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Study on Phytoplankton, Zooplankton and Ichthyo Fauna of Motia Lake

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Research Article

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ABSTRACT

Present work was carried out at Motia Lake Bhopal, Madhya Pradesh, India on phytoplankton, zooplankton and icthyo fauna. During study period phytoplankton community was represented by four groups viz., *Cyanophyceae, Bacillariophyceae, Chlorophyceae* and *Euglenophyceae*. Among the four, *Cyanophyceae* was the most dominant group. The phytoplankton abundance was evident during monsoon season. The zooplanktons were represented by four groups viz., *Rotifera, Cladocera, Copepoda* and *Ostracoda*. Among these *Rotifera* exhibited numerical dominance. The ratio between Phytoplankton to Zooplankton was found to be 29.29: 1.00. The aquatic weeds found in the lake included species of Eichornia, Hydrilla, Marsilia, Meriophyllum, Chara, Ipomea, Najas and Vallisneria. The fish diversity in Motia Lake was represented by 20 genera belonging to the respective orders. They included major carps, exotic carps, murrels, cat fishes and other species.

INTRODUCTION

In India water reservoirs have a rich and varied spectrum exceeding about 400 species. These wet lands are very important as they are good and useful sources to mankind in different ways. Some are used for irrigation, some for potable water supply, raw water supply, recreation and washing etc. With rapid urbanization, constant disturbance in demographic structure especially during second half of last century, all these water bodies have been subjected to various environmental problems. It results in the deterioration of water quality through (i) inflow sewage (ii) solid waste dumping (iii) other anthropogenic activities. These effected the fauna of water bodies and hence biodiversity of the lakes.

Seasonal rainfall and heavy discharge of water during the monsoon results in high flushing rate in most of the reservoirs which do not favour colonization by macrophytic communities. Inadequate availability of suitable substrate regards the growth of periphyton. Plankton by virtue of drifting habit and short turnover period, constitutes the major link in the trophic structure and events in the reservoir ecosystem. Fish production in reservoir is directly or indirectly dependent on the abundance of plankton. The physico-chemical properties of water determined the quality and quantity of plankton. The plankton community consists of organisms ranging from minute plants to small animals. Other two categories of life in an ecosystem are benthos and nekton. Benthos is the life at the bottom, like aquatic earthworms, insect larvae and certain fishes. Neton includes the larger swimming animals like fishes. Plankton is most essential for many fishes as food. The plankton is further divided into two main categories such as phytoplankton and zooplankton.

Phytoplankton includes algae, diatoms etc. They occupy the base of the food chain and produce the food material on which other organisms in the ecosystem sustain. The phytoplankton drifts about at the mercy of the wind and water movements. Algae consist of three major classes as *chlorophyceae, cyanophyceae and bacillariophyceae*. In natural

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water, algae are small and numerous, usually at a level of 10^2-10^6 cells/ml. Phytoplankton seems as a very good indicator of pollution of the fresh water. Blue-green algae form the main stay of phytoplankton community in the majority of the man-made reservoirs [1]. In late summer, the number of planktons declines as a thermocline develops and nutrients in surface are depleted by phytoplankton. This is called as summer minimum.

Zooplanktons are abundantly found in the shallow areas of a water body. The zooplankton unlike phytoplankton are particularly distributed horizontally and vertically in an ecosystem. The zooplankton forms an important group as it occupies an intermediate position in the food web. Many of them feeding on algae and bacteria and in turn being fed upon by fishes. They also indicate the trophic status of a water body. Their abundance increased in the eutrophic waters. They are also sensitive to pollution and many species are recognized as indicators of pollution. In fresh water reservoirs some of the organisms occasionally occur in appreciable numbers forming swarms. These swarms form bands or streaks or are arranged into thick and thin concentration and simulate the cloud effect and may give the water a stickingly different colour. The most commonly found zooplanktons are protozoans, crustaceans like *cladocerans, copepods, ostracods* and *rotifers*.

The ichthyofauna of a reservoir basically represents the fish faunal diversity. Indian reservoirs preserve a rich variety of fish species, on the basis of studies conducted so far, large reservoirs on an average harbour 60 species of fishes, of which 40 species contribute to the commercial fisheries. Indian major carps occupy a prominent place among the commercially important fishes. More recently, number of exotic species have contributed substantially to commercial fisheries. Being basically a carp country both the indigenous and exotic *carps, catla, rohu, mrigal, silver carp, grass carp* and common carp, account for a great bulk of the production.

MATERIALS AND METHODS

The present study was conducted in a minor reservoir Motia Lake in the center of Capital City of Bhopal (2316' N and 7736' E; 550 meters above MSL) spreading over 7 hills. The water spread area is 10.89 hectares. The age of the reservoir is 90 years. The reservoir is located in Bhopal city with a wellbuilt tank bund. The reservoir water is used for many purposes including fishing activities. Bhopal city is called the City of Lakes. The two main lakes upper lake and lower lake, which provide livelihood and add to scenic beauty to the Bhopal city. Which is endowed with a number of eighteen water bodies developed over a period of 900 years. The present study was conducted in a minor reservoir Motia Lake in the center of capital city of Bhopal. The water spread area is 10.89 hectares. The age of the reservoir is 90 years. The reservoir is located in Bhopal city with a well-built tank bund. The reservoir water is used for many purposes including fishing The During this period study were conducted on biological organisms such as phytoplankton, zooplankton and ichthyofaunal diversity (Figure 1).

Figure 1. Map Showing different Diversity.

Sampling procedure

The water samples were collected in five stations of the reservoir and one litre of water was collected in a wide mouth polythene bottle and tightly stoppered filled with surface water for biological analysis. Plankton net (mesh size 65 µm) was used to filter 50 litre of surface water to obtain 100 ml of the net plankton concentration. All the samples were packed in a cane basket, protected them from intense sunlight and contamination and were transported to the laboratory without any delay.

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Biological analysis

Enumeration of Plankton: Sedgwick-Rafter cell of 1.0 ml capacity was used for counting microalgal forms, rotifers and micro crustaceans from net plankton samples. Depending on the population density the number of organisms in three S-R cells was counted. Appropriate multiplication factor was used for the estimation of total number of organisms per litre.

Quantitative analysis: 50 litres water was collected and poured through plankton net and collected planktons are measured with measuring jar.

Since the water sources is not very big and do not found under the category of deep-water body, fishing is being conducted by traditional methods using the following craft and tackle.

The traditional catomarian which is improved with thermacole is used. 4 pieces of 36" Ч 18" Ч 6" size thermacole are united lengthwise to make one such box of a size of 72" Ч 18" Ч 12", wrapped in polythene cloth or a tarpolene or at time a thick gunny bag to make all the pieces as a single unit. This box will act as a float with holding the weight of person operating with a load of nets and fish. This is operated in water with the help of wooden oar.

Another method of going into water by the members is coracle. It is a wide basket of size made of a skeleton of M.S. iron spring/bar welded into required shape. The outer surface is covered with a tarpolene to enable floating water. Most of the fishing is being done by gill netting and, cast netting. All the nets consist of webbing, fastened to appropriate lines and rope only on Sundays and holidays. In the remaining months the fish were caught other than Sunday also.

After catching, the fishes were brought to the shores and segregated species-wise and sold out to customers or retailers or wholesalers or commission agents. The total catch of each species was weighed and calculated the total production of particular day. Then the whole month data was calculated species-wise. Finally, the catch of the month and then the year were calculated.

RESULTS and DISCUSSION

Plankton diversity: phytoplankton

The present observation on phytoplankton of the reservoir indicated that the communities of *Cyanophyceae, Chlorophyceae, Bacillariophyceae* and *Euglenophyceae* constitute the phytoplankton bulk in the present reservoir **(Table 1; Plates 1-9)**.

Among phytoplankton community, the *Cyanophyceae* was found to be rich and dominated in the present reservoir. *Cyanophyceae* was found 69.67 in 2011-2012 and 50.27% in 2012-2013 in Motia Lake **(Tables 2 and 3; Figure 2)**. Seven *Cyanophyceae* genera were found in the reservoir **(Table 3)**. The common *Cyanophyceae* communities observed in the reservoir were *Microcystic, Anabena, Phomidium, Oscillatoria, Merismopodia. Arthrospira* and *Nostoc*.

High quantum *Cyanophyceae* in pre-monsoon period in the reservoir of 139043 organisms/litre were observed during 2011-2012 and 115870 organisms/litre were observed during 2012-2013 **(Figures 2 and 3)**. Maximum blue greens were found in February (60615 organisms/lit) during 2011-2012 and in March (62429 organisms/lit) during 2012-2013 **(Table 2)**. The minimum value was found in January (32113 organisms/litre) during 2012-2013. The low phytoplankton values were found during post monsoon period in both the years of study.

The second dominating phytoplanktons were the *Bacillariophyceae,* which contributes 13.17% and 12.21% to the total phytoplanktons community in the reservoir during study period. The pre-monsoon period was found to be favourable for the *Bacillariophyceae* plankton. 13920 organisms/l and 13923 organisms/litre were found in the reservoir during 2011-2012 and 2012-2013, respectively. The rich *Bacillariophyceae* planktonic blooms were observed in the reservoir during both the years. The planktonic bloom of *Bacillariophyceae* was observed to be decreased considerably with the onset of monsoon period, and further reduction in the blooming was also observed in post-monsoon season during the present study.

The *Bacillariophyceae* was found to be represented by twelve genera in Motia Lake. Among these genera the common plankton blooms recorded during the study period were *Navicula, Bacillaria, Amphipleura, Fragillaria, Pinnularia, Diatomella, Synedra, Nitzchia, Cymbetta, Gamphonena Cyclostella* and *Diatoma* **(Table 1)**.

The maximum *Bacillariophyceae* plankton in the reservoir was found in February (13920 organisms/lit) during 2011-2012 and in March (13923 organism/lit) during 2012-13 high *Chlorophyceae* plankton was recorded in pre-monsoon period (1630 organisms/l and 1875 organisms/l) during 2011-2012 and 2012-2013, respectively. Low values were recorded (1090 and 895 organisms/lit) in post-monsoon period during study period **(Table 4)**.

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The presence of abundant phytoplanktons during the study period was due to the presence of more nutrients in the reservoir. Extra-nutrients came from the domestic sewage of nearby areas which evolve towards mesotrophic nature from allgotrophic nature.

As usual temperature, nitrates, phosphate and angiosperm association were cited as important factors influencing the abundance and spatio-temporal distribution of diatoms. There was considerable evidence from Indian waters that diatoms were produce maximum during summer or winter or both as in the present reservoir [2,3].

