2017. Odonata (Dragonflies and Damselflies) as bio indicators of water quality. International Journal of Innovative Research in Sciences Engineering and Technology. 6(9):19464-19474.
- Jain Y. 1999: studies on diel variation in some water quality parameter at Hnumantal Lake. Envi. Poll. 6(2&3): 95-104.
- Jain, Sharma 1997: relationship among water quality parameter of ground water. Poll. Res. 16(4): 241-246.
- Jakher G. R. Bhargava S. C. and Sinha R. K. 1990: Comparative limnology of Sambhar and Didwana lakes (Rajasthan, NW India). J. Hydrobiologia 197(1): 245-256.
- Jana, B.B. and Sarkar, H.L. 1971: the limnology of swet Ganga, a thermal spring of Bakreshwar, West Bengal. *Hydrobiol.*,**69** pp. 91-110.
- Jeppesen, E., Jensen, J. P., Søndergaard, M., Lauridsen, T. (1999): Trophic dynamics in turbid and clear water lakeswith special emphasis on the role of zooplankton for waterclarity. Hydrobiologia, 408/409, 217-231
- Jha, P. and S. Barat, 2003. Hydrobiological study of Lake Mirik in Darjeeling, *Himalayas. J. Environ. Biol*., **24**: 339-344.
- Joseph, J. 2017.Diversity and distribution of phytoplankton in an artificial pond. Int. J. Adv. Res. Biol. 4(5):114-122.
- Kangabham, R. S., S. D. Bhoominathan, S. Kanagaraj and M. Govindaraju 2017. Development of a water quality index (WQI) for the Loktak Lake of India.Appl. Water Sci.7:2907-2918.
- Karra, V. D., Dube, P., Sharma, J., Sood, Y. and Manju Sharma (2018): A critical review on the studies of phytoplankton in lotic water of India. International Journal of Life Science, Vol.7 (2): 71-74.
- Kashyap, K. 2009. A Study of certain aspects of Freshwater fin fisheries and their marketing in Jhalawar distict. M.Phil. Dissertation, University of Kota, Kota.
- Kaushik S., & Sharma N.1994: *J. Environment and Ecology*,12 (2), 429–434.

- Kaushik, S. and Saksena, D.N. 1999. Physico-chemical limnology of certain water bodies of central India. Pages 1-58, In: Vijaykumar, K. Freshwater ecosystem of India. Daya Publishing House, Delhi-110035. pp 1-336.
- Kedar, G.T., G.P. Patil and S.M. Yeole (2008). Effect of Physico-chemical factors on the Seasonal abundance of Zooplankton population in Rishi Lake. Proceeding of Taal 2007: The 12th world lake conference: 88-91.
- Keremah, R. I., O. A. Davies and I. D. Abezi 2014. Physico-chemical analysis of fish pond water in freshwater areas of Bayelsa state Nigeria. Greener Journal of Biologocal Sciences. 4(2):33-38.
- Khan, M. A. G and Choudhary, S.H. 1994. Physical and chemical limnology of lake Kaptai, Bangladesh. Trop. Eco. 35 (1): 35-51.
- Kiran BR. 2010. Physico-chemical characteristics of Fish Ponds of Bhadra project at Karnataka, India.Rasayan Journal of Chemistry, 3(4): 671-676.
- Kohli, M.P.S., Thakur, N. Kumar and Munnet S.K. 1982: Seasonal changes in plankton population of some fresh water ponds at Patna. *J. Inland Fisheries Society of India***14** pp. 69-76.
- Koli, V.K. and M.M. Ranga (2011). Physicochemical status and primary productivity of Anasagar Lake, Ajmer, Rajasthan, India. Universal Journal of Environmental Research and Technology.1 (3):286-292.
- Kosygin, L., Dhamendra, H. and Gyaneshwari, R. 2007. Pollution status and conservation strategies of Moirang river, Manipur with a note on its aquatic bio-resources. Journal of Environmental Biology, 28 (3): 669-673.
- Krishna, P .V. and H. Kumar 2017. Seasonal variation of zooplankton community in selected ponds at Lake Kolleru region of Andhra Pradesh, India. Int. J. Curr. Microbiol. App. Sci. 6(8):2968-2970.
- Kruk, C., Rodríguez-Gallego, L., Meerhoff, M., Quintans, F.,Lacerot, G., Mazzeo, N., Scasso, F., Paggi, J. C., Peeters, T.H. M. E., Scheffer, M. (2009): Determinants of biodiversityin subtropical shallow lakes (Atlantic coast, Uruguay).Freshwater Biology.54, 2628-2641
- Kumar G, D., M. Karthik, R. R. 2017. Study of seasonal water quality assessment and fish pond conservation in Thanjavur, Tamil Nadu, India. Journal of Entomology and Zoology Studies. 5(4):1232-1238.

- Kumar, A. and R. Sahu (2012). Ecological Studies of cyanobacteria in sewage pond of H.E.C. Industrial Area, Ranchi, India. Bio-science Discovery. 3(1): 73-78.
- Kumar, A., L.L. Sharma and M.C. Aery (2008). Physico-chemiocal characteristics and diatom as Indicators of Trophic status of Kishore Sagar, Rajasthan. Proceeding of Taal 2007: The 12th world lake conference: 1804-1809.
- Kumar, S. 1997. Limnological studies on Kunjwani pond, Jammu.1. Physicochemical factors and its scope to fish culture. Recent advances in fresh water biology, Vol-II. Anmol Publication, New Delhi-110002, pages 1-20.
- Kumar, S., B. K. Sharma, S. K. Sharma and B. Upadhyay 2015. Primary productivity and phytoplankton diversity in relation to fisheries potential of the Lake Udai Sagar, Udaipur. International Journal of Fauna and Biological Studies. 2(5):9-12.
- Kumara, V. and V. Kumar (2011). Evaluation of water quality of mangrove ecosystems of Kundapura, Uduki district, Karnataka, South-west Coast of India. Journal of Ecobiotechnology. 3(12): 23-29.
- Kumari, V., G. Rathore, U.K. Chauhan, A.K. Pandey and W.S. Lakra (2011). Seasonal Variation in abundance of nutrifying bacteria in fish pound ecosystem. Journal of Environmental Biology. 32:153-159.
- Kumawat, D. A. and A.K. Jawale 2003: Phytoplanktons of a fish pond at Anja1e, Maharashtra, *Eco. Env. & Cons*. **9(3):** pp411-415.
- Laishram, J., M. Dey 2014.Water quality status of Loktak Lake, Manipur, Northeast India and need of conservation measures: A study on five selected villages.International Journal of Scientific and Research Publication.4(6):1-5.
- Lucas, L. R.G., L. M. C. Ramirez and L. Arregui 2017. Physico-chemical and microbiological analysis of water of the "Presa De Los Patos" in the Desierto De Los leones National Park, Mexico. Advances in Biological Chemistry.7:122-138.
- Mahananda, M.R., B.P. Mohanty and M.R. Behra (2010). Physico-chemical Analysis of Surface and Ground water of Bargarh District, Orissa, India. IJRRAS. 2(3):284-295.

- Maheswari, K., J. Vashistha, P. V. Paulose and T. Agarwal 2015. Seasonal changes in phytoplankton community of Lake Ramgarh India. International J. Curr. Micribiol. App.Sci. 4(11):318-330.
- Mahish, P. K. 2015. Physico-chemical assessment of pond water municipal sewage and industrial effluent of Rajnandgaon Chhattisgarh, India. International Journal of Science Environment and Technology. 4(6):1549-1557.
- Makandar, B.M. and A. Bhatnagar (2010). Biodiversity of Microalgae and cyauobacteria from freshwaterbodies of Jodhpur, Rajasthan (India) Journal of Algal Biomass utilization. 1(3):54-59.
- Malten, M.A., Paeel, H.W., Rudek, J. 1991. Seeasonal phytoplankton composition, productive and biomassin the Neuse River Estuary, North Carolina. Estur. Coast. Shelf. Sci., 32: 609-623.
- Manickam, N., Asaikkutti, A., Rajkumar, G., Udayasuriyan, R. and Karthik, M. 2018. Impact of seasonal changes in zooplankton biodiversity in Ukkadam Lake, Coimbatore, Tamil Nadu, India, and potential future implications of climate change. *The Journal of Basic and Applied Zoology*, Vol. 79 (1):15.
- Manickam, N., Bhavan, P. S., Santhanam, P., Bhuvaneswari, R., Muralisankar, T., Srinivasan, V. 2015. Biodiversity of Freshwater zooplankton and Physico-chemical parameters of Barur Lake, Krishnagiri district, Tamil Nadu, India. Malaya journal of Biosciences 2015, 2 (1): 1-12.
- Maruthanayagam, C., M. Sasikumar and C. Senthilkumar, 2003. Studies on zooplankton population in Thirukkulam pond during summer and rainy seasons. *Nature Environ. Pollut. Technol*., 2: 13-19.
- Mathur. P., S. Agarwal and M. Nag (2008). Assessment of Physico-chemical characteristics and suggested Restoration Measure for Pushkar Lake, Ajmer, Rajasthan (India). Proceedings of Taal 2007: The 12th world lake conference: 1518-1529.
- Meena K. and Dube P. 2018: A critical review of zooplanktonic studies of Lentic water bodies of India. Int. journal of environmental sciences, Vol. 7(3): 79-83.
- Meena K. and Dube P. 2019: A critical review of Phytoplankton studies of Lentic Water Bodies of India. International journal of Environmental Sciences. Vol 8 (4): 45-48.

- Meena K. and Dube P. 2019: Diversity of Seasonal Variation of Similiya Village Pond. International journal of Applied and Universal Research, Vol. 6(3):13-15.
- Mishra, R.R., B. Rath, H. Thatoi (2008). Water quality assessment of Aquaculture Pounds located in Bhitarkanika Mangrove Ecosystem, Orrissa, India. Turkish Journal of fishries and Aquatic Sciences. 8: 71-77.
- Mishra, S., A. L. Singh and D. Tiwary 2014 Studies of Physico-chemical Status of the Ponds at Varanasi Holi City under Anthropogenic influences. International Journal of Environmental Research and Development. Vol. 4(3), 261-268.Mohamed H. A. 2005. Physico-chemical Characteristics of abu za'baal ponds, Egypt. Egyptian journal of Aquatic Research 31(2).
- Moitra, S.K. and Bhowmik, M.L. 1968: Seasonal cycle of rotifers in fresh water fish pond in Kalyani, west Bengal. Proceeding of Symposium on recent advance in tropical ecology, pp. 359-367.
- Mola, H.R. 2011. Seasonal and Spatial distribution of Brachionus (Pallas, 1966; Eurotatoria: Monogoranta: Brachionidae), a bioindicator of eutrophication in Lake El-Manzalah, Egypt. Biol. Medi., 3: 60-69.
- Mondal, N.K., J.K. Datta and A. Banerjee (2011). Pond Alkalinity: A study in Burdawan Muncipility, Burdwan, West Bangal, India. International Journal of Environmental Sciences. 1(7):1718-1724.
- Moundiotiya, C., R. Sisodia, M. Kulshreshta and A.L. Bhatia (2004). A case study of the Jamwa-Ramgarh Wetland with special refrences to physico-chemical properties of water and its environs. 12: 1-17.
- Muralidharan, S. (2000). Organochlorine residues in the water of Keoladeo National Park, Bharatpur, Rajasthan. Bull. Environ. Contam. Toxici. 65(1):11-13.
- N. Swaranlatha, A.N. Rao, *Ecological studies of Banjara lake with reference to water pollution*. Journal of Environmental Biology, 19,2,1998, pp.179-186.
- Nag, A. and H. Gupta 2014. Physico-chemical analysis of some water ponds in and around Santineketan, West Bengal, India. Internationl journal of Enviromental Sciences. 4(5):676-682.

