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Study of Physico-Chemical Parameters and Zooplankton of Lapkaman pond, Ahmedabad, Gujarat, India

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Abstract

Water is the most vital resource and necessity of life. Ponds of Gujarat State are often the main natural water resources which are extensively used by the local population for manifold purposes. Pollution of water affects the pond ecosystem and human health. In the present study, the specific physico-chemical indices of water i.e. Temperature, dissolved Oxygen, dissolved Carbon Dioxide, pH, Total Hardness and Chloride and zooplankton were analysed from the Lapkaman pond, Ahmedabad, Gujarat, India. Zooplankton is primary consumers, the source of food for higher organisms and important bioindicator of water quality. Hence the data obtained has added significance in this region to identify deterioration of water quality in relation to anthropogenic pressures.

Keywords: Physico-chemical parameter, Zooplankton, Lapkaman pond, water quality.

Introduction

Freshwater has always been of great importance to man[1]. It is interesting to note that early human habitations were centered near lakes, ponds and rivers for their primary requirement of water.

The rapid population explosion all over the world has resulted in an acute shortage of food[2]. Thus, it becomes imminent to explore other sources such as inland fisheries, crab and prawn fisheries that provide a perennial protein source[3]. Consequently, studies on the impact of organisms and their adaptations to the unfavorable and changing environmental conditions also has added significance in recent times. The changing physical and biotic conditions, due to natural and man-made calamites are now adequately elucidated for most water bodies[4]. Paucity of such information on the Lapkaman pond in Ahmedabad district has therefore triggered the present investigation.

Zooplankton play a fundamental role in most water bodies, as bioindicators. Zooplankton fauna are also important sensors for the assessment of the pollution status of water[5]. They play a vital part in study of the faunal biodiversity of aquatic ecosystem. Plankton is often used as indices to assess transfer of energy at secondary tropic level in aquatic ecosystems. Since phytoplanktons are their main source of food, these microscopic fauna facilitate the conversion of plant material into animal reserves and in turn constitute the basic nutrients for higher fauna including fishes[6]. They are therefore a vital link in the energy cycle. Fish are known to thrive and breed in regions where planktonic organisms abound, so that their offspring can avail of ready and abundant supplies of food for their survival, maintenance and growth[3].

The present study investigates the physico-chemical features and zooplankton diversity. The focus of the present study was to observe and monitor freshwater zooplankton from a water body in the vicinity of Ahmedabad district and determine the change associated with these planktonic forms during various seasons. Gujarat State comparatively has fewer ponds and reservoirs but is unique in possessing rich diversity within the water bodies. Lakes, ponds, dams, seasonal water bodies, rivulets, streams, marsh lands, coastline, mangroves, coral reefs, estuaries and large stretches of mudflats etc. contribute significantly to make this land rich in biodiversity.

The present study was focused on evaluating the characteristics of the Lapkaman pond, located outside Lapkaman village in Ahmedabad district, Gujarat state, India. It is natural water body where few migratory birds come during winter and a few residential birds are frequently sighted. Lapkaman is a typical village pond. Villagers utilize the water for washing clothes and other purposes. This residual water has detergent particles and other debris which is detrimental to pond water quality and its ecosystem. The pond is mostly surrounded by garbage and people are known to litter and soil in or near the pond.

The maximum rainfall is recorded between the months from July to September. During winter the minimum temperature is 13.4 ± 2˚C while the maximum temperature recorded in summer is 28 ± 1˚C. Overall the climate of the pond is sub humid to semiarid, varying with the local weather conditions. This pond is surrounded by vegetation, both terrestrial and aquatic vegetation can be seen. The terrestrial vegetation includes *Acacia arebica, Acacia nilotica, Zyzyphus mauritiana, Salvadora persica* and *S. egyptica*. Aquatic vegetation includes different varieties of algae, bacteria, fungi which have special

significance in association with the zooplankton of this particular pond.

Materials and Methods

The present research has covered two main components i.e. Physico-chemical parameters of the pond water and Zooplankton analysis.

Sampling for Physico-chemical parameters and Zooplankton analysis was done in September, January and May over a 2 year period. Samples were collected at 9:00 to 11:00 am every season. Sampling was repeated 3 times at 5 days interval and the mean value was determined.

Physico-chemical parameters: Measurement of surface water temperature is carried out using good grade, laboratory thermometer. pH was recorded in field by using pH strip as well as later checked on a laboratory Systronics pH meter. To determine the oxygen content the Winkler method was used[7]. Carbon dioxide levels were measured using the method of free carbon–dioxide estimation stated by Sharma (2005)[8]. For the total hardness estimation standard method given by Sharma (2005)[8] was employed. Choride (Cl) content was analyzed according to standard method described by Trivedi and Goel (1986)[9]. A minimum of 10 replicates were recorded for each parameter. Results were expressed as Mean ± Standard error. Students't' test was employed and a significance level of $p<0.05$ was considered.