It is clearly understood that the ecological parameters were potentially favorable for diatoms in the present reservoir, but they did not build up sizable population in the face of competition from blue-green algae. Similar observations were made by Devi [1], in Himayathsagar and Mir-alam. Vyas and Kumar [4] described phosphate and nitrate were more responsible for diatom abundance.

Low dominance of *Euglenophyceae* was recorded by Rao [1,2,5]. According to Cynthia high temperature, free CO_2, low concentration of dissolved oxygen, large amounts of organic matter and iron were favourable for the growth of these flagellates. In Gandhisagar reservoir and Jari reservoir the dominance of *chlorophyceae* among phytoplankton was reported [6,7].

According to Unni *et al.* [8] ammonical nitrogen, phosphate and highly alkaline pH supports a very rich phytoplankton and zooplankton. (138 to 1725 ml and 9 to 320 nos^{-1}) and almost 50% was dominated by *Chlorphyceae* in lake Powai [9].

The present study reveals that *Englenophyceae* domination was least among the phytoplankton population. Rao [2] in Mayira reservoir in Osmansagar and Himayathsagar reservoirs and Devi [1] in Ibrahimbagh and Shathamraj reservoirs reported the least domination of *Chlorophyceae* among the phytoplankton.

Oscillatoria was the most dominant form among all plankton in the present reservoir. It showed a continuous upward trend from December to September. The second most dominent phytoplankton of the reservoirs was *Nitzschia* of *bacillariophyceae*. It also showed an increasing trend during same period. High density of these phytoplankton was recorded at surface waters. Rao and Chowbey [6] recorded *Nitzschia* of *bacillariophyceae* as most dominant and *Microcystis cyanophyceae* as second dominant among plankton in Gandhisagar. Devi et al. [1,10,11] reported that *Oscillatoria* of *Cyanophyceae* in Ibrahimbagh and *Nitzschia* of *Bacilloriophyceae* in Shatamraj reservoirs were dominated among the plankton.

Srivastava [12] reported that among plankton, *Ceratium* was the most dominating and the forms commonly seen were *Peridium, Stanrastam, Synedra, Batryococus, Aphanocapsia, Pediastrum, Nitrocystos, Chrysamoebas* along with some algal filaments. He has also reported the dominance of phytoplankton in summer in Rihand reservoir. *Microcystis* was dominant among the phytoplankton in Rihand reservoir. He has further reported that the plankton growth was moderate in Ramgarh reservoir as the water turbidity was high.

The present study revealed that the fluctuations of phytoplankton were similar to the fluctuation of physico-chemical parameters like temperature, pH, alkalinity, nitrates and phosphates. The seasonal fluctuation of the phytoplankton organisms with the fluctuation of physico-chemical condition of water had been reported by Rao et al. [1,6,10-11] **(Figures 4-14)**.

Table 1. The Phytoplankton of Motia Lake during 2011-2012 to 2012-2013.

Order	Phytoplankton
Cyanophyceae *(9 Genra)*	*Anabena* *Arthrospira* *Lyngbya* *Merismopodia* *Microcystis* *Merismopodia* *Microcystic* *Nostoc* *Oscillatoria*
Chlorophyceae *(12 Genra)*	*Spirogyra* *Ulothrix* *Volvax* *Zygonema*

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	Eudorina *Oedogonium* *Closteridium* *Scenodesmus* *Cosmarium* *Pediastrum* *Microspora* *Cladophora*
Bacillariophyceae *(12 Genra)*	*Navicul* *Bacillaria* *Amphipleura* *Fragillaria* *Cymbella* *Diatomella* *Pinnularia* *Synedra* *Nitzschia* *Gomphonema* *Cyclostella* *Diatoma*
Euglenophyceae *(2 genra)*	*Euglena* *Paranema*

Table 2. The seasonal fluctuations of Phytoplankton of Motia Lake during 2011-2012 and 2012-2013.

During 2011 - 2012					
S. No.	**Phytoplankton organisms/litre**	**Pre-Monsoon**	**Monsoon**	**Post Monsoon**	**Average**
1.	*Cyanophyceae*	60615	46315	32113	139043
2.	*Chlorophyceae*	1630	1320	1090	4040
3.	*Bacillariophyceae*	13920	7314	6920	28154
4.	*Euglenophyceae*	3214	2712	1720	7636
	Total				178873
During 2012 - 2013					
1.	*Cyanophyceae*	64429	49810	36310	115870
2.	*Chlorophyceae*	1875	1380	895	4150
3.	*Bacillariophyceae*	13923	7912	6204	28039
4.	*Euglenophyceae*	3254	2790	1680	7724

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	Total				155783

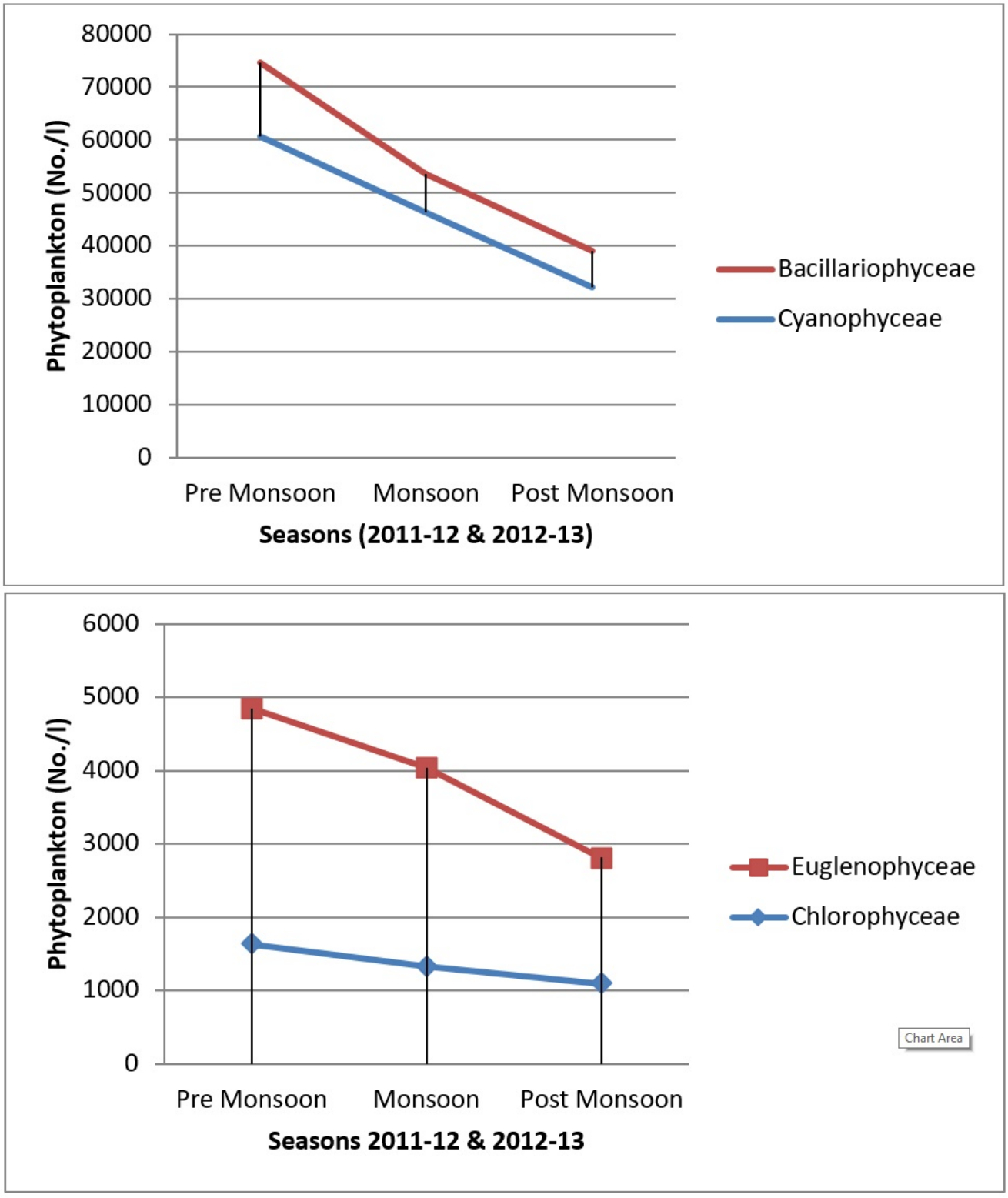

Figure 2. Seasonal fluctuations of phytoplankton in the Motia Lake.

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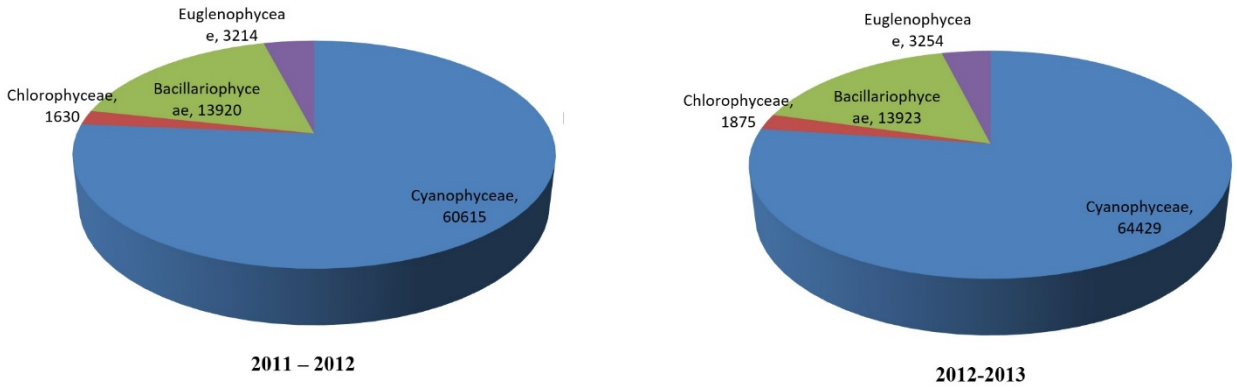

Figure 3. Fluctuations of Phytoplankton in the Motia Lake.

