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ECOPHYSIOLOGICAL STUDIES OF SELECTED POTABLE AND NONPOTABLE WATER BODIES OF NAGPUR CITY, MAHARASHTRA

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Abstract:
Algae are frequently found in polluted & non-polluted water due to this behavior, they are generally considered useful to determine the quality of water. The physicochemical parameters like water temperature, pH, free CO_2, DO, carbonate, bicarbonate, total alkalinity, chloride, hardness, Ca, Mg, phosphate& nitrate were estimated by standard methods. A perusal of literature indicates that very little work has been done on the algal flora in & around Nagpur city. It is clear that still a lot of work remains to be done with reference to Eco physiological aspect of algae in & around Nagpur city. The present investigation was therefore undertaken to access the algal flora in & around Nagpur city. The study area of Nagpur district geographically located at 20^{0}35' and 21^{0}44' North and 78^{0}15' and 79^{0}40' East, it is situated at the junction of catchment of two rivers Wardha & Wainganga rivers. The district covers an area of 3840 square miles. The Wainganga river & some surface water bodies are polluted mainly because of the sewage. In view of this, there is an urgent need to undertake remedial measures for the conservation of aquatic ecosystem.
Keywords: Freshwater, Phosphate, Nitrate, Eco-physiology, Algae

Introduction:

Water is one of the abundantly available substances in nature, which man has exploited more than any other resources for the sustenance of life. Water of good quality is required for living organisms; however, there is scarcity of the same especially with respect to its quality. Unfortunately, the water resources are being polluted by indiscriminate disposal of sewage, industrial wastes and human activities. 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. Regular checks and balances will not only prevent the outbreak of diseases and other hazards; but will also have a check on the future deterioration of these water bodies (Nagarsekar and Kakde 2014 a & b).

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. taxonomical and ecophysiological studies on the algal flora in & around Nagpur city, Maharashtra, India. Wherein, systemic enumeration of algal taxa and ecophysiological status of different habitats of Nagpur city was carried out.

Material and Methods:

Primary Data Collection-Sampling:

Based on the reconnaissance survey, total six (Gandhisagar lake, Gorewada lake, Sakkardara lake, Ambazari lake, Futala lake, Vena lake) sampling sites were selected for the purpose of data collection.

Sample Collection:

The water samples were collected by following standard methods APHA (1992) 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.

Analytical Methods Used:

A number of standard analytical methods were used APHA(1992) 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 in & around Nagpur city. 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.

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.

Results and Discussion:

Species of Algae

It was evident from the data that increased counts of algal species i.e. 64□6.6 each were identified in surface water from Gandhisagar lake, Gorewada lake, Sakkardara lake, Ambazari lake and Futala Lake; whereas lowest (55□7.5) were registered in surface water from Vena Lake. It was apparent from the statistical analysis (ANOVA) that there is no significant difference in number of algal species identified from different water bodies in & around Nagpur city during winter season. Besides, highest number of algal species (49□12.7) were identified in surface water from Gorewada lake; and lowest number of algal species (44.8□20.7) were identified in surface water from Gandhisagar lake during summer season. It was apparent from the data that highest number algal species i.e. average 28.2□7 were identified in surface water from Gorewada lake; whereas lowest number of algal species i.e., average 22.8□9.8 were identified in surface water from Ambazari lake. It was apparent from the statistical analysis (ANOVA) that there is no significant difference in number of algae identified from different water bodies in & around Nagpur city during monsoon season, however; majority of algal species were identified in surface water of Gorewada lake.

List of all the Algal species isolated and identified from these aquatic resources in & around Nagpur city is presented in Table.

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 water bodies 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 water bodies of the study region i.e. in & around Nagpur city 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 in & around Nagpur city is not up to the mark. Hence, proper guidelines pertaining to the use of freshwater should be employed to ensure sustainable development.

Table 1: List of all the Algal species isolated and identified from aquatic resources in & around Nagpur city

