e-ISSN No.: 2582-4228

Journal of Indian Association for Environmental Management

Journal homepage: www.http://op.niscair.res.in/index/php/JIAEM/index

# Biomonitoring of Lakes of Nagpur City, Maharashtra, India

Kumud Paydalwar and Sharda Dhadse

CSIR-National Environmental Engineering Research Institute, Nagpur – 440020
Omeshwari35@gmail.com, sn_dhadse@neeri.res.in

Submitted: August 11, 2020 Revised: September 26, 2020 Accepted: October 10, 2020

***Abstract:*** **The lakes are considered to be the blue lungs of the city. The phytoplankton absorb carbon dioxide and release oxygen, that helps to reform the aquatic system. It supplies oxygen to the life present in lake as well to the surrounding environment. Therefore, proper rejuvenation and restoration of lakes is highly essential. Nagpur city is surrounded with four major lakes like Ambazari, Gandhisagar, Sonegaon, and Sakkardara lake. The Biomonitoring of Ambazari Lake, Gandhisagar Lake, Sonegaon Lake and Sakkardara Lake have studied and the data have been supported with Physico-chemical parameters of the lakes. Based on the results, Gandhisagar Lake has high inorganic and organic content, than Ambazari and Sonegaon Lake while, Sakkardara lake has more metal toxicity. The studies of Planktons (Phytoplankton and Zooplankton) were assessed by Shannon Weiner Diversity Index and Benthic Macroinvertebrates were evaluated by Saprobic Score which indicates the contamination and quality of water. According to Shannon Weinner Diversity Index, the Gandhisagar Lake has shown higher pollution than any other lakes. The Saprobic Index of Ambazari lake and Sakkardara lake indicates moderate pollution and Sonegaon lake represents the slight pollution.**

***Keywords:*** **Biomonitoring, trophic status of lakes, Zooplankton, Phytoplankton, Zoobenthos sedimented**

## I. INTRODUCTION

Planktons are a microscopic life form found in lentic or lotic water system. The phytoplankton is a unicellular living structure that is the primary food source of Zooplankton and small fishes. Phytoplanktons are chief producers being liable for oxygen dependency and amount of organic matter by the process of photosynthesis. Phytoplankton is a significant part of water quality[5-8]. They spend their whole life floating above the water and thus known as 'Planktons'[9]. This organism response to light hence those known as phototropic and they are principal producers of the ecosystem[10,11]. The size of phytoplankton is ranging from 0.4 to 1000 micron in dimension[12]. The various species of phytoplankton are shows about the pollution level of the lake. The Phytoplanktons are the bases of the food chain. Some influential species of phytoplankton can also change into a different temper of a year[13]. The change in species in various climates could occur differ in their biodiversity, a number of species, denseness of water and biomass[14-16].

The Zooplankton's are the predators of a Phytoplankton as they are primary consumers and placed second in the position of an ecosystem. The Zooplanktons are dwellers of ocean, river, lake and pond and they are the nourishers of fishes[17]. The Zooplankton's are classified as Rotifers, Cladocerans, Copepods and Protozoans in addition to this there is one more group added as Ostracoda. the Rotiferans are the organic pollution indicator species[18]. The energy transferred by Zooplankton has a significant role in the secondary level of an aquatic food web[19]. The group Cladocera and Copepoda were always remain away from the coast, while they are habitually preferable to direct sunlight[20]. The Ostracoda are acknowledged as seed shrimp as they have bivalve structure. Protozoans are unicellular and they feeds on bacteria, algae, fungi Protozoans and saprobic material[21]. The Zooplanktons are more delicate to sensitive to pollution than Phytoplankton[22,23].

The Benthic Macroinvertebrates are the organisms found in sediment sample. The species are found in benthos has widely diverse creatures and belongs to various phylum such as Arthropoda, Annelida, Nematoda and Mollusca etc. The benthos is important part of the biotic environment[24]. They perform an important role in dissemination of nutrients[25]. Benthic Organism performs many functions like conversion

of organic material into Inorganic material, merging of sediments, outflowing of Oxygen into the sediments and reprising of nutrients. They perform a chief role in refining the Phytoplanktons also getting consumers of large fishes. They enhance the Oxygen concentration of the soil, sediment sample as it could have been possibilities of synthesis of remineralization of bacteria, but for that purpose the saturation of organic material has been needed so the generation of this bacterial growth would get diminished[26]. Some species of macroinvertebrates has been relying on atmospheric condition also tolerance of the species[27]. Due to declination in water quantity the eutrophication of the lake has been increased this will also decrease in number of species as well as diversity of species[28]. The enhancement of phosphorus and reduction of nutrient concentration, reduction in oxygen concentration has been performing chief role in the benthos community which creating the accent[29].

Looking at the importance of biological species in aquatic system a biomonitoring studies had been carried out in four major lakes of Nagpur city in pre-monsoon season of year 2020.

## II. Materials & Method

### Sampling Site

The four major lakes selected for sampling were Gandhi Sagar Lake, Sakkardara Lake, Sonegaon Lake and Ambazari Lake.

Gandhisagar Lake – Gandhisagar Lake is situated at the center of the city. The lake has been existing formerly 275 yrs ago. There is a Shiva temple on one side while on another side there is garden. There is a small path on two sides for a walk. Due to the existence of temple on one side and a garden, lot of waste is being dumped at the corner of the lake.

Ambazari Lake - Ambazari Lake is the largest lake in the Nagpur. It has a delightful garden and amusement park with walking route. It is one of tourist place of Nagpur city.

Sakkardara Lake - Sakkardara Lake is an urban lake encircled by a path. This lake also has garden and many aquatic weeds like *Pistia*, *Nymphaea*, *oedogonium*, and *Thypa* etc. The Lake is not much deeper and engulfed with many discarded materials that affects the quality of water.

Sonegaon Lake - Sonegaon Lake is the earliest lake from Bhosale era. This one is the smallest than all of the lake. The lake is quite clean than other lakes. It has a walking path on one side where the Hanuman Temple is located while the other three sides are sealed.

The water sample has been taken as a composite sample from four random locations of Ambazari Lake, Gandhisagar Lake, Sonegaon Lake and Sakkardara Lake. The sample was collected for Phytoplankton, Zooplankton and Benthic Macro-invertebrates study **(Table 1)**.

### Sampling for Phytoplankton, Zooplankton and Benthos

For the sampling and study of phytoplankton and zooplankton the method followed was as per the standard methods[30]. For the studies and sampling of macro-invertebrates the CPCB method has been followed.

Similarly, for the Physico-chemical characteristics of lakes water were characterized as per the Standard Methods[30]. The Benthic Macro-invertebrates were studied by the Saprobic Score. The Saprobic Score is a method where the values have computed also according to their count they are categorized under 1 to 10. This Saprobic values represents the status of water. The Benthos having longer susceptible to contamination having higher values at up to number 10. While the macroinvertebrates which are liable to pollution and their value should be near to low as compared to a polluted value.

## III. Result And Discussion

The Physicochemical characteristics of Ambazari Lake, Gandhisagar Lake, Sonegaon Lake and Sakkardara lake was carried out and the parameters has described in the (**Table 2)**. The more the alkaline property of water the more sustainability of organisms in water will be less because water dwelling organisms cannot be sustained in too high or too low pH condition. According to the grade of pH level the complete lakes showing alkaline in nature. The Electrical Conductivity is representing clearness of water quality. The charged ions constitute the electrical conductivity of the water. More the ions more will be the electrical conductance. The optimum range of electrical conductivity was 150 - 500 µS/cm which was tolerant to the organisms. The electrical conductivity was constituted according to sequence from highest to lowest range like Sakkardara lake showing highest array, then the Gandhisagar lake after that Ambazari lake and Sonegaon lake was showing least electrical conductance.

