A Study of Trophic Level Status of Freshwater Ecosystems of Bhandara District of Central India

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Abstract

Though freshwater is one of the abundantly available substances in nature, which man has exploited more than any other resources for the sustenance of life. Moreover, the uncontrolled use of natural resources has put enormous strain on the quality of inland or freshwater. In the backdrop of above information, this study was carried out to determine the trophic status of the freshwater resources of the Bhandara District of the central India. This district was selected as it is known as the district of lakes and there is abundant water availability. In all eleven different lakes were selected for the purpose of data collection. The water samples were collected and processed by following standard methods. The trophic status assessment of the lakes was carried out by following standard methods. Specifically, the parameters such as phosphorous, nitrogen, chlorophyll *a* and transparency (using Secchi disc) were assessed. Analysis of data was done with the help of suitable statistical tests and with the aid of PASW 18.0 software. The results of the study showed that the variation in concentration of phosphorous was from 1.3±0.5 to 3.1±1.1 mg/L and nitrogen was 3.4±1.3 to 8.1±2.2 mg/L. The transparency in majority of lakes was less than 1.9 meters, whereas the chlorophyll-a varied from 3.9 to 8.3 mg/L. Upon further calculation, it was observed that majority ($P<0.05$) of freshwater resources of Bhandara District are mesotrophic. Thus, it may be concluded that the freshwater resources of the region are severely under nutrient pollution threat and demand that better practices be followed to restore the water quality.

1.0 Introduction

Water is the universal solvent on Earth which man has exploited more than any other resources for the sustenance of life.Of the total amount of global water only 2.4% is distributed on terrestrial region. From this amount only a small portion can be utilized as a freshwater. Unfortunately, the water resources are being polluted by indiscriminate disposal of sewage, industrialization, urbanization & developmental thrust of man. Most water bodies become contaminated due to incorporation of untreated solid and liquid waste. Large towns in India are situated near the dams, their run off and those from agricultural lands find their way to the River and add in dam water which unfit for human use (Jayabhaye et al., 2008). Potentially the most serious factor stemming from demotechnic growth today is the severe decline in water quality, resulting from various contaminants or pollutants. Fresh waters of the world are thus collectively experiencing markedly accelerating rates of qualitative and quantitative degradation (Wetzel, 2001). The understanding of aqua resources will not only promote greater efficiency in the allocation of ecological resources for all human needs, but would also assure a sustainable scale of economic activity within the ecological life-support systems. Besides, protecting the precious aquatic ecological systems to sustain welfare is of as much importance to poor countries as it is to the rich (Khanna *et al*., 1999).

The importance of aquatic ecosystem health lies in the fact that where an ecosystem is out of balance, humans suffer as well. Human health and many of the activities are dependent on the health of aquatic ecosystems. Most of the drinking water is taken from lakes or rivers. If the lake or river system is unhealthy, the water may be unsafe to drink or unsuitable for industry, agriculture, or recreation. Uses of aquatic ecosystems are thus impaired when these systems are unhealthy. The health of aquatic ecosystem primarily depends on the status of environmental pollution, which is defined as the introduction of any organic or inorganic substance, energy form, and/ or other stresses (gases, genotoxic agents, radionuclides, etc.) to the environment at a rate faster than its assimilation by dispersion, recycling, detoxification, bioremediation, or storage in some harmless form. This pollution may change the composition, function, and trophic status of ecosystems in reversible or irreversible ways by affecting their biotic or abiotic components. Possible pathways for aquatic contamination are treated or untreated domestic/ municipal wastewater, surface runoff and industrial wastes (Heininger *et al*., 1998; Tariq *et al*., 1996; Moll and Mansfield, 1991). Amongst the biotic factors, algae are an important component of biological monitoring programs for evaluating water quality. They are suited to water quality assessment because of their nutrient needs, rapid reproduction rate, and very short life cycle. Algae are valuable indicators of ecosystem conditions because they respond quickly both in species composition and densities to a wide range of water conditions due to changes in water chemistry. For example, increases in water acidity due to acid-forming chemicals that influence lake pH levels, as well as heavy metals discharged from industrial areas, affect the composition of genera that are able to tolerate these conditions. Algae can be used as bioindicator organisms to identify and qualify the effects of pollutants on the environment. Although indicator organisms can be any biological species that defines a trait or characteristics of the environment, algae are known to be good indicators of pollution of many reasons like, they have wide temporal and spatial distribution, many species are available all the year, they respond quickly to the changes in the environment due to pollution, easier to detect and sample, etc. in the backdrop of above information, regarding the pollution of water bodies researcher decided to carry out the study selecting the topic i.e. A study of trophic level status of freshwater ecosystems of Bhandara district of central India Wherein, systemic enumeration of algal taxa and ecophysiological status of different habitats of Bhandara district was carried out.