Zooplankton analysis: Nylon 0.2 mm mesh dimension net was used for Zooplankton collection and Zooplankton samples were collected by the method of Battish (1992)[10]. Collection was similarly carried out repeatedly 3-4 times in five to six replicates of selected different sites of the pond.

Each sample was collected and taken to laboratory for analysis. For the study and observation of zooplankton a Bausch and Lomb dissecting binocular microscope was used. Zooplankton identification was carried out through two methods *i.e.* Living Material[10] and Preserved Material[11].

Results and Discussion

Season wise observations have been made for selected physico-chemical variables in conjunction with plankton data from September over a period of 2 years. The physico-chemical parameters which were analyzed from this water body include water temperature, pH, dissolved oxygen, carbon dioxide, Total hardness and chloride content. These parameters are important factors which play an extremely significant role in the productivity of the pond. Temperature imposes significant influence on the life histories of animals and plants, and affects many chemical processes[2]. Temperature was maximum in summer, minimum in winter and moderate in monsoon. Naik et al.[3] and Sharifun and Abdus[12] have also made similar observations for most ponds in the country. Water Temperature which is measured in the range between 13.5^0C and 32^0C is found to be conducive for the development of planktonic organisms correlated with higher plankton density. This observation is substantiated by the report of Gaikwad et al.[13].

Dissolved oxygen shows an inverse relationship with water temperature[14]. From the data obtained in this investigation, it is evident that in summer and monsoon, oxygen level was minimal but in winter it was maximum. It has been reported that the concentration of dissolved oxygen which is more than 5.00 mg/l is often more advantageous for superior growth of living organism[15]. This study site also has more than 5.00 mg/l concentration in water which proves to be good for living organisms. Reid[16] stated that the solubility of oxygen in water generally increases by lowering of the temperature. According to Boyd[14] Oxygen content in water bodies is mainly from i. Temperature ii. Diffusion from air and iii. photosynthetic activity within water. In Lapkaman (pond) similarly oxygen content was high in winter and minimum in the monsoon. In this study it was observed that temperature was increased, while oxygen was decreased and hence temperature and oxygen showed an inverse relationship[14].

The source of dissolved Carbon dioxide in aqueous bodies is from air, from inflowing ground water, by decomposition of inorganic matter, by respiration of biota and also by other chemicals present in the system. Photosynthesis of aquatic vegetation and agitation of water is the main cause of the reduction carbon dioxide in water. Similar findings were obtained for the analysis during the present study also maximum dissolved Carbon dioxide levels in summer and minimum levels of dissolved Carbon dioxide in winter which could be explained due to the decline in Phytoplankton in summer[17].

Relative quantity of bicarbonates, CO_2 and the biological activity of aquatic micro flora controlled the pH of water[18]. The pH values of Lapkaman pond water were alkaline in nature throughout the study period. In pH fluctuation occurred season wise, where it maximum in January and minimum in September. The monsoon pH was minimum followed by increase in pH in winter while summer pH was found again to decrease similar result were reported by Rao and Mishra[19].

The total hardness of water is not regarded as a pollution indicator but specifies water quality[20]. The water total hardness of Lapkaman pond was recorded as maximum in summer and minimum in monsoon. Water hardness up to 60 mg/l is considered as soft water, from 61-121 mg/l is termed as moderately hard water, from 121-180 mg/l is considered as hard water and above 180 mg/l it is taken as very hard water[21].

Chloride is one of the main indicators of pollution[18]. The chloride content in the water of Lapkaman pond was minimum in monsoon and this may be due to the dilution of water by rain, gradually increased in winter and was maximum in the summer, due to evaporation of water could be the main cause. Its higher level indicates the presence of large amount of organic matter[22].

Plankton analysis of the pond waters studied showed the presence of a variety of zooplanktonic organisms. They were represented by Protozoans, Rotifers and Crustaceans. Gannon and Stemberger[23] have postulated that zooplankton responds rapidly to environmental modifications and are therefore effective indicators of subtle alterations in water quality. It is probable that under a majority of circumstances, the rotifers and especially the limnetic crustaceans overwhelmingly dominate the zooplanktonic productivity.

In the study of zooplankton three classes were mainly observed which were Protozoa, Rotifera and Crustecea. In these three classes 4 species of Protozoan were recorded, 6 species of Rotifers were recorded and from Crustacean, 3 species of Copepoda, 1 species of Ostracoda and 4 species of Cladoceran were recorded. During the study Cyclops, Brachionus and Keratella were reported in every season dominantly. As every season environmental condition are changed so their population were also changed in every season.

