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Research Article

BIOMONITORING OF POLLUTION BY MICROALGAE COMMUNITY IN AQUATIC SYSTEM WITH SPECIAL REFERENCE TO WATER QUALITY OF RIVER KOLONG, NAGAON, ASSAM, INDIA

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Abstract

With growing urbanization and industrialization India faces the challenge of providing clean and safe drinking water. In the name of economic growth most rivers and streams are turning into sewers. Pollution effect is equally damaging both biotic and abiotic components. Microalgae play an interesting role in forecasting changing environment. Pollution in aquatic environment like changing pH; addition of oil, heavy metals; increase of organic matter and chemical fertilizers can be traced by studying algal community. Abundant growth of particular algae, drastic change in species diversity and depletion of long inhabitant algal flora indicates the pollution in a very initial stage. In the present study, attempt has been made to point out some indicator algae of Kolong River which is getting polluted day by day and in placed among the 71 most polluted stretch of river in the country. In our investigation, we have found microalgae mainly from groups Chlorophyceae, Cyanophyceae and Desmidiaceae which can be identified as indicator species in biomonitoring purpose.

Key words: Microalgae, Biomonitoring, Pollution, Indicator species, River Kolong.

Introduction

Biological monitoring or bio-monitoring is the use of biological response to assess changes in the environment, generally changes due to anthropogenic causes. Bio-monitoring programs may be qualitative, semi-quantitative or quantitative. Bio-monitoring is a valuable assessment tool that is receiving increased use in water quality monitoring programs of all types (Kennish, 1992). Bio-monitoring involves the use of indicators, indicator species or indicator communities. Generally benthic macro invertebrates, fish or algae are used. Certain aquatic plants have also been used as indicator species for pollutants including nutrient enrichment (Philips and Rainbow, 1993)

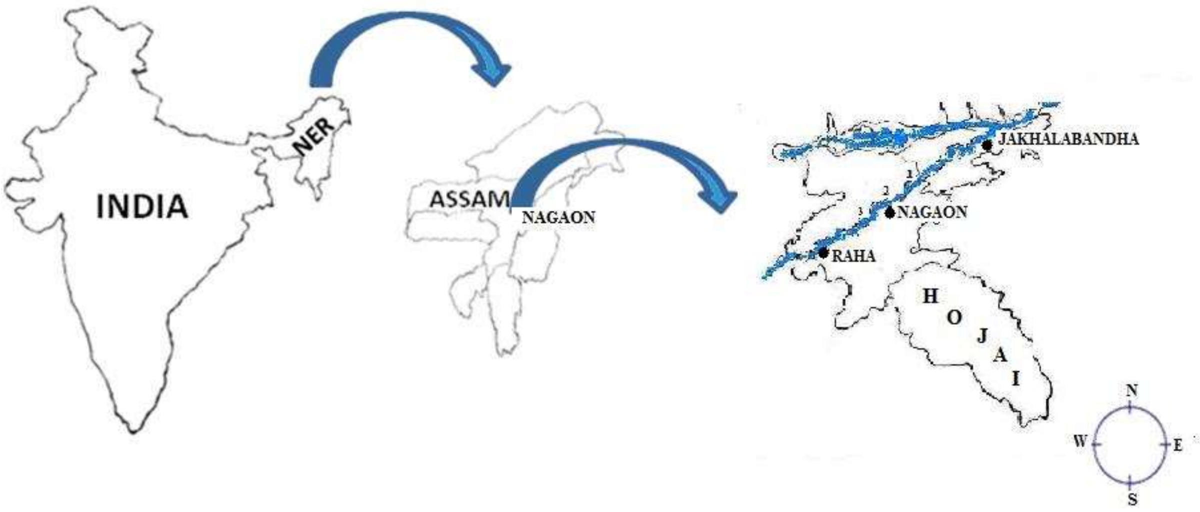
It is a truism nowadays to recognize that pollution-associated problems are a major concern of society. The great increase in population and the rapid development of agriculture and industries have caused a phenomenal increase in use of water (Palmer, 1969). Therefore, in terms of health, environment and economy, the fight against pollution has become a major issue. Water pollution affects plants and organisms living of water bodies and in almost all cases the effect is damaging not only to individual species and populations, but also to the natural biological communities. Recent developments in environmental research have revealed that many living organisms can accumulate certain toxicants to body concentrations much higher than present in their environments (Nyangababo *et al*., 2005a; Igwe *et al.*, 2008; Kord *et al.*, 2010).

Algae have been qualified as a precise bio-monitoring tool for determining and quantifying of heavy metals in aquatic ecosystems (Levkov and Krstic, 2002; Shah *et al.*, 2009). Periphyton is one of the most important algae associated with substrates in aquatic habitats. Periphyton has been widely used as a tool for biologically monitoring water quality (Leland & Carter, 1985; Newman *et al.*, 1985; Cosgrovea *et al.*, 2004). These organisms exhibit high diversity and are a major component in energy flow and nutrient cycling in aquatic ecosystems. Many characteristics of periphyton community structure and function can be used to develop indicators of ecological conditions in the aquatic ecosystem (Hill *et al.,* 1999). Periphyton is sensitive to many environmental conditions, which can be detected by changes in species composition, cell density, ash free dry mass (AFDM), chlorophyll, and enzyme activity (e.g., alkaline and acid phosphatase). A number of indices including Shannon and Weavers (1949) species diversity index have been used to assess the pollution status of aquatic bodies (Islam, 2008).