2.0 Materials and Methods

2.1 Study Area - Bhandara District

Bhandara is known as *District of Ponds.* Famous for bumper crop of rice and bamboo plantations, its traditional craft of manufacturing metal utensils and the thriving mining industry are its principal activities. The District Of Bhandara in the North-Eastern extreme of the Nagpur Division of Maharashtra State lies between 20°39' and 21°38' north latitudes and 79°27' and 80°42' east longitudes. Geographically, the district lies entirely within the Wainganga basin. The district covers an area of 9280.0 km^2.

2.2 Primary Data Collection-Sampling

Based on the reconnaissance survey, total eleven (Gosekhurd, Lake at Lakhani, Lake at Lakhandur, Chandpur Dam, Bhandara Lake, Bhandara River Stretch, Wahi Lake, Shivani Bandh, Pauni - Near Bridge on Wainganga, Khurada Lake, Balsamudra Lake) sampling sites were selected for the purpose of data collection.

2.3 Sample Collection

The water samples were collected by following standard methods and were preserved as per standard methods until they reached the laboratory. A record of identification was made of every sample collected and each sampling bottle/flask was accompanied by attaching an appropriately inscribed label of accurate descriptive data such as name of site, date and time. The quantity of sample was sufficient to carry out all the tests.

2.4 Analytical Methods Used

A number of standard analytical methods were used for the purpose of data collection. The parameters were, surface water temperature, pH, free CO_2, dissolved oxygen, total alkalinity, chloride, hardness (total, calcium and magnesium), phosphorous, nitrate, electrical conductivity, and identification and enumeration of prevailing algal flora. For qualitative study of Algal flora, samples were collected at monthly intervals from the selected sampling locations from Bhandara District. The different forms such as phyloplankton, epiphytic, epilethic & floating forms of Algae were collected in acid washed bottles & they were preserved in 4% formalin for further study of investigation. For identification of the collected algal species, line drawings of taxa were sketched with the help of camera Lucida method. The algal taxa were identified with the help of relevant monographs & standards literatures (Desikachary, 1959; Bruhl, and Biswas, 1926; Prescott, 1951; Turner, 1978; Gerrath, 2005; Brook and Johnson, 2002; Coesel and Meesters, 2007). All identified Algal taxa were arranged taxonomically.

2.5 Statistical Analysis of Data and Significance Level

The descriptive statistics, such as mean, standard deviation, standard error, percentage, minimum and maximum, etc. were determined from the collected data. The Analysis of Variance procedure was used for determining the difference in the mean values for different parameters. The significance level was chosen to be 0.05 (or equivalently, 5%). The data generated during the study was processed using various statistical tests with the aid of Statistical Package for Social Sciences (SPSS) 18.0 software.

3.0 Results and Discussion

Trophic status

The sources of nutrients in urban areas are domestic sewage, industrial waste, drainage etc. whereas in rural areas sources of nutrient are those from agriculture, forest management & rural dwellings.Out of which agricultural sources is the chief one since some lakes are situated in rural aeas, the main sources of the pollution are agriculture run of & rural dwellings. The surroundings of the lake basin is rich in agricuture particularly paddy & the waterways passing through these fields carry a load of pesticides into the lake. A normal oligotrophic lake is quickly rendered eutrophic under the influence of pollution. A lot of washer men washing the clothes were seen & the detergents' that are being used for washing the clothes from which phosphates passes into the water body, leads to deteriorate the water quality.
Vollen Weider (1968), Zutshi (1976) and Cheng & Tyler (1976) , Pant et al. (1979) have attributed different trophic classifications to different water bodies . The physicochemical factors such as temp., pH, free CO_2, DO, Carbonate, Bicarbonate, Phosphorus, nitrate, value have placed the lakes in mesotrophic status.Hence the author is placing the water bodies as Mesotrophic & getting eutrophicated.