- Nandini, S. (1999). Variation in physical and chemical parameters and plankton community structure in a series of sewage stabilization pond, New Delhi, India. Revista De Bilogia Tropical, 47(1): 144-156.
- Nas, B., & Berktay, A. (2006) Groundwater contamination by nitrates in the city of Konya, (Turkey): A GIS perspective. Journal of Environmental Management, 79, 30–37.
- Ojha Swati and Sharma K.C. 1994: Algal diversity in Gandhi Sagar lake of Bhilwara. Geobios new reparts 13: 143-146.
- Ojha DD, Bohra JL, Jain PC, 1992: Ground water quality in some arid region of western Rajasthan. Proc Int Conf Rural 23-29.
- Pahl, Z. A., K .F. Almani, M. A. Qureshi, A .R. Abbasi and K .H. Lasheri 2016. Ecological survey of phytoplankton (Nostocaceal) of Chakhan Lake, district, Dadu, Sindh, Pakistan. Research and Review: Journal of Botanical Sciences. (40):15-18
- Pandey, B.N., Das, P.K.L., Dubey, S.V and Hussain, S. 1999. Biomonitoring of water quality of river Ramjan (at Kishanganj) in relation to its impact on biological components. Pages: 310-336. In: Vijaykumar, K. Freshwater ecosystem of India. Daya Publishing House, Delhi-110035. pp 1-336.
- Pandiammal, S., J. M. Bashini and P. Senthilkummar 2017. Diversity and seasonal fluctuations of phytoplankton in temple pond at Thiruvottiyur, Chennai, South India. Journal of Academia and Industrial Research. 6(1):7-12.
- Paras, S. 2009. Study of Physico-chemical parameters and qualitative analysis of certain faunal groups in Manihara Pond, Baran. M.Phil. Dissertation, University of Kota, Kota.
- Parikh, A.N. and P.C. Mankodi: (2012) Limnology of sama Pond, Vadodara City, Gujarat. Research Journal of Recent Sciences. 1(1):16-21.
- Park, K.S. and Shin, H.W. 2007. Studies on phyto-and-zooplankton composition and its relation to fish productivity in a west coast fish pond ecosystem. J. Env. Biol., 28: 415-422.
- Pathak, N.B. and P.C. Mankodi (2013). Hydrological Status of Danteshwar Pond, Vadodara, Gujarat, India. International Research Journal of Environment Sciences. 2(1):43-48.

- Pathak, S.K. and Mudgal, L.K. 2004: Biodiversity of zooplankton of Virla reservoir Khargone (M.P.) India. In: Arvind Kumar(ed.) Biodiversity and Environment, *A.P.H. Publishing Corporation,* New Delhi. pp. 317-321.
- Patil, P.V. and A.N. Kulkarni (2008). Study of selected physico-chemical factors of reservoir Thodga TQ. Ahmedpur Dist. Latur, Maharastra. Proceeding of Taal 2007: The 12th world lake conference: 315-317.
- Pawar, R. T. 2016. Zooplankton diversity and seasonal variation of Majalgaon reservoir, Maharashtra state, India. International Journal of Environmental Sciences. (5):859-866.
- Qureshimatva, U .M., S .B. Gamit, R. R. Maurya, R.D. Patel and H .A. solanki 2015. Correlation of various physico-chemical parameters and water quality index (WQI) of Chandola Lake Ahmedabad Gujarat India. International Research Journal of Chemistry. 10:1-12.
- Ranga M.M. 1995 Limnological studies of Anasagar Lake of Ajmer. Ph.D. thesis, M.D.S. University Ajmer.
- Ranga, M.M., Sharma, S. and Sharma, P. 2006: Phytoplankton diversity in Pushkar Sarovar. Proceeding national conference on biodiversity conservation Bhiwara 21-22 September, pp. 75-79.
- Rao B.R., K.S., H.J.C. and K.C. (2019). The Physico-chemical Analysis of Pond water at AIET campus due to the overflow of sewage water. IJARIIE 5(3).
- Rao, S., P. Ramsmohan Rao and Someswora Rao (2001). Quality of drinking water from ponds in villages of Kolleru lake region. Indian J. Environ. Hith. 41(43): 45-52.
- Razzaque, A., Hossain, M.S., Islam, A.K.M.S., Hossain, M.M.M. & Ehshan, M.A. 1995. Study on plankton population of Halti beel at Natore, Bangladesh. *Bangladesh J. Aquaculture,* **17**: 19-23.
- Saidu, H., B. Usman and D. Umar, 2016. Studies of species distribution for phytoplankton in Balanga Dam. Journal of Advanced Research in Applied Sciences and Engineering Technology. 3(1):1-9.
- Sajitha, V. and S .A. Vijayamma 2016. Study of physico-chemical parameters and pond water quality assessment by using water quality index at Athiyannoor panchayath, Kerala. India. Emer. life Sci. Res. 2(1):46-51.

- Salodia P.K. 1995: Hydrobiological studies of Jait Sagar Lake, (Bundi). Ph.D. Thesis, M.D.S. University Ajmer.
- Saluja, Jain 1998: physico-chemical analysis of Machna Annicut Dam. Poll. Res. 17(3): 219-221.
- Scheffer, M., Hosper, S. H., Meijer, M. L, Moss, B., Jeppesen, E. (1993): Alternative equilibria in shallow lakes. Trends in Ecology & Evolution. 8: 275-279.
- Selvamohan, T., G. Karthick, M. Ramya, V. Sarojini, V. Sedhu and G. seetha 2014. Studies on physico-chemical characters of four ponds in Tirunelveli Distict. J. Bio. Innov. 3(4): 197-205.
- Sen, A. 2009. Icthyofaunal diversity of Kisan Sagar Pond, Jhalawar. M.Phil. Dissertation, University of Kota, Kota.
- Sharan Latika, Kumar Parveen and Sinha M.P. 2004b: Ecological investigation of a trophical fresh water habitat I water quality index and algal biodiversity. *Proc. Zool. Soc. India***3(1):** 21-34.
- Sharma J. and Dube P. (2018) A critical Evalution of Literatre on Zooplankton Research in India. International journal of current Research 10(04):68380-68382.
- Sharma J., Dube P. and Karra V.D. (2018). A Critical Review of studies related to Diversity and Seasonal Variation of Phytolankton. International Journal of Phytoplankton. Inttnational Journal of Basic and Applied Sceinces 7(3): 92-95.
- Sharma K.C. 1991: Algae of Anasagar Lake of Ajmer Rajasthan. Geobios new reports 10: 67-68.
- Sharma Renu and Sharma K.C. 1992: Diatoms of anasagar Lake of Ajmer. Acta Ecol. 14(1).
- Sharma, K. K., S. Kour and N. Antal 2015. Diversity of zooplankton and micro benthic invertebrates of two perennial ponds in Jammu Region. Journal of Global Biosciences. 4(2):1382-1392.
- Sharma, S. 2009. A study of certain physico-chemical attributes of Kisan Sagar Pond, Jhalawar with special references to fishes. M.Phil. Dissertation, University of Kota, Kota.

- Sharma, S. 2009. An investigation into water quality and its treatment with references to human consumption in Kota city. M.Phil. Dissertation, University of Kota, Kota.
- Sharma, S. 2010. Ecological study of Kishore Sagar tank of Kota, Rajasthan, India. P.hd Thesis, Banasthali University, Banasthali Rajasthan.
- Shastry CA, Aboo KM, Bhatia HL and Rao AV 1970. Pollution of upper lake and its effect on Bhopal water supply. Journal of Environmental Health, 12:218-238.
- Shringi, M. 2009. An investigation into planktons of certain water bodies of Jhalrapatan and Jhalawar. M.Phil. Dissertation, University of Kota, Kota.
- Singh A., and Singh D. (1999). Acomparative study on the phytoplankton primary production of River Ganga and Pond of Patna (Bihar), India. J. Environ. Bio., 20(3):263-270.
- Singh K.K. and B.M. Sharma (2012). Ecological Productivity studies of the macrophytes in Kharungpat Lake, Manipur North-east India. International Journal of Geology, Earth and Environmental Sciences. 2(2): 58-71.
- Singh, A.K. 1990: A review on limnological status of some lakes in U.P. *Recent Trends Limnology* pp. 271-280.
- Singh, A.K., Tiwari, R.K., Kanaujia, D.R. and Mishra, P. 2009. Physico-chemical characteristics of Ganga River water at Varanasi. J. Ecobiol. 25 (1): 45-56.
- Singh, K.K., Sharma, B.M., and Usha, Kh. 2010. Ecology of Kharungpat lake, Thoubal, Manipur, India: Part-I Water quality status. The Ecoscan, 4 (2&3): 241-245.
- Singh, M., P. Lodha, G.P. Singh and R. Singh (2011). Studies on diatom Diversity in Response to Abiotic Factors in Mawatha Lake of Jaipur, Rajasthan International Journal of Life Science and Pharma Research. 1(1): 129-137.
- Singh, R.P. And Mathur, P. (2005), Investigation of Variation in Physico-Chemical
- Singh, S. (2015). Analysis of Plankton Diversity and Density with physico-chemical parameters of open pond in town Deeg (Bharatpur) Rajasthan India. International Research Journal of Biological Sciences. 4(11):61-69.

- Sinha K. K. & Sinha D. K. (1983). *Journal of Ecobiology*, 5(4), 299–302.
- Soni, R.N. and S.A. Bhatt (2008). Periodical ecological study of an urban pond near Vadodara, Gujarat, India. Proceeding of Taal 2007: The 12th world lake conference: 1591-1596.
- Špoljar, M. (2013): Microaquatic communities as indicatorof environmental changes in lake ecosystems. Journal of Engineering Research.1:29-42
- Špoljar, M., Dražina, T., Šargač, J., Kralj–Borojević, K., Žutinić,P. (2012): Submerged macrophytes as a habitat for zooplanktondevelopment in two reservoirs of a flow-throughsystem (Papuk Nature Park, Croatia). Annales de Limnologie– International Journal of Limnology. 48:161-175.
- Srivastava N, Agrawal M, Tyagi A. 2003: Study of physico-chemical characteristics of water bodies around Jaipur. Fish Biology Laboratory, Department of Zoology, University of Rajasthan, Jaipur-302 004, India.
- Srivastava, A. and S. Srivastava (2011). Assessment of Physico-chemical properties and sewage pollution indictor bacteria in surface water of River Gomti in Uttar Pradesh. International Journal of Environmental Sciences. 2(1): 325-336.
- Srivastava, K.N., P. Srivastava and A.K. Sinha 1990: Zooplankton studies of Ganga River between Kala Kanker and Phamphaman Uttar Pradesh.*Recent trends in limnology*. pp. 129-133.
- Srivastava, N., G. Harit and R. Srivastava (2009). A study of Physico-chemical characteristics of lakes around Jaipur, India. Journal of Environmental Biology. 30(5):889-894.
- Stiers, L., L. Triest 2017. Impact of non- native invasive plant species cover on phytoplankton and zooplankton communities in temperate ponds. Aquatic invasions.12(3):385-395
- Swarnkar, A. K. and S. Choubey 2016. Testing and analysis of pond water in Raipur city, Chhattisgarh, India. International Journal of Science and Research. 5(4):1962-1965.
- Swarnlata N. and Rao A. Nursing 1997: Limnological studies of a semi-parmanent pond. *J. Phytol Res.* **10(2-1):** 15-23.
- Takamura, K.Y., Y. Sugaya, N.T. Takamura, M. Hanazato, M. Yasuno and T. Iwakuma 1989: Primary production of phytoplankton and standing crops of

zooplanktonand zoo-benthos in hypertrophic Lake, Teganuma. *Hydrobiologia* **173**, pp. 173-184.

