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Analysis of Plankton Diversity and Density with Physico-Chemical Parameters of Open Pond in Town Deeg (Bhratpur) Rajasthan, India

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Abstract

The present study was carried out on Kunda (open pond) of Town deeg (Bharatpur) Rajasthan. The town deeg is situated in Disrict, Bharatpur of Rajasthan State. The physico-chemical parameters and plankton diversity of open pond (locally known as kunda) of town deeg district Bharatpur (Rajasthan) was sampled from April to July, 2010. The plankton were collected, counted and were identified by using the method Suggested by different agencies and scientists. Freshwater Zooplankton of India and Fresh Water Biology. The plankton was counted by using Sedgwick 4 Rafter Counting Cell method. Pond water samples were collected for physico-chemical parameters. Values of the physico-chemical parameters observed ranged as follows: water temperature, 24-26.5°C; air temperature, 22-23. °C; transparency, 0.2-0.4 m; pH, 7.3-8.4; total dissolved solids, 143.8-159.5 mg/L; conductivity, 290.8-391.5 µmhos/cm; salinity, 0.11- 0.19%; dissolved oxygen, 0.7-1.8 mg/L and alkalinity, 0.8-1.7 mg $CaCO_3$/L. The study was carried out monthly but was tabulated seasonally by using statistical method. Thirty six taxa of plankton were encountered. Phytoplankton consisted of five families namely; Cyanophyceae, Chlorophyceae, Euglenophyceae, Bacillariophyceae and Dinophyceae. Three groups of zooplankton encountered were copepods, cladocerans and rotifers. The presence of pollution indicator species such as, Microcystis, Phacus, Oscillatoria, Surirella Closterium, Aphanocapsa, Anabeana and Euglena show that the pond is likely polluted. The study was carried out monthly but was tabulated seasonally by using statistical method. From the listed data the quality of water was concluded. The present study will provide an important basis to assess the fish production potentialities and to formulate sustainable aquaculture practices in man-made habitats and fishery management policies in town deeg bharatpur(Rajasthan) and nearby aquatic ecosystems

Keywords: Phytoplankton, zooplankton, physico-chemical parameters, pollution and open pond (kunda) of town deeg district Bharatpur (Rajasthan).

Introduction

Water pollution can be analyzed by the changes in physical, chemical and biological properties like colour, organic / inorganic contents and microbial load. Water quality is affected by a wide range of natural and human influences. The most important of the natural influences are geological, hydrological and climatic, since these affect the quantity and the quality of water available. Ponds, reservoirs are very large natural or artificial lakes that provide habitat and food for many species of fish and wildlife[1]. They are constructed for domestic use where large natural lakes are sparse and unsuitable for human exploitation, enhancement of fisheries and improvement of water transport. Freshwater ecosystems have been used for the investigation of factors controlling the abundance and distribution of aquatic organisms[2]. Changes in the physico-chemical parameters may positively or negatively affect the biota of water bodies in a number of ways such as their survival and growth rate and these may eventually result in disappearance of some species of organisms or its reproduction[3].Light penetration, temperature, water current and salinity affect the distribution of plankton and other organism[4]. Planktonic communities are influenced by the prevailing physico-chemical parameters and these determine their abundance, occurrence and seasonal variations[5]. Plankters respond quickly to environmental changes because of their short life cycle, hence, their species composition are more likely to indicate the quality of the water which they are found. The relative abundance of chlorophyll is indicative of productive water. Diatomic species such as *Nitschia*, *Gyrosignma* and *Epithemia* are known to avoid acid water and very low concentration of calcium and magnesium[6]. Dense surface blooms of blue-green algae are regarded as indicator of potential productivity in fish pond, while increase of *Cyclotella* species is an indicator of acidification . The town Deeg, famous for world heritage, the Jal mahal is located at the eastern gate in the state Rajasthan. The population of town is approximately 60 thousands. In Deeg, there are four ponds (also known as Kundas) Lala Kunda, Kaccha Kunda, Bagichi wala Kunda and Pitam Das Kunda. Approximately three fourth (3/4) of the population of the town resides nearby these ponds. The nearby ground water of the ponds has also become unfit for human consumption. The residents of the town have been facing the problem of water quantity and quality for a long time.