Class – I	**Class - II**
Genus - ***Achnanthes*** Bory. ***Achnanthes minutissima*** Kutz. v. ***cryptocephala*** Grun. Family - Chaetophoraceae Genus - ***Chaetophora*** Schrank	
Genus - ***Fragillaria*** Lyngbye	➢ ***Chaetophora elegans*** (Roth) Ag.
➢ ***Fragillaria capucina*** Dems v. arctica A. Cl.	Family - Chlorellaceae.
Genus - ***Gyrosigma*** Hassall	Genus - ***Chlorella***.
➢ ***Gyrosigma baikalensis*** Skv.	➢ ***Chlorella vulgaris*** Beijerinck
Genus - ***Navicula*** Bory	Genus - ***Chlorococcum*** Meneghini emend. Starr.
➢ ***Navicula cuspidata*** Kuetz. v. heribaudi Peragallo	➢ ***Chlorococcum humicola*** (Naegeli) Rabenhorst
➢ ***Navicula grimii*** Krasske	➢ ***Chlorococcum infusionum*** (Schrank) Meneghini
➢ ***Navicula halophila*** (Grun.) Cleve f. subcapitata Ostrup.	Genus - ***Cladophora*** Kuetzing
Genus - ***Nitzschia*** Hass	➢ ***Cladophora crispata*** (Roth) Kuetz. (Collins) (Phinney) (Prescott f)
➢ ***Nitzschia gracilis*** Hantzsch	➢ ***Cladophora glomerata*** (L.) Kuetz. (Collins) (Phinney) (Prescott f)
Genus - ***Pinnularia*** Threnberg.	Genus - ***Cosmarium*** Corda
➢ ***Pinnularia scythica*** (Pant.) Gandhi	➢ ***Cosmarium bioculatum*** Breb.
Genus - ***Pleurosigma***	➢ ***Cosmarium contractum*** Kirchner.
➢ ***Pleurosigma chandolensis*** Gandhi	➢ ***Cosmarium impressulum*** Elfv.
Genus - ***Synedra*** Ehrenb.	➢ ***Cosmarium margaritatum*** (Lund.) Roy & Biss.
➢ ***Synedra ulna*** (Nitzsch) Ehrenb.	➢ ***Cosmarium mononazum*** (Lund.)
Class - III	
➢ ***Anabaena circinalis*** Rab. (Geitler f) (Prescott f) ➢ ***Anabaena flos-aquae*** (Lyngb.) Breb. (Geitler f) (Prescott f) ➢ ***Anabaena variabilis*** Kutzing ex Born. et Flah. ➢ ***Aphanocapsa muscicola*** (Menegh.) Wille. Genus - ***Aulosira*** Kirchner ***Aulosira fertilissima*** Ghose	
• ***Aulosira fertilissima*** Ghose Var. **tenuis** Rao, C.B.	Genus - ***Oedogonium*** link.
• ***Aulosira prolifica*** Bharadwaja	➢ ***Oedogonium globosum*** Nordstedt ex Hirn.

Genus - ***Calothrix*** Ag.	Genus – ***Pediastrum*** Meyen
● ***Calothrix clavata*** West, G.S.	➢ ***Pediastrum boryanum*** v. ***longicorne*** Racib.
● ***Chroococcus macrococcus*** (Kutz.) Rabenh.	➢ ***Pediastrum simplex*** v. ***duodenarium*** (Bail.) Rab. (Prescott f) (Smith f).
● ***Chroococcus turgidus*** (Kutz.) Nag.	Genus **– *Pithophora*** Wittrock
Genus - ***Cylindrospermum*** Kutz.	➢ ***Pithophora kewensis*** Wittr. (Heering, 1921 f) (Smith)
● ***Cylindrospermum indicum*** Rao, C.B., orth. Mut. De. Toni	Genus - ***Scenedesmus*** Meyen.
Genus - ***Gloeocapsa*** Kutzing.	➢ ***Scenedesmus bijugatus*** (Turpin) Kutzing Var. ***Bicellularis*** (Chodat)
● ***Gloeocapsa montana*** Kutz.	➢ ***Scenedesmus dimorphus***. (Turpin) Kuetzing.
● ***Gloeocapsa nigrescens*** Nag.	➢ ***Scenedesmus falcatus*** Chodat
Genus - ***Hapalosiphon*** Nag.	➢ ***Scenedesmus obliquus***. (Turpin) Kuetzing.
● ***Hapalosiphon welwitschii*** W. et G.S. West	➢ ***Scenedesmus quadricauda*** v. ***longispina*** (Chod.) G. M. Smith(Prescott f)
Genus - ***Lyngbya*** Ag.	Genus - ***Selenastrum***. Reinsch.
● ***Lyngbya hieronymusii*** Lemm.	➢ ***Selenastrum westii*** G.M. Smith (Prescott f) (Smith, 1920 f)
● ***Lyngbya limnetica*** Lemmermann	Genus - ***Spirogyra***. Link.
● ***Lyngbya maharastrensis*** Kamat	➢ ***Spirogyra communis*** (Hassal) Kutzing. (Czurda f) (Prescott f)
Genus - ***Merismopedia*** Meyen	➢ ***Spirogyra neglecta***. (Hass.) Kuetz. (Czurda f) (Trauseau f)
● ***Merismopedia elegans*** A.Sr. ● ***Merismopedia tenuissima*** Lemm. Genus - ***Microchaete*** Thuret ● ***Microchaete calothrichoides*** Hansgirg Genus - ***Microcoleus*** Desmazieres ***Microcoleus chthonoplastes*** Thurst ex. Gomont.	
Genus - ***Microcystis* Kutzing**	**Class - IV**
● ***Microcystis aeruginosa*** Kutz.	Genus - ***Euglena***
● ***Microcystis marginata*** (Menegh.) Kutz.	● ***Euglena acus*** Ehrenberg (Gojdics f) (Prescott f) (Smith f)
Genus - ***Nostoc*** Vaucher	● ***Euglena mutabilis*** Schmitz.
● ***Nostoc commune*** Vaucher ex Born. et Flah.	Genus - ***Phacus.***
● ***Nostoc calcicola*** Brebisson ex Born. et Flah.	● ***Phacus orbicularis*** Hueb. (Pascher & Lemmermann f) (Prescott f)
● ***Nostoc sphaericum*** Vaucher ex Born. et Flah.	● ***Phacus longicaudus*** (Her.) Duj. (Pashcher & Lemmermann f) (Prescott f)
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.

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