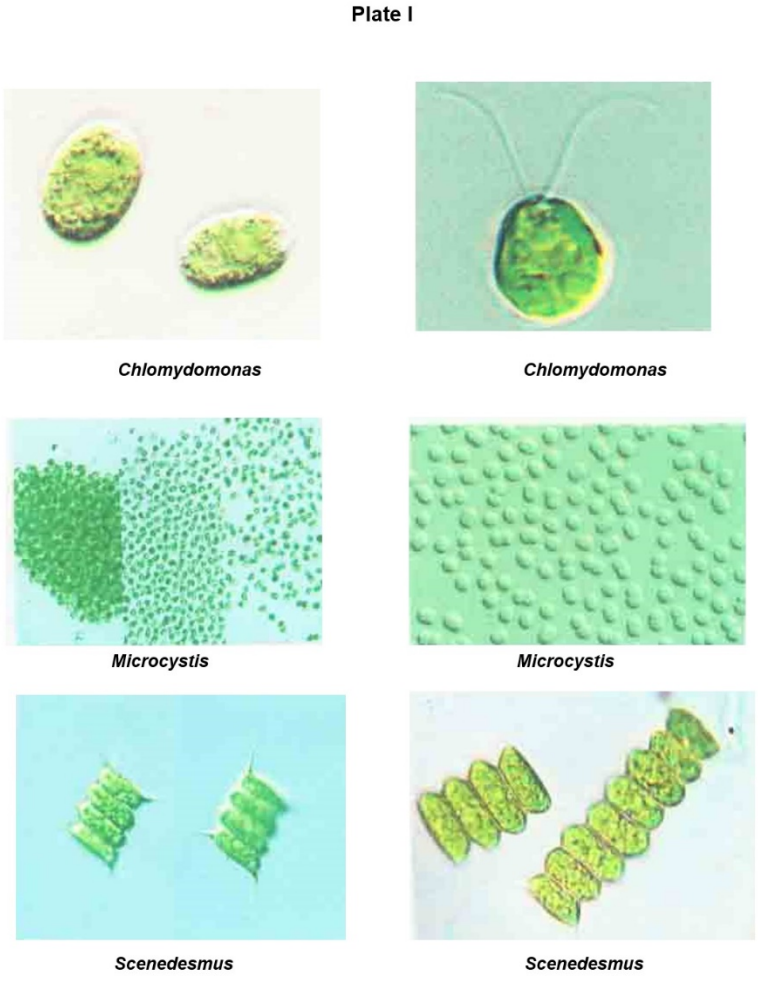

Figure 4. Showing Plate I structure.

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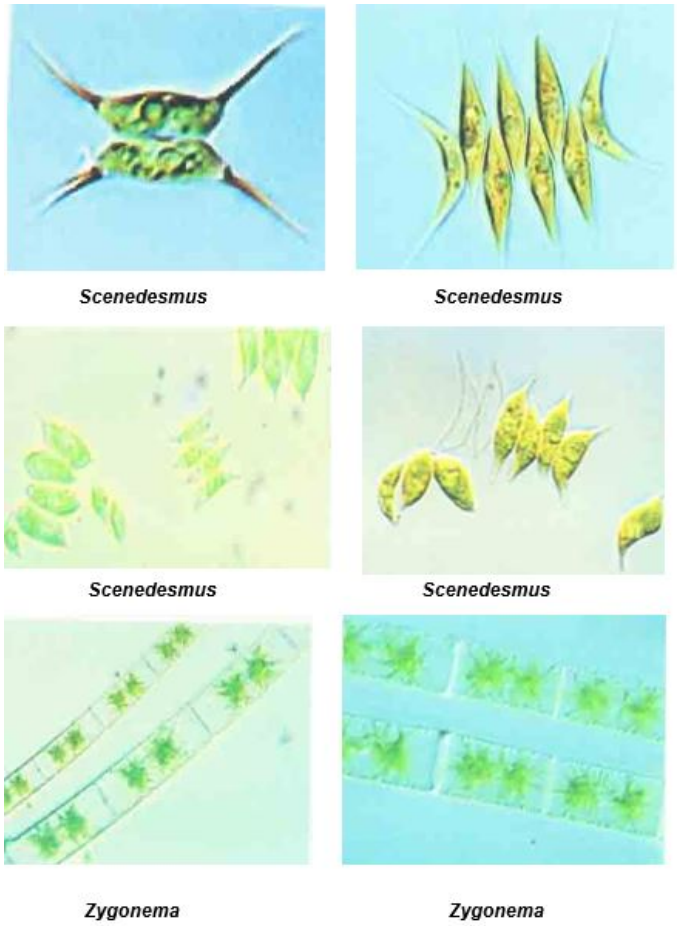

Figure 5. Showing Plate II structure.

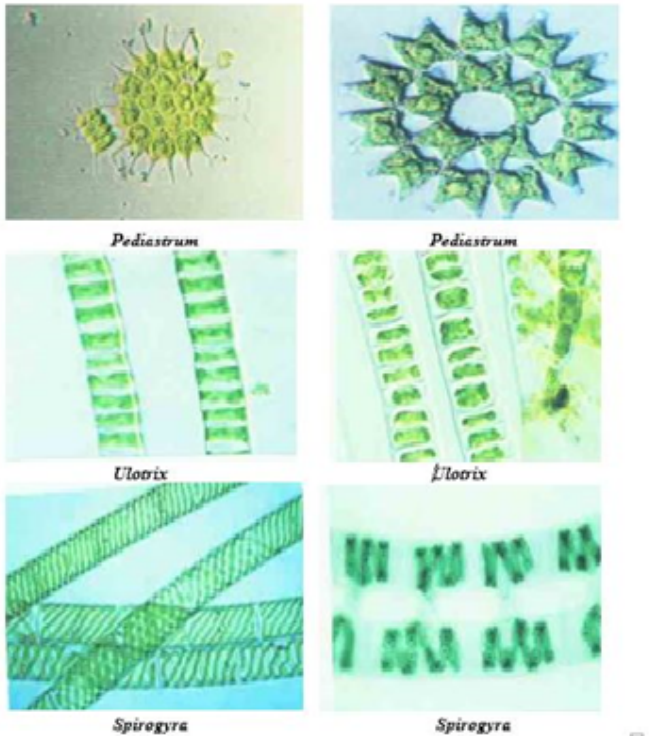

Figure 6. Showing Plate III structure.

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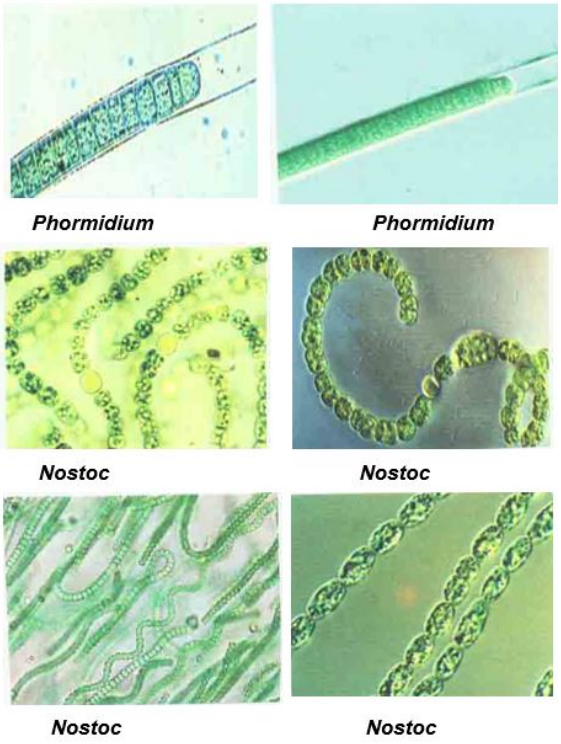

Figure 7. Showing Plate IV structure.

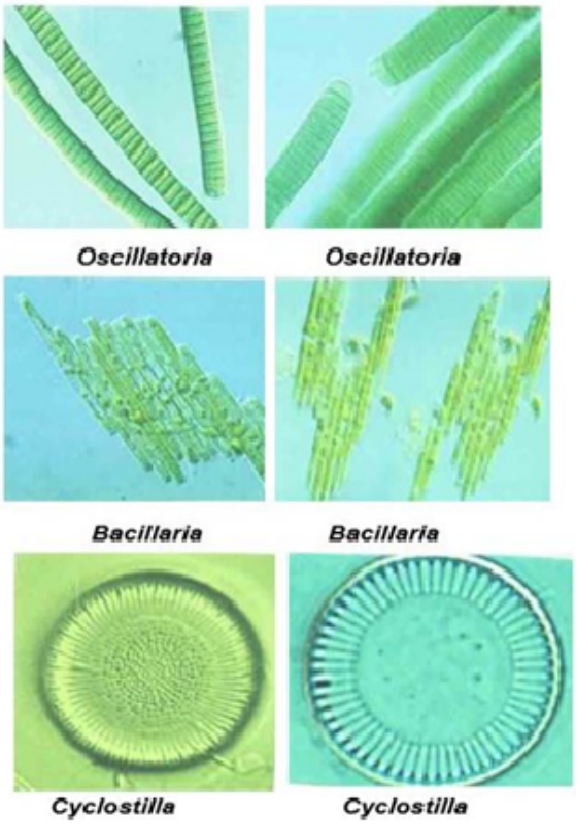

Figure 8. Showing Plate V structure.

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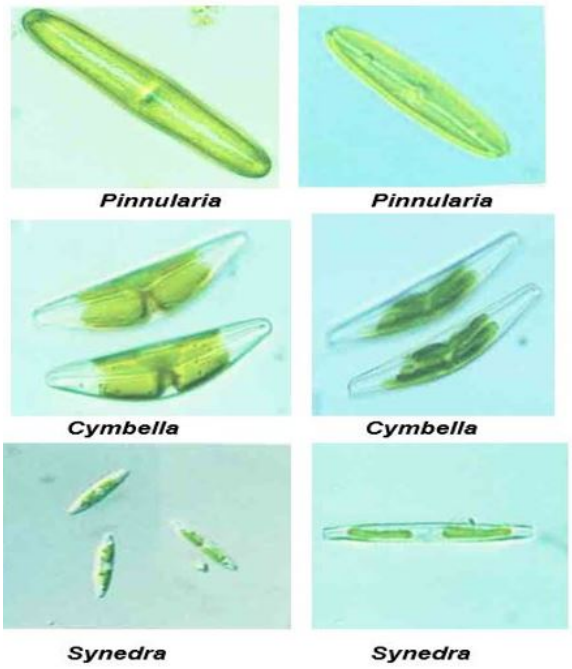

Figure 9. Showing Plate VI structure.