Open pond (kunda) of town deeg district Bharatpur (Rajasthan) is a man-made water body that serves as a source of water supply to the water treatment plant for domestic uses in the town deeg. Leaching of organic matter, domestic wastes, mass bathing (both human and animals), washing very dirty cloths (figure-1), faecal materials as has been seen in town Deeg may contribute pollution to ponds water. Knowledge of physico-chemical parameters and plankton of any body of water is not only useful in assessing its productivity, but would also allow for a better understanding of its biota. Several studies have been carried out in Open pond (kunda) of town deeg district Bharatpur (Rajasthan)[7,8]. Physico-chemical parameters and biota of any water body is known to change overtime and so the need to know the prevailing conditions the physic-chemical parameter and plankton abundance of the open pond (kunda) of town deeg district Bharatpur (Rajasthan). Present study will provide a reliable water quality data, which can be used for the assessment of precise health risks, identification of priority area, effective management and remedial measures. Awareness regarding water quality and sanitation will be generated through this study. The results of this study will be helpful to establish water treatment plants, which purify water to make it good for drinking purposes. In brief the present study is important for identification those problematic surface water of town Deeg that may cause water born diseases.

Therefore the present investigation has been undertaken to analyse the physico–chemical and biological properties of water, its health effects on human population and the probable remedies to get rid of these problems.

Material and Methods

Study area: The town Deeg district Bharatpur (Rajasthan), famous for world heritage, the Jal mahal is located at the eastern gate in the state Rajasthan. The population of town is approximately 60 thousands. In Deeg, there are four ponds (also known as Kundas) Lala Kunda, Kaccha Kunda, Bagichi wala Kunda and Pitam Das Kunda. Approximately three fourth (3/4) of the population of the town resides nearby these ponds. The nearby ground water of the ponds has also become unfit for human consumption. The residents of the town have been facing the problem of water quantity and quality for a long time. Deeg a town of heritage due to historical values and world famous Jal Mahal, gardens, forts and fountains, is located at 27°28' N latitude and 77°20' E longitude with an average elevation of 174m (571 ft.) in district Bharatpur (popular for bird sanctuary–the Keoladeo Ghana National Park), Rajasthan, India. Deeg comes under the big "Parikrama marg" of Lord Krishna starting from Goverdhan (Mathura), U.P., at a distance of 32 kms. north from Bharatpur, 153 kms. South-west from Delhi and 98 kms. North from Agra, U.P. within the territorial limits of the ancient holy Braj Bhumi. Three sampling stations were chosen for the study in the reservoir. Station 1 was located at the front point to the reservoir facing kaman Road. Station 2 was located near the bagichi and station 3 is bath point of the pond.

Surface water samples were collected monthly from April-July, 2011. The physico-chemical parameters determined were pH, conductivity, total dissolved solids, dissolved oxygen, alkalinity and salinity. Temperature and transparency were measured *in situ*. Air and surface water temperature was determined using a centigrade mercury-in-glass thermometer of range 10-110°C and the results were expressed in degrees Celsius (°C). The hydrogen ion concentration (pH) was determined in the laboratory using Buffered electronic pH meter. Salinity, TDS and conductivity were measured using an Extech meter Model ExStik EC400. Transparency was measured using a secchi disc. Dissolved oxygen concentration was determined using the azide modification of the iodometric method[9]. Alkalinity was measured with LaMotte Freshwater Aquaculture Test Kit Model AQ-2. The results were expressed as mg/L.