The COD estimates the volume of oxygen utilized by a chemical reaction in volume of solution. It is expressed in Milligrams needed for the oxidation of chemicals in 1 liter of solution. The ideal span of the COD is in between 100 - 150 mg/L.

The TDS specifies the quantity of the solids diffused into the water, which ranges in between 50 - 150 ppm. The TDS exhibits the Salinity and also increase the suspension of ionic composition has risen. The increase in salt concentration will be revealed some aspects on the flora and fauna of the lake such as the species which have more tolerance can only sustain that environment also due to that the biodiversity will be at less diverse[31]. The Hardness of water is determined the mineral content such as magnesium bicarbonate and Calcium carbonate per liter. Out of all the lakes the Sakkardara Lake has the highest hardness capacity, then Gandhisagar Lake, Ambazari Lake and least in Sonegaon lake.

Phosphorus is the kind of nutrient found mostly in the lake and is present in bulk in the nutrient rich lake. The Sewage discharge, agriculture and residential development are the

TABLE 1
Location Details at Various Lakes

| Sr. No. | Sample Code | Sample Details / Location Details | Lattitude | Longitude | Other Observations |
|---|---|---|---|---|---|
| 1 | GS - 1 | Near Empress mall, Gandhisagar Lake. | 21°08'51" | 79°05'45" | Anthropogenic Activity Bathing and Washing Clothes. |
| 2 | GS - 2 | Opposite to Raman Science, Center Gate, Gandhisagar Lake. | 21°08'44" | 79°05'45" | Anthropogenic Activity Bathing and Washing Clothes. |
| 3 | GS - 3 | Near Sindhu Jhulelal Temple, Gandhisagar Lake. | 21°08'41" | 79°05'45" | Anthropogenic Activity all stuffs used in worship to Gods, Flowers, Oil Lamp etc. |
| 4 | SG - 1 | Near Police Chowki, Sonegaon Lake. | 21°06'03" | 79°03'16" | Plastics, Polybags and Papers. |
| 5 | SG - 2 | Near Hanuman Temple, Sonegaon Lake. | 21°05'59" | 79°03'16" | Anthropogenic Activity all stuffs used in worship to Gods, Flowers, Oil lamp etc. |
| 6 | AZ - 1 | Opposite to Crazy Castle, Ambazari Lake. | 21°07'30" | 79°02'36" | Fishes are found, surrounding was clean. |
| 7 | AZ - 2 | Left hand side to Vivekanand Statue, Ambazari Lake | 21°07'33" | 79°02'38" | Fishes are found, surrounding was clean. |
| 8 | SK - 1 | Near Road Location, Outside Area, Sakkardara Lake. | 21°07'18" | 79°6'50" | Anthropogenic Activity Bathing and Washing Clothes, Plastic, Papers Oil, Glasses etc. |
| 9 | SK - 2 | Inside Garden and Lawn Area, Sakkardara Lake. | 21°07'16" | 79°6'45" | Green Floating Leaves, Fishes etc. |

TABLE 2
The Physico-chemical Characteristics of all Four Lakes

| Sr. No. | Parameter | Ambazari | Gandhisagar | Sonegaon | Sakkardara |
|---|---|---|---|---|---|
| 1 | pH | 7.86 | 8.335 | 7 | 7.90 |
| 2 | EC (EC (µS/cm)) | 330 | 445 | 155.65 | 530.5 |
| 3 | COD (mg/l) | 125 | 133 | 114.4 | 123.4 |
| 4 | TDS (mg/l) | 81.2 | 70.56 | 52.05 | 166 |
| 5 | Total Hardness (mg CaCO3/l) | 156 | 170 | 103 | 287 |
| 6 | Available Phosphorus (mg/l) | 0.0756 | 0.0985 | 0.067 | 0.099 |
| 7 | Available Nitrogen | 1.28 | 2.03 | 1.39 | 1.78 |
| 8 | Sodium (mg/l) | 50.55 | 57.08 | 19.87 | 43.36 |
| 9 | Potassium (mg/l) | 5.99 | 8.47 | 3.31 | 6.58 |
| 10 | Nitrate (mg/l) | 245.2 | 270.4 | 73.15 | 208.2 |
| 11 | Chloride (mg/l) | 64.6 | 90.23 | 20.15 | 89.85 |
| 12 | DO (mg/l) | 4.5 | 2.56 | 5.91 | 2.205 |
| 13 | BOD (mg/l) | 19 | 45 | 15.2 | 28.06 |
| 14 | Alkanity (mg/l) | 134 | 128 | 11 | 336 |
| 15 | Salinity (g/Kg) | 1.83 | 2.05 | 1.11 | 9.055 |
| 16 | Copper (mg/l) | 0.018 | 1.107 | 0.006 | 0.015 |
| 17 | Chromium (mg/l) | 0.009 | 1.232 | 0.023 | 1.043 |
| 18 | Iron (mg/l) | 0.808 | 1.034 | 0.39 | 0.91 |
| 19 | Manganese (mg/l) | 0.022 | 1.003 | 0.031 | 0.130 |
| 20 | Nickel (mg/l) | 0.001 | 1.207 | 0.005 | 1.051 |
| 21 | Lead (mg/l) | 0.002 | 0.623 | 0.008 | 0.40 |
| 22 | Zinc (mg/l) | 0.019 | 1.006 | 0.004 | 0.22 |

causes of the phosphorus deposition in the lake in large amount[32]. The level of Phosphorus was more than the average in all lakes. The normal level of nitrogen in lake water was ranged near to 10 mg/l. The entire lakes of Nagpur were showing the highest levels of nitrogen than the normal value. The sodium concentration of water for drinking purpose is 20 mg/l. Out of all the lakes, Sonegaon lakes was below the optimal range while remaining three lakes were showing more than usual ranges. The potassium concentration in natural water is less than 10 mg/l. The entire lakes were showing concentration lesser than the ideal value, which proves the potassium accumulation under the limit. The nitrate concentration is generally higher in anthropogenic lake at the time of delayed summer[33]. The nitrate concentration in oligotrophic lake is generally found to be 60 mg/l. The Sonegaon Lake has near to ideal concentration while remaining lakes have more than normal assemblages. The amount of chloride in lake acquired due to the mixing of chlorine gas with metal as well as the merging of chloride with sodium could be harmful to humans, it can causes the diseases like heart failure and malfunctioning of the Kidney. The ideal Chloride should not exceed than 200 mg/l. So, all the lakes had ideal assemblages of the chloride.

The BOD level gets raised due to discharge of waste in water that may be lethal to the fishes[34]. The BOD of Gandhisagar Lake and Sakkardara Lake were highly polluted as their values were more than 20 mg/l, while Ambazari Lake was near to highly polluted and Sonegaon Lake was showing moderate pollution level. The Alkalinity is the property which maintains an acid level of the water. It is an attribute which resemble due to Bicarbonates, Hydroxide and Carbonates. It also assists in maintaining the pH level. The alkalinity of Sonegaon lake was lower than the optimum level, whereas other lakes such as Gandhisagar lake, Ambazari lake has standard alkalinity and remaining Sakkardara lake has high alkaline property. The Salinity of Sakkardara lake was more than any other lakes. Gandhisagar lake has quiet high salinity than the ideal concentration. The heavy metals include metals like Lead, Zinc, Nickel, Manganese, Iron, Chromium[35]. The metal concentration of Gandhisagar lake was more than all the lakes.

