

# Physico - Chemical Characteristics and Zooplankton in Lake Hatia (Dhurwa Dam) In Ranchi Jharkhand

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## 1. Introduction

Our planet Earth has a very essential element present in it which is also a life supporting renewal energy that is WATER; it covers about 70% of the earth's surface. Water is an essential natural resource for sustaining life and also the environment (Mishra and Bhatt, 2008, Dikio, 2010)

The functioning of the aquatic system depends on a great extent on the physico – chemical characteristics of its water (Sharmila and Rajeswari, 2015). The physical and chemical characteristics of water are important parameters as they may directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals (Moses,1983).The physico-chemical characteristics of a lake refer to its physical and chemical composition. It greatly influences its overall biodiversity. The physical and chemical properties of water can affect the quality and these characteristics include temperature which is a crucial factor in lakes especially freshwater lakes.as it affects the life cycle of aquatic organisms. pH also influence the health of a lake as it measures from acidic to basic, it also affects the survival of aquatic life. Dissolved Oxygen is also important for aquatic organisms and its level is influenced by temperature as well as photosynthesis. As the temperature of water rises the oxygen level decreases and it becomes difficult for the aquatic organisms to breath. Whereas the photosynthesis done by plants and algae always increases the oxygen level and provide a safe environment for aquatic organisms. Nutrient levels in lake play a significant role in the physico-chemical characteristics. Humans as well as aquatic organisms require a balance of nutrients to thrive. Excessive nutrients such as Nitrogen and Phosphorus can lead to eutrophication; it is a process in which algae and other aquatic plants grow rapidly; depleting the oxygen levels and creating an unhealthy environment for other organisms. So the physico-chemical characteristics of freshwater lakes are crucial in maintaining a healthy ecosystem. There is a very close relationship between metabolism of aquatic organism and hydrobiological parameters in the freshwater body (Deshmukh and Ambhore, 2006).

The Zooplanktons are small animals that live in the water column of almost all water bodies. They range in size from a few millimeters down to a few microns (one micron is equal to 1/1000 of a millimeter) and may include the larval stages of larger animals such as mussels and fish. They are the important link in the transformation of energy in an aquatic food web because of their drifting nature, large density, high species diversity and tolerance to the stress (Bhat et.al. 2014).The Zooplanktons are the most important

primary consumer of aquatic food chain which helps in influencing the productivity of fishes. Zooplanktons are important food item of omnivorous and carnivorous fishes (Alam et.al.1987). The larvae of carps mainly feed on zooplanktons (Bardach et.al 1972). Zooplanktons occurrence depends on its productivity which intern is influenced by physico – chemical parameter and level of nutrients in water (Sawane et.al. 2009). The zooplankton community fluctuates according to physico-chemical parameter of the environment and their density in any water is governed by various water quality parameters such as light penetration, temperature, nutrient enrichment and micro-organisms (Reynolds, 1987). They are included in bio-monitoring program because their densities and species composition can be sensitive to change in environmental conditions.

## **2. Materials and Methods**

### **Study Area**

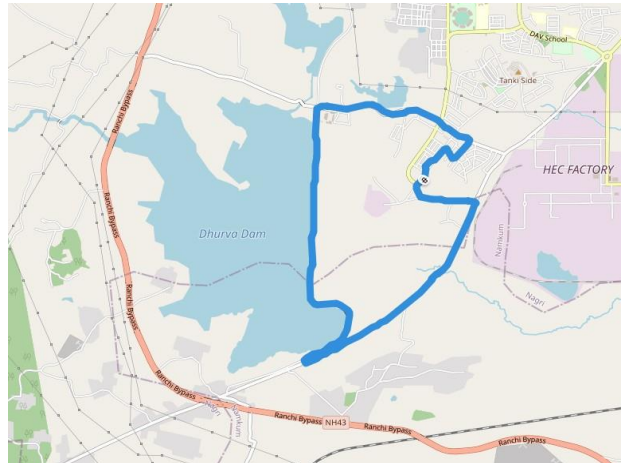
Jharkhand state is known as the “Land of Forests” because “Jhar” means “Forest” and “Khand” means “Land”. The state has dense forest, rich mineral resources and has a diverse wildlife which makes it a very fantastic and unique region of Indian states. Ranchi is the capital city of Jharkhand. It has a natural beauty surrounded by hills and forest. It has rich history, diverse tribes and various festivals in the form of cultural heritage; it has a hub of industries like steel, coal and manufacturing. It is also growing in education as there are several prominent institutions.

### **Physiography of Ranchi**

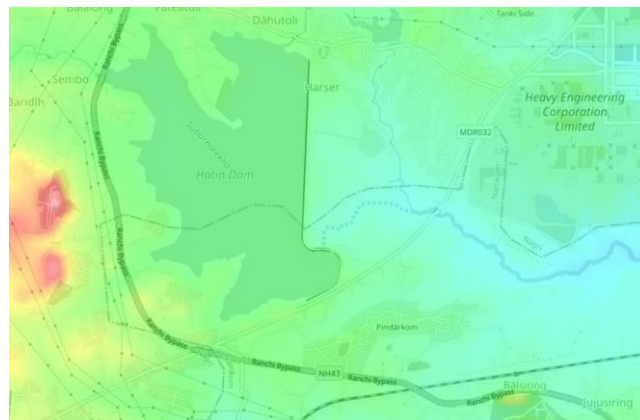
Ranchi is the capital of Jharkhand. It is geographically situated in north eastern part of peninsular plateau of India (also known as Chhotanagpur Plateau). Geographical area of Ranchi District is 7,593 sq. km. The latitude of Jharkhand, India is 23.61018080, and the longitude is 85.27993540. Jharkhand is a state in India and its GPS coordinates as 23° 36' 36.651" N and 85° 16' 47.767 E.

### **Lake Hatia (Dhurwa Dam)**

Lake Hatia (Dhurwa Dam) a major reservoir which is used to supply the water to the local people. This dam is located at latitude 23.2898° N, 85.2490°E. It has an average elevation of 641 m (2,103 ft). The depth of Hatia /Dhurwa dam is about 38 feet. All the sides of this lake have sloppy shore. It serves as an essential source of water for both domestic and industrial purposes. It also supports agriculture in the surrounding areas by irrigation facilities. Lake Hatia (Dhurwa Dam) is home to an impressive array of physico-chemical characteristics and zoological diversity.