Plankton samples were collected with a plankton net (55 µm) mesh size, just below the surface water. Samples collected in 250 mL bottles were immediately fixed and preserved in 4% formalin solution in the field[9]. The preserved plankton samples was allowed to settle first and 5 mL of the sample was withdrawn and placed in Sedge-wick rafter counting chamber using a pipette and observed under the microscope[10]. Keys provided by different agencies and scientists, were used for identification of the plankton species[11]. The total number of organisms per milliliter for each sample was determined by simple calculation after counting the number in the 5 mL sub-sample examined. Cells of phytoplankton were counted. Biological data for plankton was analyzed using quantitative indices to determine the relative abundance and diversity of species and groups using PAST software. Plankton identification up to genus level was performed by using descrioto-identification key and monographs and counting by Sedgwick-Rafter cell method[11,12].

Results and Discussion

The physico-chemical parameters of Open pond (kunda) of town deeg district Bharatpur (Rajasthan): Table-1 shows the mean, standard error and range of physico -chemical parameters of Open pond (Kunda) of town deeg district Bharatpur (Rajasthan) measured during the study period. Figure-2 to 8 shows the monthly variation of the measured physico-chemical parameters for the study period. The lowest mean air and water temperatures were recorded in June while the highest mean temperature was in April. Transparency was highest in April and lowest in July with mean valu of 2.70+-0.66 variation in conductivity recorded a highest mean value in may at station 2 while the lowest was in july at station 1.

Dissolved oxygen was lowest in April and highest in June. The highest alkalinity level was recorded in June was recorded in station 1 in April while the highest was in station 2 of June. The salinity value of 0.1 ppt. (parts per thousand) was obtained during the study period and this value remained constant with a small increase to 0.19 in station 1 in June. Correlation

coefficient (r) values for physico-chemical parameters are presented in table-2. Air Temperature correlated negatively with TDS (r = -0.684; $p<0.05$) while transparency correlated significantly with water temperature (r=0.614; $p<0.05$).

Phytoplankton composition and abundance: Five groups of phytoplankton namely Cyanophyceae, Bacillariophyceae, Chlorophyceae, Dinophyceae and Euglenophyceae were encountered in the reservoir. The most abundant phytoplankton was the blue-green algae, Microcystiswith a relative abundance of 47% and the least was the dinoflagellate Peridinium with a relative abundance of 1.17% (table-3). Four colonial forms of Cyanophyceae; *Microcystis Aphanocapsa*, *Oocystis* and *Chroococcus* and two filamentous forms; *Anabaena*,*Oscillatoria*were encountered. Copepoda. The cladocerans included *Miona* while copepods comprised of *Thermocyclops*, *Mesocyclops* andnauplius larvae. The most abundant zooplankton was the copepod *Thermocyclops* with a relative abundance of 95.34% and the least abundant was the cladoceran, *Moina* with 22.16% relative abundance.

Figure-1
Pond of Deeg (Bharatpur) Rajasthan, Determination of physico-chemical parameters

Table-1
The mean, standard error and range of physico-chemical parameters of Open pond (kunda) of town Deeg district Bharatpur (Rajasthan)

Parameters	**Mean ±S.E**	**Range**
Dissolved Oxygen (mg/L)	1.03±0.370	0.7-1.8
Alkalinity (mg $CaCO_3$ /L)	1.24±0.420	0.8-1.95
Conductivity (µmhos/cm)	347.43±36.95	290.75-391.5
Total Dissolved Solids (mg/L)	153.56±5.31	143.7 -159.5
Salinity (ppt)	0.10±0.000	0.11- 0.19
pH	7.98±0.380	7.3 -8.4
Air temperature (°C)	22.75±0.78	22 -23.5
Water temperature (°C)	25.12±1.00	24-26.5
Transparency()	2.70±0.660	0.2- 0.4

Table-2
Correlation co-efficient(r) matrix for physico-chemical parameter during the study period

