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STUDY OF PLANKTON COMPOSITION AND ABUNDANCE IN RENUKA WATER RESERVOIR

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ABSTRACT:

An investigation has been conducted to study the plankton composition and abundance in Renuka water reservoir. Plankton constitutes a vital link in the aquatic food chains. Despite their importance as food for fish, quantitative studies on tropical plankton are supposed to be a neglected area of aquatic research. The planktons are sensitive to environmental fluctuation due to their short life cycle and hence the abundance and species composition is an indicator of the quality of water mass in which these are found. Throughout the entire period of study, the physico-chemical parameters of water revealed that reasonable concentration of dissolved oxygen (DO), low concentration of ammonia and optimum range of temperature was observed in Renuka. Distribution and composition of plankton groups varies insignificantly. A balanced proportion of plankton growth was observed in Renuka (phytoplankton 61.7% and zooplankton 38.3%) which presume to promote the growth performance of omnivorous fish. it was observed that phytoplankton group dominated over the zooplankton group in sampling station of Renuka. Appearances of various phytoplankton forms indicate good ecological condition of the water bodies. The dominance of diatom species such as *Nitzschia sigma* and *Melosiragranulata*; green algae *Ankistrodemusspirilliformis;* blue-green algae *Anabaena circularis* and *Oscillatoria limnosa*showed that the water body is eutrophic. So, the study is very much important to create educational awareness to the inhabitants of this study area and the general public on the effects of anthropogenic activities in aquatic ecosystems for a sustainable management and healthy productivity.

Keywords: plankton, composition, abundance, distribution, eutrophic, sustainable management

INTRODUCTION:

Plankton have universal occurrence in natural water and play a significant role in the aquatic ecosystem. The plankton community consists of aquatic organisms those have little or no resistance to current, living free, floating, and suspended in the open or pelagic waters (Raymond, 1983).

Plankton constitutes a vital link in the aquatic food chains. While phytoplankton plays a phenomenal role in the biosynthesis of organic material, zooplankton, an important component of secondary production, provides a link between the producers and secondary consumers. In general, quantitative studies on tropical plankton are supposed to be a neglected area of aquatic research, despite their importance as food for fish. However, it is well established that composition and abundance of phytoplankton is greatly regulated by zooplankton (Gulati, 1975). Many studies have suggested that an increase in the quantity of phytoplankton would result in an increase in the abundance of zooplankton (Leukowicz 1974). On the other hand, some workers have also reported an inverse relationship between the two groups (Gulati, 1975).

Plankton form a wide range of morphological and physiological types and are present in vast number of different environments. The plankton are sensitive to environmental fluctuation due to their short life cycle and hence the abundance and species composition is an indicator of the quality of water mass in which these are found. They not only influence physicochemical parameter of water such as pH, colour, taste and odour but, they are a part of water quality. Planktonic communities are frequently used as bioindicators to monitor ecological changes in aquatic ecosystems (Paul S. et al., 2016). Besides, they also make important contributions to the global biogeochemical cycle and improve the accumulation of carbon dioxide in the atmosphere, 'pumping' carbon into the deepest regions of the sea (Brierley AS et al., 2017). The main factor that affects the density and diversity of the two planktons is the pattern of algal distribution. The density and diversity of plankton are controlled by several other physicochemical factors of the water apart from the algal distribution. Hanazato and Yasuno (1985), Bhati and Rana (1987) and Takamura *et al.* (1989) reported that temperature, dissolved oxygen (DO) and organic matter are the important factors which control the zooplankton growth. Substantial amount of information on plankton diversity and abundance have been made available in Indian fresh water bodies. Rama Rao *et al.* (1978) have monitored the water quality using species diversity of planktons. Raina *et al.* (1982) had studied water quality and plankton of Jhelum River.