The Kolong river is a tributary of the Brahmaputra, which divert out from the Brahmaputra in Jakhalabandha (Nagaon district, Assam, India), and meets the same at Kolongpar near Guwahati. The tributary is approximately 250 km in length, and flows through the districts of Nagaon, Morigaon and Kamrup; on the way, several smaller streams (Diju, Misa and others) meet it. The river flows through the heart of the Nagaon urban area dividing the town into Nagaon and Haiborgaon. The Kolong is placed among the 71 most polluted stretch of river in the country, according to a study by the Central Pollution Control Board of India (The Assam Tribune, 2008). This investigation is a timely approach to assess the pollution level in terms of diversity index particularly on algae.

Materials and Methods

Three different stations for collection were selected in a part of Kolong which flows through Nagaon District within the geographical position N26º20'09.3", E 92º40'02.0" to N26º21'34.3", E92º42'54.3". Station 3 was selected from the part of the Kolong where activities like washing cloths, utensils etc. and growing paddy in adjusting areas were done. Station 2 was selected from the area inhibited by urban population. Station 1 was selected from less disturbed by human being and nearby area was mostly grazing fields (Map 1). Study was done during warm wet season [May to October 2012]. Randomly 150 representative samples were collected from surface water, natural periphyton and benthic habitat. Water samples were collected both horizontally and vertically at a depth of about 30 cm from the surface. One part of the samples was fixed immediately in 4% formaldehyde for future observation. Physico-chemical properties of the water sample including K^+, Na^+, Ca^{2+}, Mg^{2+} and Phosphorous were determined by standard laboratory procedures. Temperature reading was taken in *in-situ* condition using (ºC) thermometer. pH was measured with the help of portable pH meter [Eutech Make]. Dissolved Oxygen (DO), Total Dissolved Solids (TDS) and conductivity were determined using respective meters.



Map 1: Portion of Kolong flows through Nagaon District
NER- North Eastern Region

Morphological details of samples were studied using Trinocular Research Microscope (Labomed Lx400) and photographs were taken with Sony make digital camera (Cyber Short DSC-W210). Identification till genus level was done with standard literature (Desikachary, 1959; Anand , 1988; John *et al*., 2002, West & West, 1905, 1912; Prescot, 1976). Numbers of genera were count by Micro-transect method. Shannon and Weaver's Diversity Index (H') which is based on Shannon's information theory (Shannon and Weaver, 1949) has been calculated for each station to interpret richness and evenness of genera by the following formula:

$H' = (ni/N) \Sigma^{n}_{i=1} \log2 (ni/N))$

Where, H'- Shannon's Diversity Index,

n= Number of genera in the sample,

ni= Number of individuals of each genera,

N= Total number of individuals in the sample,

Log2= 1.443 ln N,

1.443= amplification factor, (Hutchinson, 1967)

The scale for pollution level in aquatic habitat was used as per Stub *et al.,* (1970) and Wilhm and Dorris (1966).

Results

Though almost all classes of algae were encountered, Bacillariophyceae, Cyanophyceae and Chlorophyceae were found to be more widely and frequently distributed throughout the study period. Moreover, Chlorocoocales and desmidiaceae were found to be regular in appearance among other Chlorophycean members. Considering this, emphasis was given to the members which might be probable indicator algae (Table1). Physico-chemical parameters of the water sample were recorded (Table 2). Shannon's Diversity Index of all three stations was shown in graph (Fig. 1).

Discussion

Our aquatic environment is getting polluted day by day. There should be an initial monitoring system to understand the pollution level by simple observation where growth of algae or blooms on aquatic systems can be used for this purpose. Algal growth and hydrological environment is related to each other and is well documented (Fried *et al.*, 2003; Coesel , 1984). Kolkwitz and Marsson (1908) were the pioneers who classified algal species based on their tolerance to various kinds of pollution. They stated that the presence of certain species of algae could define various zones of degradation in a river. Palmer (1969) published a composite rating of algal species that could be used to indicate clean and polluted waters.

Table1: Record of probable indicator algae in different stations.

Groups	Station 1	Station 2	Station 3
Bacillariophyceae	332	788	1424
Desmidiaceae	21	4	8
Chlorocoocales	141	109	86
Cyanophyceae	420	332	408

Table 2: Some physico-chemical parameters of water in stations.

