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A Seasonal Variations of Plankton Population of Maheshara Lake in Gorakhpur, India

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Abstract: Seasonal variation of the plankton populations of Maheshara Lake, Gorakhpur District was carried out during November 2006 to October 2008. Phytoplankton density was slightly higher during November 2007 to October 2008 (2974.3 org/L) than November 2006 to October 2007 (1957.3 org/L). Bacillariophyceae appeared as the dominant group of phytoplankton in Maheshara Lake during both the study years. During the first year of study period, these group exhibited maximum density of 871.7 org/L followed by Cyanophyceae (633.2 org/L), Chlorophyceae (543.6 org/L), Dinophyceae (44.8 org/L) and Euglenophyceae (22.3 org/L). Similarly, Bacillariophyceae also registered maximum density of 1149.0 org/L during second year of period followed by Cyanophyceae (929.1 org /L), Chlorophyceae (773.1 org/L), Dinophyceae (86.4 org/L) and Euglenophyceae (36.7 org/L). Annual densities of the zooplanktons 657.2 org/L during November 2007 to October 2008 as compared to that of November 2006 to October 2007 (635.2 org/L).Rotifer appeared as dominant group of zooplanktons with higher density of 279.5 org/L during first year of study, followed by Protozoa (116.0org/L), Cladocera (114.0 org/L),Copepoda (90.4org/L) and Ostracoda (35.3 org/L). During the second year of study period, the average density of Protozoa, Rotifer, Cladocera, Copepoda and Ostracoda was computed as 119.0 org/L,298.0org/L, 117.1 org/L,91.6 org/L and 31.5 org/L respectively. Rotifer again contributed maximum density of zooplanktons to be followed by protozoa, Cladocera, Copepoda and Ostracoda. Population density of phytoplankton was higher during summer month with an average number 3423.1org/L. The minimum number of phytoplankton was recorded in rainy with an average number 2743.7 org/L. Total average density of zooplankton was higher during summer with an average number of 777.5 org/L. The minimum number of zooplankton was recorded in rainy with an average number of535.5 org/L. Phytoplankton and zooplanktons have a nominal positive relationship. Phytoplankton was increased or ecreased with the relation with zooplankton.

Key words: Seasonal variation · Phytoplankton · Zooplankton

INTRODUCTION

Fresh water resource is not unlimited. The high rate of increase of human population of India and rapid rate of industrialization have created problems of disposal of waste water products. The undesirable substance is regularly mixed into the water of lake through surface run of that degrades the water quality.Water quality is defined in terms of the chemical, physical and biological content of water [1]. The detail information of water quality and status of affected living organisms of water bodies are necessary for implementation of any management plan. Maheshara Lake is a natural habitat Lake and slightly attached with River Rapti of Gorakhpur District. Availability and quality of fresh water in this lake is important because it provide employment to local fisherman and main source of livelihood of some of very poor community of this area. But now a day Maheshara Lake is much affected due to discharge of effluents from industries, domestic sewage and municipal waste bodies washing from agricultural land using pesticides and chemical fertilizers. Income from capture fishery is main source of livelihood of some of very poor community. It is obvious that major food fishes are under threat and needs urgent strategic conservation effort. Lack of information in this field has become a stumbling block in the development of long run conservation and recovering process [2]. This work present the result of our field

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study,which assessed seasonal variations of plankton population and nutrient load of pore water of sediments of selected Maheshara Lake in Gorakhpur District. Thus, the study of seasonal variation of plankton population and other aspects become necessary to conserve the valuable indigenous species, enhance the income of local communities and increase the weight of national food basket.