	DO	Alkalinity	Conductivity	TDS	pH	Air temp	Water temp Transparency
DO	-	-	-	-	-	-	-
Alkalinity	0.859	-	-	-	-	-	-
Conductivity	-0.081	0.138	-	-	-	-	-
TDS	0.805	0.819	-0.278	-	-	-	-
pH	-0.283	-0.093	0.916	-0.536	-	-	-
Air Temp	-0.572	-0.471	0.814	-0.684*	0.884	-	-
Water Temp	-0.757	-0.738	0.556	-0.912	0.748	0.911	-
Transparency	-0.441	-0.495	0.269	-0.731	0.453	0.465	0.614*

*: Correlation is significant at ($p<0.05$)

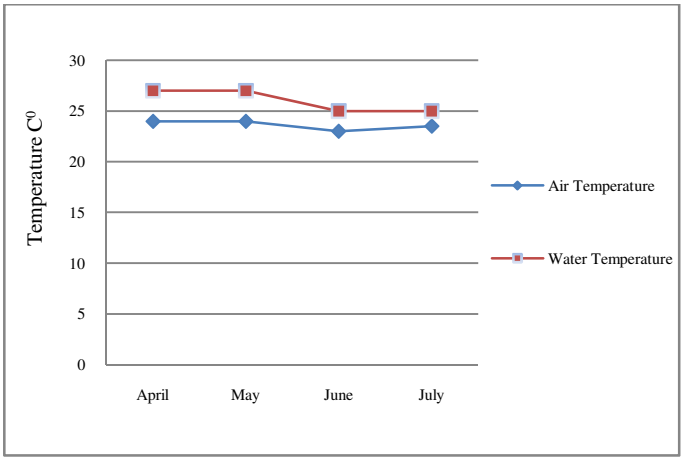

Figure-2
Monthly variation of temperature

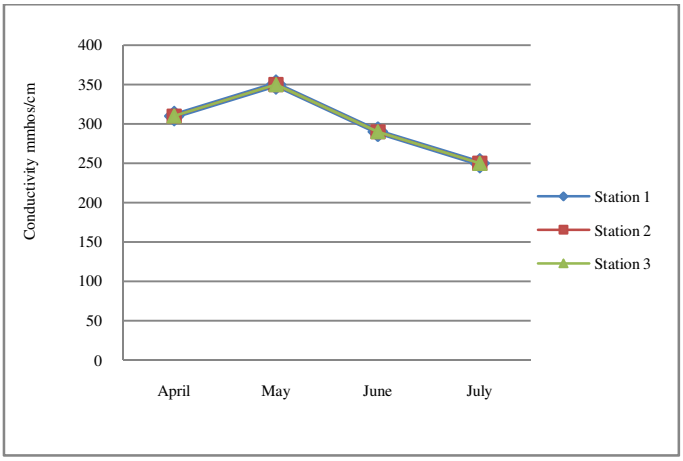

Figure-4
Monthly variation of conductivity (µmhos/cm)

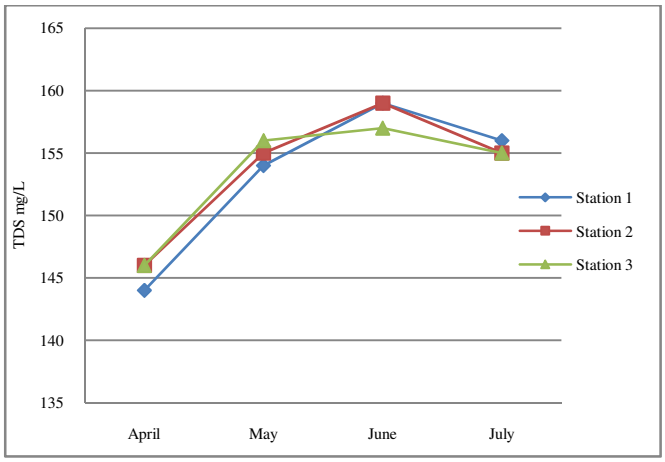

Figure-3
Monthly variation of transparency (m)