- Tiwari, M. and M.M. Ranga (2012). Assessment of Diurnal Variation of Physico-chemical status of Khanpura Lake, Ajmer, India. Research Journal of Chemical Sciences. 2(7): 69-71.
- Tidame, S.K. and S.S. Shinde (2012). Seasonal Variation in rotator diversity of temple ponds of Nashik District (M.S.) India. International Multi-disciplinary Research Journal. 2(5): 19-22.
- Totawar, D .V. and H.L. Tamlurkar 2017. Physico-chemical parameters of Nizam Sagar dam with respect to fish production phytoplankton, zooplankton .Int .J. of Life Sci. 5(3):451-454.
- Tripathi, A.K. and Pandey, S.N. 1990: Studies on algae of polluted ponds of Kanpur, India III, *Eutro.*
- Verma (2001): Ecology a perennial wetland. Environ. Poll. 8(1); 53-59.
- Verma, P. U., U .C. Gupta, R .P. Adiyecha and H. A. Solanki 2014. Seasonal variation in the phytoplankton biodiversity of Chandolia Lake. International Journal of Innovative Research in Science, Engineering and Technology. 3(1):8466-8471.
- Verma, P.K. and J.S. Dutta Munshi 1987: Plankton community structure of Badua Reservoir, Bhagalpur, Bihar. *Trop. Ecol*. **28**, pp. 200-207.
- Verma, S. and J. B. Khan 2015. Analysis of water quality by physico-chemical parameters in Fateh Sagar talab in Bagar, District of Jhunjhunu (Raj.) India. IOSR journal of pharmacy and biological sciences. 10(5, 4):41-45.
- Veronica, E., A. S. Leksono, Soemarno, D. Arfiati 2014. Effect of water quality on phytoplankton abundance in Hampalam River and fish pond of Batanjung village. IOSR Journal of Environmental Science, Toxicology and Food Technology. 8(1, 1):15-21.
- Vyas L. N. and Kumar H. D. 1968: Studies on the phytoplankton and other algae of Indrasagar Tank, Udaipur, India, *Hydrobiologia*,**31**: 421-434.
- W.H.O. (World Health Organization), Guidelines for drinking water quality 2 ed. Recommendations, 172-181 (1993).

- Waghmare, N.V., V.D. Shinde, P.R. Surve and Ambare, N.E (2012). Seasonal Variation of Physico-chemical characteristics of Jamgavan Dam water of Hingoli district (M.S.) India. International Multidisciplinary Research Journal. 2(5): P. 23-25.
- Wetzel, R.C. (1983) Limnology 3rdedn. Sounders college publishing, Philadelphia.
- Yadav V.G. and Rana K.S. (2001). Effect of Temperature and Tansparency on Seasonal changes of Phytolankton Community in a pond at Fatehpur Sikri, Agra. Bionotes 3(2):40.
- Yadav, A., P .K. Sahu, S. Chakradhari, K .P. Rajhans, S. Ramteke, N. S. Dahariya, G. Agnihotri and K. S. Patel (2016). Urban pond water contamination in India. Journal of Enviromental Protection. 7:52-59.
- Yadav, J., R.K. Pathak and E. Khan (2013). Analysis of water quality using Physico-chemical parameters, State Reservoir in Khargone District, M.P., India. International Research Journal of Environment Sciences. 2(1): P. 9-11.
- Yadav, L. B. P. and A. singh, 2017. Study of zooplankton diversity of Chhapakaiya pond Birgunj, Nepal .Int. J. Life .Sci. Scienti. Res. 3(2):925-931
- Zafar, A.R. 1964: On the ecology of algae in certain ponds of Hyderabad, India. *Physico-chemical complex Hydrobiologia*,**23** pp 179-195.
- Zebek, E. and U. Szymanska 2017. Abundance Biomass and Community Structure of Pond Phtoplankton Related to the Catchment Characteristics. Knowledge and Management of Auatic Ecosystem.
- Zutshi, B., S.G. Raghu and R. Nagaraja (2008). Anthropogenic Impact on the Lake Ecosystem in Hi-Tech City, Banglore, Karnataka. Proceeding of Taal 2007: The 12th world lake conference: 1786-1793. Agarwal, S.S. 1978: Hydrobiological survey of Janaktal Tank, Gawlior (M.P.) India. *Proceeding of All Indian Seminars on Ichthylogy* pp. 20-26.

PUBLISHED RESEARCH PAPER'S

SJIF IMPACT FACTOR: 5.416 CRDEEP Journals
International Journal of Environmental Sciences Meena & Dube Vol. 7 No. 3 ISSN: 2277-1948
International Journal of Environmental Sciences. Vol. 7. No. 3. 2018. Pp. 79-83
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Review Paper

A Critical Review of Zooplankton Studies of Lentic Water Bodies of India

Kamlesh Meena and Prahlad Dube*
Department of Zoology, Government College, Kota, Rajasthan, India.

Article history
Received: 24-02-2018
Revised: 02-03-2018
Accepted: 08-03-2018

Corresponding Author:
Prahlad Dube
Department of Zoology, Government College, Kota, Rajasthan, India.

Abstract
Zooplanktons are the primary consumers of aquatic ecosystem. Zooplanktons are the plankton consisting of small animals and the immature stages of larger animals. Zooplanktons play an important role in food chain and also evaluate the ecological status of water bodies. Zooplanktons are the bio indicators of pollution and water quality. Present study reveals on the research on zooplanktons in India. . Zooplankton population is very useful indicators of food web stability. Zooplanktons are affected by many environmental factors such as pH, temperature, salinity, oxygen etc. zooplanktons are play important role on food chain, energy transfer between primary and tertiary trophic levels. Due to their large densities they are being used as the indicator organisms of physical, chemical and biological process of aquatic system

Key words: *Zooplankton, lentic water bodies, India, rotifera, copepoda, cladocera*

Introduction

Zooplanktons are the important portion of aquatic ecosystem. Zooplanktons play vital role in the biogeochemical cycles and in food web. They are the useful indicators of environment changes. So according to present context zooplankton is the intent area for research. In this paper we are try to collect review of literature at one place. Zooplanktons are the bio indicators of environment for pollution, physical, chemical and biological status of aquatic system.

Literature Review

Forel *(1841 – 1912)* was the founder of modern hydrobiology. He worked on different lakes found in Switzerland. The early fresh water stations yielded a mass of information, which made early groundwork of modern ecology. Elaborated investigations have been carried out during last few decades on limnology of different types of water resources. The study includes various aspects of lotic and lentic fresh water ecosystems, such as quality of water its physical, chemical and biological characteristics (phytoplankton, zooplanktons, macrophytes and animal of different taxonomic categories which has been reviewed and included in many research papers, dissertations, theses, monographs and books (Dube, *2002 and Basavarajappa et al., 2014).*

Ecologically zooplanktons are important biotic components and play an important role in the aquatic ecosystem as they constitute the most import link in the energy transfer between phytoplankton and higher aquatic fauna (Iloba, 2002).

Dube (2005a) has studied physicochemical characteristics of a semi-permanent pond at Baran Rajasthan, India. In the same year (2005b), Dube and Sharma have studied distribution pattern of amphibian biodiversity in southeastern plateau of Rajasthan, India in relation to ecology of the habitat and niche. In southeastern plateau of Rajasthan, Jhalawar, Baran district represent the rich amphibians biodiversity.

Zooplanktons influence all the functional aspects of an aquatic ecosystem such as food chains, food webs, energy flow and cycling of nutrients (Park and Shin, 2007). Zooplankton diversity responds rapidly to changes in the aquatic environment. Several zooplankton species are served as bio indicators (Ahmad *et al.,* 2011, Mola, 2011). Shallow lakes have an exceptional ecological significance (biodiversity of invertebrates, fish, water birds), but they are often neglected in limnological studies (Céréghino *et al.*, 2008).

Anthropogenic impacts frequently lead to the eutrophication and acidification of these habitats, and the introduction of invasive plants and animals results in reduced biodiversity (Kruk *et al.,* 2009). Water quality of several lakes of Bucharest city area on the comparison of standard and florescence measurement was studied (Ghir Vase *et al.* 2011). According to fluorescence measurement it appears that the lake water quality is not directly influenced by the Geological characteristic but more likely by the flora and fauna and the combination of anthropogenic degradation sources. The correlation between the fluorescence spectroscopy appears to the suitable for the evaluation and monitoring of the health of water system thus providing the opportunity for real time. Concurrently,

macrophytes increased habitat diversity, provided plenty and diverse food resources and refuge from predators (larvae and adult fish insects) forth zooplankton and benthic invertebrates (Estlander *et al*., 2009; Špoljar, 2013).

Soil bank diversity and zooplankton emergence pattern of some recently dried water bodies in north Maharashtra region, comparing to that of neighboring temporary pond and that permanent ponds studied by *Gaikwad et al.,(2008)* the diversity in permanent pod was significantly higher(i.e. 19) than the diversity in the temporary ponds (i.e. 8). We have recorded 8 species of rotifera species which are not present in the neighboring permanent for ephemeral water bodies during that period. A total 19 species were recorded including copepoda 6 species, cladocera 5 species, and rotifera 8 species.

Kedar et al., (2008) studied the seasonal abundance of zooplankton population in Rishi Lake with physico-chemical parameters. The no. of zooplankton recorded in summer and lowest in rainy season. The inter-relationship between physico-chemical factors and zooplankton is that all parameters pH, DO, alkalinity, total hardness, chlorides, sulphates, nitrates, and phosphates were at peak in summer and minimum in rainy season. Total 61 species were identified during study period such as Protozoa (14 sp.) Rotifera (29 sp.), Copepoda (6 sp.), ostracoda(5sp.) and Cladocera(7sp.).

Periodical ecological study of an urban pond near Vadodara Gujarat was studied by Soni and Bhatt (2008) with the physic-chemical, biological and microbiological parameters. The physic-chemical parameters show N max up to 3.4 mg/l, total phosphates 1.45 mg/land BOD 33 mg/l. The pond is full of algal growth. Microbiological analysis show positive result for *E. coli*, *Vibrio species* and many other pathogenic bacteria. These in water increase pollutants in terms of nutrients, organic matter and toxic substance in water bodies and disturb its ecosystem.