Environmental disturbance induce change in the structure and function of biological systems and it can be well reflected in occurrence pattern of distribution and diversity of biotic community. The plankton productivity of water differs considerably from very high to scanty plankton production [3]. Individual species of aquatic flora and fauna are highly sensitive to toxic substance. Mostly primary producers (Phytoplankton) and benthic organism are highly sensitive including fish and other aquatic species and as a result whole tropic level of aquatic system drastically declines. The abundance and biomass of both phytoplankton and zooplankton are largely regulated by the resource base and tend to increase with trophic state of the lake [4]. Species diversity indices when correlated with physical and chemical parameters, provide one of the best ways to detect and evaluate the impact of pollution on aquatic communities [5]. The variety of phytoplankton and zooplankton is an important indicator or anthropogenic interference with in natural ecosystem may lead to reduction in Biodiversity [6]. Due to absence of planktonic study in the Maheshara Lake, the present study was undertaken to study seasonal variations of plankton population with some water quality parameters and to find out the scope of aquaculture in this lake.

MATERIALS AND METHODS

Gorakhpur is a part of Eastern Uttar Pradesh (lies at 26 48' N and 82 08'E) its high above mean sea level is 114 m. The main Rapti River flows from northern border. Hydro biological study of Maheshara Lake was done regularly for two from 2006-2008. Four Sampling sites were selected after preliminary observation for the purpose of present study. These sites were chosen on the basis of the magnitude of activities and disturbances. These sites are: (1) Junction point of lake with River Rohini i.e. Washer men's site, (2) Near Railway Bridge receives the domestic sewage from the fertilizer colonies and (3) Area receives agricultural run-off.Water samples were collected between 6A.M. to 8 A.M. at the midpoint of the lake. The collected samples were protected from direct sunlight and bacterial activity. The parameter like water temperature, pH, Total Dissolved Solid (TDS) and depth were recorded at the sampling sites with the help of water Analysis Kit. While American Public Health Association (APHA) [7] methods was adopted for the determination of other parameters i.e. Biological Oxygen demand (B.O.D.), Chemical Oxygen Demand (C.O.D.), chlorine, phosphate and Ammonia.

For study of plankton, the collected water was filtered through plankton net. The filtrates were then immediately preserved in 5% buffered formalin for further studies. Microscopic identification up to genera level was performed following the standard manual. Each sample was stirred well just before microscopic examination. One ml of stirred sample was transferred to Sedgewick-Rafter (S-R cell) cell with a wide mouth pipette. Identificationand enumeration were done by a compound electrical microscope. All the planktons present in 20 squares of the cell chosen randomly were counted. The mean of three estimates was then calculated for each component occurring in the total count. Finally the quantitative counts of plankton were done according toRahman [8] and expressed in cells/I.

RESULTS

Water is the basic element of theexistence of aquatic fauna and its specific properties as a cultural medium are naturally of great significance in the productivity of lake. The fresh water bodies are being greatly affected by excessive influence of human activity. The interaction of physical and chemical parameters of any aquatic system determines the nature of aquatic organisms inhabiting it. In the present study temperature ranged from 17.8°C to25.3°C and between 17.6°C to 25.4°C during the first and second years of study period. pH of water varied between 7.49 to 7.81 and between 7.56 to 7.77 during the study period. The average maximum depth was recorded 8.0 meter and 8.7 meters and average minimum depth 3.4 meters and 3.0 meters during the study periods respectively.

During the study period, NO_3-N(Nitrate) concentration fluctuated widely from 12.44 to14.56 mg/l. The highest value was recorded in summer season and lowest inrainy season. Fluctuation of PO_4-P (phosphate) concentration ranged from 0.39 to0.722 mg/l with the maximum in rainy season and minimum in summer season.

Phytoplankton Population: Temporal abundance of total phytoplankton density was slightly higher during November 2007 to October 2008 (2974.3 org/L) than November 2006 to October 2007 (1957.3 org/L). Bacillariophyceae appeared as the dominant group of phytoplankton in Maheshara Lake during both the study years. During the first year of study period, these group exhibited maximum density of 871.7 org/L followed by Cyanophyceae (633.2 org/L), Chlorophyceae (543.6 org/L), Dinophyceae (44.8 org/L) and Euglenophyceae (22.3 org/L). Similarly, Bacillariophyceae also registered maximum density of 1149.0 org/L during second year of period followed by Cyanophyceae (929.1 org /L), Chlorophyceae (773.1 org/L), Dinophyceae (86.4 org/L) and Euglenophyceae (36.7 org/L).