**Plankton Study**

The enrichment of Phytoplanktons is due to the raise in temperature and water column[36] and inducing of sediments by biotic and abiotic factors[37]. The Phytoplankton species are autotrophic primary plant, which reciprocates according to the accessibility of nourishment and variant anthropogenic compression[38-40]. The phytoplankton species of whole lakes recounted some impurity of the environmental condition of the lake.

The Ambazari lake is a huge lake. The Microcystin concentration is depends on the amount of the biotic stuff present inside the lake[41]. The Eutrophication of the lake is due to the influence of the Cynobacterial species. Ambazari Lake has possessed assorted diversity. The supplementary species have been from Phylum Cynophyceae, Chlorophyceae and the Phylum Bacillariophyceae. According to Shannon Weiner Diversity Index the Ambazari Lake indicated the value 2.32 which constituted as a eutrophic lake as it comprised of plentiful nutrients **(Table 3)**.

The Gandhi Sagar Lake comprises of the identical number of species from Cynophyceae and Chlorophyceae. The Gandhi Sagar Lake showed more diversity than any other lake showing highest nutrient enrichment. The Microcystin is a Cynobacteria specifically contributed 1.5% which is toxic in nature which is based on the quantity of Chl-a content in the water **(Table 3)**.

The Sonegaon lake was approving quiet, fresh and clearer water than the other lake. The Sonegaon lake consisting some species such as *Synchococcus*, *Chlorella*, *Nitzscia*, *Cylindrospemiopsis* and various other species were also found. The Sphaereocystis species has been found in Oligotrophic lake. The Sonegaon lake has been quite good in condition than other lakes. The *Synechococcus* is a Picoplankton species[42]. *Nitzschia* is the species has often found in mild region and also is tolerant to biotic pollution[43]. The species get floats due to gas vacuoles that present inside the *Cylindrospermopsis*44. The planktons get varied according to seasons, years and amount of bacterial production[45-48] **(Table 3)**.

The Sakkardara Lake has contained some species such as *Microcystis*, *Cylindrospermopsis*, *Tetradesmus*, *Euglena* and so on. This species have been fixing nitrogen and phosphorus at low concentration[49,50]. The *Tetradesmus* species helped in fixing inorganic carbon and $CO_2$ emerges into high biomass concentration[51,52]. The *Cylindrospermopsis* species has induced the algal toxic bloom in the water as this lake containing algae concentrations in high amount which affected the water quality. *Euglena* has been generally found in the nutrient rich lakes and having high contamination **(Table 3)**.

The Phytoplankton diversity of entire lakes gets influenced by miscellaneous diversity. There were more diverse species was found in Gandhisagar Lake, whereas less diverse species was observed in from Sonegaon Lake. According to the Shannon Weiner Diversity Index the value of Gandhisagar lake, Ambazari lake and Sakkardara lake were constituted as Eutrophic quality of water. Conversely the Sonegaon lake comprises the mesotrophic quality of water **(Table 6 and Figure 1)**.

The Zooplanktons are at on transitional phase and are associated with transforming of energy from primary consumers which tolerate stress[53]. They are the organic matter comestible organisms which helps in clearing the water bodies[54].

The Ambazari lake comprised three groups out of which the Rotifera possesses highest assemblages than the other groups. Copepoda has fewer species whereas the Protozoans have the minimum value. The majority of Rotifers

comprising in the higher water temperature, pH, and nutrient concentrations[55]. Rotifers has been found generally in excessive high biological trophic level[56,57]. The *B. calyciflorus* has been specified as semi-polluted species[58]. The other species of Rotifers such as *Brachionus* species have been appointed as polluted water containing species and it considered as mixotrophic species[59-61]. The value of SWDI was noted as 2.1 **(Table 4, 7 and Figure 1)**.

The Zooplanktons population of Gandhisagar Lake was more distinct diverse than any other Lake. Ostracoda are active in all seasons[62]. The Ostracoda was detected in Gandhisagar lake only. The percentage of Rotifera has been more diverse than the Copepod and Cladocera. As the Phylum Rotifera comprising almost 67% out of which polluted species were more in number. The phylum Rotifera comprising of two kinds of species such as easily influencing and tolerable[63]. The *Asplachna* species of Rotifera together with some Copepoda species influenced by the traits of predatory Rotifera species as a result of distinctly differ in structure or by divergently functioning or by their behavior[64,65]. The measurement of *B. calyciflorus* species has been expanding elongate with the raising of food level[66]. *Brachionus calyciflorus, Brachionus diversicornis, Brachionus falcatus, Keratella tropica* all have been species are considered to be a good indicator of Eutrophication. The SWDI value was represented as 2.4 **(Table 4, 7 and Figure 1)**.

The Sonegaon lake possess Rotifera, Copepoda and Cladocera in the ratio of 50:25:25. As this lake was showing less nutrient concentration apart from any other lake. This lake representing the most of the species which specifying fresh water. *Daphnia* species has been easily affected by cyanobacteria[67]. The Copepoda and Cladocera has been generally active in pre monsoon and post monsoon as collection of samples has been done in March month[62]. Due to freshwater species this lake has been considered as mesotrophic Lake. The SWDI value for this lake was observed 1.7 **(Table 4, 7 and Figure 1)**.

The Sakkardara Lake has been studied under physicochemical parameters as this lake showing highest metal toxicity as well as it exhibited Rotifera and Copepoda only. The extremely long-suffering species were Rotiferans and then Copepods[68.] The value of SWDI was found to be 2.1 **(Table 4, 7 and Figure 1)**.

**Benthic Community**

The Benthic Macroinvertebrates are the primary consumers and indicate with sensitive link between food chain[69]. Its study has been done by calculating Saprobic Index. The Saprobic value constituted by the study of pollution indicator species which helps to assess the quality of water. The Ambazari Lake has resembled of some Phyla such as Arthropoda, Annelida and Mollusca. The Ambazari lake showing the insect species from family Belostomatidae which was a tolerable species. The other were *Thiara*, *Melanoides tuberculata*, *Bellamya bengalensis* were the pollution indicator species. This species has been tolerable to salt concentration and used for edible purpose in some countries such as Nepal and Bangladesh[70]. The other remaining species from Glossiphonidae and Lumbriculidae indicated the freshwater species. The Saprobic Index value was observed to be 4.4 **(Table 5, 8 and Figure 2)**.

The Gandhisagar lake exhibiting the most diverse species as it highly comprising of high amount of organic bloom so it was more diversification. The mass of *Chironomous* species has been more in quantity which is more pollution tolerable species. The *Chironomus* species has been used as a consumer of the fish, Duck, Geese and Swans also they have been considered as delicate sustainable species[71-74]. The Tipulidae and Simulidae family of Order Diptera has been observed as pollution tolerant species. The Trichopteran species and Coleopteran species has been detected as a tolerant to pollution. The Dytiscidae family lives in fresh water inside the bottom region where the plant growth taken place[75]. The life stages of Trichoptera insect have formed a connection in the food chain as well as it is used for the purpose of Trout fishing[76]. The Viviparidae family species have easily found in any kind of water, whereas Ampularidae family is found in freshwater only. The *Indoplanorbis* species has been observed in the lake where the existence of organic bloom moreover the proximity of nitrate and sulphur concentration remains available[77]. The Physidae family has been considered as highly pollution tolerant species. *Erpobdella* species have been found in clear water in addition with that *Pila* species has been endurable to saline water[78]. *Ceriagrion* species found in the lake has been said that it represents a bad quality of water[79]. Out of these all species most tolerant species have been a pollution tolerant species, whereas remaining often species have been regarded as clear dweller species. This lake plentiful of nutrients has been present. The Saprobic index value was noted as 4.6 **(Table 5, 8 and Figure 2)**.