Zushi et al., (2008) studied the anthropogenic impact on the lake ecosystem in Hi-tech city Bangalore, Karnataka. A Hi-tech city Bangalore originally had 290 lakes many decades ago and today about 81 are left and of these 21 are said to be live. Lakes in and around urban areas of Bangalore receive considerable effluents and sewage inflow. The result are very evident showing depletion in oxygen level, high level of chlorophyll 'a', TDS, BOD, phosphate, sulphates, ammonia and high alkalinity etc. which inturn has altered the nutrients concentration contributing to the formation of algal blooms causing high mortality of fishes. A few badly effected lakes in and around Banglore city such as Bellandur, Varthur, Ulsoor, Byramangla, Madivala, Agra and Nagawalaare the one from where in even the hardy fish species like Murrels, Clarias, singhi etc. have completely disappeared. In recent years, limnology of different water bodies of Rajasthan was studied by several workers and total 144 zooplanktonic forms were reported belonging to 3 phyla, 27 families, 64 genera and 105 species. Protozoa (13), Rotifera (39), Copepoda, Cladocera and Ostracoda were represented by 13,39,22 and 6 forms respectively. Biodiversity in the zooplankton has been calculated in the Menhinick's index and values have been discussed in relation to physico-chemical characteristics and primary productivity.

Kumar *et al.,* (2008) evaluate the physico-chemical characteristics and diatom as indicators of trophic status of wetland namely Kishore Sagar Lake of Kota Rajasthan. The Diatom community comprised of 42 species representing 8 centric forms and 34 pennate forms. *Melosira granulata, Cocconies placentula, Diatoma elongatum, Fragilara crotoneinsis, Ghomphonema olivacium, Ghomphoneis herculum, Nitzchia sp. Navicula radios* and *Synendra ulna* were the most dominant species from this wetland. Highest population density of diatoms was observed in winter season. The abundance of diatoms in cold months is probably due to the fact that they are able to grow under the condition of weak light and low temperature. The dominance and abundance of diatoms the wetland is indicative of eutrophic nature of the water body. The water quality of the lake has detroited and is potential threat to human health as well as aquatic flora and fauna.

Dube *et al.* (2010a) investigated on Community structure of zooplanktonic groups of Kishore Sagar Tank. In this investigation they recorded total 36 species of zooplankton which belong to 7 groups. Dube *et al.* (2010b) have studied the occurrence and seasonal variation of the plankton in Kishore Sagar Tank, Kota, Rajasthan and a total 60 species of planktons (twenty four species of phytoplankton and thirty six species of zooplanktons) were recorded. The ecological study of the sewage Pond of H. E .C. industrial area Ranchi has been studies by Kumar and Sahu (2012). Studies were conducted to determine the occurrence and abundance of cynobacteria in relation to Physical-Chemical characteristics of Sewage Pond. This study indicates the maximum occurrence and abundance of *Microcys oscillatoria*, a Phormidium spp. in all the sites of Sewage Pond. The physic chemical parameter show maximum nitrogen up to 35.4 mgl^{2}, 4.8 mgl^{1}, Phosphate 147.131 mgl^{1} Cl and alkaline nature of water throughout the year favour the growth of *cyanophean* members and promote algal bloom formation of *Microcysis aeruginosa, O. princeps* and otenus in pond. The algal diversity of the Sewage pond is bio indicator of organic pollution.

Tidame and Shinde (2012) studied the zooplankton diversity in the temple pond of Nasik District. Different Zooplanktons were noticed during the study period, amongst them rotifers are more dominant. Total 17 genera were reported from rotifers and genus *Brachionus* in abundant and more common to both the ponds. In amrutkund 21 species of rotifers were recorded belonging to 15 genera while in pond Ramkund 23 species to 14 genera. The maximum diversity of rotifers was observed in the monsoon season in both Amrit Kund and Ram Kund Pond. Banerjee *et al.* (2014) analyzed zooplankton abundance in ponds under different fish farming system in west Bengal. The identified zooplanktons were under 4 orders namely Copepoda, Rotifera, Cladocera and Diaptomus.

Among these four orders Copepoda and Cladocera were dominant and represented by cyclops species and daphnia species respectively.

Physico-chemical parameters and plankton diversity of Konda (open pond) pond of Bharatpur is studied by Singh (2015). Physico-chemical parameters of pond are water temperature 24-25.6 ˚c ,transparency 0.2-0.4 m , pH 7.3-7.4 ,total dissolved solids 143.8-159.5 mg/L, conductivity 290.8-391.5 µmhos, salinity 0.11-0.19 %,dissolved oxygen 0.7-1.8 mg/L, and alkalinity 0.8-1.7 mg $CaCo_3$ mg/L, five families of phytoplankton are identified at the time of study Cyanophyceae, Colorophyceae, Euglenophyceae, Bacillirophyceae and dinophyceae. Three groups of zooplanktons are also identified namely copepods, Cladocerons and Rotifers. Pond is likely polluted as some pollution indicator species are present such as Microcystis, phacus, Oscillatoria, Anabeana, Euglena.

Sharma *et al*. (2015) studied the diversity of zooplankton and macro benthic invertebrates in Jhakhand Dilli pond. 29 species of zooplanktons were identified viz. Protozoan, Rotifers, Cladocerons, Copepods and Ostracods.

Biswas (2015) studied the relationship between the physico- chemical properties and zooplankton in Dhakuria Lake. 31 species of zooplankton comprising of 4 groups were reported viz. Rotifera (17 species), Cladocera (10 species), Copepoda (3 species), Ostracoda (1 species). copepodes were dominant. There is positive relationship between high level of physico-chemical parameters such as total hardness, Do, BOD, COD, sulphate and phosphate with the abundance of Cladocera, Copepoda and total zooplankton population.
Manikam et al. (2015) studied the zooplankton diversity and physico-chemical parameters of Barur Lake, Krishnanagri district Tamil nadu. 47 species of zooplankton were reported of which 18 species of Rotifers, 11 species of Cladocera, 11 species of Copepoda and 7 species of Ostracoda were observed. Rotifera was dominating group among all species.

Seasonal variation of zooplankton diversity of Majalgaon reservoir Maharashtra was assessed by Pawar (2016) During the study period 23 species were recorded among them Rotifers (8 species), Cladocera (6 species), copepod (5 species), Ostracod (2 species) and Protozoa (2 species). During summer season number of zooplankton were highest and lowest during winter season. Lucas *et al*.(2017) studied the microbiological and and physico-chemical parameters of water bodies of Desiroto de los leones National Park located in central region of the Mexico city. They identified five bacterial genera (*Escherichia, Pseudomonas, Klebsiella, Shigella and Salmonella*). Result of testing of water is as follow: pH 5.5-5.9, turbidity 10.7-32.3, Nephlometric turbidity units (NTU's), chemical oxygen demand (COD) 106-450 mg/L, total coliforms 98-956 colony forming units (CFU'S), faecal coliforms 78-807 CFU'S, 90% isolated bacteria were resistant to ampicillin while 25% resistant to ciprofloxacin.

Yadav and Singh (2017) studied the zooplankton diversity of Chhapakaiya pond Birgunj Nepal. A total 27 taxa from different classes of zooplankton were identified. The zooplankton were reported maximum (774.4 unit/L) during summer and minimum (539.2 unit/L) during rainy season in Chapakaiya pond. Triest and Stier (2017) studied the impact of non-native plant species on phytoplankton and zooplankton communities in temperate pond. Investigation shows the relationship between the three aquatic nonnative invasive species (*Hydrocotyle ranunculoides, Ludwigia randiflora* and *Myriophyllum aquaticum*), zooplankton and phytoplankton density Jacob *et al*. (2017) studied the odanata (dragonflies and damselflies) as bio indicators of water quality of 30 ponds of Maanachil taluk of Kottayam district Kerala. The water quality index, Simpson's diversity index and species abundance values were calculated. Bradinopyga germinata and Trithemis festiva species were fresh water indicator species whereas Zyxomna petiolatum and Ceriagrion cerinorubellum were indicates the polluted water.

Seasonal variation of zooplanktons of pond at Lake Kollore region of Andhra Pradesh was assessed by Krishna and Kumar (2017). Zooplankton richness, evenness and diversity were observed. A total number of 16 species recorded with 9 rotifers, 3 cladocera and 4 copepods. In the rotifers genus Branchionus was the dominating group. Seasonal succession and role of temperature of zooplankton of Talpad pond and Jonu pond of Udhampur city studied by Devi (2017). Total 34 genera were identified belonging to 5 groups Protozoa (6 genera), Rotifera (12 genera), Copepoda (6 genera), Cladocera (6 genera) and Ostracoda (2 genera).

DV and HL (2017) studied the physico-chemical parameters of Nizam Sagar dam for fish production, phytoplankton and zooplankton. Water temperature, pH, total alkanity, dissolved oxygen and carbon dioxide were investigated. The pH shows alkaline trend in Nizam Sagar dam which is more suitable for fish culture.

Physico-chemical parameters and zooplankton diversity of a perennial lake, Dharampuri, Tamil Nadu assessed by Dhanasekaran *et al*. (2017). Total 29 zooplankton species were identified during the period of study among them 10 species of Rorifers, 8 species of Cladocera, 6 species of Copepoda and 5 species of Ostracoda. There is positive co-relation between physico-chemica parameters and zooplankton species. Abbai (2017) assessed the zooplankton diversity of Sogal pond in Belagavi district of north Karnataka. Total 16 species were identified belonging to 3 different groups 43% Rotifera, 36% Cladocera, and 21% of Copepoda. In winter season density of zooplanktons were high and low during summer. Diversity of zooplankton in municipal waste water contaminated urban pond of the lower gangetic plains were studied by Adhikari *et al*. (2017). 22 species of zooplankton were identified ,14 species of Rotifera, 3 species of copepoda, 4 species of Cladocera and single species of Ostracods , which suggest that municipal waste water loaded with various nutrients has influenced the zooplankton diversity and abundance.

Conclusion

On the basis of above review it can be concluded that inspite of the fact that a lot of work has been done on limnology of lotic and lentic water resources, much is to done in changing scenario of environment and climatic condition. Climate change is a distasteful truth of over time it has impact on various components of nature including natural lentic water bodies. This demands serious investigation with fresh approaches and new technologies.

References

Abbai, S.S.,2017. A study on zooplankton diversity of sogal pond in Belagavi district, north Karnataka. IJIRSET .6(9):19071-19071.

Adikari, S., A.R. Goswami and S.K. Mukhopadhyay, 2017. Diversity of zooplankton in municipal wastewater contaminated urban pond ecosystem of the lower gangetic plains. Turkish journal of zoology. 41:464-475.

Ahamad, V., Parveen, S., Khan, A.A., Kabir, H.A., Mola, H.R.A. and Ganai, A.H. 2011: Zooplankton population in relation to physiochemical factors of the sewage fed pond of Aligarh (U.P) India. Biol. Medic., 3: 336-341

Banerjee, S., R. Nur and S. Barat 2014. Study on the zooplankton production in ponds under different fish farming system in west Bengal. J. krishi Vigyan. 3(1):79-83.

Basavarajappa,S. H.,Raju N. S., and Hosmani S. P. (2014).Limnological: Critical Review. Current World Enviroment, 9(3):741-749.

Iloba, K.I. 2002. Vertical distribution of Rotifera in the Ikpoda reservoir in southern Nigeria. Tro. Fres. Bio, 11: 69-89.

Biswas, M. 2015. Seasonal abundance of zooplankton in physico-chemical features in Rabindra Sarobar, Kolkatta. International Journal of Interdisciplinary and Multidisciplinary Studies. (5):56-72.