During the present study protozoans were recorded in every season from the water body. Protozoans were recorded maximum during monsoon and winter but minimum in summer season. This may be because the environmental condition during monsoon was favorable for them. Moreover, winter temperature was less, pH was alkaline and oxygen was suitable hence they are in greater numbers[24].

Rotifers were recorded maximum in monsoon and minimum in winter, while the numbers were moderate in summer during the present study. From the data obtained, few species of rotifer were recorded in only one season like winter or summer or monsoon, while other species were recorded in all seasons. Herzing[25] reported that seasonal variations in environmental features result in an annual succession of rotifer species.

In winter Cyclops and Diaptomus was recorded in maximum and some were reported with eggs. Copepods (Figure-2) were reported fewer than other classes. Specie species namely Cyclops sp., Diaptomus sp., and Mesocyclops sp. were observed (Figure-2) during the study. Copepods were present in every season but found to be maximum in summer and moderately present in other seasons. They were abundance during winter might explained as be due to the favorable conditions, such as, abundance of food organisms, optimum physical condition, favorable range of pH level, dissolved oxygen and alkalinity as also mentioned by Sharifun and Abdus[12].

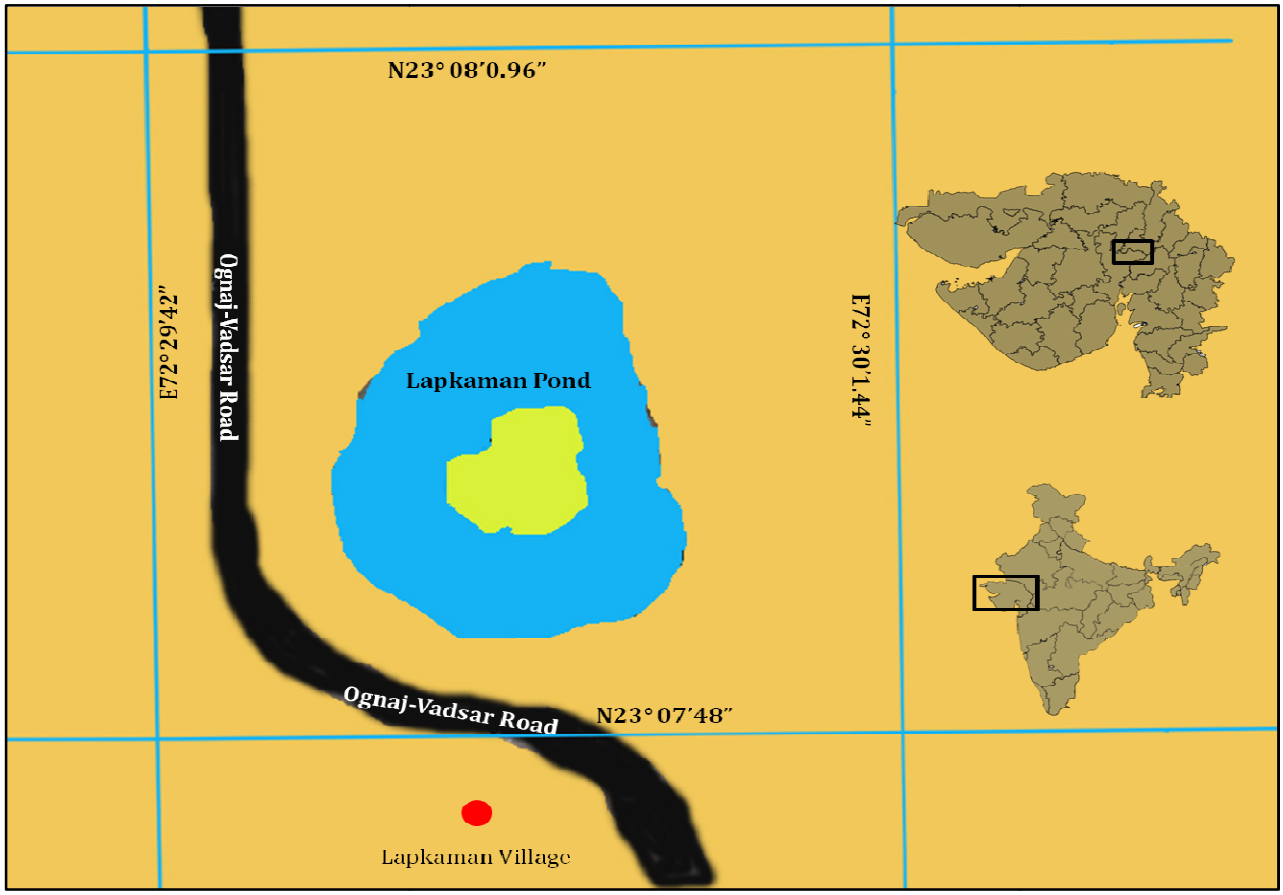

Figure-1
Study Area- Lapkaman Pond

Figure-2
Photomicrographs of Zooplankton

Table-1
Physico-chemical parameters of Lapkaman Pond

Sr. No.	Seasons / Parameters	Monsoon	Winter	Summer
1	Temperature (˚C)	25.8 ± 0.3	22.0 ± 0.4	29.0 ± 0.3
2	Dissolved Oxygen (mg/l)	5.9 ± 0.1	6.7 ± 0.1	6.0 ± 0.2
3	Carbon Dioxide (mg/l)	0.88 ± 0.3	0.67 ± 0.1	0.97 ± 0.2
4	pH	7.5 ± 0.2	8.3 ± 0.3	7.9 ± 0.1
5	Total Hardness (mg/l)	116± 0.1	128 ± 0.1	139 ± 0.1
6	Chloride (mg/l)	35.1 ± 0.2	49.9 ± 0.3	67.9 ± 0.1

Ostracoda was recorded from all three seasons. They were recorded every season equally may be due to pollution of water[26]. During the present study Cladocerans such as Alonella sp., Bosmina sp. and Daphnia Lumholtzi were reported in monsoon and winter but cladocerans were not reported during summer. Daphnia species was reported only during winter. A similar seasonal variation in cladocerans was documented by Alfred and Thapa (1996)[24].

Lapkaman Pond is a Natural pond, but certain selected physico-chemical parameters of water are below the threshold of the World Health Organization guidelines. The studied water body manifests ambient conditions in monsoon and winter season for the Zooplankton. Winter and monsoon seasons were found to be preferable for Protozoans, Copepods and Cladocerans. Copepods may survive in all conditions as compared to other groups so they thrived in all three seasons. Rotifers were seen only during