Temperature

It was evident from the data that highest average surface water temperature of 28.5±1.8°C (26°C - 31°C) was recorded at Wahi Lake, whereas lowest average surface water temperature of 22.5±2.0°C (21°C - 26°C) was observed at Gosekhurd

Dam during the winter season. Whereas, highest average surface water temperature of 32.5±3.0°C (28°C - 37°C) was recorded at Bhandara Lake, whereas lowest average surface water temperature of 26.3±5.8°C (21°C - 34°C) was observed at Gosekhurd Dam during the summer season. Moreover, it was apparent from the data that highest average surface water temperature of 27.6±2.9°C (23°C - 31°C) was recorded at Bhandara river, whereas lowest average surface water temperature of 24.1±3.4°C (21°C - 28°C) was observed at Gosekhurd Dam during monsoon season.

pH

It was evident from the data that highest average surface water pH of 8.3±0.5 (7.8 - 9.3) was recorded at Pauni- Near Bridge, whereas lowest average surface water pH of 7.2±0.1 (7.1 - 7.3) was observed at Chandpur during winter season. Furthermore, highest average surface water pH of 8.6±0.5 (8 - 9) was recorded at Bhandara river, whereas lowest average surface water pH of 7.5±0.2 (7 - 8) was observed at Bhandara Lake during summer season. Besides, highest average surface water pH of 8.1±0.5 (7 - 9) was recorded at Bhandara river, whereas lowest average surface water pH of 6.5±0.4 (6 - 7) was observed at Gosekhurd Dam during monsoon season.

Free CO_2

It was evident from the data that highest average surface water Free CO_2 of 9.5±0.5ppm (8.9 - 10.3 ppm) was recorded at Bhandara River, whereas lowest average surface water Free CO_2 of 2.8±1.1ppm (1.5 - 4.2 ppm) was observed at Lakhani during winter season. It was apparent from the data that highest average surface water Free CO_2 of 9.2±3.1ppm (6 – 13 ppm) was recorded at Bhandara river, whereas lowest average surface water Free CO_2 of 2.6±0.8 ppm (1 – 4 ppm) was observed at Lakhani during summer season. It was apparent from the data that highest average surface water Free CO_2 of 6.0±0.7 ppm (5 -7 ppm) was recorded at Balsamudra Lake, whereas lowest average surface water Free CO_2 of 3.1±0.5ppm (3 – 4 ppm) was observed at Lakhandur during monsoon season.

Dissolved Oxygen

Highest average surface water Dissolved Oxygen of 8±0.5 ppm (7.1 - 8.7 ppm) was recorded at Wahi Lake, whereas lowest average surface water Dissolved Oxygen of 6.5±1.7ppm (4.5 - 8.3 ppm) was observed at Khurada Lake during winter season. Moreover, highest average surface water Dissolved Oxygen of 7.1±0.7 ppm (6 – 8 ppm) was recorded at Lakhani, whereas lowest average surface water Dissolved Oxygen of 4.6±0.5ppm (4 – 5 ppm) was observed at Khurada Lake during summer season. Besides, highest average surface water Dissolved Oxygen of 6.9±1.1ppm (6 – 9 ppm) was recorded at Lakhandur, whereas lowest average surface water Dissolved Oxygen of 6±0.3 ppm and 6±0.2 ppm was observed at Chandpur and Shivani Bandh respectively during monsoon season.

Carbonate

Highest average surface water carbonate of 21.3±1.5ppm (19.4 - 23.8 ppm) was recorded at Lakhani, whereas lowest average surface water carbonate of 13.2±1.6ppm (10.5 - 15.6 ppm) was observed at Gosekhurd during winter season. Furthermore, highest average surface water carbonate of 24±2.1ppm (21 – 17 ppm) was recorded at Lakhani, whereas lowest average surface water carbonate of 13.4±1.9ppm (varied between 11ppm and 16ppm) was observed at Gosekhurd Dam during summer season. Highest average surface water carbonate of 21.2±2.7ppm (17 - 25ppm) was recorded at Khurada Lake, whereas lowest average surface water carbonate of 16±4ppm (10 – 20 ppm) was observed at Balsamudra Lake during monsoon season.

Bicarbonate

Highest average surface water bicarbonate of 191±9.4ppm (varied between 176ppm and 203ppm) was recorded at Shivani Bandh, whereas lowest average surface water bicarbonate of 127.1±14.4ppm (varied between 111ppm and 148ppm) was observed at Bhandara Lake during winter season. Furthermore, highest average surface water bicarbonate of 212±6.4ppm (201 – 222 ppm) was recorded at Shivani Bandh, whereas lowest average surface water bicarbonate of 131.4±24.9ppm (109 - 175ppm) was observed at Chandpur during summer season. Highest average surface water bicarbonate of 180.2±13.2ppm (156 – 192 ppm) was recorded at Wahi Lake, whereas lowest average surface water bicarbonate of 118.1±46.8ppm (9 - 152ppm) was observed at Balsamudra Lake during monsoon season.