Bacillariophyceae: Bacillariophyceae was the most dominant group of phytoplankton in respect to abundance with mean value 1149 org/lit. A total of 14 genera of Bacillariophyceae were observed in Maheshara Lake.Among these *Achnanthes, cyclotella, Cymbella, Gomphonema, Naviculaviridula, Synedra* were predominant. Bacillariophyceae was most dominant during summer season (1816 org/L) and lowest in rainy season (1353 org/L).

Chlorophyceae: Chlorophyaceaeranked as thesecond highest among phytoplankton group in respect to abundance and first in number of genera (16). The range of Chlorophyceae was from 892 to 1250 org/Lwith an average mean 773.1 org/L.The occurrence of Chlorophyacea was highest in summer and lowest in rainy season. *Zygnemagiganteum, Zygnemaczurdae, Coelastrum* sp., *Ankistrodesmus*sp. etc were predominant genera.

Cyanophyceae: The abundance of Cyanophyceae was found to highest in summer season 1452.2 org/L and lowest in winter season 1099.6 org/L15 number of genera.Among them, *Anabeanafertilissima, Spirulina* sp., *Merismopedia* sp., *Phormidium* sp. were predominant.

Dinophyceae: The abundance of Dinophyceaewas found to be highest in summer 123 org/L and lowest in rainy season 89 org/L with 2 number genera. The frequently occurring genera were *Ceratiumhirundinella* and *Tetradinium* sp.

Euglenophyceae: Euglenophyceae was the least dominant group of phytoplankton in respect of both abundance and number of species. Euglenophyceae was the most abundant during summer season (57org/L). This group was rarely found in Maheshara Lake in rainy season.

The maximum density was recorded for Bacillariophyceaeand minimum for Euglenophyceae followed by Dinophyceae, Chlorophyceae and Cyanophyceae in all season (Fig. 1).

Zooplankton Population: Annual densities of the zooplanktons 657.2 org/L during November 2007 to October 2008 as compared to that of November 2006 to October 2007 (635.2 org/L). Rotifer appeared as dominant group of zooplanktons with higher density of 279.5 org/L during first year of study, followed by Protozoa (116.0org/L), Cladocera (114.0 org/L), Copepoda (90.4org/L) and Ostracoda (35.3 org/L). During the second year of study period, the average density of Protozoa, Rotifer, Cladocera, Copepoda and Ostracoda was computed as 119.0 org/L, 298.0org/L, 117.1 org/L, 91.6 org/L and 31.5 org/L respectively. Rotifer again contributed maximum density of zooplanktons to be followed by protozoa, Cladocera, Copepoda and Ostracoda.

Population density of phytoplankton was higher during summer month with an average number 3423.1org/L. The minimum number of phytoplankton was recorded in rainy with an average number 2743.7 org/L. Total average density of zooplankton was higher during summer with an average number of 777.5 org/L. The minimum number of zooplankton was recorded in rainy with an average number of 535.5 org/L.

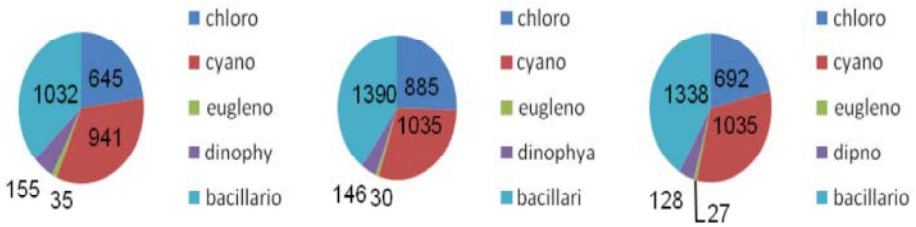


Fig. 1: Percentage composition of various phytoplanktons (unit/L) groups in winter, summer and Rainy season