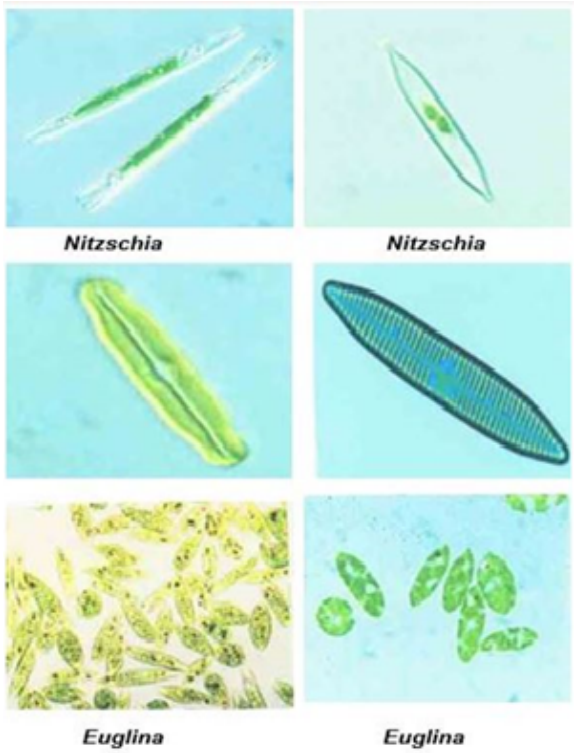

Figure 10. Showing Plate VII structure.

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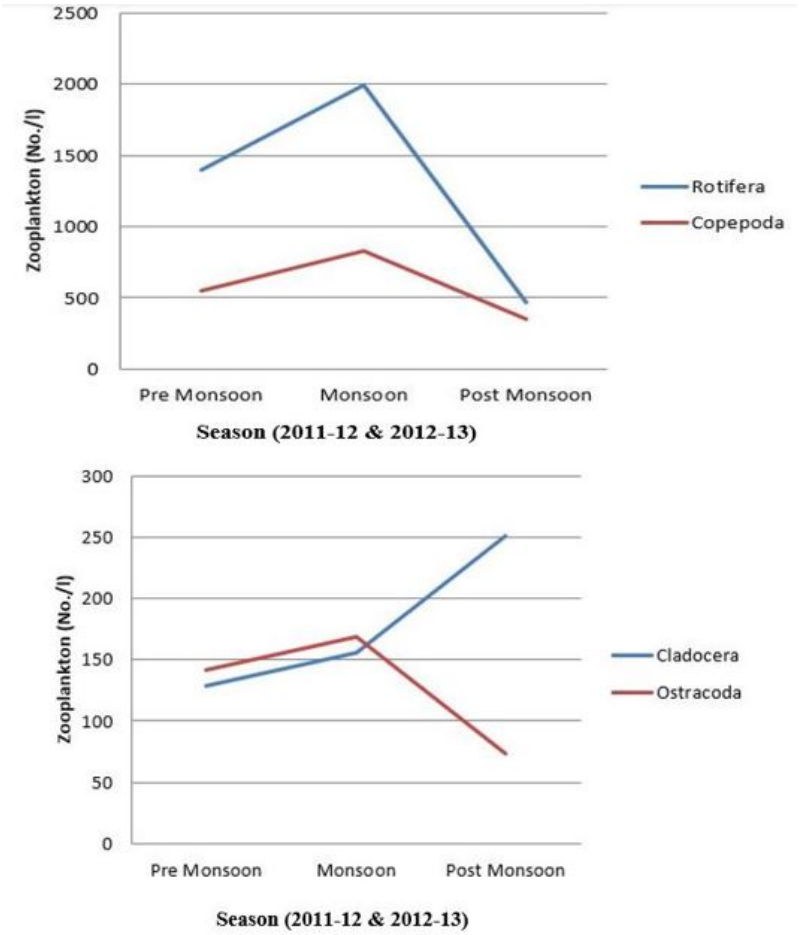

Figure 11. Seasonal fluctuations of Zooplankton in the Motia Lake.

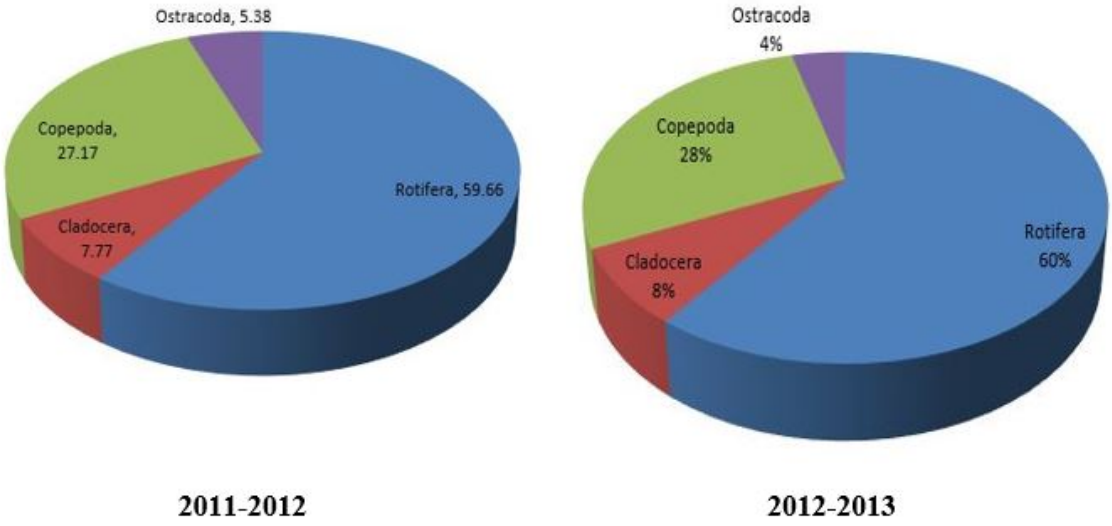

Figure 12. Fluctuations of Zooplankton in Motia Lake.

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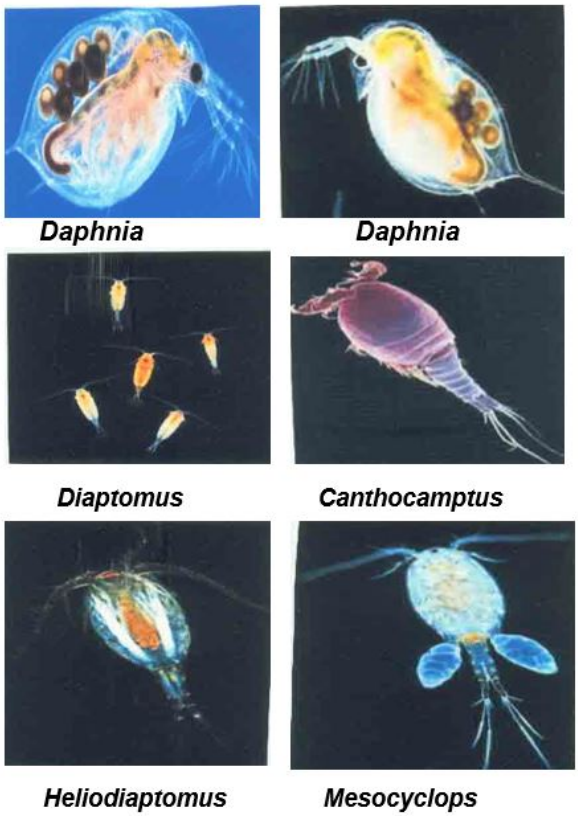

Figure 13. Showing Plate VIII structure.

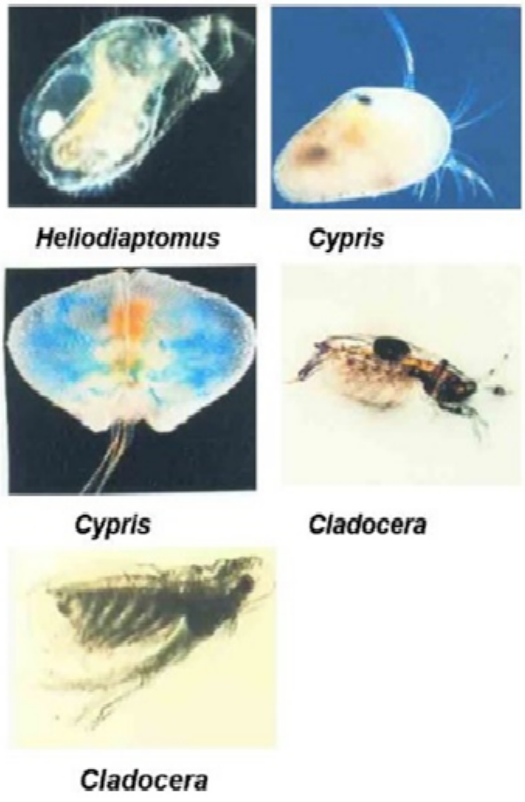

Figure 14. Showing Plate IX structure.

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Table 3. The Phytoplanktons and their percentages in Motia Lake during 2011-2012 and 2012-2013.

2011- 2012			
S.No.	Phytoplankton	Total No.	Percentage (%)
1.	*Cyanophyceae*	35019	69.67
2.	*Chlorophyceae*	4124	8.20
3.	*Bacillariophyceae*	32012	6.36
4.	*Euglenophyceae*	7918	15.75
	Total	50262	
1.	*Cyanophyceae*	42713	50.27
2.	*Chlorophyceae*	4125	4.83
3.	*Bacillariophyceae*	3021	3.55
4.	*Euglenophyceae*	7913	7.31
	Total	84963	
2011-2012 to 2012-2013			
1.	*Cyanophyceae*	77732	77.28
2.	*Chlorophyceae*	8249	-2.27
3.	*Bacillariophyceae*	66229	-17.29
4.	*Euglenophyceae*	15832	-4.24
	Total	108.35	

Plankton diversity: zooplankton

Zooplantons were represented by *Rotifera, Cladocera, Copepoda* and *Ostracoda* (**Table 5, Figure 14**). Among zooplankton, *Rotifera* was dominated followed by *Copepoda, Cladocera* and *Ostracoda*. Rotifera accounted for about 59.66% and 60.51% during 2011-2012 and 2012-2013 respectively (**Figures 4 and 5**). In Rotifera seven genera were found in the reservoir. *Keratella, Brachionus, Hexarthra, Epiphanus, Filina, Ceprolodella* and *Ceacane* were present during the two years. The maxima of *Rotifera* genera was observed in monsoon period (1993 organisms/lit and 2013 organisms/lit) during 2011-2012 and 2012-2013 respectively.

