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Comparative study on biodiversity of phytoplankton and zooplankton of Navargaon Lake in Maregaon Taluka, district-Yavatmal (Maharashtra) India

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Abstract
Present work was carried out at Nawargaon Lake, Maregaon Taluka, District-Yavatmal, Maharashtra, India on phytoplankton and zooplankton. During study period phytoplankton community was represented by four group's 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 group's viz., *Rotifera, Cladocera, Copepoda* and *Ostracoda*. Among these *Rotifera* exhibited numerical dominance. The aquatic weeds found in the lake included species of *Eichornia, Hydrilla, Marsilia, Meriophyllum, Chara, Ipomea, Najas* and *Vallisneria.*

Keywords: community, monsoon, phytoplankton, zooplankton, dominance

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.
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. 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 water, algae are small and numerous, usually at a level of 102-106 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. In late summer, the number of plankton's 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. The most commonly found zooplanktons are protozoans, crustaceans like *cladocerans*, copepods, ostracods and rotifers.

Materials and Methods
The present study was conducted in a minor reservoir Nawargaon Lake in the (Latitude:20.0763283N and Longitude:78.7675095E), constructed as a part of irrigation project by Government of Maharashtra and situated in the periphery of 6 to 8 km of Maregaon Taluka. The reservoir is located in Nawargaon village with a well-built tank bund. During this period study were conducted on biological organisms such as phytoplankton and zooplankton.

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.

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 SR cells was counted.