**FIG – 1 GPS PHOTO (taken from Net)**



**FIG – 2 TOPOGRAPHIC MAP OF LAKE HATIA (DHURWA DAM)**

(taken from Net )



**FIG -3 Lake Hatia (DHURWA DAM)**

## Water Sample

The water sample was collected once in a week at 8 A.M from Lake Hatia (Dhurwa Dam) in Ranchi Jharkhand. The time of water sample collection was fixed throughout the investigation. Water was collected in black-painted Winchester bottle of two liter capacity, adding few drops of chloroform or toluene. Determination of temperature, turbidity and pH were also done on the spot. For the methods employed for the chemical analysis of water Welch (1948), Dowdeswell (1959), APHA (1965), Jhingran et.al.(1969) and Michael (1984) were followed.

Methodology adopted for analysis of water quality parameters as under:-

## Physical Parameters

### Temperature

The temperature of the surface water was recorded weekly at the time of sampling with the help of a mercury bulb thermometer while avoiding its direct exposure to the sunlight (Welch 1952).

### Transparency

The transparency of the water was determined by Secchi disc of 20 cm in diameter (painted black and white on the upper surface) and determined by the formula:

The reading

$$\text{in cm} \quad \frac{d1+d2}{2}$$

gave a measure of light penetration and is known as Secchi Disc transparency.

Where,

d1 = Depth of disappearance in cm.

d2 = Depth of reappearance in cm.

## Chemical Parameters

### Hydrogen ion Concentration (pH)

The HANNA-pHep is a digital pH meter that can be used to estimate the hydrogen ion concentration or pH of solution. was utilized for estimating hydrogen particle concentration (pH) by plunging the electrode into experimental water in clean beaker at the sampling station. This pH meter was previously calibrated in the laboratory utilizing various buffers.

### Dissolved Oxygen (OD)

The determination of dissolved oxygen content of lake waters the unmodified Winkler's technique gave the most satisfactory result.

### **Free Carbon - di – oxide (FCO<sub>2</sub>)**

50 ml of the water sample was taken and 2 drops of phenolphthalein indicator were added to it. It was titrated with N/44 sodium hydroxide solution which was standardised against sulphuric acid solution of equal strength with phenolphthalein as an indicator. The alkali was run slowly till the colour of the sample turned pink.

### **Phosphate, Silicate, Organic matters, Nitrate Nitrogen and Ammonia Nitrogen contents**

These dissolved salts in water was determined with the help of a Systronic's Digital Spectrophotometer 103.

### **Zooplankton Sample**

Planktonic invertebrates or zooplankton were collected by filtering 100 liters of water sample through the plankton net of standard bolting silk cloth no.25 (mesh size 0.003 – 0.004 microns). Finally the volume of zooplankton samples was adjusted to 20 ml and preserved by adding 5% formalin. The preserved zooplankton sample were then brought to the laboratory and analyzed both qualitatively and quantitatively. The identification was done using the keys by Ward and Whipple (1959), Pennak (1978), and Adoni (1985).

### **Data Analysis**

Various diversity indices – Shannon – Wiener diversity index, Simpson's Index, Margalef's Index were applied to the resultant data.

## **3. Result and Discussion**

### **Physical factors**

#### **Water Level**

During September in the post-monsoon period of the year. The water level of Hatia Dam was 19.63 m, subsequently there occurred a gradual decrease in the level due to the onset of winter and followed by the summer causing ample evaporation of water. These months were also associated with a gradual increase in the exposure of the surface water to the bright sunshine. The decrease continued till the month of June when the minimum level was observed to be 10.34 m in Hatia Dam. From July onwards it showed an increasing tendency due to the heavy rain of monsoon and continued till the month of September 2022 (40.86 m in Hatia Dam), which was the highest water level of the year. There was no marked change in the level of water till the month of February but it started decreasing from March onwards. Then the same trend followed. It reveals that the water level always tends to remain near the overflow level and is only distributed by the onset of hot weather or monsoon seasons, there was no other source of incoming of water in the lake except through rains.

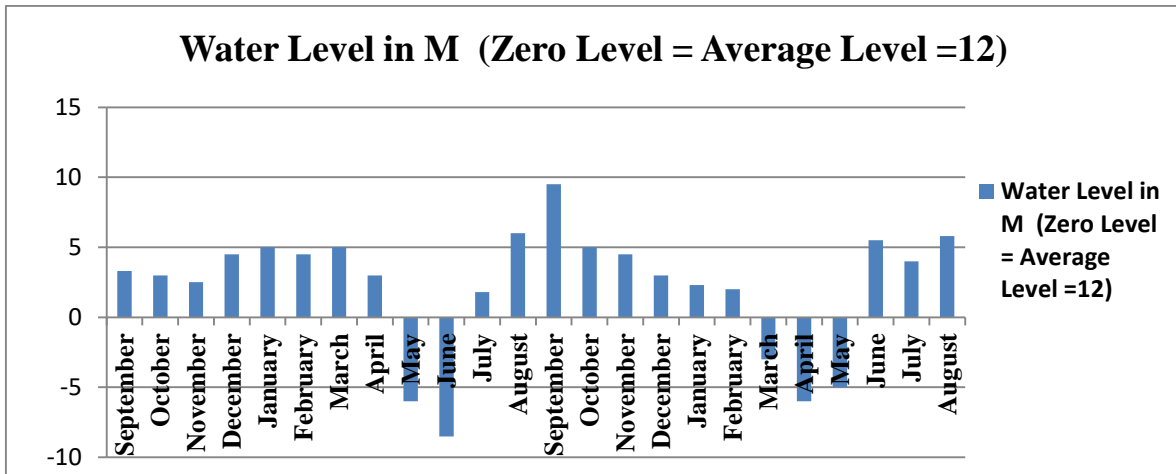


Fig 4– Showing Water Level in Meter in Hatia Dam

### Temperature

The seasonal fluctuation of surface water temperature of the lake showed that it was 27°C in the month of September. It tended to decrease gradually in succeeding months and reached the minimum 12°C in the month of December. From January onwards, the water temperature gradually increased with the approach of summer and was maximum 31°C in the month of May. Due to the onset of monsoon the water temperature then steadily went down. During the succeeding year, the maximum temperature was 32°C was recorded in May. For the rest of the months the fluctuation of the water temperature followed the same pattern. An obvious linear relationship between the surface water and air temperature was observed in Figure 5. A gradual downfall of temperature with the increase of rainfall was also recorded.