The Sonegaon lake containing some families such as Hirudinea, Diptera and Odonata. The most of the families from this lake have been recognized as fresh water dwellers. *Limnodrilus hoffmeisteri* has been an indicator as biological indicator of pollution[80,81]. Naididae family has been estimated as fresh water species and residual families have been supposed to be said that they found in clear water except Chironomidae family as it considered to be most tolerant species. Hence, according to Simpson Diversity Index this lake has been less polluted than any other lake so it comes under the in slight pollution range and also it indicated light blue color. The value of Saprobic Index was found to be 6.5 **(Table 5, 8 and Figure 2)**

The Sakkardara lake showing least diversity as it has been containing only 5 families. This metal toxicity of this lake has been more than Gandhisagar lake, hence the most of the diversity has not been viable to live in this lake. The Nepidae family species has been existing near photic zone[82]. The Saprobic Index value had been noted as 3.2 **(Table 5, 8 and Figure 2).**

TABLE 3
Phytoplankton Species from all Four Lakes

| Sr. No. | Location | Phylum | Genus |
|---|---|---|---|
| 1 | Ambazari Lake | Cynophyceae | *Anabaenopsis* |
| | | | *Cylindrospemeopsis* |
| | | | *Gomphosphaeria* |
| | | | *Microcystis* |
| | | | *Aphanocapsa* |
| | | Bacillariophyceae | *Bacillaria paradoxa* |
| | | | *Navicula* |
| | | | *Pinnularia* |
| | | Chlorophyceae | *Closterium* |
| | | | *Chlorococcales* |
| | | | *Microspora* |
| 2 | Gandhisagar Lake | Cynophyceae | *Cylindrospermeopsis* |
| | | | *Gomphosphaeria* |
| | | | *Microcystis* |
| | | | *Anabaenopsis* |
| | | | *Aphanocapsa* |
| | | Chlorophyceae | *Chlorococcales* |
| | | | *Microspora* |
| | | | *Schroederia* |
| | | | *Sphaerocystis* |
| | | | *Chlorella* |
| | | | *Closterium* |
| | | Bacillariophyceae | *Bacillaria* |
| | | | *Nitzschia* |
| | | | *Synedra* |
| | | | *Navicula* |
| 3 | Sonegaon Lake | Cynophyceae | *Arthrospira* |
| | | | *Synechococcus* |
| | | | *Cylindrospermopsis* |
| | | Chlorophyceae | *Chlorella* |
| | | | *Microspora* |
| | | | *Pandorina* |
| | | Bacillariophyceae | *Nitzschia* |
| 4 | Sakkardara Lake | Cynophyceae | *Gomphosphaeria* |
| | | | *Microcystis* |
| | | | *Cylindrospermopsis* |
| | | | *Anabaenopsis* |
| | | Chlorophyceae | *Crucigenia* |
| | | | *Tetradesmus* |
| | | | *Tetraedron* |
| | | Euglenophyceae | *Euglena* |
| | | Bacillariophyceae | *Pinnularia* |

TABLE 4
Zooplankton Species of all Lakes

| Sr. No. | Location | Phylum / Class | Species |
|---|---|---|---|
| 1 | Ambazari Lake | Protozoa | *Euglypha tubercular* |
| | | Copepoda | *Cyclops strenuous* |
| | | | *Eudiaptomus gracilis* |
| | | | *Pseudodiaptomus doughilishi* |
| | | Rotifera | *Keratella tropica* |
| | | | *Brachionus* |
| | | | *Filinia opoliensis* |
| | | | *Brachionus calyciflorus* |
| | | | *Brachionus plictalis* |
| | | | *Brachionus falcatus* |
| | | | *Brachionus quadridenatatus* |
| 2 | Gandhisagar Lake | Copepoda | *Cyclops strenuous* |
| | | | *Pseudodiaptomus incises* |
| | | | *Pseudodiaptomus trihamatus* |
| | | | *Nauplius* |
| | | Rotifera | *Brachionus calyciflorus* |
| | | | *Brachionus diversicornis* |
| | | | *Brachionus forficula* |
| | | | *Brachionus falcatus* |
| | | | *Keratella tropica* |
| | | | *Asplachna priodonata* |
| | | | *Testudinella patina* |
| | | Ostracoda | *Stenocypris* |
| 3 | Sonegaon Lake | Cladocera | *Daphnia* |
| | | | *Moina* |
| | | Copepoda | *Pseudodiaptomus doughilishi* |
| | | | *Diaptomus gracilis* |
| | | Rotifera | *Brachionus diversicornis* |
| | | | *Nauplius* |
| 4 | Sakkardara Lake | Rotifera | *Keratella cochlearis* |
| | | | *Brachionus rotundiformis* |
| | | | *Brachionus calyciflorus* |
| | | | *Brachionus diversicornis* |
| | | | *Brachionus forficula* |
| | | | *Brachionus falcatus* |
| | | Copepoda | *Cyclops strenuous* |
| | | | *Pseudodiaptomus incises* |
| | | | *Pseudodiaptomus doughilishi* |

TABLE 5
Benthic Species of all Four Lakes

| Site | Phylum | Class / Order | Families | Genus |
|---|---|---|---|---|
| GS | Arthropoda | Diptera | Chironomidae | *Chironomus* |
| | | | Simulidae | - |
| | | | Tipulidae | - |
| | | Odonata | Coenagrionidae | *Ceriagrion coromandelianum* |
| | | Hemiptera | Pleidae | *Neoplea striola* |
| | | | Nepidae | *Nepa cinera* |
| | | Trichoptera | Hydropsychidae | *Hydropsyche* |
| | | Coleoptera | Dytiscidae | *Hydrovatus concerts* |
| | | | Hydrophilidae | - |
| | Annelida | Hirudinea | Erpobdelidae | *Erpobdella* |
| | Mollusca | Gastropoda | Viviparidae | *B. Bengalensis f. colairensis* |
| | | | | *B. Bengalensis f. balteata* |
| | | | Physidae | *Physa acuta* |
| | | | Ampularidae | *Pila* |
| | | | Thiaridae | - |
| | | | Planorbidae | *Indoplanorbis exustus* |
| AZ | Arthropoda | Hemiptera | Belostomatidae | *Belostoma* |
| | Mollusca | Gastropoda | Viviparidae | *Bellamya bengalensis* |
| | | | Thiaridae | *Melanoides tubercular* |
| | | | | *Thiara* |
| | Annelida | Hirudinea | Glossiphonidae | - |
| | | | Lumbriculidae | - |
| SG | Annelida | Hirudinea | Erpobdelidae | *Erpobdella* |
| | | | Tubificidae | *Tubifex tubifex* |
| | | | | *Limnodrilus hoffmeisteri* |
| | | | Naididae | - |
| | | | Glossiphonidae | |
| | Arthropoda | Diptera | Chironomidae | *Chironomus* |
| | | Odonata | Coenagrionidae | - |
| | | | Libellulidae | - |
| SK | Annelida | Hirudinea | Naididae | - |
| | | | Erpobdelidae | *Erpobdella* |
| | Arthropoda | Diptera | Chironomidae | *Chironomus* |
| | | | Tipulidae | - |
| | | Hemiptera | Nepidae | *Nepa cinera* |