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

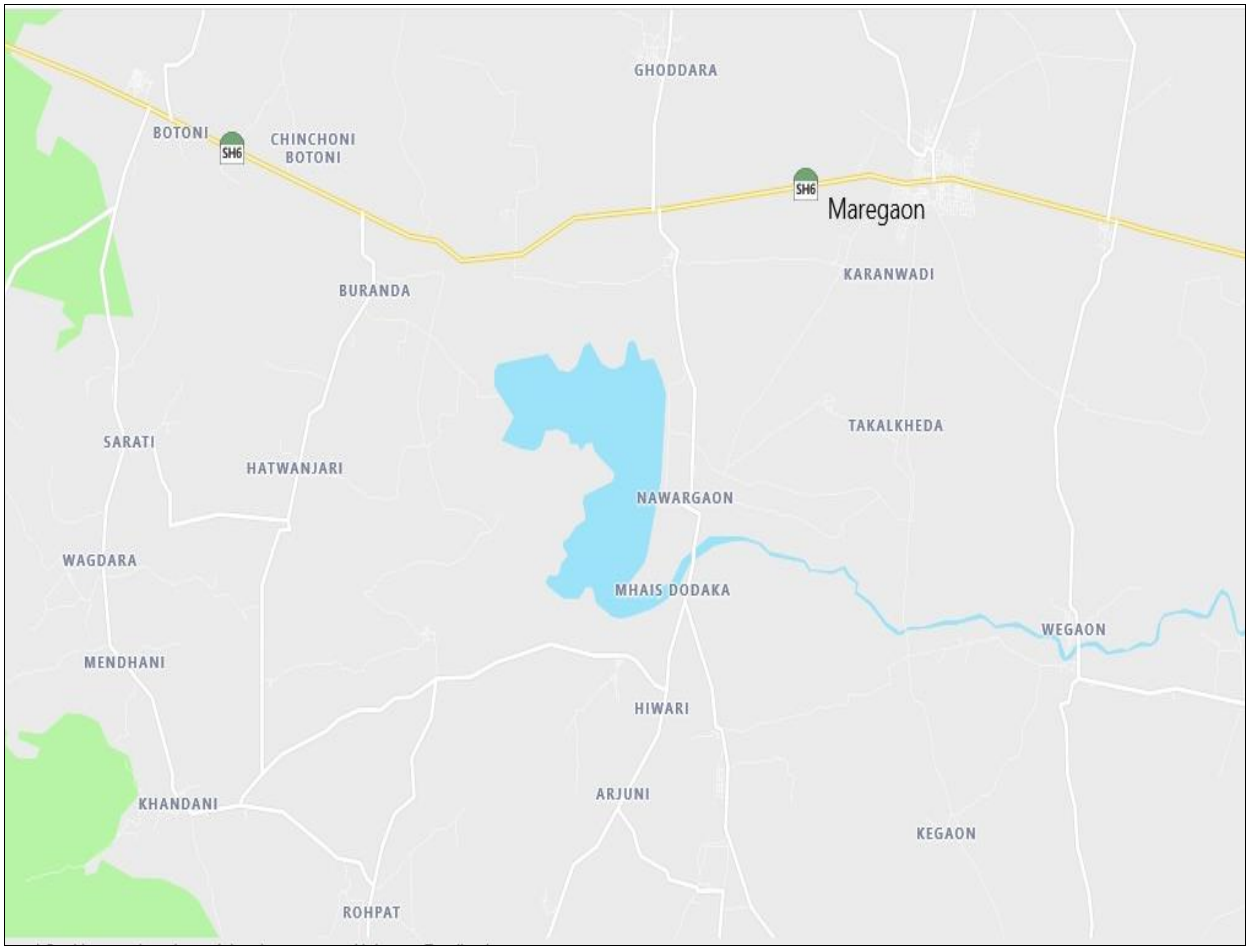

Fig 1: Map of Nawargaon Lake in Maregaon Taluka, District.-Yavatmal. Maharashtra. India.

Results and Discussion

Plankton diversity: phytoplankton

The present observation on phytoplankton of the reservoir indicated that the communities of *Cyanophyceae*, *Chlorophyceae*, *Bacillariophyceae* and *Euglenophyceae* con stitute the phytoplankton bulk in the present reservoir. Among phytoplankton community, the *Cyanophyceae* was found to be rich and dominated in the present reservoir. *Cyanophyceae* was found 69.67 in 2018-2019 and 50.27% in 2019-2020 in Nawargaon Lake (**Tables** 2 and 3; Figure 2).

Five *Cyanophyceae* genera were found in the reservoir (Table 3).

The common *Cyanophyceae* communities observed in the reservoir were, *Anabena*, *Nostoc*, *Oscillatoria*, *Microcystis* and *Merismopodia* respectively.

Table 1: The Phytoplankton of Nawargaon Lake during 2018-2019 to 2019-2020

Order	Phytoplankton
Cyanophyceae (5 Genera)	*Anabena, Nostoc, Oscillatoria, Microcystis* and *Merismopodia*
Chlorophyceae (3 Genera)	*Spirogyra, Ulothrix* and *Volvax*
Bacillariophyceae (3 Genera)	*Bacillaria, Cyclostella, Diatoma and Fragillaria*
Euglenophyceae (2 genera)	*Euglena* and *Paranema*

Table 2: The seasonal fluctuations of Phytoplankton of Nawargaon Lake during 2019-2020.

During 2018 - 2019					
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 2019 - 2020					
1.	*Cyanophyceae*	64429	49810	36310	115870
2.	*Chlorophyceae*	1875	1380	895	4150
3.	*Bacillariophyceae*	13923	7912	6204	28039
4.	*Euglenophyceae*	3254	2790	1680	7724
	Total				155783