Céréghino, R., Biggs, J., Oertli, B., Declerck, S. (2008): The ecology of European ponds: defining the characteristicsof a neglected freshwater habitat. Hydrobiologia, 597,1-6

Devi, S. 2017. Role of temperature for the zooplankton growth and seasonal fluctuations. International Journal of Advance Research in Science and Engineering. 6(90):337-346.

Dhanasekaran, M., P. S. Bhavan, N. Manickam and R. Kalpana, 2017. Physico-chemical characteristics and zooplankton diversity in a perennial Lake at Dharampuri, Tamil nadu India. Journal of Entomology and Zoology Studies. 5(1):28

Dube, P. 2002: Ecobiological studies of amphibians around south eastern plateau of Rajasthan. Ph.D. Thesis, M.D.S. University, Ajmer.

Dube P. and Sharma K.K. 2005b: Distribution pattern of amphibian biodiversity in southeastern plateau of Rajasthan, India. *Indian j. Environ. Sci*. **9(1)** pp. 35-38.

Dube P. Garg, V. and Sharma S. 2010a: Community structure of zoo planktonic groups of Kishore Sagar Tank, Kota, and Rajasthan. Life Sci. Vol. 6(3): 451-453.

Dube P. Garg, V. and Sharma S. 2010b. The occurance and seasonal variation of the plankton in Kishore Sagar Tank, Kota, Rajasthan. Life Sci. Bull. 6(3): 327-330.

Estlander, S.,Nurminen, S. L., Olin, M., Vinni, M., Horppila,J. (2009): Seasonal fluctuations in macrophyte cover and water transparency of four brown-water lakes: implicationsfor crustacean zooplankton in littoral and pelagichabitats. Hydrobiologia, 620, 109-120

Gaikwad, S.R., K.M. Ingle and S.R. Thorat (2008). Study of Zooplankton emergence pattern and resting egg diversity of recently dried waterbodies in North Maharastra Region. Journal of Environmental Biology. 29 (3):353-356.

Jacob, S., A .P. Thomas, E. K. Manju 2017. Odonata (Dragonflies and Damselflies) as bio indicators of water quality. International Journal of Innovative Research in Sciences Engineering and Technology. 6(9):19464-19474.

Kedar, G.T., G.P. Patil and S.M. Yeole (2008). Effect of Physico-chemical factors on the Seasonal abundance of Zooplankton population in Rishi Lake. Proceeding of Taal 2007 : The 12th world lake conference: 88-91.

Krishna, P .V. and H. Kumar 2017. Seasonal variation of zooplankton community in selected ponds at Lake Kolleru region of Andhra Pradesh, India. Int. J. Curr. Microbiol. App. Sci. 6(8):2968-2970.

Kruk, C., Rodríguez-Gallego, L., Meerhoff, M., Quintans, F.,Lacerot, G., Mazzeo, N., Scasso, F., Paggi, J. C., Peeters, T.H. M. E., Scheffer, M. (2009): Determinants of biodiversityin subtropical shallow lakes (Atlantic coast, Uruguay).Freshwater Biology.54, 2628-2641

Kumar, A., L.L. Sharma and M.C. Aery (2008). Physico-chemiocal characteristics and diatom as Indicators of Trophic status of Kishore Sagar, Rajasthan. Proceeding of Taal 2007: The 12th world lake conference: 1804-1809.

Kumar, A. and R. Sahu (2012). Ecological Studies of cyanobacteria in sewage pond of H.E.C. Industrial Area, Ranchi, India. Bio-science Discovery.3(1): 73-78.

Lucas, L. R .G., L. M. C. Ramirez and L. Arregui 2017. Physico-chemical and microbiological analysis of water of the "Presa De Los Patos" in the Desierto De Los leones National Park, Mexico. Advances in Biological Chemistry.7:122-138.

Manikam, N., P. S. Bhavan, P. Santhanam, T. Murlisankar, V. Srinivasan, K.Vijayadevan and R. Bhuvaneswari, 2015. Biodiversity of freshwater zooplankton and physico-chemical parameters of Barur Lake, Krishnagiri district, Tamil nadu,India.Malaya journal of biosciences. 2(1):1-12.

Mola, H.R. 2011. Seasonal and Spatial distribution of Brachionus (Pallas, 1966; Eurotatoria: Monogoranta: Brachionidae), a bioindicator of eutrophication in Lake El-Manzalah, Egypt. Biol. Medi., 3: 60-69.

Park, K.S. and Shin, H.W. 2007. Studies on phyto-and-zooplankton composition and its relation to fish productivity in a west coast fish pond ecosystem. J. Env. Biol., 28: 415-422.

Pawar, R. T. 2016. Zooplankton diversity and seasonal variation of Majalgaon reservoir, Maharashtra state, India. Internationa Journal of Environmental Sciences. (5):859-866.

Sharma, K .K., S. Kour and N. Antal 2015. Diversity of zooplankton and micro benthic invertebrates of two perennial ponds in Jammu Region. Journal of Global Biosciences. 4(2):1382-1392

Soni, R.N. and S.A. Bhatt (2008). Periodical ecological study of an urban pond near Vadodara, Gujarat, India. Proceeding of Taal 2007: The 12th world lake conference:1591-1596.

Špoljar, M. (2013): Microaquatic communities as indicatorof environmental changes in lake ecosystems. Journal of Engineering Research.1:29-42

Tidame, S.K. and S.S. Shinde (2012). Seasonal Variation in rotator diversity of temple ponds of Nashik District (M.S.) India International Multi-disciplinary Research Journal. 2(5): 19-22.

Totawar, D .V. and H.L. Tamlurkar 2017. Physico-chemical parameters of Nizam Sagar dam with respect to fish productior phytoplankton, zooplankton .Int .J. of Life Sci. 5(3):451-454.

Yadav, L. B. P. and A. singh, 2017. Study of zooplankton diversity of Chhapakaiya pond Birgunj, Nepal .Int. J. Life .Sci. Scienti. Res 3(2):925-931.

Zutshi, B., S.G. Raghu and R. Nagaraja (2008). Anthropogenic Impact on the Lake Ecosystem in Hi-Tech City, Banglore, Karnataka Proceeding of Taal 2007: The 12th world lake conference, :1786-1793.

Vol. 8. No. 4. 2019
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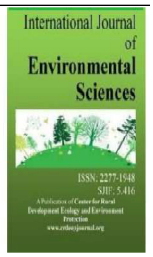
Contents available at:
www.crdeepjournal.org

International Journal of Environmental Sciences (ISSN: 2277-1948)



Review Article

A Critical Review of Phytoplankton Studies of Lentic Water Bodies of India

Kamlesh Meena and Prahlad Dube*
Department of Zoology, Government. College, Kota-324001, India.

ARTICLE INFORMATION

Corresponding Author:
Prahlad Dube

Article history:
Received: 02-06-2019
Accepted: 18-06-2019
Published: 26-06-2019

Key words:
Phytoplankton, lentic water bodies, India, chlorophyceae, cynophycea

ABSTRACT

Phytoplankton is microscopic organisms that lie in watery environment and make their own food from sunlight through photosynthesis. Phytoplankton's are the primary producers and play important role in the food web. Many physico-chemical were affecting the phytoplankton. In the present paper an effort has been made to give broad review of literature on phytoplankton. This review clearly indicates that such research is necessary and emphasis the urgency of present work. According to present condition it is very important to investigate with fresh approaches in this field for diversity, abundance and variation in the biotic factors in the aquatic system.

Introduction

Phytoplanktons are producers of aquatic ecosystem. These are autotrophic components of the plankton community and a key part of oceans, seas and freshwater ecosystem. Also are very important organisms from ecological point of view. Most of the aquatic food chains begin with them. Therefore, these remained popular subjects for research during last couple of centuries. The literature of such studies is available and while collecting most of the research the difficulties are faced by most of the researchers. A systematic review of such references is a need of the time. Present paper is trying to fulfill this need and reviews various aspects of phytoplankton research presented in the research articles.

Review Methodology and Review details

The various aspects studied by the researchers are their diversity, analysis of the attributes of their surrounding medium, seasonal variations and their role/functions in their habitats etc.

Studies from abroad Periodic environmental changes in temperature, water movement, light, soil and other biological factors lead to changes in species composition and food chain of marine ecosystem (Gray,1974, 1981). Phytoplankton, the most important biological phenomenon in nature on which the entire array of life depends is the integral component of riverine ecosystem which determines the primary productivity of the system. It is the bio-indicators of water pollution. Its appearance, disappearance, density and pattern of distribution depends on biotic and abiotic factors (Lewitus *et al*., 1998; Escaravage *et al*., 1999; Escaravage *et al*., 2002; Kauppila *et al*., 2004; Gupta *et al*. 2005; LeQuere *et al*., 2005; Komala *et al*., 2013). Phytoplankton is the major primary producers in many aquatic ecosystems (Kensa, 2011).

Winder and Sommer (2012) studied the effect of climate change on phytoplankton. Climate affects phytoplankton directly through physiology and indirectly by changing water column stratification and resource availability, mainly nutrients and light. Climate also effects phytoplankton species composition and size structure and favors' species trait.

Veronica *et al*.(2014) studied the effect of water quality on phytoplankton abundance in Hampalam river and fish pond of Batanjung village. In these 60 genera of phytoplankton phyla were found in the river and pond with the highest abundance of Pluerosigma belonging to Chrysophyra in the river and euglena species belonging to euglenophyta in the pond.

Palh*et al*.(2016) studied the phytoplankton of Chakhan Lake district Dadu, sindh Pakistan. Phytoplankton algal species belonging to genera Anabaenospsis, Anabaena, Nostoc of family Nostocaceae were reported. Zebek and Szymanska(2017) assessed the differences in phytoplankton abundance, biomass,

structure and the environment requirement of dominant species of pond of Warmia Mazury region of north-east Poland.

Giripunje *et al.* (2013) studied a comprehensive review of phytoplankton ecology in freshwater lakes of India. In this the relations of phytoplankton with factors like lake temperature, sunlight exposure period, sunlight penetration, water pH, wind, transparency, seasonal variations, water characteristics, nutrient enrichment and prey-predator relation in the lakes of India were discussed.

Hosmani (2014) assessed phytoplankton influenced climatic changes and by variation in the physico-chemical constituents of the water and the uncontrolled conditions lead to pollution.

Kumar *et al.*, (2008) evaluate the physico-chemical characteristics and diatom as indicators of trophic status of wetland namely Kishore Sagar Lake of Kota Rajasthan. The Diatom community comprised of 42 species representing 8 centric forms and 34 pennate forms. *Melosira granulata, Cocconies placentula, Diatoma elongatum, Fragilara crotoneinsis, Ghomphonema olivacium, Ghomphoneis herculum, Nitzchia sp. Navicula radios* and *Synendra ulna* were the most dominant species from this wetland. Highest population density of diatoms was observed in winter season. The abundance of diatoms in cold months is probably due to the fact that they are able to grow under the condition of weak light and low temperature. The dominance and abundance of diatoms the wetland is indicative of eutrophic nature of the water body. The water quality of the lake has deteriorated and is potential threat to human health as well as aquatic flora and fauna.