TABLE 6
Biological Parameter: Phytoplankton

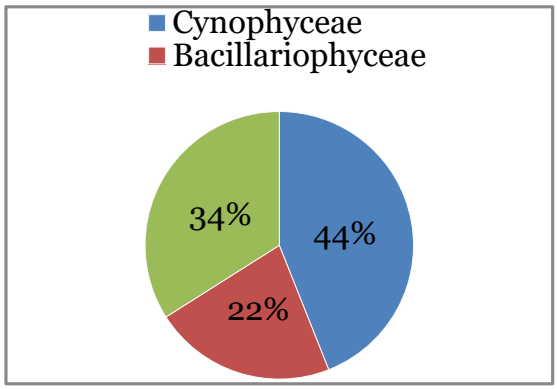
| Sr. No. | Sample Code | Percentage Composition of Algal groups | | | | SWDI | Evenness |
|---|---|---|---|---|---|---|---|
| | | Cynophyceae | Chlorophyceae | Bacillariophyceae | Euglenophyceae | | |
| 1 | A | 53 % | 10 % | 37 % | - | 2.32 | 0.97 |
| 2 | G | 44 % | 34 % | 22 % | - | 2.69 | 0.99 |
| 3 | Sg | 43% | 50% | 7% | - | 1.88 | 0.97 |
| 4 | Sk | 41% | 35% | 12% | 12% | 2.13 | 0.97 |

TABLE 7
Percentage of Zooplankton and SWDI with Eveneness Index

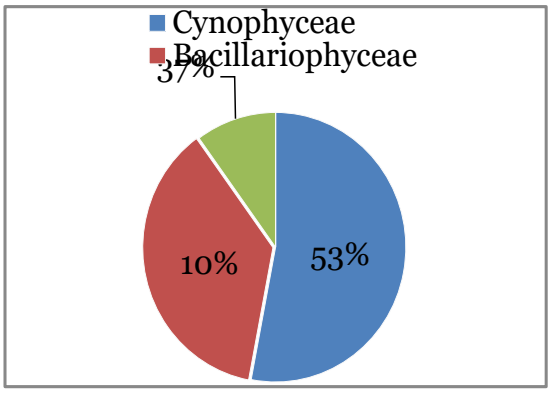
| Sr.No. | Sample Code | Zooplankton No/m3 | Percentage Composition of Zooplankton groups | | | | | SWDI | Eveness |
|---|---|---|---|---|---|---|---|---|---|
| | | | Rotifera | Copepoda | Protozoa | Cladocera | Ostracoda | | |
| 1 | A | 7000 | 71% | 25% | 4% | - | - | 2.3 | 0.97 |
| 2 | G | 13,000 | 67% | 27% | - | - | 7% | 2.4 | 0.97 |
| 3 | Sg | 2000 | 25% | 25% | - | 50% | - | 1.7 | 0.96 |
| 4 | Sk | 6000 | 64% | 36% | - | - | - | 2.1 | 0.97 |

TABLE 8
Saprobic Index

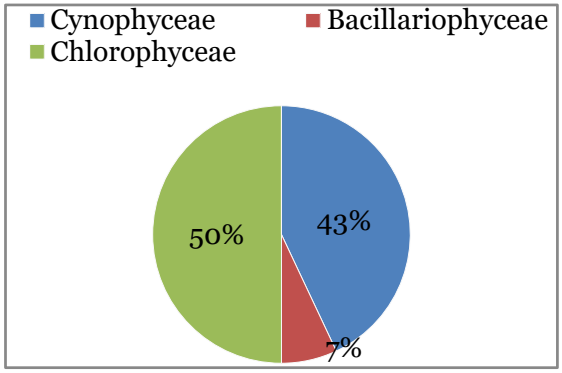
| Location | Saprobic Score | Water Quality | Water Quality Class | Indicator colour |
|---|---|---|---|---|
| Ambazari Lake | 4.4 | Moderate Pollution | C | Green |
| Gandhisagar Lake | 4.6 | Moderate Pollution | C | Green |
| Sonegaon Lake | 6.5 | Slight Pollution | B | Light Blue |
| Sakkardara Lake | 3.2 | Moderate Pollution | C | Green |