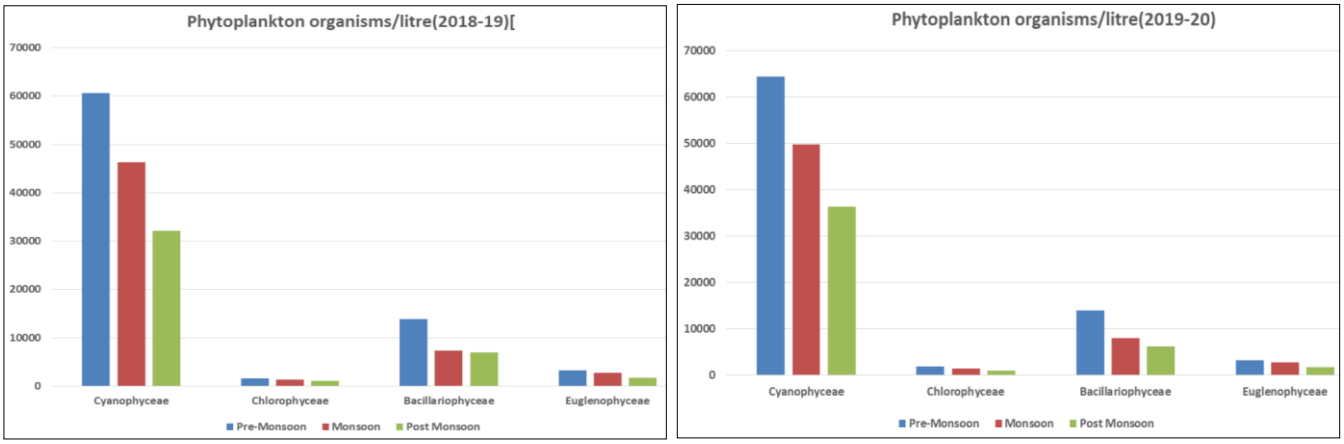

Fig 2: Seasonal fluctuations of phytoplankton in the Nawargaon Lake during 2018 – 2019.

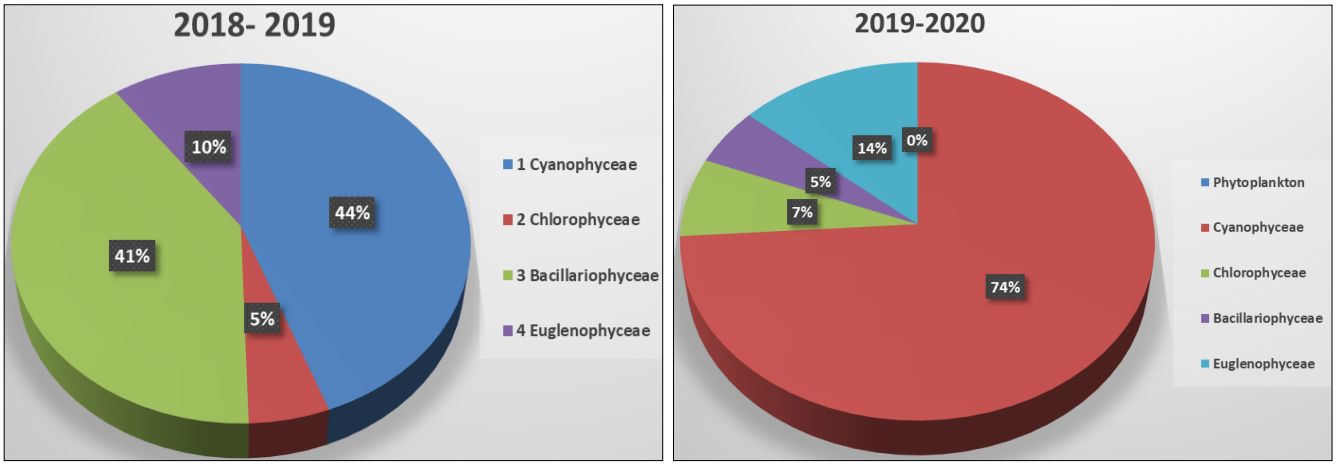

Fig 3: Fluctuations of Phytoplankton in the Nawargaon Lake.

Table 3: The Phytoplanktons and their percentages in Nawargaon Lake during 2018-2019 and 2019-2020.

2018- 2019			
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	
2018-2019 to 2019-2020			
1.	*Cyanophyceae*	77732	77.28
2.	*Chlorophyceae*	8249	-2.27
3.	*Bacillariophyceae*	66229	-17.29
4.	*Euglenophyceae*	15832	-4.24

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 2018-2019 and 2019-2020, 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 four genera in Nawargaon Lake. Among these genera the common plankton blooms recorded during the study period were *Bacillaria*, *Cyclostella*, *Diatoma and Fragillaria* (Table 1).The maximum *Bacillariophyceae* plankton in the reservoir was found in February (13920 organisms/lit) during 2018-2019 and in March (13923 organism/lit) during 2019-20 high *Chlorophyceae* plankton was recorded in premonsoon period (1630 organisms/l and 1875 organisms/l) during 2018-2019 and 2019-2020, respectively. Low values were recorded (1090 and 895 organisms/lit) in post-monsoon period during study period (Table 3).