The study includes various aspects of lotic and lentic fresh water ecosystems, such as quality of water its physical, chemical and biological characteristics (phytoplankton, zooplanktons, macrophytes and animal of different taxonomic categories which has been reviewed and included in many research papers, dissertations, theses, monographs and books (Dube, *2002 and Basavarajappa et al., 2014)*. Periodical ecological study of an urban pond near Vadodara Gujarat was studied by Soni and Bhatt (2008) with the physic-chemical, biological and microbiological parameters. The physic-chemical parameters show N max up to 3.4 mg/l, total phosphates 1.45 mg/land BOD 33 mg/l. The pond is full of algal growth. Microbiological analysis show positive result for *E. coli, Vibrio species* and many other pathogenic bacteria. These in water increase pollutants in terms of nutrients, organic matter and toxic substance in water bodies and disturb its ecosystem.

The primary productivity of phytoplanktons of Kolayat Lake, Bikaner. The monthly primary productivity in the lake revealed a seasonal cycle in the values for gross and net primary production (Barupal and Gehlot 2014).

Bhupender and Kumar (2015) studied the phytoplankton diversity of desert village pond in Bikaner Rajasthan. The reported species of phytoplankton were the members of three algal groups namely Cholorophyceae, Cynophyceae, and Bacillariophyceae were observed. The species cladocera, crucigenia,murospora, chara , spirogyra (5 green), Navicula , Nitzchia , Synedra, diatoma ,coscrnodiscus (5 diatoms), Spirulina, Nostoc, Anabaena, Oscillatoria (4 blue green algae) were recorded from pond.

Physico-chemical parameters and plankton diversity of Konda (open pond) pond of Bharatpur is studied by Singh (2015). Physico-chemical parameters of pond are water temperature 24-25.6 ˚c ,transparency 0.2-0.4 m , pH 7.3-7.4 ,total dissolved solids 143.8-159.5 mg/L, conductivity 290.8-391.5 µmhos, salinity 0.11-0.19 %,dissolved oxygen 0.7-1.8 mg/L, and alkalinity 0.8-1.7 mg $CaCO_3$/L, five families of phytoplankton are identified at the time of study Cyanophyceae, Cholorophyceae, Euglenophyceae, Bacillirophyceae and Dinophyceae. Three groups of zooplanktons are also identified namely Copepods, Cladocerons and Rotifers. Pond is likely polluted as some pollution indicator species are present such as Microcystis, Phacus, Oscillatoria, Anabeana, and Euglena.

Seasonal changes of phytoplankton community of Lake Ramgarh was studied by Maheshwari *et al.* 2015correlation between various physico-chemical parameters , productivity and plankton groups were calculated according to Karl Pearson's formula. During summer gross and net primary production were high and low during the winter season. Bacillareophyceae (43.58%) > Chlorophyceae (33.41 %) > Cyanophyceae (23 %) were three major groups according to their density. Nitzchia, synedra and Naviculla were the main contributors of bacillariophyceae, Closterium and Chlorella were from the group Cholorophyceae, Cynophyceae was dominated by *Spirullina ,Anabaena, Microcystis.*

Kumar*et al.* (2015) studied the phytoplankton diversity in relation of primary productivity of Lake Udai Sagar Udaipur. The mean primary productivity (GPP) was to be 0.50 gcmh^{-1} in surface.

Mishra *et al.* (2017) assessed the seasonal diversity of phytoplankton by Palmer's Index. In Pichola Lake 36 genera were repoted among them 12 from Cyanophyceae, 9 from Bacillariophyceae, 12 from Chlorophyceae and 3 from Desmidiaceae. Chlorophyceae were dominant among phytoplankton.

The phytoplankton study is a very useful tool for the assessment of water quality and productivity of any type of water body and also contributes to understanding of lentic water bodies Pawar*et al.*, 2006.

Ansari*et al.* (2015) assessed the diversity of phytoplankton and physico- chemical parameters of ONGC pond Hazira. During the time period of study 73 genera belonged to 4 classes' viz. Euglenophyceae, Cholorophyceae, Bacillariophyceae and Cyanophycea were identified. Among the four classes cholrophyceae group was dominating class. Level of various physico-chemical parameters are as follow oxygen (5.678±0.218 mg/L, nitrate (4.089±0.926mg/L), phosphate (0.257±56.786mg/L) and silicate (0.218±0.029 mg/L). Physico-chemical parameters show direct relationship.

Joseph (2017) studied the diversity and distribution of phytoplankton in an artificial pond, Phytoplankton species cyanophyceae (39%) was the dominating group followed by

Cholrophyceae (34%), Bacillariophyceae (235%) and Euglenophyceae (4%).

Triest and Stier (2017) studied the impact of naon native plant speeies on phytoplankton and zooplankton communities in temperate pond. We investigated the relationship between the three aquatic nonnative invasive species (Hydrocotyle ranunculoides, Ludwigia, randiflora and Myriophyllum aquaticum), zooplankton and phytoplankton density.

Saidu *et al.* (2016) studied the species distribution of phytoplankton in Balanga Dam. 21 species were identified belonging to about 7 taxa. Cholorophyceae were dominating about 28.6%, followed by Bacillariophyceae 19%, Cyanophyceae (19%), Desmidiaceae (14.3%) and Chrysophyceae (9.5%) respectively.

Pandiammal *et al.* (2017) assessed on the diversity of phytoplankton and seasonal fluctuation in temple pond at Thiruvottiyur Chennai. Totally 5 groups of phytoplankton taxa were identified which were chlorophyceae 10, Bacilliariophyceae 11, Cyanophyceae 6, Euglenophyceae 3, Dinophyceae 2.

Phytoplankton diversity is influenced by physical and chemical parameter of pond water was studied by Devi and Antal (2013). Phytoplankton showed significant correlation with certain abiotic parameters such as water and air temperature, phosphate, carbonates and chlorides. Margalef's index, Menhink's index, Simpson index, Shannon Wiener index and Equitability index were used for phytoplankton population.

Sharma *et al.* 1985 studied relationship of phytoplankton and physico chemical parameters which shows that increase in concentration of physico-chemical parameters has an adverse effect on phytoplankton density.

Roy et al. (2015) studied plankton diversity of urban and rural ponds of Raipur. Total 67 algal genera were reported belonging to classes Chlorophyceae (29), Bacillariophyceae (18), Cyanophyceae (15), Chrysophyceae (2), Euglenophyceae (2) and Dynophyceae (1) while among zooplankton 24 genera were stated belonging to classes Rotifera (11), Copepoda (7), Protozoa (3), Cladocera (2) and Ostracoda (1). These ponds have high plankton diversity.

Verma *et al.* (2016) assessed phytoplankton diversity. Phytoplankton diversity is important for evaluation of suitability of water for irrigation and drinking purpose.

Bordolol and Baruah (2014) studied correlation between phytoplankton and physico- chemical parameters of water. There is positive relationship with surface water temperature, electric conductivity, turbidity, BOD, potassium, phosphate ad nitrate with the total density values of Palmer's genera.

Das and Sayantan (2016) assessed the physicochemical parameters and biological parameters as plankton of different ponds. Sharma *et al.*, (2018) critically reviewed the literature on diversity and seasonal variation of phytoplankton. The important components of phytoplankton are Diatoms (Bacillariphyceae), Dinoflagellates (Xanthophyceae, Chrysophyceae, Haptophyceae, Cryptophyceae) and Nanoplankters (*Chlorella, Nannochlorpsis*, etc.). In addition to these, two other classes namely Silicoflagellates and Coccolithophores also belong to the category of phytoplankton.

Karra *et al.*, (2018) reviewed the studies of Phytoplankton in Lotic Water of India. Phytoplanktons are microscopic creatures mainly algae contain chlorophyll and live near the surface of water where there is sufficient light, producing their own food and thus providing meals for countless other aquatic dwellers. They play important role in maintaining the equilibrium between living organism and abiotic factors. The density and diversity of phytoplankton and their association as biological indicator is significant in the assessment of water quality.

Conclusion

This review clearly indicates that the pocket of such research is necessary and emphasis the urgency of present work. According to present condition it is very important to investigate with fresh approaches in this field for diversity, abundance and variation in the biotic factors in the aquatic system.

References

Ansari, E., M. Gandhia and N. C. Ujjania 2015. Phytoplankton diversity and water quality assessment of ONGC pond, Hazira .International Journal of Research in Enviromental Sciences. 1(1): 1-5.

Barupal G.K. and R.K. Gehlot (2014). Assessment if Primary Productivity of Phytoplanktons of Kolayat Lake, Bikaner (Rajasthan), India.Phykos 44(2):3-5.

Basavarajappa,S. H.,Raju N. S., and Hosmani S. P. (2014).Limnological: Critical Review. Current World Enviroment, 9(3):741-749.

Bhupender, J. and K. A. Kumar 2015. Phytoplankton diversity of a desert village pond in Bikaner Rajasthan, India. International Research Journal of Environmental Sciences. 4(2):43-46.

Bordolol D. and P.P. Baruah (2014). Water quality assesment using phytoplankton in a historical pond of upper Assam. J. Algal Biomass Utln.. 5(2):1-7.

Das S.S. and Sayantan (2016).Limnological studies on different ponds of Bihar, India :a Review. Mapana J Sci.15 (4):49-53.

Devi A. and N. Antal (2013). Variation in phytoplankton diversity and its relationship with abiotic Enviroment of a temple pond in Birpur (J &K) India. Universal Journal of Environmental Research and Technology. 3 (2):181-189.

Dube, P. 2002. Ecobiological studies of amphibians around south eastern plateau of Rajasthan. Ph.D. Thesis, M.D.S. University, Ajmer.

Escaravage, V. and Prins, T.C.(2002). Silicate availability, verticalmixing and grazing control of phytoplankton blooms in mesocosms. *Hydrobiol*. 484: 33-48.

Escaravage, V., Prins, T.C., Nijdam, C., Samal, A.C. and Peeters, J.C.H. (1999) Response of phytoplankton communities to nitrogen input reduction in mesocosm experiments. *Marine Ecol. Prog. Series*. 179: 187-199.

Giripunje M.D., A.B. Fulke, K., K. Kharnar , P.U. Mishram, W.N. Paunikar 2013. A Review of phytoplankton ecology

Gray, J.S.(1974). Animal sediment relationships. Oceanogr. Mar. Biol. Annu. Rev..12:223-261 .

Gray, J.S.(1981). Detecting pollution induced changes in communities using the lognormal distribution of individuals among species. Mar. Pollut. Bull., 12,173-176 .

Gupta, S.K., Dixit, S. and Tiwari, S. (2005). An assessment of heavy metals in surface water of lower lake, Bhopal, India. *Poll.Res*. 24(4): 805-808.

Hosmani S. (2014). Freshwater Plankton Ecology: A Review. Abhinav International Monthly Refereed Journal of Research in Management and Technology. 3(8):1-9.

Joseph, J. 2017.Diversity and distribution of phytoplankton in an artificial pond. Int. J. Adv. Res. Biol. 4(5):114-122.

Karra, V. D., Dube, P., Sharma, J., Sood, Y. and Manju Sharma (2018): A critical review on the studies of phytoplankton in lotic water of India. International Journal of Life Science, Vol.7 (2): 71-74. Sharma J., Dube P. and Karra V.D. (2018). A Critical Review of studies related to Diversity and Seasonal Variation of Phytolankton. International Journal of Phytoplankton. Inttnational Journal of Basic and Applied Sceinces 7(3): 92-95.