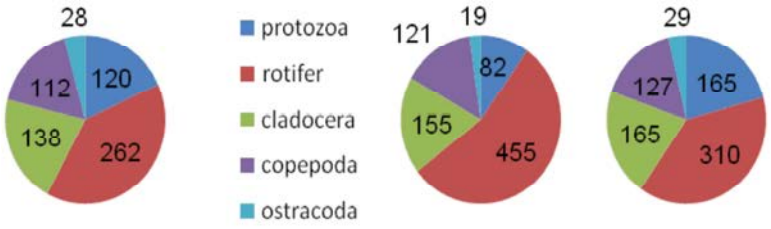


Fig. 2: Percentage composition of various zooplanktons (unit/L) groups in winter, summerand Rainy season

Protozoa: Among Protozoan *Amoeba* sp., *Englypha* sp., *Diffusia* sp., *Euglena spirogyra, E. gracilis, Para mecium* sp., *Vorticella companula, Epistylisamastica* were predominant. The abundance of protozoans was the highest during rainy season. Average abundance of protozoan's ranged from 148 org/L to173 org/L. This group was rarely found in winter season.

Rotifers: Rotifers are most dominant group of zooplankton in respect to abundance with mean value 298 org/L.Among *Rotifers Monostyla* sp., *Keratella* sp., *Brachionusquadridentatus, B. Patulus, B. rubens, B. caudatus, Filinialongiseta, Lecameaculiata, Polyarthra* sp., *Rotaria* sp., *Trichocerca* similes were predominant. Rotifers are most abundant in summer season (477 org/L) and least in rainy season (285 org/L).

Cladocera: A total of 4 genera of Cladocera were observed in Maheshara Lake. Among these genera *Alona* sp., *Basmina* sp., *Dophnia* sp., *Moina* sp. were predominant. Cladocera was the most dominant in summer season (171.0org/L) and lowest in rainy season (125.0org/L).

Copepoda: The abundance of Copepoda was found to be highest in summer season (139.0org/L) and lowest in rainy season (90.0org/L) with 3 numbers of genera. Among them, *Cyclops* sp., *Gammarus so* sp., *Nauplius*sp. were predominant.

Ostracoda: Ostracoda was the least dominant group of zooplankton. Ostracoda is most dominant season (35org/L). This group was rarely found in the rainy season (16org/L). *Cypris* sp. was predominant.

The maximum density was recorded for Rotifera and minimum for Ostracoda followed by Cladocera, Copepoda and Protozoa in all season (Fig. 2).

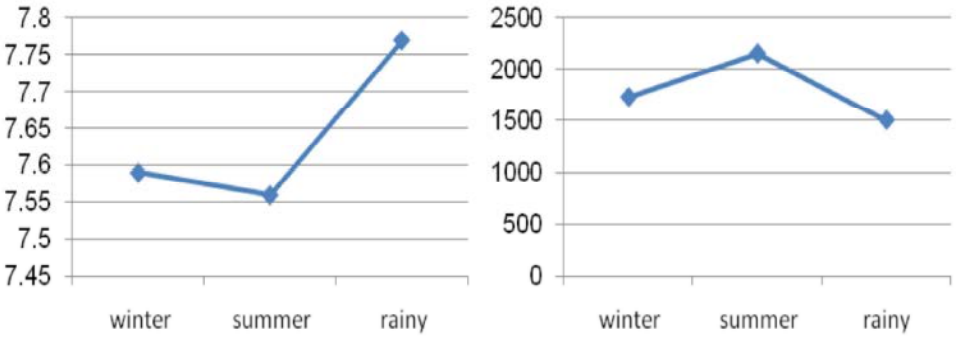
DISCUSSION

The plankton plays an important role in the biological treatment of organic wastes loaded in water as during putrefaction of organic matter by bacteria, the oxygen is supplied by them. The environment of plankton exhibits a unity and is characterized by some extreme orderliness in the change of physic-chemical properties. Severallimnologists from all over the world observed seasonal variations in both plankton i.e. phytoplankton and zooplankton while working in both lentic and lotic water bodies [9, 10].