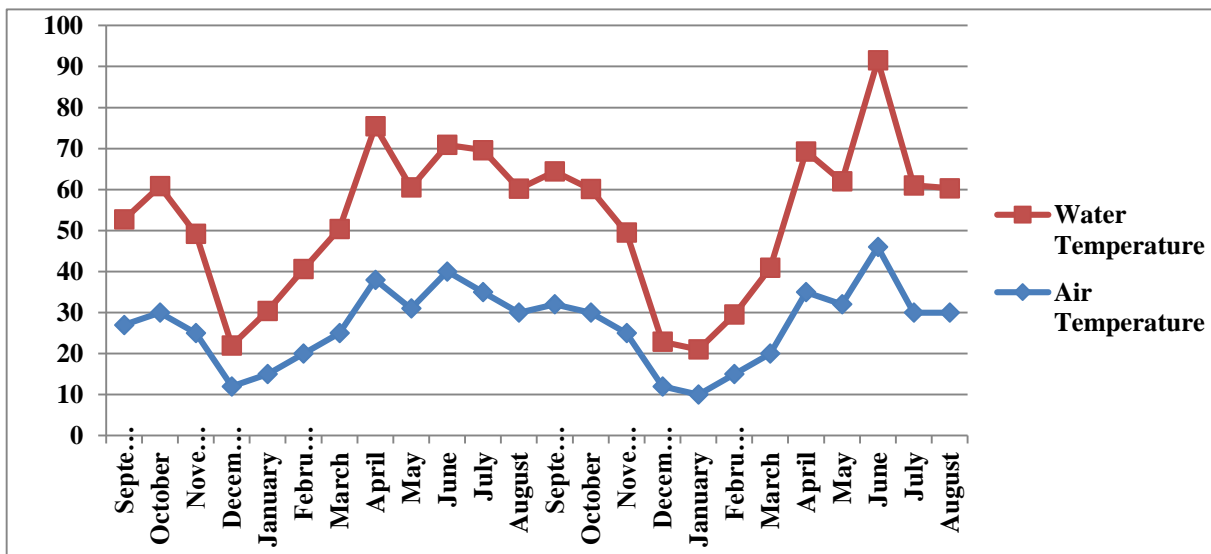


Fig 5–Air Temperature and Water Temperature showing Temperature in 0°C of Lake Hatia / Dhurwa Dam

### Transparency

During September, the transparency of water was recorded to be 73.0 cm. there occurred a steady increase in the transparency of water with a slight fall in December and February, until the highest value was observed in April 172.0cm. From March onwards there was a sharp decline in the transparency value of water. The minimum value was recorded in the month of August 21.0 cm. After two months of heavy rain. The shorter light penetration during the month of August and September can be well attributed to the steady inflow of turbid water from the surrounding during the monsoon. In the succeeding year, the fluctuation followed the same pattern through the highest value were recorded in March, 152.0 cm with subsequent steady reduction of transparency values caused by the onset of showers.

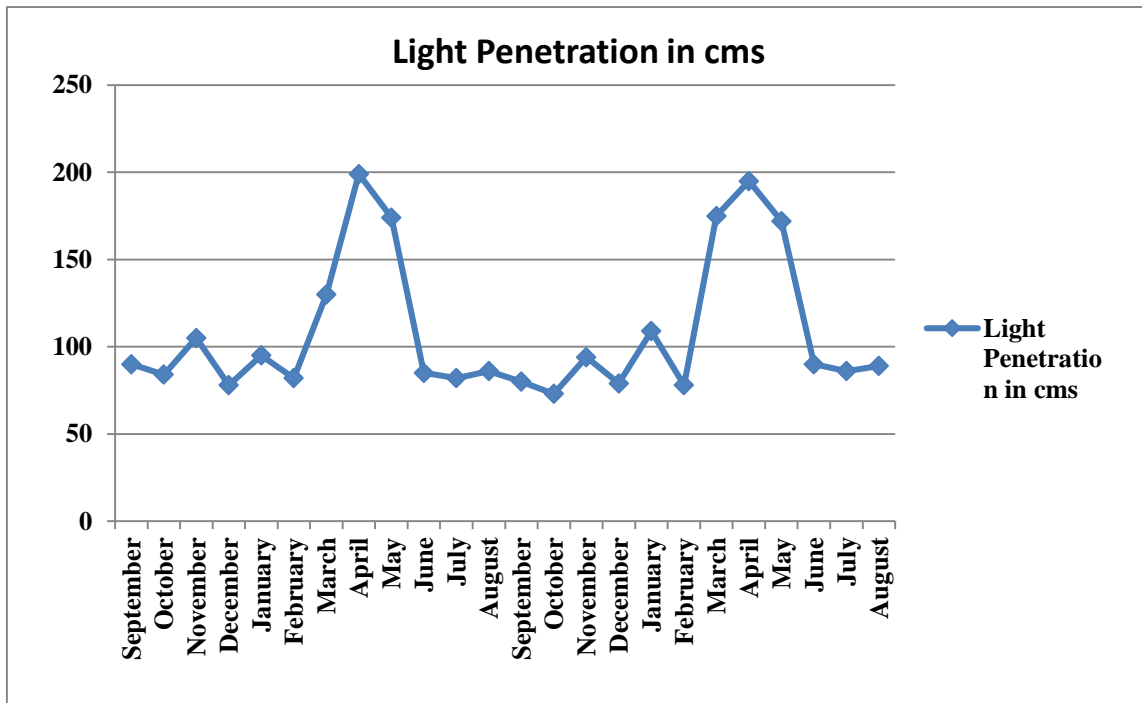


Fig 6–Light Penetration in cms of Lake Hatia / Dhurwa Dam

### Chemical Factors

#### Hydrogen-ion concentration

The pH of the lake water tended to remain acidic throughout the period of investigation barring a few months in the beginning of the study. In September the pH value recorded was 7.25, which was subsequently found to be the maximum value during the entire course of the investigation.