Phytoplankton is an integral component of riverine ecosystem and the primary productivity of the system depends on it. Phytoplankton act as bioindicators of water quality, some algae such as *Anabaena*, *cylindrospermopsis*, *Aphanizomenon*, *Microcystis*, are known to produce toxins. Its presence and absence mainly depend on the biotic and abiotic factors (Mathew, 1977; Nautiyal, 1996; Bhatti and Bhatti, 1988; Sastry, 1988; Singh M and Sinha R.K. 1994).

Certain zooplanktons play an important role in aquatic ecosystem. Their seasonal abundance, population peaks depend on water temperature, DO and nutrients present in the medium (Nautiyal *et al.*, 1996). Zooplanktons can be used as indicators of the trophic phase of a water body, they play an important role in transferring to the consumers and hence they occupy the next higher trophic level in the energy flow after phytoplankton (Mathew, 1977; Verma and Dutta Munshi, 1987). Zooplankton is commonly used as live food for larval stages to the period of termination of fish, shrimp, molluscs and corals (Olaizola M; 2019, Vigani M *et al.*, 2015; Voort MPJ 2015).

Knowledge of distribution in time and space of environmental condition which is favorable for its development is the fundamental to be scientific utilization of natural water for fishery exploitation. As the phytoplankton and zooplanktons are bio-indicators of pollution and forms an integral part of the aquatic food chain an investigation has been made in sites to identify the presence of various planktonic groups (taxonomic identification) and quantitative survey of various phytoplankton and zooplankton.

MATERIAL AND METHODS:

Renuka water body is located at Banki, in the district of Cuttack, Odisha lies between 20^0 22'11'' North latitude and 85^0 20' East longitudes taken as study site for present research work.

The materials used during the experiments were plankton net, glass bottles measuring cylinder stemple- pipette, Sedgewick-rafter counting cell, microscope and 5% formalin for plankton study. Plankton samples were collected using Plankton net (Nylo - bolt silk cloth no. 25) by filtering 50 liters of water and preserved in 5% formalin and analyzed qualitatively and quantitatively by following standard method of Santhanam *et al*. (1989). For plankton analysis 1 ml of concentrated plankton sample was taken in the Sedgewick rafter cell with the help of stemple pipette.

Counting in Sedgewick rafter cell:

1 ml of stock plankton sample contained in Sedgwick rafter cell was placed on the mechanical stage of the microscope. The organisms were then counted from one corner of the counting cell. The rafter was moved horizontally along the 1st row of squares and the organisms in each square of the row were thus counted. When the row was finished, the next consecutive row was adjusted using the mechanical devices of the stage. In this way all the organisms present in all the squares were counted i.e., for counting one can also make use of a mechanical counter for getting final sum immediately.

Calculation:

The total number of plankton present in one litre of water sample was calculated by using the following formula Santhanam *et al.* (1989).

$$N = \frac{n \times v}{V}$$

Where, N = The total number of plankton cells per litre of water filtered.
n = Average number of plankton cells in 1 ml. of plankton samples.
v = Volume of plankton concentrate (ml)
V = Volume of water filtered (l)

Qualitative analysis

Using a plankton sampler with a conic net (mesh 30-µm) the samples were obtained by horizontal surface trawling for 10 min, for the identification of the species present in water bodies. The obtained phytoplankton were put in plastic bottles (500 mL) and preserved with 4% formalin for the subsequent analysis. The identification of plankton species was done placing a drop of the preserved samples in a glass slide to observe the organisms with a compound microscope, using the objectives 10x, 40x and 100x, depending on the size of the planktons to be identified. The keys of Reynolds et al. 2002 Balech (1988), Taylor (1987), Sournia (1984), Hernández-Becerril (1991), Licea et al. (1995), and Moreno-Ruiz et al. (1996), were consulted for the species identification.