Observations on physico-chemical characteristics of Maheshara Lake suggest that the physical and chemical properties are related to their seasonal and spatial changes and in most instances are interdependent. The pH, DO, alkalinity and the dissolved nutrient are important for the phytoplankton production [11]. Marked seasonal variations are exhibited by most of the parameters. During the present study the pH recorded maximum in rainy season and minimum in summer (Fig. 3) the maximum depth was recorded in rainy season whereas minimum depth in summer season (Fig. 4) while plankton population is maximum in summer season and minimum in rainy season.

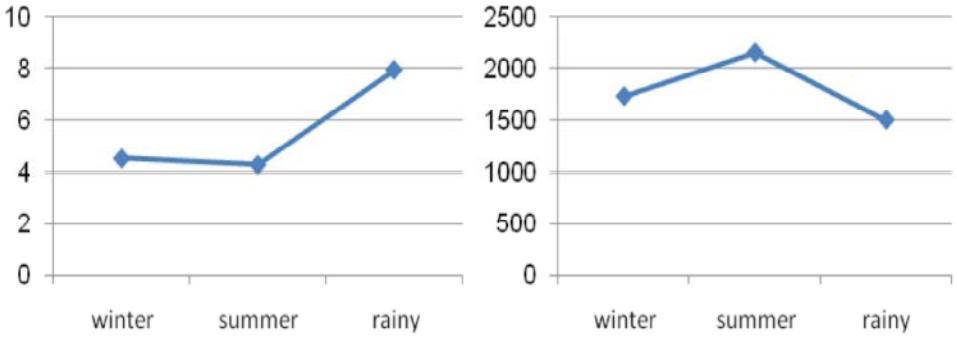
Plankton abundance and taxonomic diversity depend upon the supply of nutrients in natural waters. In the present study, the highest Plankton density was recorded during summer season when $N\text{-}NO_3$concentrations were found to be highest (Fig. 5). Similarly relationship also present in case of lower abundance of phytoplankton in low $N\text{-}NO_3$ concentration. Phosphate exhibited inverse relation with the growth rate of Plankton. The lower value of phosphate corresponded with the higher value of Plankton (Fig. 6). Patra [12] found similar relationship between $P\text{-}PO_4$ and Plankton population.

Temperature directly affects plankton population. During summer the temperature is high and the plankton population is also reach to the maximum and when the temperature is low during winter the plankton population is also reach to the minimum (Fig. 7).



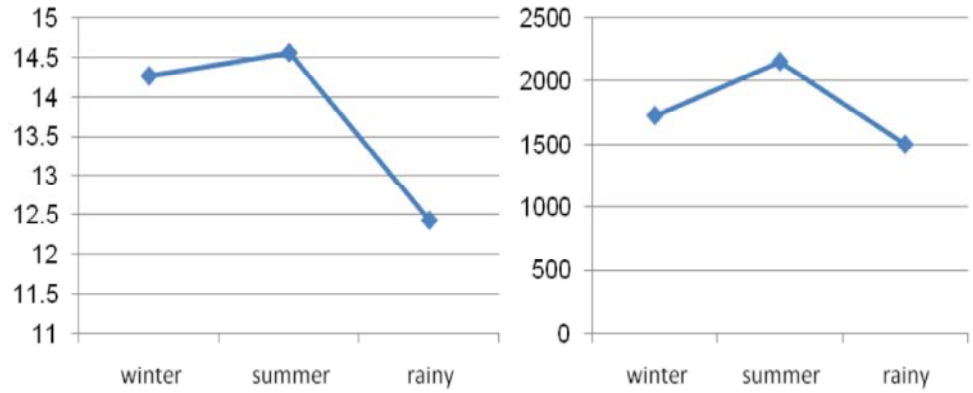
A- (pH) B-(plankton population)

Fig. 3: Effect of (A)pH of Maheshara Lake in different seasons compared with(B)plankton population density



A-(Depth) B-(Plankton population)

Fig. 4: Effect of (A) Depth (Meter) of Maheshara Lake in different seasons in compared with(B)plankton population