In the succeeding months of October and November the hydrogen ion concentration value remained alkaline but December onwards the pH value shifted again to the acidic range. A lower pH value in the cold season (December, January and February) was recorded in comparison to that of summer seasons. This was followed by a sharp decrease in the pH value during July that was 6.3, due to the onset of first

heavy showers later on. In August a marked increase of 6.87 in the pH value was recorded followed by a fall during the month of September were 6.44.

During the succeeding year of investigation the pH of the lake water remained acidic and the fluctuation of its value showed a regular rise and fall, the trend of which was the same to that of the previous year.

The level of pH support many aquatic invertebrates and fishes in aquatic ecosystem similar observation was made by Edema .et.al.(2002).

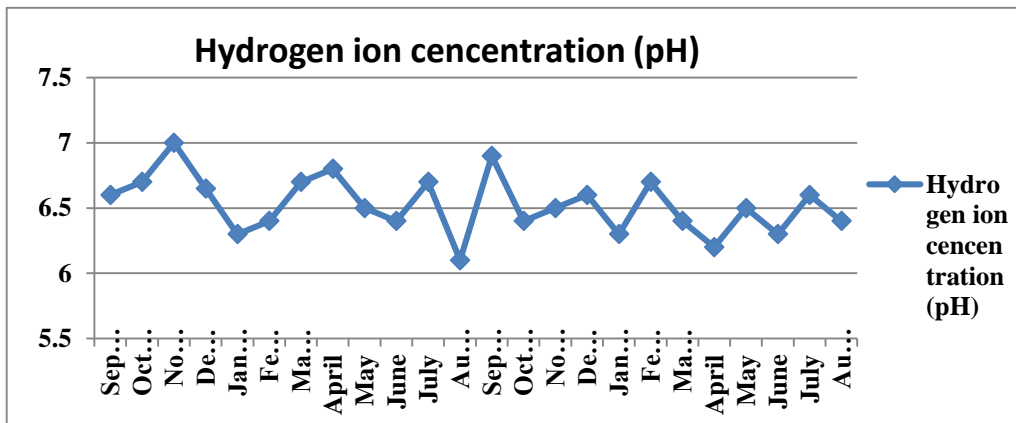


Fig 7–Hydrogen ion Concentration of Lake Hatia / Dhurwa Dam

### Dissolved Oxygen (O<sub>2</sub>) in ppm

The dissolved content of lake water varied from 4.2 ppm to 11.6 ppm during the period of investigation. During September the dissolved Oxygen content of water was 7.1 ppm, then a gradual increase in the oxygen content of water was observed till January which was followed by a decline in the months of March and April. The dissolved Oxygen content of lake water showed an increased value during the monsoon months.

In the succeeding year, the trend followed more or less the same pattern but the highest values of 11.6 ppm were recorded in the month November and lowest value was recorded in the month of May.

The data also reveals that the dissolved oxygen was high during the winter months and low during the summer months. The periods of high dissolved oxygen content corresponded with the periods of low water temperature. It was further observed that the periods of high dissolved oxygen content of water corresponded with a decreased pH value.

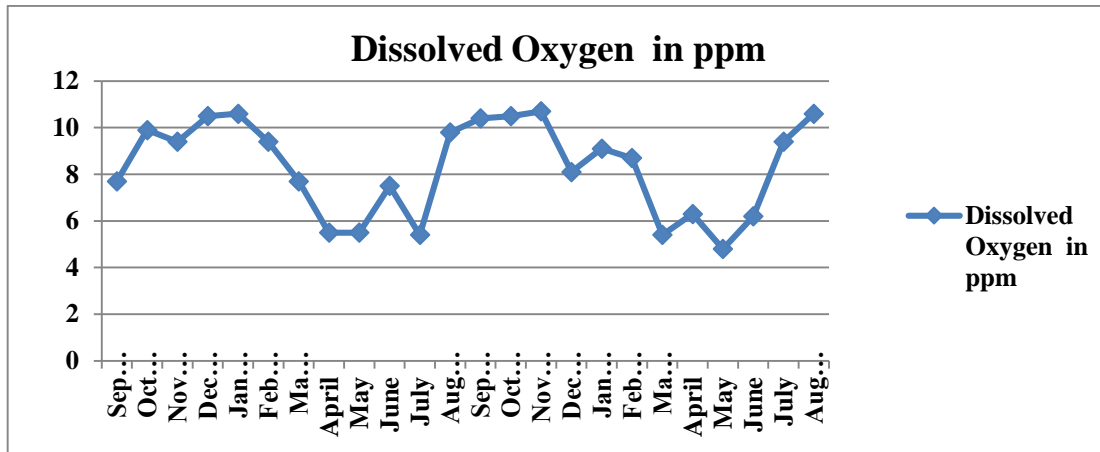


Fig 8 - Showing Dissolved Oxygen (O<sub>2</sub>) in ppm in Lake Hatia / Dhurwa Dam

### Chloride

The Chloride content was found to vary from a minimum of 9.6 ppm in September to a maximum of 72.8 ppm in July. The chloride content was found to be very high during the early monsoon and rainy seasons (June, July and August) which was mainly due to washing down of organic matter from the surrounding catchment area. Afterwards there was a sharp downward trend to chloride content of the lake water up to October. From May onwards there was a steady increase of chlorides in water which may be attributed to the low water level caused by surface water evaporation due to summer beat.