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. Low dominance of *Euglenophyceae* was recorded by Rao. 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. According to Unni *et al.* 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 Srivastava 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.

Plankton diversity: zooplankton:- Zooplantons were represented by *Rotifera*, *Cladocera*, *Copepoda* and *Ostracoda* (Table 5, Figure 4). Among zooplankton, Rotifera was dominated followed by *Copepoda*, *Cladocera* and *Ostracoda*. Rotifera accounted for about 59.66% and 60.51% during 2018-2019 and 2019-2020 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 during 2018-2019 and 2019-2020 respectively.

Table 4: The Zooplankton of Nawargaon Lake during 2018-2019 and 2019-2020.

Order	Zooplankton
Rotifera (2 species)	*Keratella, Brachionus, Hexarthra, Epiphanus, Filina, Ceprolodella* and *Ceacane*
Cladocera (6 species)	*Alona, Cereodaphnia, Daphnia, Lactona, Leptodera and Leydiga*
Copepoda (3 species)	*Canthocamptus, Cyclops* and *Diaptomus*
Ostracoda (1 species)	*Cypris*

Table 5: The seasonal fluctuations of Zooplankton in Nawargaon Lake during 2018-2019 to 2019-2020.

During 2018-2019					
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
	2019-2020				
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

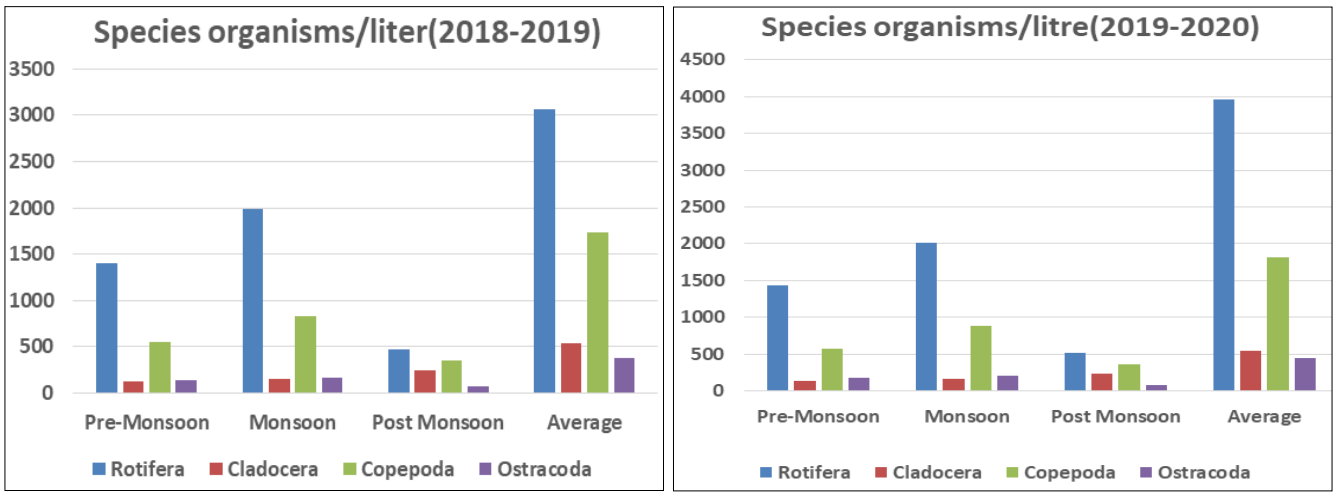

Fig 4: Seasonal fluctuations of Zooplankton in the Nawargaon Lake.