Copepoda was the second dominant group among the zooplankton in the reservoir. Five *Copepoda* genera were found in Motia Lake. The *Copepodas* accounted for about 27.17% and 29.08% during both the years (**Figure 7**). The *Copepoda* group was represented by *Cyclops, Mesocyclops, Canthocamptus, Diaptomus, Heliodiaptomus*. Maximum copepods were found during monsoon period (832 organisms/litre and 890 organisms/litre) during 2011-2012 and 2012-2013, respectively (**Table 5; Figure 11**).

Cladocera contributed 7.77% and 7.87% in total zooplankton in Motia Lake during the study period (**Figures 4 and 5**). Eleven genera were found *Daphnia, Moina, Sinocephalus, Scapholebris, Leydiga, Cereodaphnia, Aloua, Sida, Loctona, Leptodera, Macrothrix* (**Table 4**). The common genera observed were *Daphnia, Cereodaphnia, Alova* and *Lactora*. Maximum *Cladocerans* were found during post monsoon period (251 and 235 organisms/lit) during 2011-2012 and 2012-2013, respectively (**Table 5**). Highest number of *Copepoda* were observed in the Post Monsoon (350 organisms/lit) during 2011-2012 and 360 organisms/lit) in Post Monsoon during 2012-2013.

Among *Crustacea, Ostracoda* was the least group available in the present reservoir *Ostracodes* constitute only 5.38% and 2.52% among the total zooplanknic community during 2011-2012 and 2012-2013, respectively (**Figures 4 and 5**). Only *Cypirus* was found in the reservoir. Monsoon was observed as the peak period for this genus while lean period was the post-monsoon.

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Rotifer formed an important component in the net plankton of the reservoirs. The shallow basin of these reservoirs with rich littoral macrophyte growth provided many ecological niches for these organisms. According to Pennak the extensive growth of Potatnogeton was said to inhibit the development of *Rotifers*.

Brachinoids formed the dominant group among *Rotifers* in the reservoir Filina *Rotifers* occurred as planktonic forms more or less throughout the period of investigation. These were known to be monofilter feeders, ex Filina. (Ruttener and Radwan stated that abiotic factors have a weak influence on the abundance and fertility of pelagic rotifers.

In the present work, the *Rotifers* occurred more during monsoon months in the reservoir. This indicated that the greater occurrence of loricate forms was related to the monsoon period with moderate temperature. The similar reports were given by Kumar et al. [13].

Cladocerons are widely distributed and have been considered as one of the most important components of the fish food, they may accumulate in the reservoirs in numbers large enough to create a problem for water work engineers, however, were considered beneficial for the removal of harmful bacteria from water [14]. Highest diversity as well as maximum number of new records of *Cladoceran* species observed in Santrogachi beel was presumably due to important bio-ecolgical relationship between macrophytes and zooplankton along with possible dispersal of zooplankton by avian agents.

In the alkaline pH found in the reservoir physico-chemical factors other than temperature did not apparently influence the periodicity and density of Cladocera. The similar observation was made by Rao [2] in Manjira reservoir Devi and Piska [1,10] in Ibrahimbagh and Shathamrai reservoirs.

It is generally recognized that Crustacean community structure depends upon the temperature and food conditions, predation by animals and competitive interaction among crustacean species. It has also been observed that decreasing importance of Copepods and increasing *Cladocerans* and *Cyclopoid* importance are associated with increasing productivity [14-20].

Free living Copepods are an essential link in the food chain occupying the intermediate trophic level between bacteria and algae on the hand and small and large plankton predators on the other. Though they are not as important as *Cladocerans* in the diet of fish, they are well known as important intermediate hosts for helminth parasites.

The seasonal fluctuations of zoopfankton did not always follow the fluctuations of physico-chemical parameters. The observed genera appeared only seasonally as festival vernal or hibernal and a few were of course perennial. Devi and Piska [1,10] reported that zooplankton was not always follows the fluctuations of physico-chemical parameters.

Devaraj et al. [14] reported that the plankton enrichment in Hemavathy reservoir depends on the nutrients brought in by the rain washings during monsoon from the catchment area. Total phytoplankton contributed to 48.85% as against 51.15% by zooplankton. Among the phytoplankton, Chlorophyceae dominated followed by *Myxophyceae* and *Bacillariophyceae*. Among the zooplankton, *Cladocera* dominated followed by *Copepoda*, *Rotifera*, *Ostracoda*. Devaraj et al. [14] reported that the abundance of plankton and bottom fauna on which aquatic population depends directly or indirectly is largely influenced by the interaction of a number of physico-chemical factors. They also pointed out that any single factor which is solely responsible for the influence of the abundance of plankton, but a combination of factors has certainly registered their influence.

Perumal and Santhanam [16] reported 37 species of zooplantons in Vedanthangal lake, Tamilnadu. *Rotifers* were dominated group in the lake. The order of abundance was *Rotifera<Copepoda<Cladocera<Dinoflagellata<Oligohymenophora* in the lake. Anjinappa and Kumar (2003) observed the *Rotifera* (48.46%), *Cladocera* (27.27%), *Copepola* (13.44%) and *Ostracoda* (10.83%) composition of zooplankton in Bonal reservoir, Karnataka. The domination of Rotifera species was clearly noticed.

Srinivas [17] reported that Hussainsagar lake has been subjected varying degrees of pollution and consequent eutrophication. The current patterns of plankton biodiversity in the lake revealed a marked decline in the species diversity and only pollution resistant species dominated replacing the freshwater indicating forms of earlier studies.

Zooplankton in general are very sensitive to changes in environment and constitute in aquatic food webs. Therefore, any adverse effect on zooplankton will reflect on productivity of system and most suitable indicator groups for assessment of any kind of aquatic pollution [18-30].

The observations made on the density of plankton in the reservoirs indicated that it can support Indian major carps and other fishes. Major carps showed preference for phytoplankton and zooplankton as major items of food. In addition, exotic common carp can also stock, as its natural food items are also available in sufficient quantities.

The quantity of plankton fluctuated between 0.5 to 0.75 ml/50 lit in the present reservoir during the study period. The ratio between phytoplankton and zooplankton was 8.58:1.0 **(Tables 6 and 7)**. The domination of phytoplankton was clearly noticed.

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Srivastava [19] reported that the ratio between zoo and phytoplankton was estimated to be 1:6.5 in Govindsagar reservoir. He found that the zooplankton was dominated only in September and October. Devi [1] reported the 1:2.08 and 1:2.39 ratio of zooplankton and phytoplankton in Ibrahimbagh and Shathamraj reservoirs, respectively.

Sakhare and Joshi [20] reported that phytoplankton of Yeldari reservoir constituted 84.03% of the total plankton, while zooplankton recorded only 15.97%, i.e., the ratio was 5.26:1 (p:z). Shrivastava [21] reported the dominance of zooplankton (79.9-87.8%) over phytoplankton (12.2-20.1%) in Ravishankar sagar, Chhattisgarh.

Table 4. The Zooplankton of Motia Lake during 2011-2012 and 2012-2013.

Order	Zooplankton
Rotifera *(7 species)*	*Brachionus* *Ceacane* *Cephalodella* *Filina* *Epiphanus* *Hexarthra* *Keratella*
Crustaceae *Cladocera* *(11 species)*	*Alona* *Cereodaphnia* *Daphnia* *Lactona* *Leptodera* *Leydiga* *Macrothrix* *Monia* *Scapholebris* *Sida* *Sinocephalus*
Copepoda *(5 species)*	*Canthocamptus* *Cyclops* *Diaptomus* *Heliodiaptomus* *Mesocyclops*
Ostracoda (1 species)	*Cypris*

Table 5. The seasonal fluctuations of Zooplankton in Motia Lake during 2011-2012 to 2012-2013.

During 2011 - 2012					
S. No.	Species organisms/litre	Pre-Monsoon	Monsoon	Post Monsoon	Average
1.	*Rotifera*	1398	1993	472	3063
2.	*Cladocera*	129	156	251	536
3.	*Copepoda*	549	832	350	1731
4.	*Ostracoda*	142	169	73	384
	Total				6514
2012-2013					

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1.	*Rotifera*	1430	2013	517	3960
2.	*Cladocera*	139	169	235	543
3.	*Copepoda*	567	890	362	1819
4.	*Ostracoda*	172	201	78	451
	Total				6773

Table 6. The Zooplankton and their percentages in Motia Lake during 2011-2012 and 2012-2013.

2011- 2012			
S.No.	Zooplancton	Total No.	Percentage (%)
1.	*Rotifera*	3778	59.66
2.	*Cladocera*	492	7.77
3.	*Copepoda*	1721	27.17
4.	*Ostracoda*	341	5.38
	Total	6332	
2011-2012			
1.	*Rotifera*	3829	60.51
2.	*Cladocera*	498	7.87
3.	*Copepoda*	1840	29.08
4.	*Ostracoda*	160	2.52
	Total	6327	
2011-12 and 2012-13			
1.	*Rotifera*	7607	60.09
2.	*Cladocera*	990	7.82
3.	*Copepoda*	3561	28.13
4.	*Ostracoda*	501	3.95
	Total	12659	

Aquatic weed in Motia Lake are like *Eichhornia, Hydrilla, Marsilia, Meriophyllum, Chara, Ceratophyllum, Potamogeton, Najas, Typha* and *Vallisneria* Nagar Nigam department is removing aquatic weeds regularly. This is mainly due to avoid the obstruction for boating operations in the reservoir. The weeds in the shallow areas of reservoir and were cleared during summer. The aquatic weeds were also eradicated by introducing grass carps. Aquatic macrophytes do not figure prominently in the community structure and trophic events of the reservoirs in India, barring some exceptional circumstances such as low water renewal, ageing of reservoir and pollution stress [22-45].

Ichthyofaunal diversity

Twenty genera of fishes were found in the reservoir **(Table 7)**. Majority of genera belong to order *cypriniformes*. Five species of major carps (*Cypriniformes*), three species of carp minnows. (*Cypriniformes*), two species of murrels (*Channiformes*), four species of cat fishes (*Siluriformis*), two species of ornamental fishes and one species of *Mastacembeliformes* were found in Motia lake.

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Based on their food and feeding habits, the fishes of Motia lake can be categorised into herbivores, carnivores, omnivores and planktonvores.

The abundance of ichthyofauna in the reservoir is depicted as shown in **Table 8**. The most abundant fishes were only the major carps like catla, rohu, mrigal, common carp and grass carp throughout the study period. Silver fish (bacaila), spotted and striated murrels, singhi were abundantly found during 2011-12, 2012-2013 and became less abundant or rare in remaining years. Silver fish is less abundantly found during 2011-2013 and became rare or absent in remaining years.