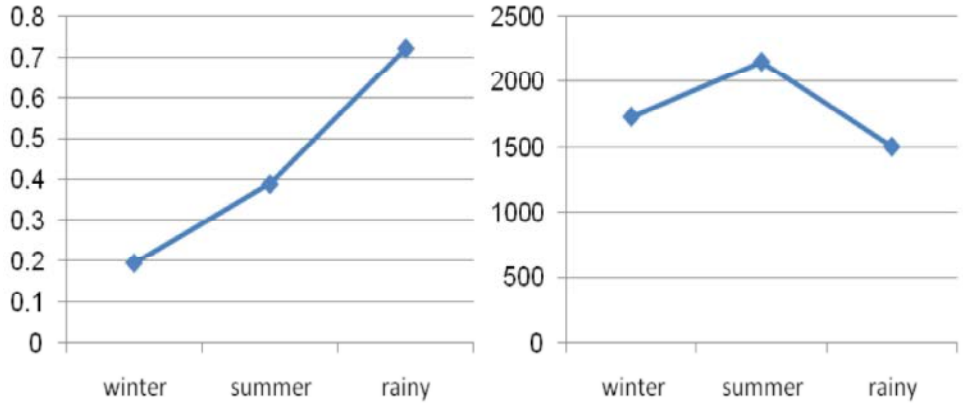


A-(Nitrate Concentration) B-(Plankton population)

Fig. 5: Effect of (A) nitrate-N concentration on the seasonal abundance of total (B)plankton population in MaheshaLake during study period

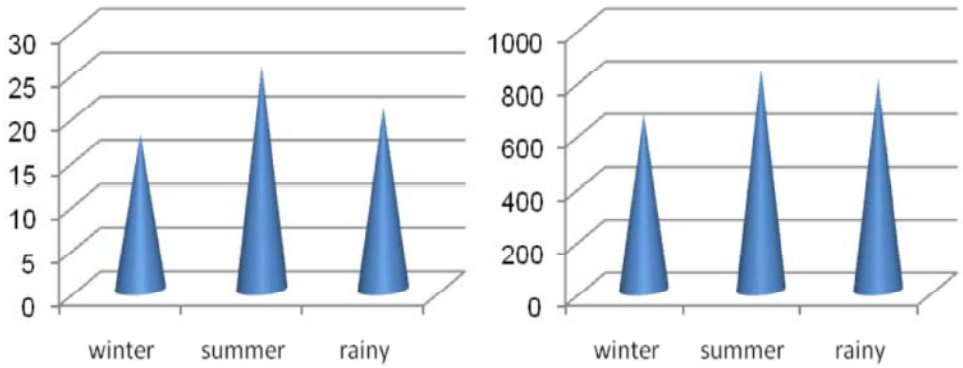
The total of 42 genera and species of phytoplankton belonging to five groups of algae has been observed in the Maheshara Lake during the study period. Out of 48 species. 16 species are belonging to Chlorophyceae 02 species of Cyanophyceae, 01 species of Euglenophyceae, 02 species of Dinophyceae and 14 species of Bacillariophyceae. In present investigation Chlorophyceae was found to be the main component of the phytoplankton population, followed by Cyanophyceae, Bacillariophyceae, Dinophyceae and Euglenophyceae.

Mean annual density of phytoplankton in Maheshara Lake was observed to be 1957.3org/L during study period. In Ganges the diversity of phytoplankton was recorded to be 200 to 300 unit /L between Patna and Bhagalpur [13].



A-(Phosphate concentration) B-(Plankton population)

Fig. 6: Effect of (A) Phosphate-P concentration on the seasonal abundance of total (B) plankton population in Maheshara Lake during the study



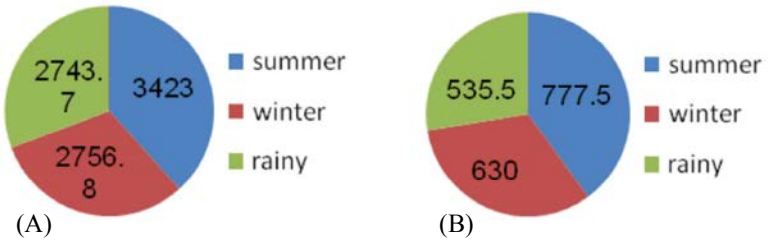
A (Temperature) (B) Plankton population

Fig. 7: Effect of (A) temperature on the seasonal abundance of (B) plankton population in Maheshara Lake during the study period