Copepoda was the second group among the zooplankton in the reservoir. Three *Copepoda* genera were found in Nawargaon Lake. The Copepodas accounted for about 27.17% and 29.08% during both the years (Figure 4). The Copepoda group was represented by *Cyclops*, *Canthocamptus*, and *Diaptomus*. Maximum copepods were found during monsoon period (832 organisms/litre and 890 organisms/litre) during 2018-2019 and 2019-2020, respectively (Table 5; Figure 5). Cladocera contributed 7.77% and 7.87% in total zooplankton in Nawargaon Lake during the study period (Figures 4 and 5). Six genera were found *Daphnia*, *Leydiga*, *Cereodaphnia*, *Aloua*, *Loctona* and *Leptodera*, (Table 4). The common genera observed were *Daphnia*, *Cereodaphnia*, and *Lactona*. Maximum

Cladocerans were found during post monsoon period (251 and 235 organisms/lit) during 2018-2019 and 2019-2020, respectively (Table 5). Highest number of *Copepoda* were observed in the Post Monsoon (350 organisms/lit) during 2018-2019 and 360 organisms/lit) in Post Monsoon during 2019-2020. Among *Ostracoda* was the least group available in the present reservoir *Ostracodes* constitute only 5.38% and 2.52% among the total zooplanknic Community during 2018-2019 and 2019-2020, 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. 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.

Table 6: The Zooplankton and their percentages in Nawargaon Lake during 2018-2019 and 2019-2020.

2018- 2019			
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	
2019-2020			
1.	*Rotifera*	3829	60.51
2.	*Cladocera*	498	7.87
3.	*Copepoda*	1840	29.08
4.	*Ostracoda*	160	2.52
	Total	6327	
2018-19 and 2019-20			
1.	*Rotifera*	7607	60.09
2.	*Cladocera*	990	7.82
3.	*Copepoda*	3561	28.13
4.	*Ostracoda*	501	3.95
	Total	12659	

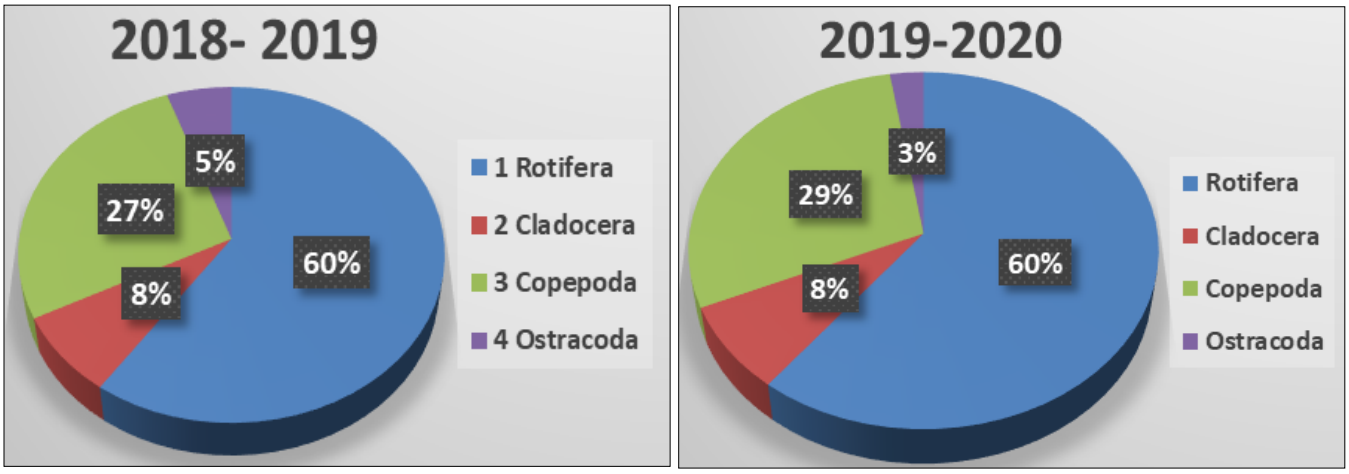

Fig 5: Fluctuations of Zooplankton in Nawargaon Lake

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