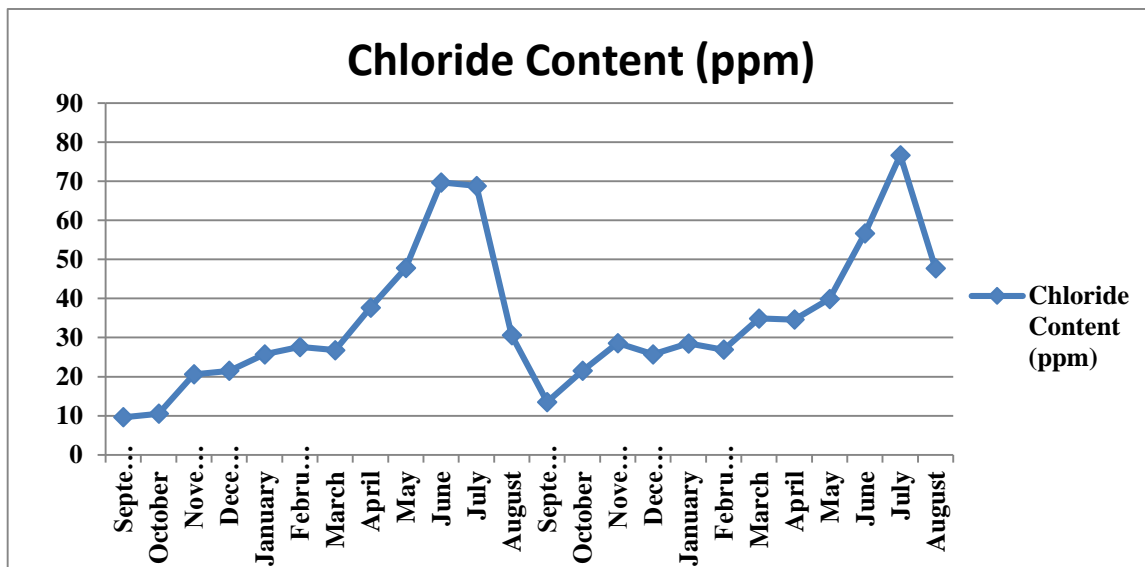


Fig 9 - Chloride Content of Dhurwa Dam

### Phosphate

The present study revealed a distinct seasonal, unimodal fluctuation of phosphate content in the lakes water. In September the phosphate content value was 0.364 ppm. In the following month it rose up to 0.384 ppm. From September onwards, a gradual decrease of phosphate value was observed till it reached

the minimum during the month of August (0.096 ppm). In the succeeding year, the value fluctuated in the same way, but the peak was observed during the month of December, which was incidentally the highest value observed ever (0.428 ppm). The minimum value for the second year was observed to be during the month of July, 2024(0.084 ppm).

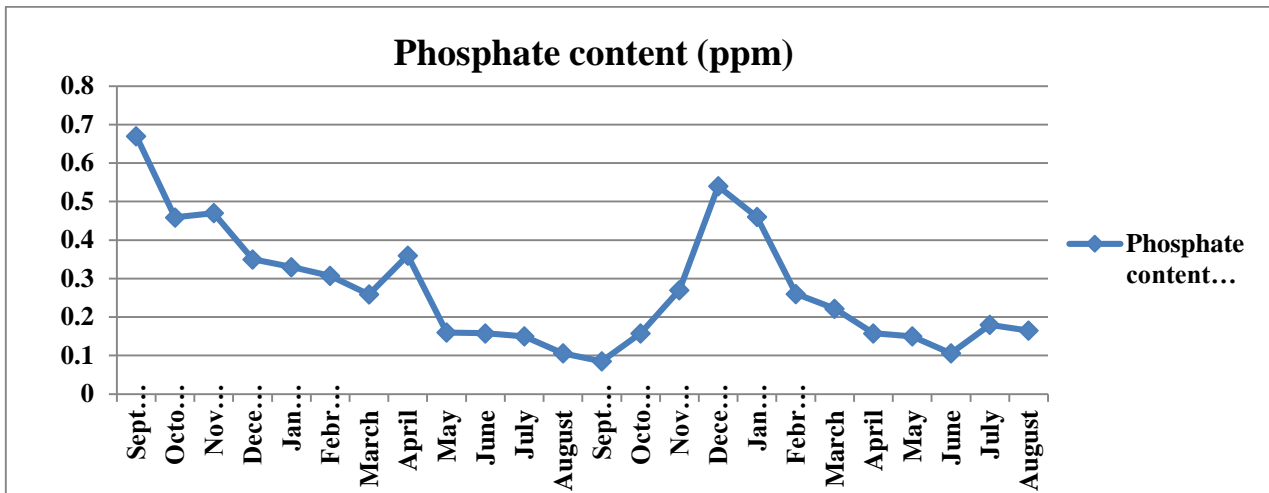


Fig 10 - Phosphate Content of Lake Hatia / Dhurwa Dam

### Organic matter content

The organic matter content of the lake was found to be 0.532 ppm in the month of September, which gradually decreased then onwards and the minimum value of 0.173 ppm was reached in December. This abiotic component gradually increased as the monsoon approached and the highest value of 0.574 ppm was obtained during the month of heavy shower in July. The post monsoon period also showed the increased value.the amount of organic matter content decreased in the lake water in early winter months.

The second year of study also revealed the same pattern, where the highest value was in the month of July (0.590 ppm) and lowest value was during the month of January (0.176 ppm)

A pronounced increase in the organic matter content of the lake water was observed in the rainy months. This may be due to the influx of organic matter from the surrounding catchment area along with rain waters into the lake. The decay of diatoms and phytoplankton also contribute to the increase of organic matter content in water.

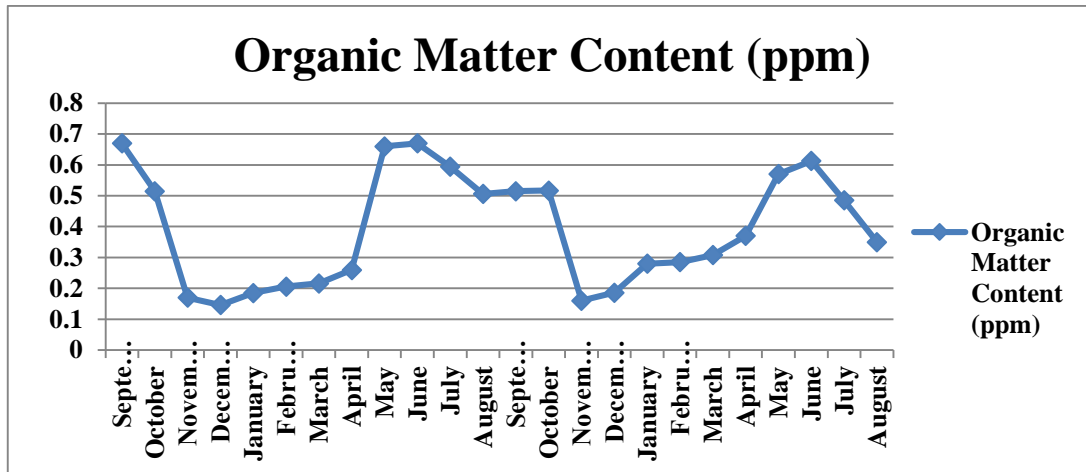


Fig 11– Organic Matter Content of Lake Hatia / Dhurwa Dam

### Sulphate

Sulphate was chiefly contributed from biotic sources and its concentration varied between a minimum of 15.4 ppm to a maximum of 35.2 ppm. The fluctuation of sulphate content of the lake water showed a high value in the rainy as well as colder months throughout the period of observation. In warmer months, the sulphate content value was observed to decline to the lowest in the month of April during all the years of investigation (18.4, 15.4 ppm). The decrease and increase of the sulphate content of lake water was not observed to be in any relation with the other abiotic components of the lake.