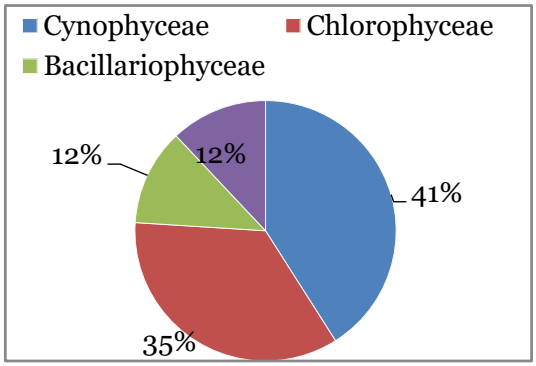
Phytoplanktons of Gandhiasagar Lake



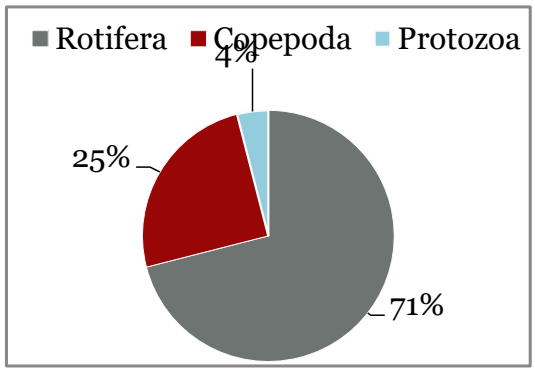
Phytoplanktons of Ambazari Lake



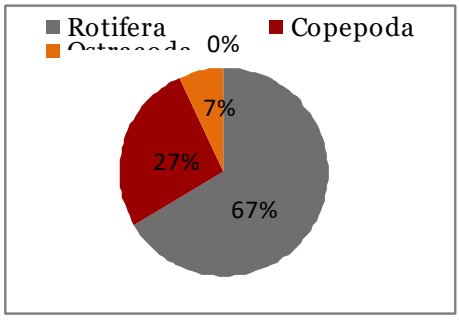
Phytoplanktons of Sonegaon Lake



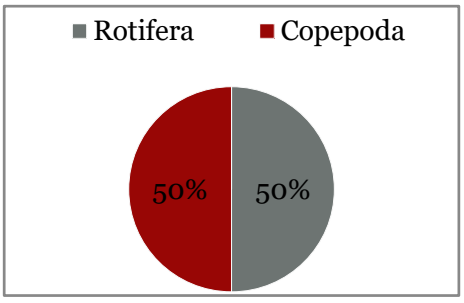

Phytoplanktons of Sakardhara Lake



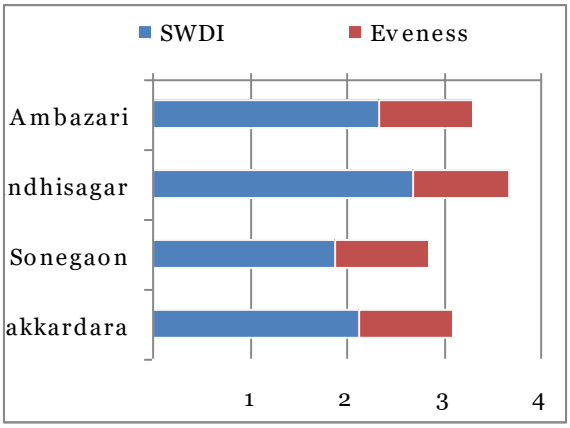

Zooplanktons of Ambazari Lake




Zooplanktons of Gandhisagar Lake

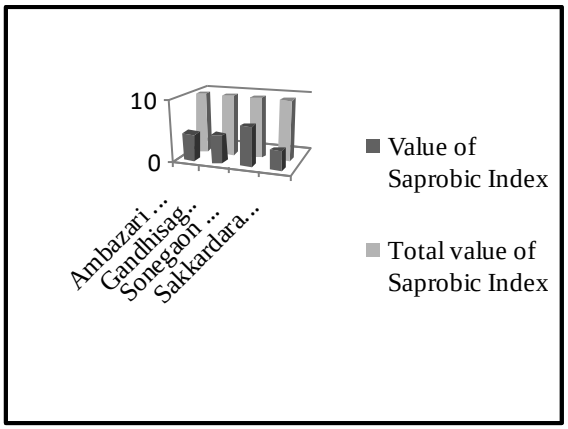


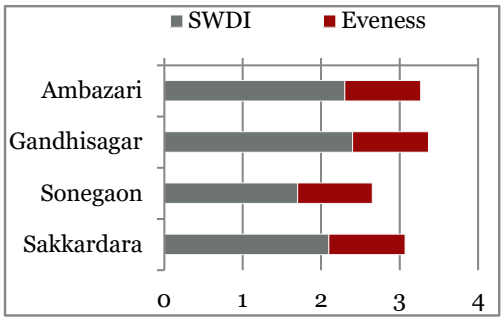

Zooplanktons of Sonegaon Lake




SWDI and Evenness of Phytoplakton

Figure 1: Family wise Composition of Phytoplankton and Group wise composition of Zooplankton of all four lakes



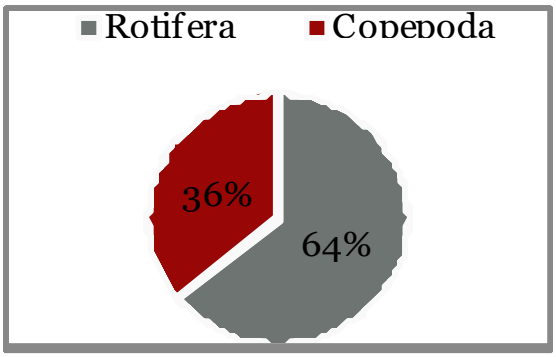




Figure 2 : Family wise Composition of Benthic organisms

## IV. CONCLUSIONS

The biomonitoring of lake witnesses the sequential changes over the time in waterbody because the macro-invertebrates present in the water and sediments tolerate the pollution and if they are intolerant, they get phased out.

Based on the results of Shannon Weinner Diversity Index of phytoplankton and zooplankton and the saprobic index of macroinvertebrates indicates the trophic status of the lakes. The trophic levels of the lakes showed the order as Gandhisagar lake > Ambazari lake > Sakkardara lake> Sonegaon lake.

To overcome the pollution levels of lake, it is very essential to take proper care for its maintenance. It's a responsibility of both public and government to protect lakes as they are the blue lungs of the city. They provide cooling effect to the city and help to reduce the heat generated due to traffic and nearby thermal activities. Moreover, it has big role on storage of water that helps to maintains ground water table. Hence, the lake needs to be protected.

## V. ACKNOWLEDGEMENT

Authors are thankful to the CSIR-NEERI, Nagpur, India.

## VI. REFERENCES

Muniyellappa, R. M. (2018). Water Quality Monitoring of Magadi Hill Range Lakes and Reservoirs of India. *Hydrology*, *6*(1), 18-31.

Chaudhry, F. N., & Malik, M. F. (2017). Factors affecting water pollution: a review. *J Ecosyst Ecography*, *7*(225), 2.

Ochuka, m., ikporukpo, c., ogendi, g., & mijinyawa, y. (2019). Current World Environment.

Ondiba, R., Omondi, R., Musa, S., Nyakeya, K., Oyoo-Okoth, E., & Abwao, J. (2018). Environmental constraints on macrophyte distribution and diversity in a tropical endorheic freshwater lake (Lake Baringo, Kenya).

Cadotte, M. W., Carscadden, K., & Mirotchnick, N. (2011). Beyond species: functional diversity and the maintenance of ecological processes and services. *Journal of applied ecology*, *48*(5), 1079-1087.

Jiang, Y. J., He, W., Liu, W. X., Qin, N., Ouyang, H. L., Wang, Q. M., ... & Xu, F. L. (2014). The seasonal and spatial variations of phytoplankton community and their correlation with environmental factors in a large eutrophic Chinese lake (Lake Chaohu). *Ecological Indicators*, *40*, 58-67.

Stevenson, J. (2014). Ecological assessments with algae: a review and synthesis. *Journal of Phycology*, *50*(3), 437-461.

Liu, B., & Stevenson, R. J. (2017). Improving assessment accuracy for lake biological condition by classifying lakes with diatom typology, varying metrics and modeling multimetric indices. *Science of the Total Environment*, *609*, 263-271.

Chunne, C. S., & Nasare, N. P., (2018). Macrophytes Biodiversity Assesment of Nanadangaon and Arwat Lakes of Chandrapur District, Maharashtra, India. *International Journal of Scientific Research in Science and Technology*, *4(1)*, 271-273.

Verma, R., Singh, U. B., & Singh, G. P. (2012). Seasonal distribution of phytoplankton in Laddia dam in Sikar district of Rajasthan. *Vegetos*, *25*(2), 165-173.

Singh, U. B., Ahluwalia, A. S., Sharma, C., Jindal, R., & Thakur, R. K. (2013). Planktonic indicators: A promising tool for monitoring water quality (early-warning signals). *Ecology, Environment and Conservation*, *19*(3), 793-800.

Kruk, C. (2010). *Morphology captures function in phytoplankton: a large-scale analysis of phytoplankton communities in relation to their environment*.

Striebel, M., Schabhüttl, S., Hodapp, D., Hingsamer, P., & Hillebrand, H. (2016). Phytoplankton responses to temperature increases are constrained by abiotic conditions and community composition. *Oecologia*, *182*(3), 815-827.

Dooley, Á., Isbell, F., Kirwan, L., Connolly, J., Finn, J. A., & Brophy, C. (2015). Testing the effects of diversity on ecosystem multifunctionality using a multivariate model. *Ecology Letters*, *18*(11), 1242-1251.

Vallina, S. M., Cermeno, P., Dutkiewicz, S., Loreau, M., & Montoya, J. M. (2017). Phytoplankton functional diversity increases ecosystem productivity and stability. *Ecological Modelling*, *361*, 184-196.

Ke, Z., Xie, P., & Guo, L. (2008). Controlling factors of spring–summer phytoplankton succession in Lake Taihu (Meiliang Bay, China). *Hydrobiologia*, *607*(1), 41-49.

Contreras, J. J., Sarma, S. S. S., Merino-Ibarra, M., & Nandini, S. (2009). Seasonal changes in the rotifer (Rotifera) diversity from a tropical high altitude reservoir (Valle de Bravo, Mexico). *Journal of Environmental Biology*, *30*(2), 191-195.

Vaidya, S. R. (2017). Biomonitoring of zooplankton to assess the quality of water in the nagpokhari of Kathmandu valley. *International Journal of Zoology Studies*, *2*(1), 61-65.