Quantitative analysis

Using a Van Dorn bottle,500 mL of water was taken at 40 cm depth in every one of the sampling points to know the number of cells/mL of each species. The samples were preserved with Lugol-Acetate, adding 1 mL for each 100 ml of sample (Throndsen, 1978). Using sedimentation chambers, tubular chambers (2, 10 or 50 mL), or Neubauer chamber, depending on the cell concentration, the quantification of specific cells was made from preserved samples. For very low densities the tubular chamber of 50 mL was used following the method Utermöhl modified by Edler and Elbrächter (2010), by allowing a sample to settle in a sedimentation cylinder and giving adequate time, it is assumed that all organisms present in the sample are in the sedimentation chamber. After 4 h of sedimentation for chambers of 4 cm height, the counting and identification were done in a Carl Zeiss inverted microscope.

The species abundance was calculated as:

$$\text{Abundance (Cells /L)} = ((Z \times F) / V) \times 1000$$

Where: Z is the number of individuals of a particular species, F is the counted area over the total area of the chamber and V is the volume of the sample. Both the quantitative analysis and the identification followed the UNESCO protocols proposed by Karlson et al. (2010).

RESULTS:

Physico-chemical parameters:

Average Physico-chemical parameters of water at different sampling stations during March-April 2023are given in Table-1. Throughout the entire period of study, high concentration of dissolved oxygen (DO), low concentration of ammonia and optimum range of temperature were observed in Renuka. These are some of the conducive factors which influence the growth performance of fish.

Table-1 Average Physico-chemical parameters of water at different sampling stations of Renuka water reservoir during March - April, 2023

Parameters	Sampling station-1	Sampling station-2	Sampling station-3	Average
Water Temperature (^{0}c)	35	34.8	35.2	35
$_p$H	7.8	7.6	7.4	7.6
Dissolve Oxygen (mg/l)	5.6	5.8	5.4	5.8
Total Alkalinity (mg/l)	98	100	99	99

Plankton analysis:

The term plankton is a collective name for all such organisms including certain bacteria, algae, protozoans, coelenterates, crustaceans, and moluscs. Plankton is the productive base of both marine and freshwater ecosystem, providing food for larger animals and indirectly for humans, whose aquaculture depend upon plankton. In view of its high biological productivity and wide extent, plankton has only begun to be developed and exploited. It has been demonstrated on several occasions that large-scale culture of algae is technically feasible. The unicellular green algae *Chlorella* has been used particularly in this connection.

Phytoplankton:

The plantlike community of plankton is called phytoplankton. This convenient division is not without fault, for, strictly speaking, many planktonic organisms are neither clearly plant nor animal but rather are better described as protists. Based on size, plankton can be subdivided into macroplankton, microplankton, and nanoplankton, though no sharp lines can be drawn between these categories. Macroplankton can be collected with a coarse net, and morphological details of individual organisms are easily discernible. These forms, 1 mm (0.04 inch) or more in length, ordinarily do not include phytoplankton. Microplankton (also called net plankton) is composed of organisms between 0.05 and 1 mm (0.002 and 0.04 inch) in size and is a mixture of phytoplankton and zooplankton. The lower limit of its size range is fixed by the aperture of the finest cloth used for plankton nets. Nannoplankton (dwarf plankton) passes through all nets and consists of forms of a size less than 0.05 mm. Phytoplanktonic organisms dominate the nannoplankton.

Zooplankton:

The animal-like community is known as zooplankton. The zooplankton is divided into two groups. Temporary plankton consists of planktonic eggs and larvae of members of the benthos and nekton; permanent plankton includes all animals that live their complete life cycles in a floating state. The temporary plankton, particularly abundant in coastal areas, is characteristically seasonal in occurrence, though variations in spawning time of different species ensure its presence in all seasons. Representatives from nearly every phylum of the animal kingdom are found in the permanent plankton. Freshwater rotifers may be present in plankton in vast numbers during the warmer seasons.

After thorough observation under microscope the average density of phytoplankton (Figs.1- 6) and zooplankton (Figs.7-12) genera (Nos/Litre) in the sampling stations during March- April-2023 are given in Table2. It was observed that the density of phytoplankton was more than the density of zooplankton. The highest percentage of phytoplankton was recorded in the month of March. The composition of zooplankton was highest in March and lowest in April. A balanced proportion of plankton growth was observed in Renuka (phytoplankton -61.7% and zooplankton-38.3%) which presume to promote the growth performance of omnivorous fish.