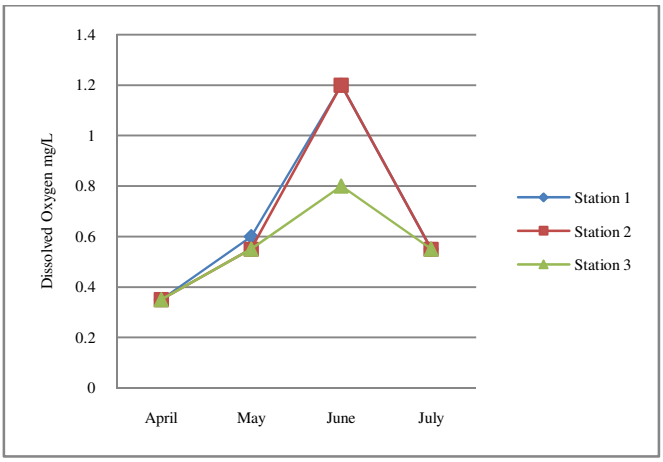

Figure-5
Monthly variation of dissolved oxygen (mg/L)

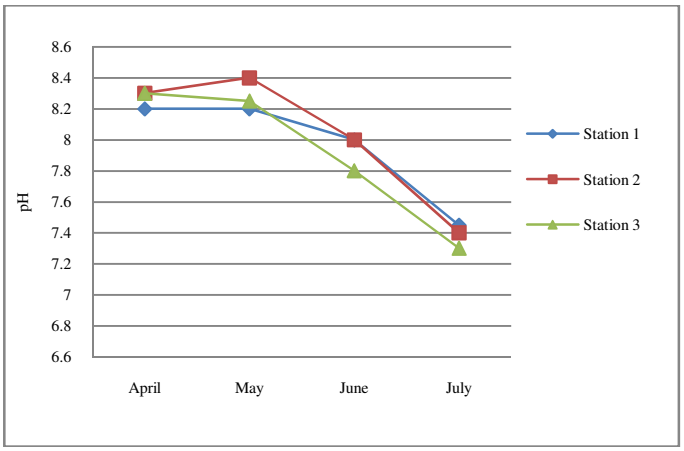

Figure-6
Monthly variation of pH

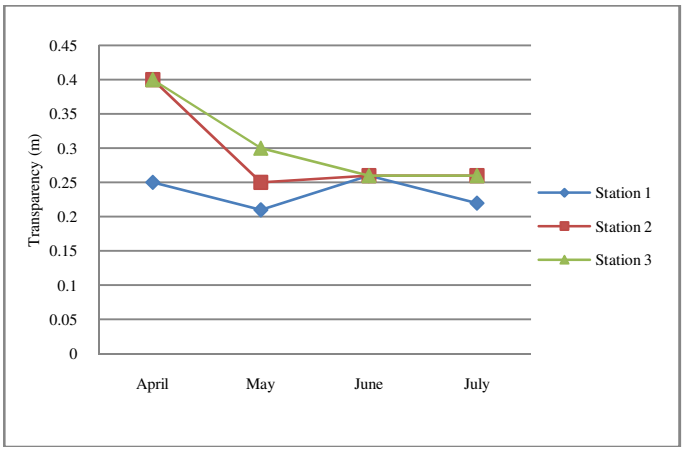

Figure-7
Monthly variation of TDS (mg/L)

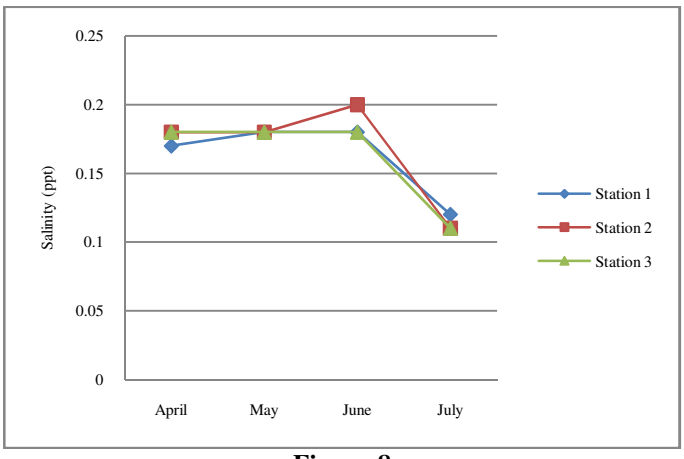

Figure-8
Monthly variation of salinity (ppt)