Manickam, N., Bhavan, P. S., Santhanam, P., Chitrarasu, P., & Jawahar Ali, A. (2012). Zooplankton diversity in a perennial freshwater lake. *Diversity and Physiological Processes, Goa University, Goa, India. 2012b*, 25-37.

Adelayo, A. A., & Ifianyi, O. E. (2019). Spatio Temporal Distribution and Abundance of Zooplankton Fauna of Edierinal Reservoir. *International Journal of Scientific and Research Publications*, 9(8), 975 ISSN 2250-3153.

Phan, D. D., Nguyen, V. K., Le, T. N., Dang, N. T., & Ho, T. H. (2015). Identification handbook of freshwater zooplankton of the Mekong River and its tributaries. *Mekong River Commission, Vientiane*, 207.

Umadevi, T. (2013). Limnological Investigation and Zooplankton Diversity of Karanja River, Karnataka.

Malhotra, P. (2012). Studies on Zooplanktonic Diversity of River Yamuna in Yamunanagar (Haryana) India. *Egyptian Journal of Aquatic Research*, *33*(1), 183-192.

Manfrin, J., Schwantes, D., Jr. Goncalves, A. C., Schiller, A. D. P., Zimmermann, J., Oliveira, V. H D. D. (2019). Evaluation of benthic macroinvertebrates as indicators of metal pollution in Brazilian rivers, *INTL. J. RIVER BASIN MANAGEMENT*, https://doi.org/10.1080/15715124.2019.1628032.

Ambili, T., & Reenamole, G. R. (2016). Diversity and distribution of benthic macro invertebrates in Ayiroor River, Kerala, South India. *International Journal of Scientific Research*, *5*(3), 1146-1149.

Sharma, R., Kumar, A., & Vyas, V. (2016). Assemblage of macrozoobenthos in Ganjal River-A tributary of River Narmada in the central zone, India. *International Journal of Environmental Sciences*, *6*(6), 1096-1112.

Heino, J. (2009). Biodiversity of aquatic insects: spatial gradients and environmental correlates of assemblage-level measures at large scales. *Freshwater reviews*, *2*(1), 1-29.

Moreno, P., & Callisto, M. (2006). Benthic macroinvertebrates in the watershed of an urban reservoir in southeastern Brazil. *Hydrobiologia*, *560*(1), 311-321.

Peralta, E. M., Batucan Jrd, i, L. S., De Jesus, I. B. B., Trinoc, E. M. C., Ueharaf, Y., Ishidaf, T., Kobayashif, Y., Kog, C., Iwatah, T., Borjae, A. S., Briones, J. C. A., Papa, R. D. S., Magbanuad, F. S., Okudaf, N. (2019). Nutrient loadings and deforestation decrease benthic macroinvertebrate diversity in an urbanised tropical stream system, *Limnologica*, https://doi.org/10.1016/j.limno.2019.125744.

APHA, A. W., Greenberg, W. I. A., Clesceri, L., & Eaton, A. (2012). Standard methods for the examination of water andwastewater. *Wasghington DC American Public HealthAssociation*.

Weber-Scannell, P. K., & Duffy, L. K. (2007). Effects of total dissolved solids on aquatic organism: a review of literature and recommendation for salmonid species. In *American Journal of Environmental Sciences*.

Minnesota Pollution Control Agency, Nutrients: Phosphorus, Nitrogen Sources, Impact on Water Quality, 2008, https://www.pca.state.mn.us/sites/default/files/wq-iw3-22.pdf.

Bhateria, R., & Jain, D. (2016). Water quality assessment of lake water: a review. Sustain Water Resour Manag 2: 161–173.

Penn., Pauer., Mihelcic. (2003). *Environmental and ecological chemistry*, vol 2.

Radulescu, C., Dulama, I. D., Stihi, C., Ionita, I., Chilian, A., Necula, C., & Chelarescu, E. D. (2014). Determination of heavy metal levels in water and therapeutic mud by atomic absorption spectrometry. *Romanian Journal of Physics*, *59*(9-10), 1057-1066.

Recknagel, F., Orr, P. T., & Cao, H. (2014). Inductive reasoning and forecasting of population dynamics of Cylindrospermopsis raciborskii in three sub-tropical reservoirs by evolutionary computation. *Harmful Algae*, *31*, 26-34.

Chang, C. H., Cai, L. Y., Lin, T. F., Chung, C. L., Van der Linden, L., & Burch, M. (2015). Assessment of the impacts of climate change on the water quality of a small deep reservoir in a humid-subtropical climatic region. *Water*, *7*(4), 1687-1711.

Livingston, R. J. (2000). *Eutrophication processes in coastal systems: origin and succession of plankton blooms and effects on secondary production in Gulf Coast estuaries*. CRC press.

Paerl, H. W., Valdes, L. M., Pinckney, J. L., Piehler, M. F., Dyble, J., & Moisander, P. H. (2003). Phytoplankton photopigments as indicators of estuarine and coastal eutrophication. *BioScience*, *53*(10), 953-964.

Leruste, A., Malet, N., Munaron, D., Derolez, V., Hatey, E., Collos, Y., ... & Bec, B. (2016). First steps of ecological restoration in Mediterranean lagoons: Shifts in phytoplankton communities. *Estuarine, Coastal and Shelf Science*, *180*, 190-203.

Pick, F. R. (2016). Blooming algae: a Canadian perspective on the rise of toxic cyanobacteria. *Canadian Journal of Fisheries and Aquatic Sciences*, *73*(7), 1149-1158.

Shi, X., Li, S., Li, H., Chen, F., & Wu, Q. L. (2019). The community structure of picophytoplankton in Lake Fuxian, a deep and oligotrophic mountain lake. *Frontiers in microbiology*, *10*, 2016.

Round, F. E. (1984). *The ecology of algae*. CUP Archive.

Codd, G. A., Lindsay, J., Young, F. M., Morrison, L. F., & Metcalf, J. S. (2005). From mass mortalities to management measures. *Harmful Cyanobacteria*, 1-23.

Gaedke, U., & Straile, D. (1994). Seasonal changes of trophic transfer efficiencies in a plankton food web derived from biomass size distributions and network analysis. *Ecological Modelling*, *75*, 435-445.

Auer, B., Elzer, U., & Arndt, H. (2004). Comparison of pelagic food webs in lakes along a trophic gradient and with seasonal aspects: influence of resource and predation. *Journal of Plankton Research*, *26*(6), 697-709.

Work, K., Havens, K., Sharfstein, B., & East, T. (2005). How important is bacterial carbon to planktonic grazers in a turbid, subtropical lake?. *Journal of plankton research*, *27*(4), 357-372.

Havens, K. E., Beaver, J. R., & East, T. L. (2007). Plankton biomass partitioning in a eutrophic subtropical lake: comparison with results from temperate lake ecosystems. *Journal of Plankton Research*, *29*(12), 1087-1097.

Shafik, H. M., Herodek, S., Presing, M., & Vörös, L. (2001). Factors effecting growth and cell composition of

cyanoprokaryote Cylindrospermopsis raciborskii (Wołoszyńska) Seenayya et Subba Raju. *Algological Studies/Archiv für Hydrobiologie, Supplement Volumes*, 75-93.

Sprőber, P., Shafik, H. M., Présing, M., Kovács, A. W., & Herodek, S. (2003). Nitrogen uptake and fixation in the cyanobacterium Cylindrospermopsis raciborskii under different nitrogen conditions. *Hydrobiologia*, *506*(1-3), 169-174.