Table.2 The average density of phytoplankton genera (Nos./litre) in the sampling during March-April, 2023

Sampling months	Renuka water reservoir		
	A	B	C
March	51	26	32
April	46	18	34
Total	**97**	**44**	**66**

A – Chlorophyceae, B-Cyanophyceae, C-Baccillariphyceae

Observation of planktons under microscope:

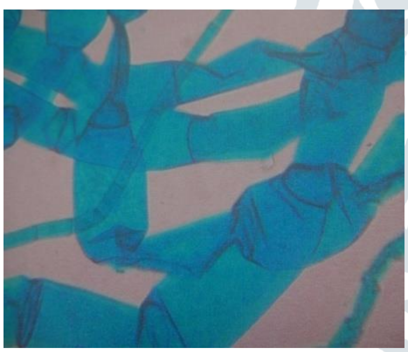

Fig.1 *Oedogonium* sp.

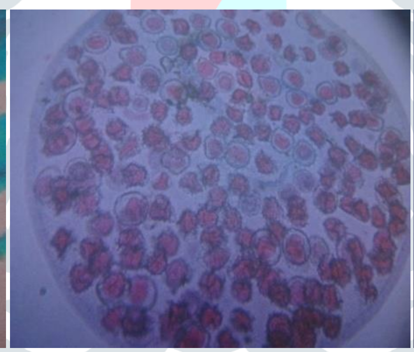

Fig.2 *Volvox* sp.

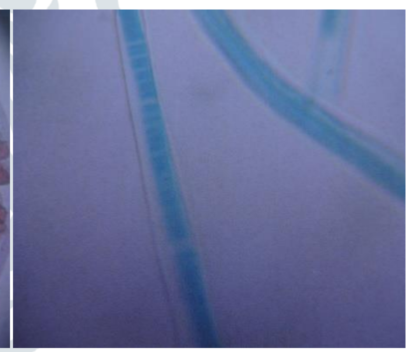

Fig.3 *Oscillatoria* sp.

Fig.4 *Ulothrix* sp.

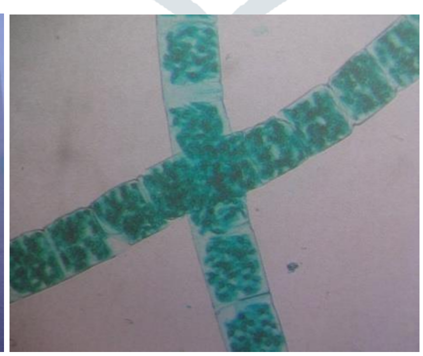

Fig.5 *Spirogyra* sp.

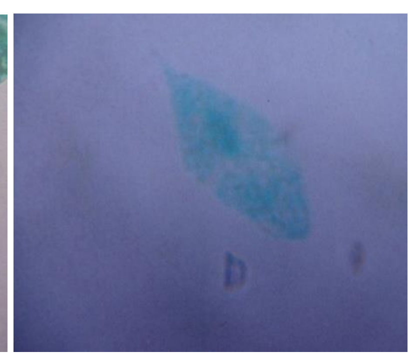

Fig.6 *Euglena* sp.

Table.3 The average density of zooplankton genera (Nos/litre) in the sampling during March-April, 2023

Sampling months	Renuka water reservoir		
	X	Y	Z

March	16	4	4
April	13	0	7
Total	**29**	**04**	**11**

X-Rotifera, Y – Cladocera, Z – Copepoda

Table.4 The average density of plankton (Nos/litre) in the sampling station during March-April, 2023

Sampling months	Phytoplankton (A+B+C)	Zooplankton (X+Y+Z)	Total Plankton
	Renuka	Renuka	Renuka
March	109	24	133
April	105	20	125



Fig.7 Gammarus **Fig.8 Daphnia** **Fig.9Cyclops**



Fig.10 Amphipod **Fig.11** ***Copepod Maldives*** **Fig.12 Naupllus**

Table.5 Total Plankton density (Nos/litre) in the sampling stations and their percentage contribution during March-April, 2023