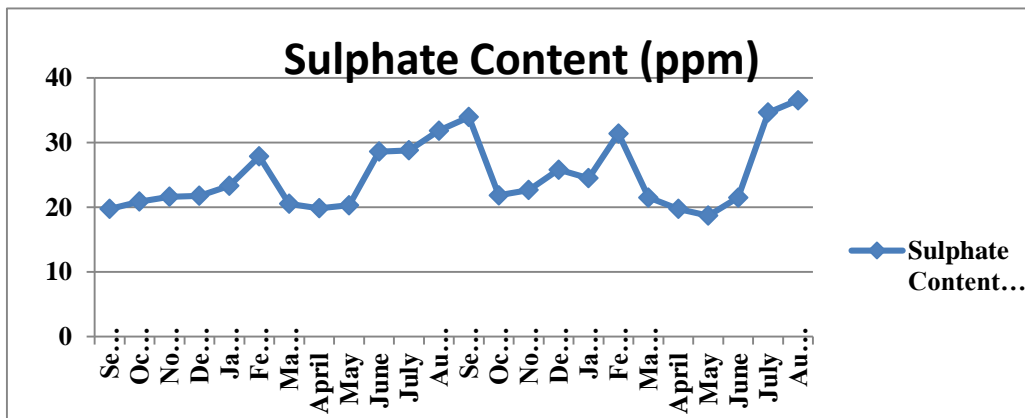


Fig 12– Sulphate Content of of Lake Hatia / Dhurwa Dam

### Nitrate contents

The chemical analysis of water samples of the lake revealed the presence of both Nitrate Nitrogen (NO<sub>3</sub>-N) and Ammonia Nitrogen (NH<sub>3</sub>-N); though the latter was found only in traces.

### Nitrate Nitrogen (NO<sub>3</sub>-N)

A distinct seasonal fluctuation of Nitrate Nitrogen content of the lakes shows the minimum value which was recorded to be 0.101 ppm in the month of April and the maximum value was observed to be 0.354

ppm in the month of August. A steady decrease in the Nitrate Nitrogen content of water was observed during the month of summer, followed by a steady increase of the values in the monsoon and post – monsoon periods.

In the succeeding year the minimum value was observed to be nil in the month of April and maximum value was recorded in the month of September (0.358 ppm). The supply of the Nitrate to the lakes appeared to be regulated by the drainage and surface run-off of water during the monsoon months.

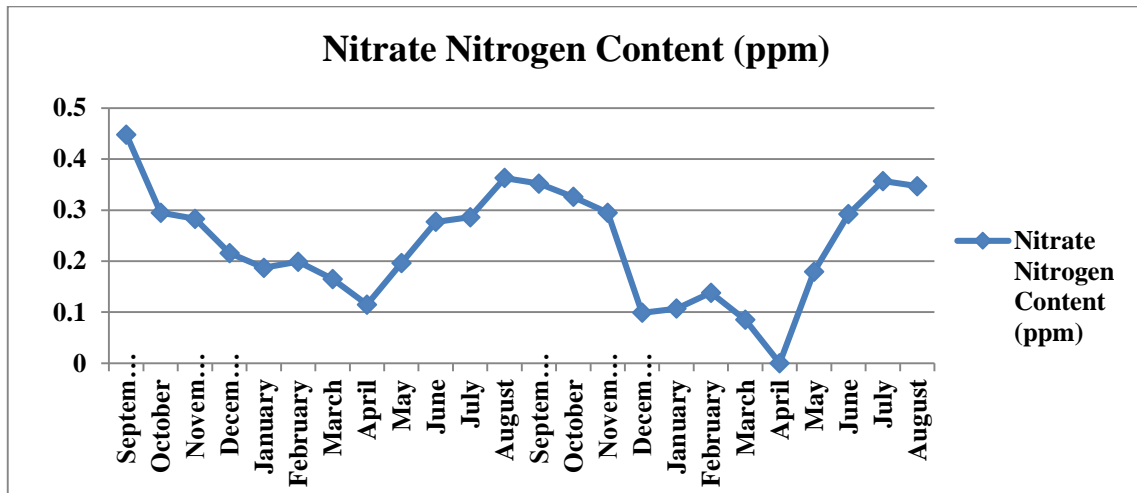


Fig 13– Nitrate Nitrogen Content of Lake Hatia / Dhurwa Dam

### Ammonia Nitrogen (NH<sub>3</sub>-N)

During the present investigation, the minimum value recorded for the Ammonia Nitrogen of the lakes was 0.012 ppm. Throughout the period of observation the seasonal fluctuation followed more or less the same pattern, which was evidenced by lower value in the colder and warmer months. During the investigation, higher value was obtained in the post monsoon months, whereas in the second investigation, the higher values were obtained during the monsoon months. The results of the first year’s observation may well be caused by the abundance of decaying organic matter in the lakes.