Devi [1] studied the ichthyofouna of Ibrahimbagh and Shathamarj reservoirs of Hyderabad and twenty-one genera of fishes were found in two reservoirs. Order *Cypriniformes* were dominated and followed by order *Siluriformes, Channiformes* and *Percifomes*.

Jain [23] reported 53 species of fish fauna and were grouped into seven categories in Rajasthan state. Sukumaran and Rahman [24] stated that majority of the reservoirs of Karnataka state has a large population of predatory fishes. 27 species of fishes belonging to six families have been encountered in Pong reservoir. Sakhare and Joshi [25] reported the ichthyofauna of Bori reservoir of Maharashtra. Total 20 species of fishes belonging to 14 genera falling under 4 orders (*Cyprinoformes, Perciformes, Siluriformes and Osteoglossiformes*). They also reported 34 species of fishes in reservoirs of Pharbhani district of Maharashtra. Suresh reported 54 fish species in Loktak lake, Manipur and 15 species are commercially important. Mahapatra [26] recorded abundance of cat fishes in Hirakud reservoir. About 43 species present, in which 18 of economically important.

Kumar [27] reported 51 ichthyofauna of 4 families in Govindsagar reservoir, Himachal Pradesh, out of which 12 fishes were commercially important. Sugunan [28] reported that on an average, large reservoirs (>5000/ha) in India harbor about 60 species of fishes. Jha reported that 49 ichthyofauna found Mahananda reservoir (280/ha).

Rao [29] reported that the Indian reservoirs harbour a rich variety of fish species. This is basically a consequence of the rich fauna diversity of the parent river system. Large reservoirs on an average will harbour about 60 fish species (range 40-90 species) with at least 40 fish species contribute to the commercial fishery. The fast growing gangetic carps (Indian major carps) occupy an important place both as natural and stocked species. Sultan and Chauhan reported 39 ichthyofouna in Pohnuj reservoir (U.P.) [46-55].

Srinivas [30] reported 32 species in Edulabad reservoir, Ranga Reddy District, out of which 13 species of *Cypriniformes*, 9 species of *Siluriformes*, 4 species each of *Channiformes* declined from 32 (2000-01) to 13 (2001-02) and further to 8 (2002-03) and only rohu, catla, grass carp and tilapia found most abundantly in the reservoir.

Table 7. Ichthyofunal diversity in Motia Lake.

Order	Group	Fish
Cypriniformes	Major carps (5)	*Labeo rohita* (Rohu) *Catla catla* (Catla) *Cirrhina mrigala* (Mrigal) *Cyprinus carpio* (Common carp) *Ctenopharyngodon idella* (Grass crap)
Cypriniformes	Minor carps (1)	*Labeo calbasu (Kalbasu)*
Cypriniformes *Channiformes*	Carp min snows (3) Murrels (2)	*Salmostoma bacaila* *S. clupevides (Silver fish)* *Amblyphamgodon (Mola)* *Channa striatus* *(Stripped murrel)* *C. marulius (gaint murrel)*
Siluriformes	Cat fishes (4)	*Clarius batrachus (Maruf)* *Heteropneustes fossilis (singhi)* *M. Vittatus (Chinna Jella)* *Rita rita (Rita)*

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Mastacembeliformes	Snake fish (1)	*Mastacembelus armatus*
	Ornamental fishes (2)	*Poecilia velifera (Black molly)* *Gambusia affinis* *(Mosquito fish)* *Helostoma temmincki* *(Kissing gourami)* *Xiphophorusmaculates (Platies)*

Table 8. Ichthyofunal abundance in Motia Lake.

Fish	Abundance
Labeo rohita (Rohu)	+ + +
Catla catla (Catla)	+ + +
Cirrhina mrigala (Mrigal)	+ + +
Cyprinus carpio (Common carp)	+ + +
Ctenopharyngodon idella (Grass crap)	+ + +
Labeo calbasu (Kalbasu)	+ +
Salmostoma bacaila	+ +
S. clupevides (Silver fish)	+
Amblyphamgodon (mola)	+ +
Channa striatus (Stripped murrel)	+ + +
C. marulius (gaint murrel)	+
Clarius batrachus (Marruf)	+ +
Heterupneustes fossilis (singhi)	+ +
M. vittatus (Chinna Jella)	+
Rita rita (Rita)	+
Mastacembelus armatus	+
Poecilia velifera (Black molly)	+
Gambusia affinis (Mosquito fish)	+
+++ Most Abundance ++ Abundence + Less Abundence.	

Krishna and Piska [31] reported 31 ichthyofauna in secret lake, Durgamcheru, Ranga Reddy District, belongs to *Cypriniformes* (14 species), *Siluriformes* (7 species), C*hanniformes* (3 species), *Perciformes* (4 species) and a species each of C*lupeiformes, Mastacembeliformes* and *Cyprinodontiformes* and classified them into major carps (6), minor carps (3), cat fishes (7), murrels (3), trash fishes (6) and other fishes (6). They also reported that only 5 species most abundantly found during 2003 and 2004.

The major carps were most abundantly found in the reservoir due to the stocking of their seed every year. The most abundance of major carps in the reservoirs were also reported by many authors like Kumar et al. [1,23,27,31] opined that the stocking of their seed was main reason for their most abundance in the reservoir [56-90]. But Srinivas [30] reported that the decline of major carps, especially bottom dwelling carps like mrigal and common carp in a reservoir, Edualabad and stated that the decline was related to environmental pollution due to the entry of polluted river Musi water into the reservoir [91-139].

Rao [32] reported twenty-four species of fishes were found in the reservoir. Majority of genera belong to order *cypriniformes*. Five species of major carps (*Cypriniformes*), three species of carp minnows. (*Cypriniformes*), three species of murrels (*Channiformes*), six species of cat fishes (*Siluriformes*) and seven species of other fishes (*Clupeiformes, Mastacembeliformes, Perciformes, Cyprinodontiformes*) were identified in the reservoir [140-166].

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REFERENCES

1. Piska RS, et al. The present status of fisheries of Ibrahimbagh, a minor reservation of Hyderabad. Fishing Chimes 2000;20:41-43.
2. Rao IS. Ecology of the Manjira Reservoir. PhD Thesis, Osmania University, Hyderabad; 1982.
3. Dhanapathi MVSSS. Taxonomic notes on the Rotifiers from India of IAAB, Publication, Hyderabad; 2000.
4. Vyas BN and Kumar HD. Studies on the phytoplankton and other algae of Indrasagar tank, Udaipur, India. Hydrobiologia 1968;31:421-435.
5. RAO DS. Poor growth performance of Rohu and Mrigal in Turbid tanks of Karnataka analysis. Fishing Chimes 2000;20:42-44.
6. Rao KS and Chowbey U. Studies on phytoplankton dynamics and productivity fluctuations in Gandhinagar Reservoir Proc Nat workshop. Reservorr Fish 1990; pp: 106-110.
7. Sharma N and Sahai YN. Some observations on the plankton population of Jari reservoir near Allahabad (UP) and their significance to fisheries, Proc Nat Workshop. Reservoir Fish 1990; pp: 131-138.
8. Unni KS, et al. Limnology and eutrophication of Tawa Reservoir, MP State, Central India. J Inland Fish Soc 1998;30:13-23.
9. Kohli MPS. Manpower requirements in Indian Fisheries Sector. Fishing Chimes 1998;18:42-46.
10. Piska RS. Concepts of Aquaculture, Lahari Publications, Hyderabad; 2000.
11. Piska RS. Fisheries of minor reservoir, Shathamraj, Hyderabad. Ind J Fish 1990;48:119-122.
12. Srivastava A. Inland Fish Marketing in India Indian Institute of Management, Ahmedabad, India; 1985.
13. Kumar JK, et al. Observations on diurnal variations in hyderobiological conditions of two fish ponds, Hyderabad, India. Comp Physiol Ecol 1978;3:11114.
14. Jones WH. Cladocera of Oklahoma. Trans Amer Micros Soc 1958;77:243-257.
15. Devaraj KV, et al. Hydrobiology of the Hemavathy reservoir. Proc First Ind Fish Forum 1988; pp: 323-328.
16. Perumal P and Santhanam P. Zooplanktor production in the lake of Vedanthangal Bird Sanctnam, Kancheepuram District, Tamilnadu. AE-12, The sixth Indian Fisheries Form, 2002; p: 93.
17. Srinivas SV, et al. Recent trends of plankton diversity in Hussainsagar lake, Hyderabad, India, Abstract No.016, 67, Nat Conf Recent Trends in Aquat Biol, 2003.
18. Chandrasekhar SVA. Trophic status of Saroornagar lake, Hyderabad, Andhra Pradesh, Nat Conf Urban lakes 2003; pp: 90-91.
19. Srivastava A. Inland Fish Marketing in India Indian Institute of Management, Ahmedabad; 1985.
20. Sakhare VB and Joshi PK. Plankton diversity in Yeldari reservoir, Maharastra. Fish Chjm 2006;25:23-25.
21. Shrivastava NP. Plankton status of Ravi Shankar Sagar reservoir. J Inland Fish Soc India 2005;37:43-47.
22. Sugunan VV. Salient features of reservoir limnology and their significance to fisheries development. In: Jhingran AG and Sugunan VV (eds.) Conservation and Management of Inland capture fisheries reservoirs of India, Inland Fisheries Society of India, Barrackpore, India, 1989; p: 275.
23. Jain AK. Fisheries resource Management in Rajasthan: An overview of present status and future scope. Fishing Chimes 1998;17:9-15.
24. Sukumaran PK and Rahman MF. Prospects of reservoir fisheries development in Karnataka. Fishing Chimes 1998;18:1920.
25. Sakhare VB and Joshi PK. Water Quality of Migni (Pangaon) Reservoir and its significance to fisheries ABN – 008. Nat Conf Recent Trends Aquat Biol; 2003.
26. Mahapatra OK. Present status of Fisheries of Hirakud reservoirs, Orissa. Fishing Chimes 2003;22:76-79.
27. Kumar K. Management and development of Gobindsagar reservoir. A case study. Proc Nat Workshop Reservoir Fish 1990; pp: 13-20.