According to Shukla [14], the higher density of phytoplankton in Narmada upstream at Bherghat like Varanasi and Mirzapur from Ganges is due to higher pollution of the river at that station. Unni [15] also reported that during most of the sampling occasions between Novembers onwards in Narmada River, the Normal phytoplankton counts do not exceed 5000units/L. of but the excessive plankton exceeding the normal counts explains the input of nutrient. Phytoplankton species and diversity fluctuate according to the season. It has been shown that the many of these fluctuations, called seasonal succession, could result from the life activity of the previously existing phytoplankton and zooplanktons, fishes and other organisms [16].

In the present study the population density of phytoplankton was higher during summer months in both the study years (2006-2008), followed by winter and rainy months. Average density of phytoplankton in Maheshara Lake was recorded as 2733.6org/L and 3423 org/L in summer season, 1913.4org/L and 2756.8org/Lin winter season and 1229.9org/L and 2743.7org/L in rainy season during both the study years respectively. Bacillariophyceae constituted the dominant group in MaheshsaraLake followed by Cyanophyceae, Chlorophyceae, Dinophyceae and Euglenophyceae during all seasonsof the two years. Euglenophyceae is represented by a single genus *Phacus* sp.

Zooplankton constitutes an important source of food for fishes and benthic macro-invertebrate.These form an integral part of the lotic community and significantly contribute to the fresh water.A total of 27 species comprising 11 rotifers,8 protozoans,4cladocerans,3 copepods and 1 Ostracods have been observed in the MaheshsaraLake during present investigation.



(A) (B)

Fig. 8: Population density of (A) phytoplankton (org/L) and (B) Zooplankton in Maheshara Lake during the study period

The maximum average density of plankton in MaheshsraLake observed during summer season and minimum in rainy season (Fig. 8). During winter season, summer season and rainy season, the maximum density was recorded for Rotifers, followed by Cladocera, Copepoda, Protozoa and Ostracoda. Zooplankton exhibited higher density during summer months (744.7org/L and 777.5org/L) followed by winter months (643.7org/L and 630.0org/L) and rainy months (395.5 org/L and 535.5 org/L) during the first and second years of study periods.

Rotifers exhibit high turnover rates in nature. According to Adoni [17], Gannon and Stemberger [18] the density of rotifers as well as their diversity increases due to increases in eutrophication. Chaurasia [19] reported that the density of rotifers and their species diversity is highest in eutrophic condition.Bhowmic [20] suggested that increase in zooplankton population in summer is due to higher concentration and increased photosynthetic activity. Water temperature and flow of water have been observed as the most significant controlling factors of zooplankton density as reported by Coffing [21] and Patrick [22]. Our observation also supports the above findings. However, Das and Srivastava [23] observed inverse correlation between phytoplankton and zooplankton.

Among the vast inland fishery resources, Maheshara Lakeismore potential. But fish production from Maheshara lake fishery is decrease day by day due to various man made activities. So Maheshara fishery should be preserved for augmenting fish production and ecological balance of this habitat. Therefore, restoration and development of degraded habitats and rehabilitation of depleted stocks by ranching programmed are urgently needed from the present study, it is suggested that further study on seasonal changes of phytoplankton in relation to some water quality parameters should be under taken in different sites of Maheshara Lake.