Phosphorous

Highest average phosphorous content of surface water was2.3±1.2ppm (1 - 5ppm) recorded at Gosekhurd Dam, whereas lowest average phosphorous content of surface water was1.3±0.1ppm (0.9 - 1.4ppm) observed at Shivani Bandh and Pauni-Near Bridge during winter season. Highest average phosphorous content of surface water was5.1±1.8ppm (3 – 9 ppm) recorded at Gosekhurd Dam, whereas lowest average phosphorous content of surface water was 1.3±0.2ppm (1 - 2 ppm) observed at Shivani Bandh during summer season. Highest average phosphorous content of surface water was6.9±4.4ppm (1.3-11ppm) recorded at Gosekhurd Dam, whereas lowest average phosphorous content of surface water was 0.9±0.2ppm (0.6 – 1 ppm) observed at Lakhandur during monsoon season.

Nitrate

Highest average nitrate content of surface water was5.2±0.7ppm (varied between 4ppm and 6ppm) recorded at Lakhani, whereas lowest average nitrate content of surface water was0.2±0.1ppm (0.2-0.3ppm) observed at Shivani Bandh during winter season. Furthermore, highest average nitrate content of surface water was 6.7±0.7ppm (5-7ppm) recorded at Lakhani, whereas lowest average nitrate content of surface water was 0.3±0.1ppm (0.1-0.5 ppm) observed at Shivani Bandh during summer season. On the other hand highest average nitrate content of surface water was5.6±0.6ppm (5 - 7ppm) recorded at Wahi Lake, whereas lowest average nitrate content of surface water was 0.5±0.2ppm (0.3 - 1ppm) observed at Shivani Bandh during monsoon season.

No. of Species of Algae

It was evident from the data that highest no. algal species i.e. 63±6.5 each were identified in surface water from Gosekhurd Dam, Chandpur, Shivani Bandh, Pauni-Near over bridge and Khurada Lake; whereas lowest no. of algal species i.e., 56±7.4 were identified in surface water from Wahi Lake. It was apparent from the statistical analysis (ANOVA) that there is no significant difference in no. of species of algae identified from different water bodies in Bhandara District during winter season. Besides, highest no. algal species i.e. 49±12.7 were identified in surface water from Lakhandur; whereas lowest no. of algal species i.e., 43.8±20.9 were identified in surface water from Lakhani during summer season. It was apparent from the data that highest no. algal species i.e. average 28.1±7 were identified in surface water from Lakhandur; whereas lowest no. of algal species i.e., average 21.8±9.9 were identified in surface water from Pauni- Near Bridge. It was apparent from the statistical analysis (ANOVA) that there is no significant difference in no. of species of algae identified from different water bodies in Bhandara District during monsoon season, however; majority of algal species were identified in surface water of Lakhandur. List of all the

Algal species isolated and identified from aquatic resources of Bhandara District is presented in Annexure.

Conclusions

The study results indicated that there was a significant (P <0.05) positive relationship between nutrients like phosphorous and nitrate and the number of algal species. This was evident for all the waterbodies indicating that the overall water quality with respect to nutrient status is not appropriate and needs attention from the Govt. as well as other agencies. The study indicates that the overwhelming proportion of the waterbodies of the study region i.e. Bhandara District are polluted with nutrients, organic contents, which was evident from the phosphorous and nitrate concentration of the aquatic resources studied. So though good quality freshwater is important for health, economic prosperity, and personal enjoyment, on the basis of the study results, it can be concluded that the water quality of the lakes and other aquatic resources of Bhandara District is not up to the mark. Hence, proper guidelines pertaining to the use of freshwater should be developed to ensure sustainable development.

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List of all the Algal species isolated and identified from aquatic resources of Bhandara District

Class – I

Genus - ***Achnanthes*** Bory.
- ***Achnanthes minutissima*** Kutz. v. ***cryptocephala*** Grun.