Kauppila, P., Pakanen, H., Raike, A., Kiirikki, A., Back, M. and Kangas, S.P. 2004.The Baltic waters around Finland,Eutrophication continues despite decreased nutrient loading.In: P. Elorantant (ed.). Inland and Coastal waters of Finland. SIL XXIX Congress, Lahti, Finland: pp.8-11.

Kensa, V. 2011. Interrelationship between physico-chemical parameters and phytoplankton diversity of two perennial ponds of Kulasekharam area, Kanyakumari district, Tamil Nadu.*Pl. Sci. Feed*. 1(8): 147-154.

Komala, H.P., Nanjundaswamy, L. and Devi Prasad, A.G. 2013.An assessment of Plankton diversity and abundance of Arkavathi River with reference to pollution. Adv. Appl. Sci. Res. 4(2): 320-324.

Kumar, A., L.L. Sharma and M.C. Aery:(2008) Physico-chemiocal characteristics and diatom as Indicators of Trophic status of Kishore Sagar, Rajasthan. Proceeding of Taal 2007 : The 12th world lake conference.

Kumar, S., B. K. Sharma, S. K. Sharma and B. Upadhyay 2015. Primary productivity and phytoplankton diversity in relation to fisheries potential of the Lake Udai Sagar, Udaipur. International Journal of Fauna and Biological Studies. 2(5):9-12.

LeQuere, C., Harrison, S.P., Prentice, I.C., Buitenhuis, E.T., Aumont, O., Bopp, L. and Clauster, H. 2005. Ecosystem dynamics based on plankton functional type for Global ocean biogeochemistry models. Glob. Change Biol. 11: 2016-2040.

Lewitus, A.J., Koepfler, E.T and Morris, J.T.(1998). Seasonal variation in the regulation of phytoplankton by nitrogen and grazing in a salt-marsh estuary. *Limnol. Oceanograph*. 43(4):636-646.

Maheswari, K., J. Vashistha, P. V. Paulose and T. Agarwal 2015. Seasonal changes in phytoplankton community of Lake Ramgarh India. International J. Curr. Micribiol. App.Sci. 4(11):318-330.

Mishra V., S.K. Sharma, B.K. Sharma, L.L. sharma, A. Shukla (2017).Seasonal phytoplankton diversity using Palmer's Pollution Index of Pichhola Lake Dist.- Udaipur (Rajasthan) India. Int. J. Pure App. Biosci.. 5 (4):1857-1861.

Pahl, Z. A., K .F. Almani, M. A. Qureshi, A .R. Abbasi and K .H. Lasheri 2016. Ecological survey of phytoplankton (Nostocaceal) of Chakhan Lake, district, Dadu, Sindh, Pakistan. Research and Review: Journal of Botanical Sciences. (40):15-18.

Pandiammal, S., J. M. Bashini and P. Senthilkummar 2017. Diversity and seasonal fluctuations of phytoplankton in temple pond at Thiruvottiyur, Chennai, South India. Journal of Academia and Industrial Research. 6(1):7-12.

Pawar, S.K., J.S. Pulle and Shendge, K.M., 2006. Thestudy on phytoplankton of Pethwadaj Dam, Taluka Kandhar, District-Nanded,Maharashtra. *J.Aqua.Biol.*, 21:1-6.

Roy K., S. Gupta, S.K. Nandy (2015). Checklist of commonly available phytoplankton and zooplankton genera of urban and rural ponds of Raipur, Chattisgarh, India. World Journal of Zoology. 10 (4):351-357.

Saidu, H., B. Usman and D. Umar, 2016. Studies of species distribution for phytoplankton in Balanga Dam. Journal of Advanced Research in Applied Sciences and Engineering Technology. 3(1):1-9.

Sharma MS, Durve VS.(1985) Proceedings of the National Symposium for the Evaluation of Environment. (Eds. Mira, S. D., Sen., D.N.and Ahmed, I.) Geobios.180-186.

Singh, S. 2015. Analysis of Plankton Diversity and Density with physico-chemical parameters of open pond in town Deeg (Bharatpur) Rajasthan India. International Research Journal of Biological Sciences. 4(11):61-69.

Soni, R.N. and S.A. Bhatt : (2008) Periodical ecological study of an urban pond near Vadodara, Gujarat, India. Proceeding of Taal 2007 : The 12th world lake conference. P. 1591-1596.

Stiers, L., L. Triest 2017. Impact of non- native invasive plant species cover on phytoplankton and zooplankton communities in temperate ponds. Aquatic invasions.12(3):385-395.

Verma A.K., S. Prakash and B.K. Mishra (2016). Phytoplankton diversity in Alwara Lake of district Kaushambim(U.P.).Jouranl of Entomology and Zoology Studies.4(1):170-172.

Veronica, E., A. S. Leksono, Soemarno, D. Arfiati 2014. Effect of water quality on phytoplankton abundance in Hampalam River and fish pond of Batanjung village. IOSR Journal of Environmental Science, Toxicology and Food Technology. 8(1, 1):15-21.

Wender M., U. Sommer (2012). Phytoplankton response to a changing climate. Hydrobiologia. 698:5-16

Zebek E. and U. Szymanska (2017) Abundance, biomass and community structure of pond phytoplankton related to the catchment characteristics. Knowl. Manag Aquat. Ecosyt. 418-445.

International Journal of Applied and Universal Research E- ISSN No: 2395-0269
Volume VI, Issue III, June 2019 Available online at: www.ijaur.com

DIVERSITY AND SEASONAL VARIATION OF SIMILIYA VILLAGE POND

Kamlesh Meena and Prahlad Dube*
Department of Zoology, Govt. College, Kota: 324001 (India).

ABSTRACT: Water is the most precious substance on the earth. Life on the earth is not possible without water. The determinant of good water body is determined by physico-chemical characteristics. In the present study seasonal variation of physico-chemical characteristics were statically analyzed and graphically presented. The following ranges were obtained for the parameters evaluated atmospheric temperature 23.1-34.6 ^{0}C, atmospheric relative humidity 40.9-78.9 %, water temperature 22-29 ^{0}C, transparency 13.43-83.55 cm, electric conductivity 120.76-391.96 µmhos/cm, total dissolved solids 57.8-128.9 mg/l, pH 7.11-8.9, free carbon dioxide 0.50-4.86 mg/l, total alkalinity 86.44-155.87 mg/l, dissolved oxygen 6.46-9.57 mg/l, chloride 26.80-145.61 mg/l, total hardness 86.80-198.33 mg/l, phosphate 0.86-1.98 mg/l and nitrate 0.16-0.56 mg/l. Phytoplankton species were more diverse and dominant than zooplankton communities. These were found to be present in the ratio of 6.4:3.6 (64 % phytoplankton 36 % zooplankton). The study concluded that the water of the village pond Similiya showed variation in the various physico-chemical parameters in all the three seasons.

KEYWORDS:- Physico-chemical, phytoplankton, zooplankton and village pond.

INTRODUCTION:-

Ecology is the study of the relationship between living organism, including humans, and their physical environment, it seeks to understand vital connection between plants and animals and the world around them. Freshwater systems- lakes, wetlands, rivers and streams, have been critical to the establishment of civilizations throughout human history. Water bodies are essential to humans not only for drinking but also for transportation, agriculture, energy, production, industry etc. Determining which of these factors has the most significant influence on the quality of water body with its watershed and how the various inputs affect its physical, chemical and biological characteristics. One of critical sciences required to understand aquatic ecosystem interactions in called limnology. Limnology incorporates many scientific disciplines into one including physics, chemistry, and biology. While the main thread of limnology is water system, these water systems are interconnected host plant and animal life band both influence and interact with weather patterns. The Pond is a small body of standing water and the pond ecosystems complex interaction between its biotic and abiotic components. Abiotic components of pond ecosystem are environmental factors (light, temperature, water), inorganic components (O_2, CO_2, N_2, nitrate, phosphates, carbonates etc.). Biotic factors are phytoplankton and zooplanktons.

MATERIAL AND METHODS:-

Study area:

In the present study involves the analysis of diversity and seasonal variation of Similiya village pond, Kota district, Rajasthan, India. It is 28 KM towards east from district headquarters Kota on national highway number 27. Its Geographical location is at longitude 76˚11 N and latitude 25˚17 E. The pond water was used for bathing purposes by local people.

Sample Collection:

The standard APHA, (2005) methods were followed for estimation of physical, chemical and biological parameters. To carry out the study ECOLOGICAL STUDY OF SIMLIYA VILLAGE POND, DISTRICT KOTA RAJASTHAN (INDIA) water sample will be collected twice in a month for a period of two years.

RESULT AND DISCUSSION:-

Water is precious for living organisms on this earth. . Deterioration of the water quality is now a global problem (Mahananda et.al. 2010). The physico-chemical parameters have important significance in determining the water quality of aquatic habitat. Water temperature is considered as one of the important factors that controls aquatic life in headwater stream (Wetzel, 1983). The Atmospheric Temperature in the present study ranged between from 23.1 to 36.6 ^{0}C. similar results were found by Dey and Laishram (2014) in the study of Loktok Lake Manipur. Kaushik and saksena (1999) also noted the same results at Motijheel 12 ^{0}C to 43.8 ^{0}C. Temperature plays and important role in the biological balance and the solubility of oxygen and mineral salts. In the present study temperature was found ranging from 21.7 ^{0}C to 29 ^{0}C. Many researchers observed similar trends while working on the different ponds (Tidame & Shinde 2012) water temperature is very important because it influence the biota in a water body. All the metabolic and physicochemical activities of life process are greatly influenced by temperature. The atmospheric temperature

is always higher than the water temperature (Verma & Khan 2015, Kangaban et. al. 2017).

Light penetration into a water body is influenced by turbidity and the extent of light penetration determines depth of euphotic zone in a water body. The depths of visibility give firsthand information regarding water quality. In the present study, the depth of visibility varied between 13.43 cm to 83.55 cm which is maximum in winter season and minimum summer season. Conductivity is defined as the ability of a substance to carry electrons. In the water this capacity is influenced by the amount of dissolved salts and the temperature (Lucas et. al. 2017). The conductivity ranged from 120.60 to 392.67 micro mhos / cm. Electric conductivity shows significantly negative relation with chlorine and salinity (Nag and Gupta 2014). Total dissolved solids denote mainly the various kinds of minerals present in the water. TDS indicate the salinity behavior of ground water (Gohar 2002). TDS ranged between 57.80 to 128.96 mg/L maximum in summer season and minimum in rainy season. A similar result was found by Darasingh and Laxmi (2014).

pH is an important factor in determining of productivity of an ecosystem (Singh et. al. 2009). In the present study highest value of pH was recorded 7.11 to 8.92. High pH value was recorded in rainy season because of pH shows highly significant positive relationship with chlorinity, salinity and COD (Nag and Gupta 2014). In the present investigation free CO_2 is recorded 0.50 to 4.86 mg/l. Highest in the winter season and lowest in rainy season. DV and HL (2017) found free CO_2 from 3.81 to 6.81 mg/L. Kumar et al. (2017) found similar results. Free CO_2 recorded its presence in some winter months (November and January) which may be associated with low temperature, decrease water level Total alkalinity of the water sample ranges 86.44 to 157.87 mg/L. The alkalinity values were maximum during summer and minimum in monsoon. The values obtained were low than the Indian Standard (200-600) and WHO Standard (100-200). The decrease in alkalinity was due to dilution caused by the rain water during monsoon (Verma and Khan 2015). The results is also in close conformity with the findings (Mishra et. al. 2013) (Darasingh and Laxmi 2014) (Laishram and Dey 2014). The dissolved oxygen is obtained from this study had ranged between 6.46 to 9.87 mg/L. Highest values in winter season and lowest in summer season. Results of the present study were similar to other (Laishram and Dey 2014).