monsoon except some species such as *Branchionus, Keratella* and *Rataria neptunia*. As the planktons are bio indicators, the presence of rotifer and flagellated protozoans species reflecting eutrophication and pollution in the water. In the present study total 18 species of zooplankton represented by Protozoans *i.e Paramecium sp., Pseudoblepharisma sp., Stentor sp., Vorticella sp.,* Rotifers *i.e Brachionus sp., Filiniaminuta sp., Hexarthra sp., Keratella sp., Notholca accuminata, Rotaria neptunia,* Copepods *i.e Cyclops sp., Diaptomus sp., Mesocyclops sp., Ostracoda sp*., Cladoceran *i.e. Alonella sp., Bosmina sp., Daphnia Sp. and Daphnia Lumholtzi* were reported during the present study.

As a few residential birds occur around the water body and a few migratory birds also visit during winter, this could be the good site for the birds. However, the anthropogenic pressures i.e. detergent water which comes from washing clothes, soil and litter as well as other disturbance factors to the birds must be restrict. Discharge of anthropogenic wastes dumping of domestic water, agricultural and surface run-off cause deleterious effect on flora and fauna and other aquatic organisms.

Table-2
Zooplankton recorded from the Lapkaman pond

Groups	Name	Monsoon (September)	Winter (January)	Summer (May)
Protozoan	*Paramecium sp.*	++	++	+
	Pseudoblepharisma sp.	++	+	+
	Stentor sp.	+	+	-
	Vorticella sp.	+	+	-
Rotifera	*Brachionus sp.*	++	++	+
	Filinia minuta	+	-	-
	Hexarthra sp.	+	-	-
	Keratella sp.	++	++	+
	Notholca accuminata	++	-	-
	Rotaria neptunia	++	-	+
Copepoda	*Cyclops sp.*	++	++	+++
	Diaptomus sp.	++	++	++
	Mesocyclops sp.	+	+	++
Ostracoda	*Ostracoda sp.*	+	+	+
Cladocera	*Alonella sp.*	+	+	-
	Bosmina sp.	+	++	-
	Daphnia Sp.	-	+	-
	Daphnia Lumholtzi	+	+	-

Note: -Absent, + - Rare, ++ - Common, +++ - Abundant

Conclusion

The physico-chemical indices of the water of Lapkaman pond were found to be correlated with the seasonal conditions. Specifically ambient temperatures between 15 and 32 ^{o}C were found during monsoon and winter was observed to conducive for Zooplankton to flourish. The dissolved oxygen content was also high and supported photosynthetic activity in the pond. The elevated temperatures, lower oxygen content and increased CO_2 levels in the Lapkaman pond water in summer explain the depletion of phytoplankton during this season. Microscopic observations revealed a moderate species diversity of Zooplankton. Moreover, certain selected physico-chemical parameters of water are below the threshold of the World Health Organization guidelines. This could be correlated with the rampant use of this village pond water, which is therefore under anthropogenic pressures. Stringent strategies are therefore necessary for the conservation and management of this pond which is home to several fauna including migratory birds.

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