Discussion: Physico-chemical parameters: The physico-chemical parameters of open pond (kunda) of town deeg district Bharatpur (Rajasthan) show variation. These variations may be associated with patterns of water use and rainfall[13]. Temperatures were relatively lower in June-July than in April-May. Water temperature values followed closely changes in air temperature. This may be attributed to the sampling time which was between 8:00 and 10:00 am, when the water is warmer than air. The relationship between surface water temperature and transparency were significant positively. This could be possible because light heats the surface of the water before penetrating into other depths. Temperature is an important factor that influences primary production in reservoir. The dissolved oxygen value for the reservoir was very low. This depression in dissolved oxygen level could be due to chemical and biological oxidation process in water. Sources of dissolved oxygen in the aquatic environment include the atmosphere and photosynthesis. This depends on its solubility while a loss of oxygen includes respiration, decay by aerobic bacteria and decomposition of dead decaying sediments[14].

The pH range shows that the reservoir is tending towards alkalinity. In monsoon season pH values recorded ranging from 6.9-9.6, while in post monsoon season reported a pH range of 6.2-8.5 in Open pond kunda) of town Deeg district Bharatpur (Rajasthan)[15]. This suggests that the pond water is good for fish production. Accumulation of free carbon dioxide due to little photosynthetic activities of phytoplankton will lower the pH value of the water while intense photosynthetic activities of the phytoplankton will reduce the free carbon dioxide content resulting in increased pH values[15].

The values of salinity recorded throughout the study period were constant. Salinity was low and show no relationship with other physico-chemical parameters since the reservoir is fresh water and the salt content of a fresh water body is usually low. The fluctuations in total alkalinity of tropical water bodies depend on the location, season, plankton population and nature of the bottom deposits. The values of alkalinity obtained were very low.

The mean value of conductivity (347.44±36.96 µmhos/cm) shows that the conductivity level is intermediate. Conductivity levels below 50 µmhos/cm are regarded as low; those between 50-600 µmhos/cm are medium while those above 600 µmhos/cm are high conductivity[15,16]. Similar result found that the conductivity of open pond (kunda) of town deeg district Bharatpur (Rajasthan) could be regarded as intermediate (239.65±74.31 µhomS/cm)[16].

The Total Dissolved Solid (TDS) values obtained during the study periods were relatively constant all through the stations. This may be due to organic and inorganic substances dissolved and washed into the reservoir by runoffs. The correlation between TDS and air temperature suggests that the dissolved solids in the Pond are mainly ionic. The decrease in transparency from April to July may be due to the increase in turbidity of the water as a result of run-off carried into the reservoir. This agrees with some scientists who reported that the pattern of change of transparency varies inversely with that of turbidity and rainfall and that higher transparency leads to deeper light penetration and consequently a wider depth of photosynthetic activity of phytoplankton[17].