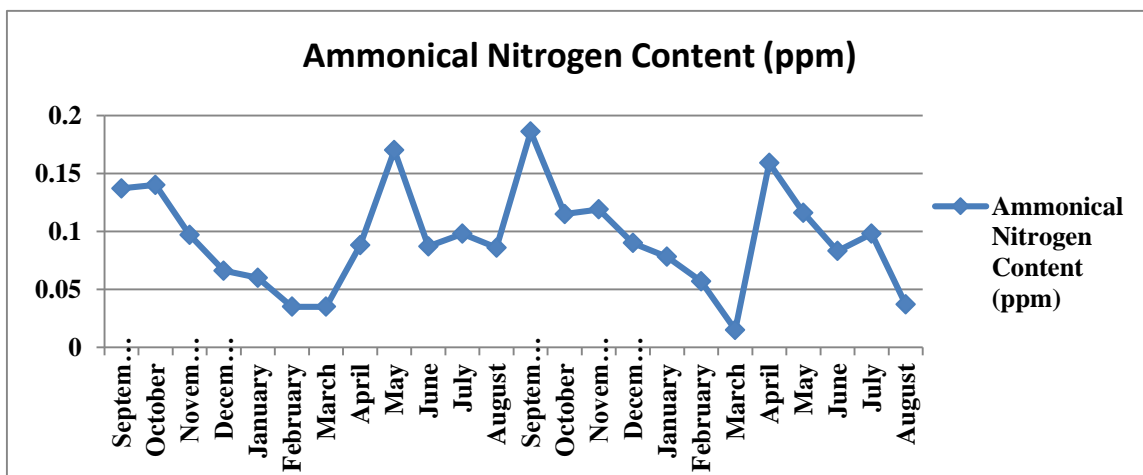


Fig 14- Ammonical Nitrogen Content of Lake Hatia / Dhurwa Dam

### Silicate contents

During the study, the silicate value of 0.11 ppm was found to be the minimum whereas the maximum value was 0.89 ppm. It was evident, that silicate value of lake water was minimal in cold weather and post monsoon seasons, whereas it increased during the hot weather and pre-monsoons.

During the second year of study, more or less a similar trend was found, whereas the minimum value was obtained to be 0.16 ppm ( January) and the maximum value was found in the month of April (0.96 ppm).

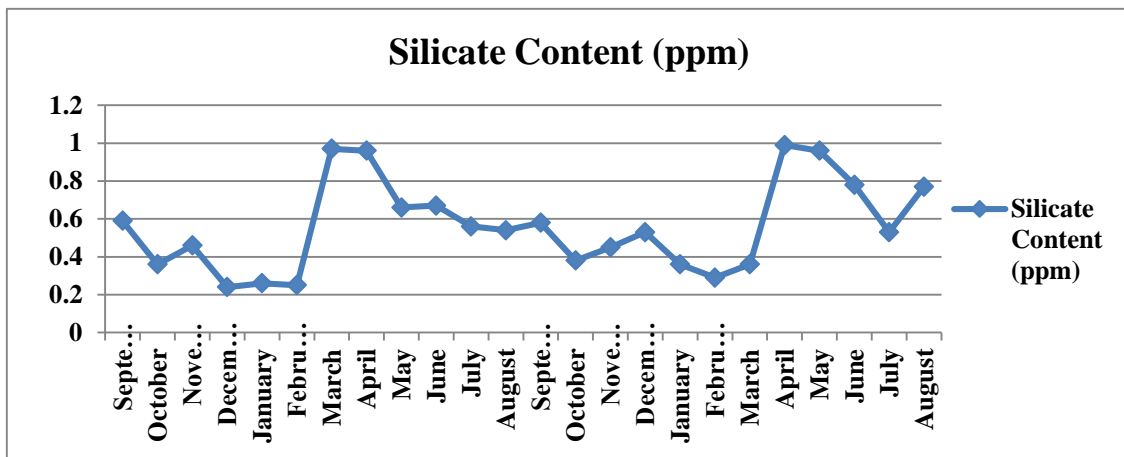


Fig 15– Silicate Content of Lake Hatia / Dhurwa Dam

### Zooplanktons

Zooplankton of the lake was represented by rotifers, cladocerans and copepods and to a less extent by the protozoans. The seasonal variations of volumetric and numerical abundance of the total zooplankton and the important forms of the different zones of the lake. The various zooplankton encountered during the investigation period were **Brachionus** sp., **Keratella** sp., **Filinia** sp., and **Esplanchna** sp., among rotifers, **Diaphanosoma** sp., **Daphnia** sp., **Simocephalus** sp., **Caridaphnia** sp., **Bosmena** sp., and **Chydorus** sp., among the Cladocerans, **Cyclops** sp., and **Diaptomus** sp. among the cepepods and **Diffflugia** sp., **Paramecium** sp., **Vorticella** sp., **Stentor** sp. among the protozoans. Cladocerans were next to copepods while rotifers showed minimum abundance.