REFERENCES

1. Lawson, E.O., 2011. Physico-chemical Parameters and Heavy Metal Content of Water from Mangrove swamps of Lagos Lagoon, Lagos, Nigeria. Advan. Biol. Res., 5(1): 08-21.
2. Jain, S., 2009. Significance of environmental education in socio economic development of organized by India. National Seminar organized by U.P. Government Colleges Academic Society, Allahabad at Government Girls P.G. College, Ghazipur-233001 U.P. 17-18 January 2009 pp: 216.
3. Radhakrishnan, M.V. and E. Sugumaran, 2010. Fluctuations in zooplankton Diversity on Sugarcane Bagasse Substrate used for fish culture. Pa Am. Euras. J. Sci. Res., 5(2): 153-155.
4. McCauley, E. and J. Kalff, 1981. Empirical relationship between phytoplankton and zooplankton biomass in lakes. Can. J. Fish. Aquat. Sci., 38: 458-463.
5. Maraglef, R., 1968. Perspectives in ecological theory. (University of Chicago press.Chicago), pp: 111.
6. Isshad Ahmad, AhangarMohanmad and Faooj Mir, 2012. Zooplankton diversity of Anchar Lake with Relation to trophic status, Srinagar, Kashmir Global J. Environ. Res., 6(1): 17-21.
7. APHA, 1992. Standard method for the examinations of water and waste water.American Public Health Association,1015 eighteen street, New Delhi, New York, Washington D.C., 20035, pp: 847.
8. Rahman, M.S., 1992. Water quality management in aquaculture. BRAC Prokashana, Dhaka, pp: 83-84.
9. Nandan, S.N. and V.S. Galankar, 2000. Limnological study of Unapdeo thermal spring of Maharastra (India). Journal of ecology and Ecoplan, 3(2): 360-375.
10. Tiwari, D and M. Shukla, 2007. Algal biodiversity and tropic status of some temporary water bodies of Kanpur. Nat. Environ. And Pollut. Tech., 6(1): 85-90.

11. Sivakumar, K. and R. Kareppasmy, 2008. Factor affecting productivity in a Reservoir of Tamilnadu, India. IDOSI Publication 2008 Am. Euras. J. Bot., 1(3): 99-103.
12. Patra, R.W.R. and M.A. Azadi, 1987. Ecological studies on the planktonic organisms of the Halda River. Bangladesh J. Zool., 15(2): 109-123.
13. Ray, P. and K.L. Singh, 1966. A study of some aspect of the River Ganga and Yamuna at Allahabad (U.P) in 1958-1959. Proc. Nat. Acad. Science of India, 36(3B): 235-272.
14. Shukla, S.C., R. Kant and B.D. Tripathi, 1989. Ecological investigation on physicochemical characteristic and Phytoplankton productivity of River Ganga at Varanasi. Giobios, 16: 20-27.
15. Unni, K.S., 1996. Ecology of River Narmada. APHA publishing Co-operation, 5 Ansari Road, Daryaganj New Delhi, pp: 371.
16. Ali Ganjian Khenari's, 2010. Seasonal succession of phytoplankton community structure in the southernrt of caspion Sea Am. Euras. J. Agaric. Environ. Sci., 8(2): 146-155.
17. Adoni, A.D., 1975. Studies on microbiology of Sagar Lake. PH.D. Thesis. Saga University, Sagar (M.P) University, Sagar (M.P) pp: 243.
18. Ganond, J.E. and R.S. Stemberger, 1978. Zooplankton especially crustaceans and rotifer as indicator of water quality. Trans Amer. Microscopic. Soc., 97(1): 16-35.
19. Chaurasia, S., 1996. Seasonal fluctuation of zooplankton in Burha tank water, Raipur India. J. Evn. Prot., 16(2): 140-142.
20. Bhowmic, M.L., 1968. Environmental factors affecting fish food in freshwater fisheries, Kalyani (West Bengal). PhD Thesis, Kalyani University, pp: 238.
21. Coffing C., 1937. A quantitative study of India: Present status and conservation measures. Environmental Pollution, pp: 199-218.
22. Patrick, R., 1972. Aquatic communities as indices of pollution in indicators of Environmental quality. William and Thomas (ed.) plenum Press, New York, pp: 93-100.
23. Das, S.M. and A.K. Srivastava, 1956. Quantitative studies of freshwater plankton: Plankton of a fish tank in Lucknow, India. Proc. National Academy of Science, India, pp: 26.