Piasecka, A., Nawrocka, A., Wiącek, D., & Krzemińska, I. (2020). Agro-industrial by-product in photoheterotrophic and mixotrophic culture of Tetradesmus obliquus: Production of ω3 and ω6 essential fatty acids with biotechnological importance. *Scientific Reports*, *10*(1), 1-11.

Shan, C. J., Jin, Y. Y., Zhou, Y., & Li, H. (2020). Nitric oxide participates in the regulation of ascorbate-glutathione cycle and water physiological characteristics of Arabidopsis thaliana by NaHS. *Photosynthetica*, *58*(1), 80-86.

Sulata, K., & Devashish, K. (2013). Studies on Zooplankton Diversity of an Oxbow Lake of South Assam, India, *International Journal of Current Research*, Vol. 5, Issue, 12 pp 3652-3655.

Derevenskaya, O., & Umyarova, R. (2016). Zooplankton as an indicator of river ecological condition.

Paulose, P. A., & Maheshwari, K. (2008). Seasonal variation in zooplankton community structure of Ramgarh Lake, Jaipur, Rajasthan. In *Proceedings of Taal2007: The 12 th World Lake Conference* (pp. 82-87).

Badsi, H., Ali, H. O., Loudiki, M., El Hafa, M., Chakli, R., & Aamiri, A. (2010). Ecological factors affecting the distribution of zooplankton community in the Massa Lagoon (Southern Morocco). *African Journal of Environmental Science and Technology*, *4*(11), 751-762.

Sládeček, V. (1983). Rotifers as indicators of water quality. *Hydrobiologia*, *100*(1), 169-201.

Vásquez, E., & Rey, J. (1992). Composition, abundance and biomass of zooplankton in Orinoco floodplain lakes, Venezuela. In *Annales de Limnologie-International Journal of Limnology* (Vol. 28, No. 1, pp. 3-18). EDP Sciences.

Saksena, D. N. (1987). Rotifers as indicators of water quality, *Acta Hydrochimica et Hydrobiologia*, 15 (5), https://doi.org/10.1002/aheh.19870150507.

Patrick, R. (1950). A proposed biological measure of stream conditions: With 4 figures in the text. *Internationale Vereinigung für theoretische und angewandte Limnologie: Verhandlungen*, *11*(1), 299-307.

Kumari, P. R. A. M. I. L. A., Dhadse, S. H. A. R. D. A., Chaudhari, P. R., & Wate, S. R. (2007). Bioindicators of pollution in lentic water bodies of Nagpur city. *Journal of Environmental Science & Engineering*, *49*(4), 317-324.

Trommer, G., Lorenz, P., Lentz, A., Fink, P., & Stibor, H. (2019). Nitrogen enrichment leads to changing fatty acid composition of phytoplankton and negatively affects zooplankton in a natural lake community. *Scientific reports*, *9*(1), 1-11.

Hanazato, T., & Dodson, S. I. (1995). Synergistic effects of low oxygen concentration, predator kairomone, and a pesticide on the cladoceran Daphnia pulex. *Limnology and Oceanography*, *40*(4), 700-709.

Halbach, U., & Halbach-Keup, G. (1974). Quantitative beziehungen zwischen phytoplankton und der populationsdynamik des rotators Brachionus calyciflorus Pallas. Befunde aus laboratoriumsexperimenten und freilanduntersuchungen. *Archiv für Hydrobiologie*, 273-309.

Lass, S., & Spaak, P. (2003). Chemically induced anti-predator defences in plankton: a review. *Hydrobiologia*, *491*(1-3), 221-239.

Xi, Y. L., Liu, G. Y., & Jin, H. J. (2002). Population growth, body size, and egg size of two different strains of Brachionus calyciflorus Pallas (Rotifera) fed different algae. *Journal of Freshwater Ecology*, *17*(2), 185-190.

Gobler, C. J., Davis, T. W., Coyne, K. J., & Boyer, G. L. (2007). Interactive influences of nutrient loading, zooplankton grazing, and microcystin synthetase gene expression on cyanobacterial bloom dynamics in a eutrophic New York lake. *Harmful Algae*, *6*(1), 119-133.

Saad, A., Waheed, Emam, M., Shabrawy, G., El-Shabrawy, M., Gowedar, F. (2013). Sewage pollution and zooplankton assemblages along the Rosetta Nile branch at El Rahawy area, Egypt. *International Journal Of Environmental Science And Engineering (IJESE)*, 4: 29-45. https://www.researchgate.net/deref/http%3A%2F%2Fwww.pvamu.edu%2Ftexge.

Haldar, R., Kosankar, S., Sangolkar, L. N. (2016). Ecological significance of macro-invertebrats as an indicator of environmental pollution, *International Journal of Engineering Science and Computing*, 6(11):3302-3307.

Goswami, A. P., & Mankodi, P. C. (2012). Study on Zooplankton of Fresh Water Reservoir Nyari–II Rajkot district, Gujarat, India. *ISCA Journal of Biological Sciences*, *1*(1), 30-34.

Ciborowski, J. J. H., & Corkum, L. D. (2003). Appendix 9: Sediment-zoobenthos interactions. In evaluating ecosystem results of pcb control measures within the detroit river–western lake erie basin. *United Earth Fund*, 78-82.

Saether, O. A. (1979). Chironomid communities as water quality indicators. *Ecography*, *2*(2), 65-74.

Winnell, M. H., & White, D. S. (1985). Trophic status of southeastern Lake Michigan based on the Chironomidae (Diptera). *Journal of Great Lakes Research*, *11*(4), 540-548.

Langdon, P. G., Ruiz, Z. O. E., Brodersen, K. P., & Foster, I. D. (2006). Assessing lake eutrophication using

chironomids: understanding the nature of community response in different lake types. *Freshwater biology*, *51*(3), 562-577.

Choudhary, A., & Ahi, J. (2015). Biodiversity of freshwater insects: a review. *The Int. J. Engi. Sci*, *4*(10), 25-31.

Solanki, R., & Shukla, A. (2015). Aquatic insects for biomonitoring freshwater ecosystems: A report. *International Journal of Science and Research (IJSR). ISSN (Online)*, 2319-7064.

Sitre, S. R. (2013). Benthic Macroinvertebrates and Aquatic Insects of a Rural Fresh Water Reservoir of Bhadrawati Tehsil in Chandrapur District. *Online International Interdisciplinary Research Journal*, ISSN2249-9598, III (I).

Pal, M., & Dey, A. (2011). Diversity of mollusca of wetlands of Kolkata metropolitan area. *Proceedings of the* ISSN 2348-1269, P- ISSN 2349-5138).

*National Academy of Sciences India Section B-Biological Sciences*, *81*, 280-284.

Jacob, S., & Manju, E. K. (2013). Potential of Odonate (Dragonflies and Damselflies) Diversity as a BioIndicator of Water Quality. *International Journal of Science and Research*, 6 (14).

Brinkhurst, R. O. (1963). Taxonomical studies on the Tubificidae (Annelida, Oligochaeta). Internationale Revue der gesamten Hydrobiologie, Systematische Beihefte, 2, 1–89.

Liu, Y., Fend, S. V., Martinsson, S., & Erséus, C. (2017). Extensive cryptic diversity in the cosmopolitan sludge worm Limnodrilus hoffmeisteri (Clitellata, Naididae). Organisms Diversity & Evolution, 17(2), 477-495.Bera, B. (2019). Faunal composition of benthic macro invertebrates and their importance in an urban fresh water lake ecosystem, ijrar, 6(2),www.ijrar.org(E