Sampling water reservoir	Phytoplankton			Total phyto-plankton	Zooplankton			Total zoo-plankton	Total plankton
	Chloro Phyceae	Cyano phyceae	Baccillariop hyceae		Rotifera	Cladocera	Copepada		
Renuka	676	375	350	1401	405	239	223	867	2268

Table.6 Percentage of Phytoplankton and Zooplankton contribution during the study period March-April, 2023

Sampling water reservoir	Total Phytoplankton	Total Zooplankton	Total Plankton	Composition in %	
				Phytoplankton	Zooplankton
Renuka	1401	867	2268	**61.7**	**38.3**

Different types of planktons from the sampling stations were recorded in the Table.7

Table,7 Planktons recorded from the sampling stations during the study period March-April, 2023

Phytoplankton	
Class	**Genera**
Chlorophyceae	*Pediastrum, Cblorelle, Spirogyra, Coelastrum, Volvox, Desmidium, Ankistrodesmus, Selenastrum, Microspora, Cotietozvgon, Ulothtix, Botryococcus, Protococcu Mougeotia, Zvgeneme, Cenicularia, Oedogoniu Scenedesmus, Tetraspora, Cladophora, Chaetophora*
Cyonophyceae	*Oscillatoria,Phormidium,Rivularia, Coelospharium,Polycystis, Spirufina, Aphanocaspa, Stigogloea, Nostoc, Anabaena.*
Baccillariophyceae	*Milosira, Stcphanodiscus, Cyclotella, Nevicul, Fragillaria, Nitzschia, Pinnularia, Synedra, Cocconeis, Ourococcus, Stichococcus, Spirotaeni, Diatoms, Tabellaria, Frustulia.*
Zooplankton	
Rotifera	*Brachionus, Cupelopagis, Mytilina, Asplanchna, Monostylla, Microcodon, Kellicotti, Eubrachionus, keratel, Platyas, Synchaeta, Trichocerca, Filina, Testudinella, Flosculari, Collurella, Gastropus.*
Cladocera	*Leydigia, Bosmina, Daphnia, Moina, Cypridop, Ceriodaphnia, Acroperus, Chyderus, Cathocamptus, Sida.*
Copepoda	*Cyclops, Dieptotnus, Nauplius, Eubranchipus.*

DISCUSSION:

The plankton are the most important food supply for extensive and semi-intensive pond-based production systems and play a key role in pond productivity when the environmental conditions are suitable for their development (García *et al.*, 2012). Suitable physico-chemical parameters of water are essential for all the biotic communities in an aquatic ecosystem for their optimum production and growth (Khan, A.A. and Siddiqui, A. Q. 1977). Especially in aquaculture, physico-chemical parameters of water greatly influence the growth, breeding, larval development sustainability, pathogenic effect, existence, and extinctions of aquatic species. Pisciculture is also affected by the water quality parameters. In this study, the physico-chemical parameters of three different sampling sites were found to be suitable for the growth of phytoplankton as well as zooplankton.

Water temperature is an important factor for plankton population and other parameters like DO and CO_2also determine their growth and development. Temperature has an inverse relationship with CO_2 and DO (Khan and Siddiqui, 1977). Dissolved oxygen showed an inverse relationship with temperature as reported by Srivastava, V. K. (1956), Dobriyal A.K. and Singh H.R.1989 that warm water tends to bear less dissolved oxygen in comparison to water has a low temperature. Boyd C.E. 1990 reported high values of plankton during January to March due to the favourable temperature. In the present investigation the average temperature (35^0C) was recorded in Renuka in the Month of March.

The pH of the sampling stations water ranges from 7.4 -7.6. From the present investigation it was observed that, stations containing pH values between 7.4-7.6 proved more productive than the other lower and higher pH value in relation plankton population. Increased numbers of phytoplankton indicate increased solubility of oxygen.