In the present investigation the values of chloride recorded were as 26.8 to 145.61 mg/L. Concentration of chloride was highest in summer season and lowest in rainy season. The values obtained were low than the Indian Standard (250-1000) and WHO Standard (250). Concentration of chloride ions is maximum in winter season and minimum in rainy season. Similar results were recorded (Sajitha et .al. 2016).

Table No.1-Seasonal Variation in Physico-Chemical parameters of Similiya village pond (July 2015 to June 2017)

Physico-chemical parameters	Minimum	Maximum	Maximum mean	Minimum Mean	Calculated d F between season
Atmospheric Temperature (^{0}C)	23.1	36.6	34.8	24.5	
Water Temperature(˚c)	16	33	35	16.5	0.29
Transparency (cm)	13.43	83.55	82.87	18.45	0.97
Conductivity	120.76	392.67	389.65	120.60	3.65
Total Dissolved Solids (mg/l)	57.80	128.96	124.65	58.31	1.64
pH	7.2	8.92	8.90	7.88	0.65
Free CO (mg/l)	0.50	4.86	4.45	2.34	1.65
Total Alkalinity(mg/l)	86.44	155.87	157.87	87.97	0.65
Dissolved Oxygen(mg/l)	6.46	9.57	9.87	7.27	0.25
Chloride(mg/l)	26.80	145.61	141.87	27.27	2.22
Total Hardness(mg/l)	86.80	198.33	197.67	87.27	1.02
Phosphate(mg/l)	0.86	1.98	1.97	0.87	5.02
Nitrate(mg/l)	0.16	0.56	0.50	0.17	1.32

In the present investigation the total hardness was recorded in the range of 86.80 to 197.67 mg/l. On the basis of observation the value of total hardness was under the permissible value of Indian Standard (187-500) and more than the WHO Standard (100). Value of Total Hardness in summer season is high and low in rainy season. Similar results were found by Verma and Khan (2015). In the present study maximum phosphate content was 0.86 to 1.97 mg/l. Higher values of phosphate in summer may be an account of reduced volume of water due to evaporation, the increased density of biota, which produce metabolic waste, high

temperature and high biodegradation releasing this nutrients from the sediment (Darasing and Laxmi 2014). In the present study the value nitrate was 0.16 to 0.56 mg/l which is maximum in summer season and lowest in rainy season. The nitrate level was maximum during pre-monsoon season and post-monsoon (Kumar et. al. 2017

CONCLUSION:

The physico-chemical factors showed considerable variation both monthly and seasonally. Investigation shows that there is significant amount of pollution in the tank under study and analysis of data obtained revealed that this tank is eutrophic in nature.

REFERENCES:-

1 Darasingh, W. and B. Laxmi 2014. Physico-chemical analysis of Sitapat pond and its comparison with tap water quality of Dhar town for potability status. Res. J. Animal, Veterinary and fishery Sci. 2(12): 8-13.

2 Kaushik, S. and Saksena, D.N. 1999. Physico-chemical limnology of certain water bodies of central India. Pages 1-58, In: Vijaykumar, K. Freshwater ecosystem of India. Daya Publishing House, Delhi-110035. pp 1-336.

3 Laishram, J., M. Dey 2014.Water quality status of Loktak Lake, Manipur, Northeast India and need of conservation measures: A study on five selected villages.International Journal of Scientific and Research Publication.4(6):1-5.

4 Lucas, L. R.G., L. M. C. Ramirez and L. Arregui 2017. Physico-chemical and microbiological analysis of water of the "Presa De Los Patos" in the Desierto De Los leones National Park, Mexico. Advances in Biological Chemistry.7:122-138.

5 Kumar G, D., M. Karthik, R. R. 2017. Study of seasonal water quality assessment and fish pond conservation in Thanjavur, Tamil Nadu, India. Journal of Entomology and Zoology Studies. 5(4):1232-1238.

6 Kangabham, R. S., S. D. Bhoominathan, S. Kanagaraj and M. Govindaraju 2017. Development of a water quality index (WQI) for the Loktak Lake of India. Appl. Water Sci.7:2907-2918.

7 Goher MEM 2002. Chemical studies on the precipitation and dissolution of some chemical element in Lake Qarun, Ph.D. Thesis faculty of sciences, Al-Azhar University, Egypt.

8 Mahananda, M.R., B.P. Mohanty and M.R. Behra (2010). Physico-chemical Analysis of Surface and Ground water of Bargarh District, Orissa, India. IJRRAS. 2(3):284-295.

9 Mishra, S., A. L. Singh and D. Tiwary 2014 Studies of Physico-chemical Status of the Ponds at Varanasi Holi City under Anthropogenic influences. International Journal of Environmental Research and Development. Vol. 4(3), 261-268.

10 Nag, A. and H. Gupta 2014. Physico-chemical analysis of some water ponds in and around Santineketan, West Bengal, India. Internationl journal of Enviromental Sciences. 4(5):676-682.

11 Sajitha, V. and S .A. Vijayamma 2016. Study of physico-chemical parameters and pond water quality assessment by using water quality index at Athiyannoor panchayath, Kerala. India. Emer. life Sci. Res. 2(1):46-51.

12 Sharma, S. 2009. A study of certain physico-chemical attributes of Kisan Sagar Pond, Jhalawar with special references to fishes. M.Phil. Dissertation, University of Kota, Kota.

13 Singh, A.K., Tiwari, R.K., Kanaujia, D.R. and Mishra, P. 2009. Physico-chemical characteristics of Ganga River water at Varanasi. J. Ecobiol. 25 (1): 45-56.

14 Tidame, S.K. and S.S. Shinde (2012). Seasonal Variation in rotator diversity of temple ponds of Nashik District (M.S.) India. International Multi-disciplinary Research Journal. 2(5): 19-22.

15 Totawar, D .V. and H.L. Tamlurkar 2017. Physico-chemical parameters of Nizam Sagar dam with respect to fish production phytoplankton, zooplankton .Int .J. of Life Sci. 5(3):451-454.

16 Verma, S. and J. B. Khan 2015. Analysis of water quality by physico-chemical parameters in Fateh Sagar talab in Bagar, District of Jhunjhunu (Raj.) India. IOSR journal of pharmacy and biological sciences. 10(5, 4):41-45.

17 Wetzel, R.C. (1983) Limnology 3rdedn. Sounders college publishing, Philadelphia.

SEMINARES ATTENDED

List of Seminares Attended

1. National Seminar on "Environmental Conservation and Sustainable Development: Policies for our safe Future" organized by Saifia College, Bhopal on 25 and 26 March 2014.
2. "National conference Recent Updates in Biological Research" Organized by Saifia College, Bhopal on 25 and 26 March 2014.
3. National Seminar on "Innovation in Science and Technology for Inclusive Development" on 26 March 2014 at Vigyan Bhawan, MPCST. Bhopal.(Presented Research Paper- Oral)
4. kota university
5. The International Conference on "Environmental Stresses and Ecological Challenges" from 24 to 26 February, 2019 organized by Shri Krishna University, Chhatarpur, Madhya Pradesh, India. (Presented Paper)

National Conference On Recent Updates In Biological Research

March 25th -26th, 2014

(Sponsored by UGC, New Delhi)
Organized by Department of Biotechnology
Saifia College, Bhopal

Certificate

This is to certify that Dr./Prof./Mr./Ms. ...Kamlesh Meena.....
has delivered an ~~Invited Lecture~~ / ~~Chaired a Session~~ / Oral ~~Presentation~~ / ~~Poster Presentation~~/Submitted an abstract / attended the "National Conference Recent Updates in Biological Research" Organized by Saifia College, Bhopal on 25th and 26th March 2014.

The concurrent technical session which the distinguished participant attended was in the field of .....held on .....

Dr. Sharique A. Ali
Convener

Dr. Hasan Abbas
Principal

Dr. Jawed A. Khan
Organizing Secretary

NATIONAL SEMINAR ON
ENVIRONMENTAL CONSERVATION AND SUSTAINABLE DEVELOPMENT: POLICIES FOR OUR SAFE FUTURE

March 25th -26th, 2014

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Saifia College, Bhopal

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has delivered an ~~Invited Lecture~~/ ~~Chaired a Session~~ /~~Oral Presentation~~ / ~~Poster Presentation~~ /Submitted an Abstract / Attended the National Seminar on "Environmental Conservation and Sustainable Development: Policies for our Safe Future" organized by Saifia College, Bhopal on 25th and 26th March 2014.

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Dr. Sharique A. Ali
Convener

Dr. Hasan Abbas
Principal

Dr. Ayesha S. Ali
Organizing Secretary

National Seminar
on
Innovations in Science and Technology for Inclusive Development

26th- 27th March, 2014

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This is to certify thar Mr./Mrs./Ms./Dr./Prof. Kamlesh Meena
of Govt. P.G. College, Kota *has participated in National Seminar on "Innovations in Science & Technology for Inclusive Development" on 26th ~~27th~~ March, 2014 at Vigyan Bhawan, MPCST, Bhopal.*

He/She presented a Research Paper- Oral/Poster on focal theme and awarded ✗ *prize.*

Dr. V.K. Parashar	**Dr. Narendra K. Choubey**	**Dr. Ruchira Choudhary**	**Dr. Praveen Tamot**
Convener	Organising Secretary	Organising Secretary	Convener
ISCA, Bhopal Chapter	National Seminar	National Seminar	National Seminar

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स्कूल ऑफ हेरीटेज, वंशावली शोधपीठ, कोटा विश्वविद्यालय, कोटा

राष्ट्रीय संगोष्ठी

"भारत में लोक इतिहास परम्परा एवं ऐतिहासिक स्त्रोत - वंशावली लेखन अध्ययन के विशेष संदर्भ में"

वैशाख कृष्ण त्रियोदशी एवं चतुदर्शी (विक्रम संवत 2075)
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(सौजन्य : भारतीय इतिहास एवं अनुसंधान परिषद्, नई दिल्ली)

प्रमाण-पत्र

प्रमाणित किया जाता है कि श्री/सुश्री/श्रीमती/डॉ. कमलेश मीणा शोधार्थी

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ऑफ हेरीटेज, वंशावली शोधपीठ, कोटा विश्वविद्यालय, कोटा द्वारा आयोजित "भारत में लोक इतिहास परम्परा एवं ऐतिहासिक स्त्रोत-वंशावली लेखन अध्ययन के विशेष संदर्भ में" विषयक दो दिवसीय राष्ट्रीय संगोष्ठी में ~~विषय विशेषज्ञ/ सत्राध्यक्ष / मुख्य अतिथि/आमंत्रित वक्ता/पत्र-प्रस्तोता के~~ रूप में भाग लिया और

शीर्षक से

शोध पत्र प्रस्तुत किया।

के.आर. चौधरी
आयोजन सचिव, राष्ट्रीय संगोष्ठी - 2018

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