### SOME OF ZOOPLANKTONS



Fig 16- Brachionus sp



**Fig 17 - Keratella sp**



**Fig 18 - Esplanchna sp**



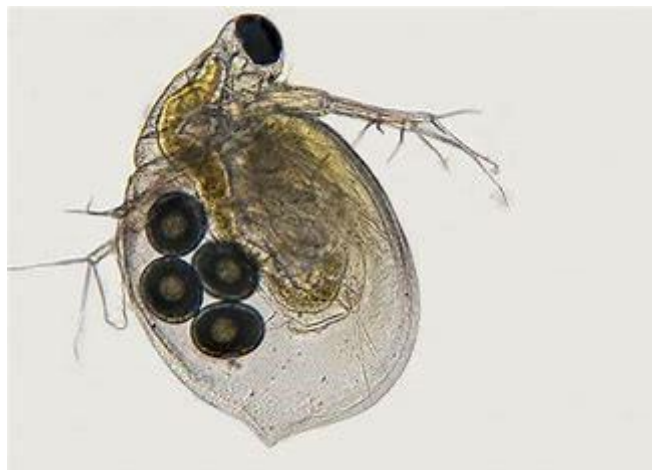
**Fig 19 - Diaphanosoma sp**



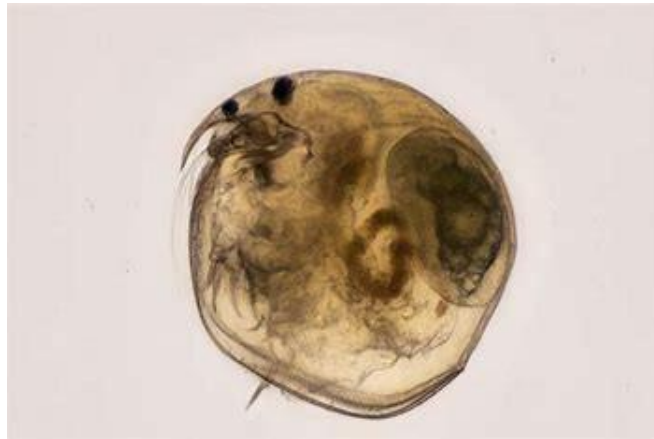
**Fig 20 - Daphnia sp**



**Fig 21 - Simocephalus sp**



**Fig 22 - Cariodaphnia sp**



**Fig 23– Chydorus sp**



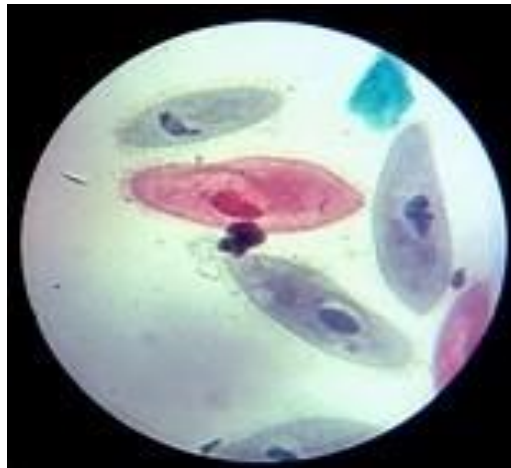
**Fig 24 – Cyclops sp**



**Fig 25 – Diaptomus sp**



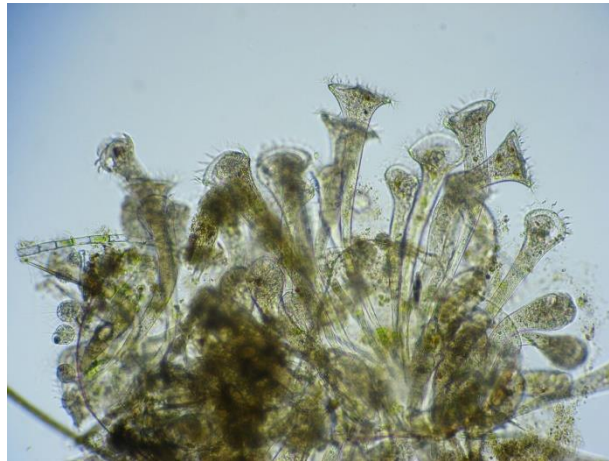
**Fig 26 - Diffflugia sp**



**Fig 27 - Paramecium sp**



**Fig 28 - Vorticella sp**



**Fig 29 - Stentor sp**

### THESE ARE SOME OF THE ZOOPLANKTONS

#### REFERENCES

1. Mishra, A. and V. Bhatt (2008). Physico - Chemical and Microbiological Analysis of Under Ground Water in V.V Nagar and Nearby Places of Anand India. *Journal of Chemistry.*, **5(3)**:487-492.
2. Dikio, E.D. (2010). Water quality evaluation of Vaal River, Sharpeville and Bedworth lakes in the Vaal Region of South Africa. *Journal of Applied Sciences, Engineering and Technology.*, **2(6)**: 574-579.
3. Sharmila, R.J. and Rajeswari, R.A. (2015). A Study of Physico- Chemical characteristics of selected Ground Water samples of Chennai City, Tamil Nadu. *J.Inn.Res.Sci.Eng.Tech.*, **4(1)**:95-100.
4. Moses.B.S (1983). *Introduction to Tropical Fisheries*. University Press, Ibadan, 105.
5. Deshmukh,J.U., and Ambjore, N.E. (2006). *J.aquabiol* 21, pp 93-96.
6. Bhat.N.A., Wanganeo. A and Raina. R (2014) The composition and diversity of net zooplankton species in a tropical water body (Bhoj Wetland) of Bhopal, India. *Int.J.Biodiv.Cons.***6(5)**, 373-381.
7. Alam, A.K.M.N., Islam, M.A., Mollah, M.F.A. and Haque, M.S. (1987). States of zooplankton in newly constructed pond and their relation to some meteorological and limnologic factors. *Bangladesh Journal of Fisheries*, **10(1)**:83-88.
8. Bardach, E.J., Ryther, H.J. and Melarny, O.W. (1972). *The farming and husbandry of fresh water and marine organisms*, John – Willey and Sons, Inc, New York.
9. Sawane. A.P., Puranik. P.G and Bobdey. A.D. (2009). Seasonal Fluctuation of Zooplankton in relation to industrial pollution in Irai river water. *Dist.Chandrapur (M.S). Environment conservation Journal* **10(3)**:81-85.
10. Reynolds, C.S. (1987). The response of phytoplankton communities to changing lake environment. *Schweiz Z.Hydrol.* **49**:220-236.
11. Welch, P.S. (1948) *Limnological methods*. First Edn. Philadelphia, The Blackiston & Co.
12. Dowdeswell, I.E.S (1959) *Animal Ecology*. Methuen & Co., 127.
13. APHA (1965) Published the first Public Health Law Manual.
14. Jhingran, V.D. and Natarajan, A.V., (1969). *J. Inland Fish. Soc. India.* 1:49-126.

15. [15] Michael, I.P. (1984) Ecological methods for fields and laboratory investigations. Tata McGraw Hill Publishing Co.Ltd., New Delhi, India.
  16. [16] Welch, P.S. (1952) Limnology:Mc Graw hill Book Company, New York, Toronto and London (2<sup>nd</sup> edition), 538.
  17. [17] Ward, H.D. and Whipple, G.C. (1959). Freshwater biology. 2<sup>nd</sup> John Wiley and Sons. Inc., New York, 1248.
  18. [18] Pennak, R.W. (1978). Freshwater Invertebrates of the United States, 2<sup>nd</sup> John Wiley and Sons, New York, pp:810.
  19. [19] Adoni, A.D. (1985). Workbook on Limnology. Pratibha Publishers, C-10, Gour Nagar Sagar-470003, India: 216.
  20. [20] Edema, C.U, Ayeni.J.O and Aruoture.A.(2002). Some observation of the Okhuo River, Nigeria journal of aquatic sciences **17(2)** :145-149.
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