Table-3
The relative abundance of phytoplankton encountered in the pond

Phytoplankton	**No of cell/mL**	**%**
Cyanophyceae		
Microcystisaeruginosa	61157	4700
Anabaena circularis	6196	4.9
Anabaena subcylindrica	46548	35.41
OscillatoriateniusAgardh	5995	4.81
Oocystis eremosphaeria	2960	2.3
Oocystis solitaria	2728	2.1
Aphanacapsadelicatissima	6868	5.12
Chroococcuscohaerens	8909	6.96
Chlorophyceae		
Scenedesmusbijuga	4904	3.84
Scenedesmusquadricauda	26328	20
Ankistrodesmusfalcatus	8665	6.8
Microsporafloccosa	4772	3.73
Coelastrumsphaericum	7628	5.93
Hyalodiscus sp.	4145	3.2
Closteriumsetazeum	9126	7.11
Cosmarium sp.	4889	3.82
Staurastrumcomptum	3297	2.56
Staurastrumtrifidum	3768	3.01
Staurastrumlimneticum	648	0.46
Staurastrum sp.	4278	3.32
Gonatozygonmonotaenium	6290	4.87
Chlorosarcina minor	5504	4.3
Sphaerocystisschroeteri	5592	4.35
Treubariatriappendiculata	961	
Treubariacrassispina	4940	3.76
Euglenophyceae	0.73	2.89
Euglena oxyurisschmarda	3728	
Euglena caudata	9122	7.1
Trachelomonaslacustris	3284	2.54
Trachelomonasensifera	8890	6.84
Trachelomonastambowica	8680	6.83
Trachelomonashorrida	4913	3.9
Trachelomonassimilis stokes	5231	4.06
Trachelomonashispida	2439	1.93
Trachelomonasspp	5250	4.16
Phacuslongicauda	16973	12.87
Phacussuecicus	4500	3.46
Phacus orbicularis	10543	8.31
Bacillariophyceae		
Synedrafasculata	5574	4.31
Cyclotellacomta	7587	5.93
Cyclotellakutzingiana	2132	1.53
Stephanodiscushantzschii	6777	5.1
Suireriatenera	9068	7.14
Tabellaria sp.	4474	3.39
Tabellaria sp.	4723	3.73
Dinophyceae		
Peridiniumbipessteia	3394	2.65
Didiniumbolbianii	1942	1.49
Oodiniumlimneticum	5645	4.32

Plankton study: The planktons are the heterogeneous assemblage of suspended microscopic materials, minute organisms and detritus in water which wander at the mercy of winds, currents and tides. The planktons have been intimately connected directly or indirectly with human beings as a source of food, fodder, manure and many other types of uses e.g. algae as medicines and antibiotics, water purification, water pollution control, land reclamation, deleterious effect, industrial uses and indicators of water quality[18]. The quantitative analysis of plankton along with physico-chemical estimations provides desired and reliable data for the purpose of management of aquatic ecosystem. The factors regulating growth and succession of planktons are light, temperature, inorganic, organic micro-nutrients, biological factors like competition and predation[19]. Aquatic environment depicts ecological features that lead to the establishment of a very dynamic system in which the plankton community plays an important role[20].

Depending on their nature planktons are divided in two major groups, namely, Phytoplanktons and Zooplanktons. Phytoplanktons are chlorophyll bearing suspended microscopic organisms consisting of algae with representatives from all major taxonomic phyla. The majority of members belong to class chlorophyceae, cyanophyceae and Bacillariophyceae. Their unique ability to fix inorganic carbon to build up organic matter through primary production makes their study a subject of prime importance[21].

In any lotic system, the nature and abundance of phytoplanktons, its quality and seasonal distribution are mainly determined by physical and chemical features. Their sensitivity and large variations in species composition are often a reflection of significant alteration in ambient condition within and ecosystem[21]. The phytoplankton serves as the producers in the food chain in the aquatic ecosystem and the productivity depends upon the quality of water. limnological feature of a pond in different seasons are related to hydrological condition which reflects in the physico-chemical characters and the plankton community of water[22].