Stations	Temperature (°C)	pH	TDS (ppm)	Conductivity (μS cm^{-1})	DO (μg/L)	K^+ (ppm)	Na^+ (ppm)	Ca^{2+} (g/L)	Mg^{2+} (g/L)	PO_4^- (mg/L)
Station1	22±2	7.1	570	8.24	6.9	20.8	11.84	$2.40x10^{-3}$	$3.8x10^{-3}$	0.139
Station2	25±2	6.9	589.54	7.8	7.1	17.22	8.29	$19.6x10^{-3}$	$13.1x10^{-3}$	0.171
Station3	24±3	6.6	561.8	8.8	6.9	15.12	9.11	$22.0x10^{-3}$	$8.75x10^{-3}$	0.189

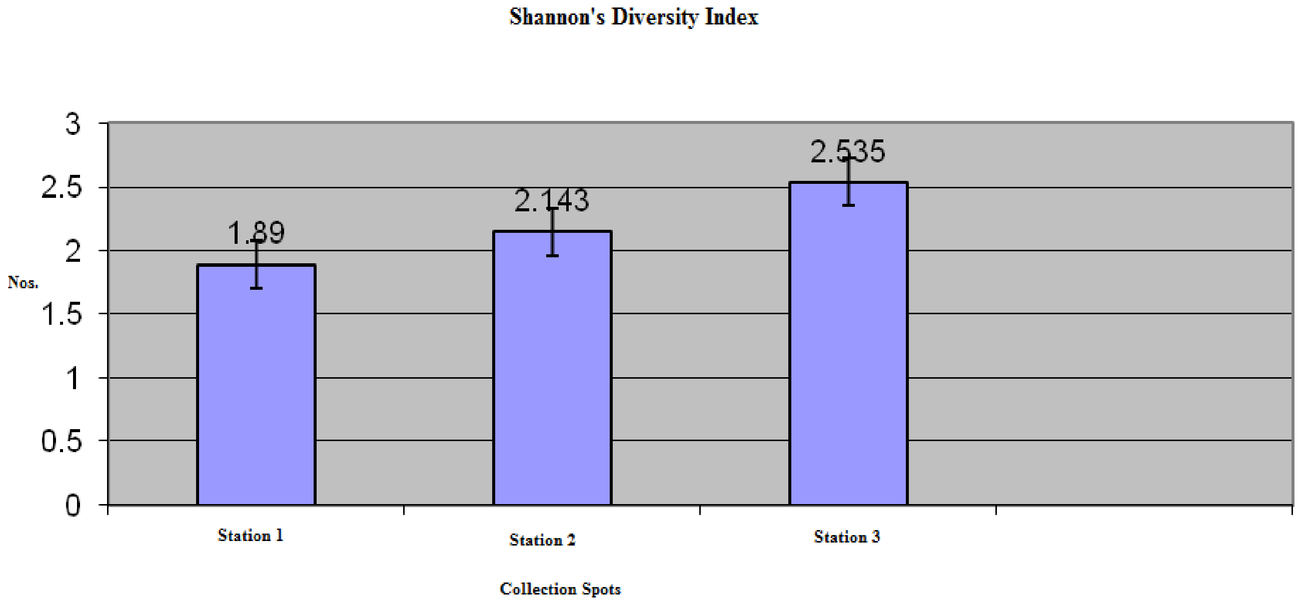


Fig. 1: Showing Shannon and Weaver's Diversity Index (H') value in different station

In our investigation water temperature, pH, DO, TDS and Conductivity of three stations are within the favourable range for an aquatic habitat. The recorded physico-chemical parameters K and Na for all the stations are within the range (15.12 ppm – 20.8 ppm) and (8.29 ppm – 11.84 ppm) respectively. Calcium level was found to be more in Station 3 ($22.0x10^{-3}$ g/L) where as low in station 1 ($2.40x10^{-3}$ g/L) but Magnesium level was maximum in Station 2 ($13.1x10^{-3}$ g/L) and minimum in station 1 ($3.8x10^{-3}$ g/L).The United States Environmental Protection Agency (USEPA) recommends that phosphate levels to be kept below 0.1mg/L to limit algal growth (USGS 1996-1998). It is found that phosphate level in study stations are exceeding from recommended value (0.1 mg/L) and thereby number of algae is also recorded more in respect of increasing amount of phosphate. Moreover, our observation on richness, occurrence and distribution of algal genera are also supporting this result. Shannon's Diversity Index of all the three stations (Station 1 = 1.89, Station 2 = 2.143, and Station 3 = 2.535) also conformed the growth of algae in relation to water quality. According to Stub *et al.*, (1970) and Wilhm and Dorris (1966), pollution level of Station 1, Station 2 and Station 3 are identified as having lightly to moderately polluted. The current findings indicate that more algae were recorded in stations which have high phosphate level compared to others. In our observation, we recorded that household related activities were prevailing in station 2 and 3. Paddy fields were near to these stations and farmers used fertilizers. The phosphate concentration might be increasing due to these kinds of human activities. The excess growth of algae was due to the presence of high amount of phosphate in Station 2 (0.171mg/L) and Station 3 (0.189mg/L) as compared to Station 1 (0.139mg/L) and Shannon's Diversity Index also conformed this in relation to water quality. Therefore, we can conclude that microalgae community can be used for biomonitoring of initial level of pollution in aquatic system.

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