Genus - ***Closterium*** Nitzsch.
- ***Closterium acerosum v. elongatum*** Breb.(Irenee-Marie f) (Prescott I)
- ***Closterium ehrenbergii*** *Menegh.* (Irenee-Marie f) (Nordstedt) (Prescott I)
- ***Closterium intermedium*** *Ralfs.* (Irenee-Marie f) (Nordstedt) (Prescott I)

Genus - ***Fragillaria*** Lyngbye
- ***Fragillaria capucina*** Dems v. arctica A. Cl.

Genus - ***Gyrosigma*** Hassall
- ***Gyrosigma baikalensis*** Skv.

Genus - ***Navicula*** Bory
- ***Navicula cuspidata*** Kuetz. v. heribaudi Peragallo
- ***Navicula grimii*** Krasske
- ***Navicula halophila*** (Grun.) Cleve f. subcapitata Ostrup.

Genus - ***Nitzschia*** Hass
- ***Nitzschia gracilis*** Hantzsch

Genus - ***Pinnularia*** Threnberg.
- ***Pinnularia scythica*** (Pant.) Gandhi

Genus - ***Pleurosigma***
- ***Pleurosigma chandolensis*** Gandhi

Genus - ***Synedra*** Ehrenb.
- ***Synedra ulna*** (Nitzsch) Ehrenb.

Class - III
- ***Anabaena circinalis*** Rab. (Geitler f) (Prescott f)

Class - II

Family - Selenastraceae

Genus - ***Ankistrodesmus*** Corda.
- ***Ankistrodesmus falcatus*** (Corda) Ralfs.
- ***Ankistrodesmus spiralis*** (Turn.) Lemm

Family - Chaetophoraceae

Genus - ***Chaetophora*** Schrank
- ***Chaetophora elegans*** (Roth) Ag.

Family - Chlorellaceae.

Genus - ***Chlorella***.
- ***Chlorella vulgaris*** Beijerinck

Genus - ***Chlorococcum*** Meneghini emend. Starr.
- ***Chlorococcum humicola*** (Naegeli) Rabenhorst
- ***Chlorococcum infusionum*** (Schrank) Meneghini

Genus - ***Cladophora*** Kuetzing
- ***Cladophora crispata*** (Roth) Kuetz. (Collins) (Phinney) (Prescott f)
- ***Cladophora glomerata*** (L.) Kuetz. (Collins) (Phinney) (Prescott f)

Genus - ***Cosmarium*** Corda
- ***Cosmarium bioculatum*** Breb.
- ***Cosmarium contractum*** Kirchner.
- ***Cosmarium impressulum*** Elfv.
- ***Cosmarium margaritatum*** (Lund.) Roy & Biss.
- ***Cosmarium mononazum*** (Lund.)

Genus - ***Docidium***, Breb.
- ***Docidium latum.***

Genus - ***Draparnaldia***

- o ***Anabaena flos-aquae*** (Lyngb.) Breb. (Geitler f) (Prescott f)
- o ***Anabaena variabilis*** Kutzing ex Born. et Flah.
- o ***Aphanocapsa muscicola*** (Menegh.) Wille.

Genus - ***Aulosira*** Kirchner

- ***Aulosira fertilissima*** Ghose
- ***Aulosira fertilissima*** Ghose Var. **tenuis** Rao, C.B.
- ***Aulosira prolifica*** Bharadwaja

Genus - ***Calothrix*** Ag.

- ***Calothrix clavata*** West, G.S.
- ***Chroococcus macrococcus*** (Kutz.) Rabenh.
- ***Chroococcus turgidus*** (Kutz.) Nag.

Genus - ***Cylindrospermum*** Kutz.

- ***Cylindrospermum indicum*** Rao, C.B., orth. Mut. De. Toni

Genus - ***Gloeocapsa*** Kutzing.

- ***Gloeocapsa montana*** Kutz.
- ***Gloeocapsa nigrescens*** Nag.

Genus - ***Hapalosiphon*** Nag.

- ***Hapalosiphon welwitschii*** W. et G.S. West

Genus - ***Lyngbya*** Ag.

- ***Lyngbya hieronymusii*** Lemm.
- ***Lyngbya limnetica*** Lemmermann
- ***Lyngbya maharastrensis*** Kamat

Genus - ***Merismopedia*** Meyen

- ***Merismopedia elegans*** A.Sr.
- ***Merismopedia tenuissima*** Lemm.