e-ISSN: 2321-6190
p-ISSN: 2347-2294

28. Sugunan VV. Fishery resources of the North - Eastern region and scope for their development. Fishing Chimes 1998;18:64-68.
29. Rao DSR. Strategies for enhancement of fish production from Indian reservoirs. Fishing Chimes 2005;25:86-90.
30. Srinivas CH. Impact of river Musi pollution on the fisheries of Edulabad reservoir, Ranga Reddy District, Andhra Pradesh, India. PhD Thesis, Osmania University, Hyderabad, India.
31. Murali KS and Piska RS Ichthyofaunal diversity and their abundance in Durgamchaeru Reservoir. J Aqua Biol 2006;22:1979-83.
32. Rao MSS. Impact of Stocking sizes of Major Carps on its production in a minor reservoir, Thesis submitted to Osmania University, Hyderabad, India; 2006.
33. Agarwal SC. Fishery Management Ashish Publishing House, New Delhi, India; 1990.
34. Aher SK, et al. A study on physico-chemical paramenters of kagdipura swamp in relation to risciculture, near Aurangabad, Maharastra. J Aqua Biol 2007;22:93-96.
35. Ahmad SH and Singh AK. Present status, potentialities and strategies for development of reservoir fisheries in Bihar. Fishing Chimes 1992; pp: 49-53.
36. Ahmed JW and Sugunan VV. Status and scope of Resenors Fisheries of the North-Easter India. Fishing Chimes 1992;18:09-12.
37. Anjinappa H and Kumar KV. Diversity of zooplankton groups in Bonal Reservoir, Sherpur, Gulbaya District. Nat Conf on Recent Trends in Aquat Biol ABN 2003; pp: 077-078.
38. ANON. Fresh water fisheries and aquaculture in china, FAO Fisheries Technical Paper, No Fir/T 1977;168:20-23.
39. ANON. Inland fish marketing in India. Publ 1983;4:1-73.
40. APHA. Standard methods for the examination of water, waste and sewage. 14th edn. New York, USA; 1995.
41. Gadapanda HS. Orissa News Letter. Fishing Chimes 2003;22:5960.
42. Bandyopadhyay MK, et al. Possibility of raising Indian major carp seed in cases for stocking larger water Bodies. CA - 1, Nat Sem Fish and Shellfish Culture; 2003.
43. Banerjee A and Chattopadyay GN. Soil quality-based approach for increasing productivity of fish ponds - a case study. Nat Symp Fisheries Enhanc Inland Waters; 2002.
44. Bhartiya MT. Management of Reservoir Fisheries through Fishermen co-operatives in Maharashtra, Constraints and Measures Proc. Nat Workshop Reservoir Fish 1990; pp: 65-70.
45. Bhuksawan T. Principles of reservoir fishery management; 1977.
46. Blum JL. An ecological study of the algae of the saline river, Michigan, Hydrologia, 1957;9:361-408.
47. Bowen HJM. Trace elements. Biochemistry Acad, Press Lond; 1960.
48. Boyd GE. Summer algal communities and primary productivity in fish ponds. Hydrobiol 1973;41:357-390.
49. Burli AS and SontakkI BS. A comparative study and Fisheries Management in Malaprabha and Ghataprabha Reservations of Karnataka, AR-16. The Sixth Indian Fisheries Forum; 2001.
50. Das SK, et al. Diet variation of pH in fish ponds of Nagaon District, Assam. J Inland Fish Soc India 2001;33:45-48.
51. Das AK. Role of physical and chemical features of Soil in reservoir productivity. Fishing Chimes 2000;20:30-32.
52. Das AK. Limno-chemistry of some Andhra Pradesh Reservoirs. J Inland Fish Soc India 2001;32:37-44.
53. Das AK and Srivastava NP Proc. Workshop on Lake Management in India 2001; p: 31.
54. Das RK, et al. Managing reservoir fisheries, certain case studies Proc. Fresh Water Fish Rural Devel Sec 1984; pp: 57-63.
55. Das AK. Evaluation of production potential in a peninsular reservoir (Yerrakalva). J Inland Fish Soc India 2002; p: 34.
56. Das AK, et al. Strategies for Management of Karnataka reservoirs. Fishing Chimes 2002;22:17-21.
57. Das SR and Nandi NC. Oxbow lake environment and management of Ichhamati river basin, West Bengal. Workshop on lake management in India, 2001; p: 27.

e-ISSN: 2321-6190
p-ISSN: 2347-2294

58. Dehadrai. Reservoir fisheries in India. Proc Nat Sem Reverine and Reservoir Fishers 2001; pp: 97-104.

59. Desai DK. Development of riverine fisheries, strategy for development of Inland fishery resources in India (New Delhi Concept Publishing Campus). 1984; pp: 291-300.

60. Desai VRNP, et al. Constraints in reservoir fishery development of care study of Ravishankar Sagar reservoir fishing chemes, 2007;27:19-22.

61. Devadasan K. Recently Commensally viable and fishing based Technologies. Fishing Chimes 2001;21:53-58.

62. Devaraj M et al. Assessment of optimum fish yields from reservoirs in Tamilnadu. Proc Nat Workshop Reservoir Fish 1990; pp: 118-130.

63. MJ. Ecological studies of the limno plankton of three fresh water bodies of Hyderabad. PhD Thesis Osmania University, 1985.

64. Dubey GP. Reservoir fisheries a comment Proc Nat Workshop on Dev. Indian Fish-Resources 1983; pp: 265-268.

65. Durve VS and Kakkar V. Catch analysis in 1974 and fishing trends in the Jaisamand lake (Rajasthan). Proc Nat Workshop on Devel Inland Fish Resource 1983; pp: 177-184.

66. Dwivedi RK, et al. Production dynamics and fisheries development in Naktara reservoir, Madhya Pradesh, India. J Inland Fish Sol India 2000;32:81-86.

67. Ganapati SV. Some observations on water of Red Hills lake at Madras (1925-28) India. J Med Res 1929; pp: 1139-1147.

68. Ganapati SV. Organic production in seven types of aquatic ecosystems in India. In: Golley PM and Golley FB (eds). Tropical ecology with emphasis on organic production Univ of Georgia, Athens 1972; pp: 312-350.

69. Ganon JE and Stemberger RS. Zooplankton (especially Crustacea and rotifers) as indicaters of water quality. Trans Amer Micros Soc 1978;97:16-35.

70. Ninan G. Fishery Management practices of the major reservoirs in Madhya Pradesh. Pro Nat Sem Riverine and Reservoir Fisheries 2001; pp: 363-370.

71. Golterman HL. Methods for chemical analysis of fresh waters IBP Handbook No. 8 Black well. Sci Publ London, 1971; p: 166.

72. Gonzalves EA and Joshi DB. Fresh water algae near Bombay. J Nat Hist Soc 1946;46:154-176.

73. Gowda HSV. Status of Fisheries Development in Karnataka. Fishing Chimes 2002;22:86-94.

74. Gulland JA. Guidelines for fishery management. JJOFC Dev Food and Agriculture Organisation, 1974; p: 74.

75. Hayes FR and Philips E. Limn Oceangr 1958;3:450-475.

76. Hussain M. Ecobiology of Fresh water Protozoa, PhD Thesis, Osmania University, Hyderabad, India; 1977.

77. Hutchinson CE. A treatise in limnology Vol. II introduction to lake biology and the Limno plankton Jhon. Wiley and Sons, NY, USA, 1967; p: 1115.

78. Jhingran AG and Sugunan VV. General guidelines and planning criteria for small reservoir fisheries management. Proc Nat Workshop Reservoir Fish 1990; pp: 1-8.

79. Jones WH. Cladocera of Oklahoma. Trans Amer Micros Soc 1958;77:243-257.

80. Joshi PK and Sakhare VB. Ecology and Icthyofauna of Bori reservoir in Maharashta. Fishing Chimes 2002;22:40-41.

81. Khalid MA and Siddiqui MS. Reservoir fishery potential of Nasik District in Maharashtra with special reference to Girna Dam reservoir fisheries. Proc Nat Workshop Reservoir Fish 2002; pp: 97-101.

82. Khan AA. An appraisal fishing gear in relation to the fishery and related problems of reservoirs of Gobindsagar (Punjab) and Hirakud (Orissa). Proc Fresh Water Fish Rural Devel Sec I 1984; pp: 5-13.

83. Khan S. Present status of the fisheries of Hirakud reservoir in Orissa and strategy of enhancing yield and betterment of fishermen communities. Proc Nat work Shop Reservoir Fish, 1990; pp: 150-154.

84. Khan MA, et al. Stocking as a management tool in optimizing fish yield from small (Bachhra) in Ganga basin. Proc Nat Workshop Reservoir Fish 1990; pp: 71-76.

e-ISSN: 2321-6190
p-ISSN: 2347-2294

85. Khan TA, et al. Jammu and Kashmir Fisheries: Present status and Future prospects. Fishing Chimes 1999;18:23-26.

86. Kohli MPS. Manpower requirements in Indian Fisheries Sector. Fishing Chimes 1998;18:42-46.

87. Kurup BM and Ranjeet K. Invasion of exotic fish pomlutions in Periyar lake-A hotspot of fish Biodiversity. Fishing Chimes 2002;22:41-44.

88. Louis A, et al. A floristic and ecological study of the plankton of five biotopes in the valley of River Oyte, Belgium, Hyderobiologia, 1964;30:417-493.

89. Mahajan S and Mandloi AK. Physico-chemical characteristics of soil and water in relations to plankton production of fish culture pond. J Inland Fish Soc India 1998;30:92-98.

90. Mahapatra BK, et al. Stocking of Indian major carps in Umiam reservoir of Meghalaya–an approach for culture-based fisheries. Proe Nat Symp Fisheries Enhanc Inland waters 2002; pp: 43-44.

91. Malu AR. Lonar Lake, a case for protection and conservation as Ramsar site Workshop on Lake Management in India, 2001; pp: 15-19.

92. Mathew PM and Mohan MU. Reservoir Fisheries in Kerala status and scope for development Proc Net Workshop Reservoir Fish 1990; pp: 111-117.

93. Mathew NPA and George JP. Reservoir Fisheries: Post-independent Scenario and Strategies for Development. Proc Nat Sem Reverine Reservoir Fisheries 2001; pp: 415-420.

94. Melack JA. Primary productivity and fish yields in tropical lakes. Trans AM Fish Soc 1976;105:575-580.

95. Mod RG and Paniker PKR. Fisheries of Vallabhasagar (Ukai reservoir) in Gujarat Fishing Chimes 1985;4:37-41.

96. Mohan B. Economic status of the fishermen of Malarapuzha reservoir proc Nat Sem Reverine and Reservoir Fisheries 2001; pp: 421-425.

97. Mohanty RK. Activated Microbial suspension and nitrogen control in aquaculture System. Fishing Chimes 2000;20:50-51.

98. Mohanty SK. An approach for the development of reservoir fisheries in Orissa. Proc Fresh Water Fish Rural Devel Sec I 1984; pp: 40-46.