Dissolved Oxygen content in water maintains certain plankton in proper density. In the present investigation, the DO content varied from 5.4-5.8 mg/l. Hutchison G.E. (1957) reported that, when the water has low temperature has greater capacity for holding dissolved oxygen and vice versa. A suitable content of dissolved oxygen (DO) is also necessary for all the aquatic species for their proper physiological activity. Higher value of DO in winter and lower in post monsoon is a well-known characteristic feature of a stable aquatic ecosystem as seen by Singh, S. 2015.Alkalinity is the capacity of water to neutralize acids without increase in pH. Total alkalinity is the sum of the bicarbonate and Carbonate alkalinity. Alkalinity concentrations in the sampling stations were varied from 98–100mg/l. Alkalinity acts as a buffering system in pH fluctuation of water. Natural plankton communities change temporally and spatially as a response to environmental changes.

During the study period March-April, it was observed that phytoplankton group dominated over the zooplankton group in sampling station of Renuka. Maximum density of plankton was recorded during the month of March and minimum during the month of April. Productivity of Planktonic population is more in the pre-monsoon and least in the summer seasons. Similar observation has been made by Khan, A.A. and Siddiqui, A. Q. (1977). According to him, the plankton were maximum in the month of March probably due to low temperature, high content of dissolved oxygen, low velocity and transparency of water and other suitable conditions which are necessary for the growth of planktonic population.

During the study period recorded maximum plankton density in the month of March Initially up to March last, certain plankton like *Cyclotella, Ulothrix, Spirogyra, Zygenema* were found more in number but after which they reduced in the subsequent months up to April. According to Randhawa (1959) number of zygenemaceae are commonly found in slow flowing fresh water streams.

A total of 79 taxa of plankton were recorded during the study of which 46 belong to phytoplankton and 31 belong to zooplankton. From the 46 phytoplankton taxa, 21 are Chlorophyceae, 12 are Cyanophyceae and 13 are Baccillariophyceae. Out of 31 zooplankton taxa, 11 are Rotifera, 10 are Cladocera and 10 are Copepoda. All the taxa of plankton with their species name have been given in the Table 7. Renuka water reservoir showed high density of phytoplankton during the month of March (109nos/litre) and low density during the month of April in Renuka-(105 Nos/litre). The diversity of phytoplankton communities in natural fresh water and brackish habitat has been shown to increase ecosystem stability and resource use efficiency (Ptacnik et al., 2008). The abundance of phytoplankton in the water column reflects the influence of the environmental factors and their bioprocesses (Suthers et al., 2009). Similarly, zooplankton density recorded highest during March (24 Nos/litre) in Renuka and lowest during April (20 Nos/litre). *Pediastrum* and *Zygenema*were the dominant species.

CONCLUSION:

Information about phytoplankton is necessary in understanding the structure and functions of the water bodies; they are important indicators of trophic status of various aquatic biotopes. Appearances of various phytoplankton forms indicate good ecological condition of the water bodies. The dominance of diatom species such as *Nitzschia sigma* and *Melosiragranulata*; green algae *Ankistro demusspirilliformis;* blue-green algae *Anabaena circularis* and *Oscillatoria limnosa* strongly showed that the water body is eutrophic. Green algae, diatoms, and blue-green algae were the dominant food items of the fish in the integrated aquaculture system. Similarly, these algae were the dominant algal groups found in the pond. Particularly, Scenedesmus was the most abundant phytoplankton. On the other hand, *Dinophyceae and Euglenophyceae* were found in a limited amount of the pond water. In general blue-green algae, green algae, and diatoms from phytoplankton and Copepods from zooplankton groups were the dominant and potential live food for the fish. Zooplankton depends greatly on phytoplankton since they cannot synthesize their food; they are also principal factor in the food chain. So, studies are very much important in understanding the composition of plankton populations.

The study therefore recommends the need to create educational awareness to the inhabitants of this study area and the general public on the effects of anthropogenic activities in aquatic ecosystems for a sustainable management and healthy productivity.

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