The most abundant phytoplankton group in the reservoir during the study period was the Cyanophyceae (blue-green algae). This agrees with the observations of same researchers that blue-green algae dominated the pond[23]. Blue-green algae, mainly *Microcystis* dominated the phytoplankton in open pond (Kunda) of town Deeg district Bharatpur (Rajasthan). *Microcystis* have been reported to dominate the phytoplankton group in Lake George, Uganda and Lake Asejire, Nigeria while *Anabeana*, a filamentous form of blue-green algae was reported to dominate phytoplankton in Lake Rudolf, Kenya and diatoms in Lake Albert[23,24]. The occurrence of *Microcystis*, *Anabaena* and *Aphanocapsa* is a clear indication that open pond (Kunda) of town Deeg district Bharatpur (Rajasthan) is polluted. This could be as a result of anthropogenic activities, such as chemicals and wastes washed into it from washing of clothes and bathing done sometimes around the pond. Some reported that in lakes where domestic, agricultural and industrial pollution is accelerated, growth of blue-green algae results in noxious water bloom of such form as *Microcystis* and *Anabaena*[24]. A similar observation that *Anabaena* and *Microcystis* are indication of Eutrophication following upwelling in pond of town Deeg[24]. The presence of *Oscillatoria* indicates the presence of high concentrations of organic matter and low oxygen content. Reported that *Oscillatoria* are favored by the high concentration of organic matter and low oxygen content.

Rotifers, cladocerans, copepods and ostracodes constitute the major group of zooplanktons. The zooplankton depends upon the availability of phytoplanktons and forms the second tropic level in the aquatic food chain. Zooplanktons mediate the transfer of energy from lower to higher tropic levels[25]. Thus zooplanktons represent an important link in aquatic food chain and contribute significantly to secondary production in fresh water ecosystem and play role as indicator of trophic condition both in cold and tropical water[26,27]. Zooplanktons have short life cycle and rapid rate of parthenogenetic reproduction which overcomes predation losses and respond quickly to environmental change.

Table-4
The relative abundance of Zooplankton encountered at the pond

	No/mL	**%**
Cladocera		
Moina sp.	4046	22.16
Copepoda		
Mesocyclopsleuckarti	18628	94.92
Thermocyclopsneglectus	18854	95.34
Nauplius larvae	5218	29.5
Gastropod egg	3522	19.45
Rotifera		
Ascomorphasaltans	2802	15.54
*Platyias*sp.	6833	37.74

The role of zooplanktons in the functioning of the ecosystems is of paramount importance to man. Food pyramids of more complex organism rest on wide zooplankton bases. Zooplankton shows variation in the species composition and abundance according to the change in several environmental factors. They form an important source of food for fishes and hence the

knowledge of abundance and variation of zooplanktons is an essential parameter for the study of pond ecosystem[28].
Crustaceans, mainly copepods dominated the zooplankton community of the reservoir. This was followed by rotifers that there was alternation in abundance between crustaceans and rotifers in pond as resulting in abundance of all zooplankton year round in the pond[29]. In the present study, copepods were the most abundant throughout the study period. The Cladocerans were represented by *Moina* sp.

The physico-chemical characteristics of the open pond (kunda) of town deeg district Bharatpur (Rajasthan) varied from station to station. The variations observed showed the effects of these parameters on the water quality and plankton abundance[30]. The presence of pollution indicator phyto and zooplankton species shows that the reservoir is under pollution stress.

Conclusion

Immediate action needs to be taken to reduce the increasing levels of anthropogenic activities which have resulted in the pollution of the pond thereby reducing the water quality and making the pond water unfit for human consumption. Thirty six taxa of plankton were encountered. Phytoplankton consisted of five families namely; Cyanophyceae, Chlorophyceae, Euglenophyceae, Bacillariophyceae and Dinophyceae. Three groups of zooplankton encountered were copepods, cladocerans and rotifers. The presence of pollution indicator species such as, Microcystis, Phacus, Oscillatoria, Surirella Closterium, Aphanocapsa, Anabeana and Euglena show that the pond is likely polluted. From the listed data the quality of water was concluded. The present study will provide an important basis to assess the fish production potentialities and to formulate sustainable aquaculture practices in man-made habitats and fishery management policies in town deeg bharatpur(Rajasthan) and nearby aquatic ecosystems. During study period it is observed that the pond of Deeg town is men made pond in which the cattle used to drink and wath, rain water enter from the surroundings into the pond. Most of the people of town deeg washing cloth and discharge shop water into the pond, local people immerge worship material in pond water. People also discharge their waste and domestic sewage directly into the water therefore water of pond becomes polluted by above mentioned regions.

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