Genus - ***Microchaete*** Thuret

- ***Microchaete calothrichoides*** Hansgirg

Genus - ***Microcoleus*** Desmazieres

- ***Microcoleus chthonoplastes*** Thurst ex.
- o ***Draparnaldia glomerata*** (Vauch.) Ag. (Hazen f) (Prescott f) (Smith).
- o ***Draparnaldia plumosa*** (Vauch.) Ag, (Hazen f) Prescott f) (Smith)

Genus - **Euastrum**

- o ***Euastrum dubium*** Nageli Synonym *Euastrum binale* Ralfs.
- o ***Euastrum spinulosum Delponate var. spinulosum*** Prescott et al, 1977:

Genus - ***Oedogonium*** link.

- o ***Oedogonium globosum*** Nordstedt ex Hirn.

Genus – ***Pediastrum*** Meyen

- o ***Pediastrum boryanum*** v. ***longicorne*** Racib.
- o ***Pediastrum simplex*** v. ***duodenarium*** (Bail.) Rab. (Prescott f) (Smith f).

Genus **– *Pithophora*** Wittrock

- o ***Pithophora kewensis*** Wittr. (Heering, 1921 f) (Smith)

Genus - ***Scenedesmus*** Meyen.

- o ***Scenedesmus bijugatus*** (Turpin) Kutzing Var. ***Bicellularis*** (Chodat)
- o ***Scenedesmus dimorphus***. (Turpin) Kuetzing.
- o ***Scenedesmus falcatus*** Chodat
- o ***Scenedesmus obliquus***. (Turpin) Kuetzing.
- o ***Scenedesmus quadricauda*** v. ***longispina*** (Chod.) G. M. Smith(Prescott f)

Genus - ***Selenastrum***. Reinsch.

- o ***Selenastrum westii*** G.M. Smith (Prescott f) (Smith, 1920 f)

Genus - ***Spirogyra***. Link.

- o ***Spirogyra communis*** (Hassal) Kutzing. (Czurda f) (Prescott f)
- o ***Spirogyra neglecta***. (Hass.) Kuetz. (Czurda f) (Trauseau f)

Genus - ***Staurastrum***

- o ***Staurastrum cuspidatum*** Breb. (Irenee-Marie f). (Nordstedt)
- o ***Staurastrum gracile*** Ralfs. (Irenee-Marie f). (Nordstedt) (Prescott I)
- o ***Staurastrum manfeldtii*** Delp. (Irenee-Marie f). (Nordstedt)

Genus - ***Stigeoclonium***

- o ***Stigeoclonium nanum*** (Dillw.) Kuetz.

Gomont.

Genus - ***Microcystis*** **Kutzing**

- ***Microcystis aeruginosa*** Kutz.
- ***Microcystis marginata*** (Menegh.) Kutz.

Genus - ***Nostoc*** Vaucher

- ***Nostoc commune*** Vaucher ex Born. et Flah.
- ***Nostoc calcicola*** Brebisson ex Born. et Flah.
- ***Nostoc sphaericum*** Vaucher ex Born. et Flah.

Genus - ***Oscillatoria*** Vaucher

- ***Oscillatoria chilkensis*** Biswas
- ***Oscillatoria limosa*** Ag. ex Gomont.
- ***Oscillatoria sancta*** (Kutz.) Gomont

Genus - ***Phormidium*** Kutz

- ***Phormidium anomala*** Rao, C.B.
- ***Phormidium autumnale*** **(Ag.) Gomont.**
- ***Phormidium subfuscum*** Kutz. Gomont
- ***Rivularia beccariana*** (De Not.) Born. et Flah.

Genus - ***Schizothrix*** Kutz.

- ***Schizothrix lardacea*** (Ces.) Gomont
- ***Scytonema javanicum*** (Kutz.) Bornet ex. Born.et Flah.

Genus - ***Spirulina*** Turpin em. Gardner

- ***Spirulina gigantea*** Schmidle
- ***Spirulina major*** Kutz. ex Gomont

Genus - ***Tolypothrix*** Kutzing

- ***Tolypothrix distorta*** Kuetzingex Born. et Flah.
- ***Tolypothrix tenuis*** Kutz.

(Hazen) (Prescott f) (Smith)

Class - IV

Genus - ***Euglena***

- ***Euglena acus*** Ehrenberg (Gojdics f) (Prescott f) (Smith f)
- ***Euglena mutabilis*** Schmitz.

Genus - ***Phacus.***

- ***Phacus orbicularis*** Hueb. (Pascher & Lemmermann f) (Prescott f)
- ***Phacus longicaudus*** (Her.) Duj. (Pashcher & Lemmermann f) (Prescott f)