99. Mudgal LK, et al. Limnological study of Yeshwant sagar, reserviour, Indore, Madhaya Pradesh, AE - 5. Sixth Indian Fish Forum, CIFE, Mumbai, 2002; p: 86.

100. Murthy DS. Highlights of fisheries development in Andhra Pradesh. Fishing Chimes 2002;22:64-70.

101. Murthy DS. Fisheries development in Andhra Pradesh. Fishing Chimes 2000;20:90-91.

102. Murugesan VK, et al. The influence of water quality on the productivity of reservoirs in Tamilnadu. Proc Nat Symp Fish Enhanc in Inland Waters 2002; p:37.

103. Murugesan VK, et al. Fish production potential, actual yield and scope for enhancement of four medium reservoirs in Tamilnadu. Proc Nat Symp Fish Enhance in Inland waters 2002; p: 56.

104. Musaddiq M, et al. Microbial riweisity and ecology of Lonar Lake, Maharashtra, India. J Aqual Bio 2001; p: 16.

105. Natarajan AV. Planning strategies for development of reservoir fisheries in India CICFRI, Barrackpore, India; 1974.

106. Nath D. Water and Soil of the Narmada estuary before commissioning of Sardar sarovar Dam. J Inland Fish Soc India 2001;33:37-41.

107. Neeri. Manual on water and waste analysis, Nagpur MS, India; 1986.

108. Piska RS. Fisheries and Aquaculture. Lahari publications, Hyderabad, India; 1999.

109. Piska RS. Concepts of Aquaculture. Lahari Publications, Hyderabad, India; 2000.

110. Piska RS. Impact of stocking Densities of Major can seed on fish production in a minor Reserviour. Fishing Chimes 2000;20:3941.

111. Piska RS. Fisheries of minor reservoir, Shathamraj, Hyderabad, Ind J Fish 2001;48:119-122.

112. Piska RS. Carp seed productions scenions in Andhra Pradesh. Fishing Chimes 2003;23:122 -123.

113. Piska RS and Naik SJK. Marine Fisheries IVC, BIE, Hyderabad, India; 2002.

e-ISSN: 2321-6190
p-ISSN: 2347-2294

114.Piska RS and Rao AM. Phenominat fish production in the Tilapia-dominated tank. Aquacult 2002;3:171-176.

115.Krishna M, et al. Fish production in a Tilapia-dominated perennial tank, Nat Symp. Fisheries Enhanced Inland Waters 2004; p: 34.

116.Piska RS, et al. The present status of fisheries of Ibrahimbagh, a minor reservation of Hyderabad. Fishing Chimes 2000;20:41-43.

117.Prochazkova L, et al. Chemical changes involving nitrogen metabolism in water and particular matter during primary production experiments. Limmnol Occeanogr 1970;15:797-807.

118.Pulle JS and Khan AM. Seasonal variations in primary production in Isapur Dam, Maharashtra. J Aqua Project 2001;16:19-33.

119.Rajashekhar AV, et al. The studies on water quality parameters of a minor reservoir, Nadergul, Rangareddy district, Andhra Pradesh. J Aqua Biol 2007;22:118-122.

120.Rajeeb K and Mohan T. Activated Microbial suspension and Nitrogen control in Aquaculture system. Fishing Chimes 2000;20:50-51.

121.Rao DS. Poor growth performance of Rohu and Mrigal in Turbid tanks of Karnataka analysis Fishing Chimes. 2000;20:42-44.

122.Ramakrishnaiah M, et al. Limnology and Fish Yield enhancement through stocking in Markona halli reservoir. Nat Symp Fish Enhanc Inland Waters, 2002; p: 17.

123.Rao KS and Chowbey U. Studies on phytoplankton dynamics and productivity fluctuations in Gandhinagar Reservoir. Proc Nat Workshop Reservorr Fish 1990; pp: 106-110.

124.Rao MSS. Impact of Stocking sizes of Major Carps on its production in a minor reservoir. Thesis submitted to Osmania University, Hyderabad, India; 2006.

125.Rao NP and Raju PBJ. Limnological investigations and diversity of Plankton in sewage - fed fish culture pond at Nambur near Guntur, Andhra Pradesh, India. J Aquat Biol 2001;116:11-14.

126.Rath RK. Fresh water Aquaculture Scientific Publishers, Jodhpur, India; 1993.

127.Sakhare VB and Joshi PK. Fisheries of some selected reservoirs in Solapur District of Maharashtra. Nat Conf Fish Fish; 2001.

128.Sakhare VB and Josh PK. Reservoir fishery potential of Parbhani District of Maharshtra. Fishing Chimes 2003;23:1316.

129.Sakhare VB and Joshi PK. Plankton diversity in Yeldari reservoir, Maharastra. Fish Chjm 2006;25:23-25.

130.Salve BS and Hiware CJ. Studies on water quality of Wanparakalap reservoir. Nagapur, near Parli Vaijnath, dist, Marathawada region. J Aqua Bio 2007;22:113-117.

131.Sasmal D and Qureshi TA. Inter relationship of the multitudiuous factors influencing the socio-economic status of fisher communities at Hoshangabad. Fishing Chimes 2001;21:106-107.

132.Saxena BS. Potentialities production and problems of Indian reservoir fisheries Proc Nat Workshop Reservoir Fish 1990; pp: 3438.

133.Selvaraj C. and Murugesan VK. Management techniques adopted for achieving a record fish yield from Aliyar reservoir, Tamilnadu. Proc Nat Workshop Reservoir Fish 1990; pp: 86-96.

134.Sharma MS and Durve VS. Tropic status and fishery potential of Rajastan waters. In: Mishra SD, Sen DN and Ahmed I (eds.). Pro Nat Symp Evaluation of Environ 1985; pp: 180186.

135.Sharma N and Sahai YN. Some observations on the plankton population of Jari reservoir near Allahabad (U.P.) and their significance to fisheries. Proc Nat Workshop Reservoir Fish 1990; pp: 131-138.

136.Siddiqui R. A study of the fishermen in Tamilnadu and Orissa. Fishing Chimes 1996;16:35-36.

137.Singh CS, et al. Energy flow with perspective to fish production in Nanaksagar reservoir (U.P.), India. Proc Nat Workshop Reservoir Fish 1990; pp: 155-162.

138.Singh VK and Sharma AP. Economic analysis of carp culture in Tarai region of U.P. state. Fishing Chimes 1998;18:23-26.

e-ISSN: 2321-6190
p-ISSN: 2347-2294

139.Sinha M. Revenue and reservoir fisheries of India Present status and future prospects. Proc Nat sem Revenue and Reservoir Fisheries 2001; pp: 197-203.

140.Sinha M. Reservoir fisheries, its present status and future potentials in North Eastern region. Proc Nat workshop Reservoir Fish 1990; pp: 57-64.

141.Sinha M. Policy options for integrated development of reservoir fisheries from production to Marketing. Fishing Chimes 1998;18:54-59.

142.Sinha M. Inland Agri. Development A necessity for the North-Eastern States, 2003; pp: 86-94.

143.Sinha M. Inland Aquaculture development a necessity for the North-Eastern states. Nat Sem Fish and Shellfish Culture for North-Eastern India, 2003; p: 85.

144.Sreenivasan A. Stagnating reservoir fish production of India. Fishing Chimes 2001;21:39-43.

145.Sreenivasan A. Influence of stocking on fish production in reservoirs in India. FAO Fisheries Report 1984;312:40-52.

146.Sreenivasan A. The role of small reservoir in fish production. Fishing Chimes 1999;18:29- 31.

147.Sreenivasan A. Fish production in some small reservoirs of Tamilnadu. Fishing Chimes 1999;19:32-34.

148.Srivastava A and Tamot P. Liminified status of Kernian Reservoir with special reference to Socio-economic survey of threatened fish Mahseer Ac-9, The Sixth Indian Fisheries forum, CIFE Murnbai, India, 2002; p: 90.

149.Srivastava A. Inland Fish Marketing in India Indian Institute of Management, Ahmedabad, India; 1985.

150.Srivastava NP, et al. Phytoplankton primary productivity and fish production potential of Tawa reservoir. J Inl Fish Soc India 2002;34:2329.

151.Srivastava VK and Reddy MD. Fishery development in India. Concept publishing company, New Delhi, India; 1983.

152.Sugunan VV. Stocking in small Reservoirs for enhancement. Nat symp fish enhance Inland waters 2002; pp: 30-37.

153.Sugunan VV and Maurye P. Global warming and climate change perspective on impact over inland fisheries. Fishing Chimes 2003;23:27-36.

154.Sukumaran PK and Das AK. Distribution of Plankton in some fisheries reservoirs of Karnataka. J Inland Fish Soc India 2001;33:29-36.

155.Swingle HS. Standardization of chemical analysis for water and pond muds. FAO Fish Rep 1967;44:397-421.

156.Unni KS, et al. Limnology and eutrophication of Tawa Reservoir, M.P. State, Central India. J Inland Fish Soc 1998;30:13-23.

157.Velayudhan TD. Issues in fish marketing and scope for interceptor by the local bodies. Fishing Chimes 1999;18:1925.

158.Venkataraman K, et al. Zooplankton diversity in fresh water wetlands of Haora, District, West Bengal. J Aqua Biol 2000;14:19-25.

159.Verma MN. Training farmers to produce their own seed. Fishing Chimes 1983; p: 3.

160.Wani F and Dana SS. Problems and prospectors of fisheries in J and K state CA-26. Nat Sem Fish and Shellfish Cult North-East, India, 2003; p: 67.

161.Wanjari HV and Malu RA. Studies on population structure of zoo - benthos in Ek burji reservoir, Maharashtra. Proc Nat Conf Fish Fisheries 2001; p: 66.

162.Wilcox LV and Hatcher JT. Methods of analysis used in the Rhidoux Laboratory, Riverside, California, US Dept of Agriculture, California, USA; 1950; p: 67.

163.Yadav PK. A comment on reservoir fish system. Proc Nat workshop on devel Inland Fish Resources 1983: pp: 269-275.

164.Yelavarthy E. Hydro-biological studies of Red Hills Reservoir, North Chennai, Tamilnadu. J Aquat Bio 2002;17:13-16.

165.Hannan HH, et al. Nitrogen and Phosphorus in a stretch of Goadelupe River, Texas with five main stream impoundments. Hydrobiologia 1973;43:419441.

e-ISSN: 2321-6190
p-ISSN: 2347-2294

166.Song Z. Manual of small-scale reservoir fishery culture. FAO Pub, Rome; 1980.