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BIOMONITORING OF A FRESHWATER HABITAT OF RANCHI (HATIA DAM) ON THE BASIS OF NYGAARD'S INDICES

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ABSTRACT
The paper deals with evaluation of the trophic status of a freshwater habitat of Ranchi (Hatia Dam) on the basis of year round qualitative and quantitative investigation of microphytic community and calculation of Myxophycean, Chlorophycean, Diatom and Compound indices of Nygaard. The values of all the indices indicated that the water body is oligotrophic. The Myxophycean and Chlorophycean indices varied from 0.020 to 0.400 while Diatom index ranged from 0.20 to 0.66 and Compound index showed the variation from 0.102 to 1.200.

INTRODUCTION

With the continuous increase in human population and its constant demand of the freshwater aquatic resources of the globe, there has been a "compounding of the interrelationships between algae and man" (Jackson, 1964). This relationship has become all the more complex and important with advances in technology and the increased eutrophication of lakes and streams.The process of changing of oligotrophic to eutrophic state of lakes show a gradual change in its flora and fauna, the first being reflected by phytoplankton.

From the earliest years of the study of algal ecology, the community that has received most attention is the phytoplankton owing to its central position in limnology.

The algae occupy the basic level of food chain and play a significant role in the transfer of energy in aquatic systems. The distribution and occurrence of algae in both time and space are related to certain fundamental factors which may in general be divided into three categories- physical, chemical and biological.

Sarkar and Krishnamoorthy (1977) have emphasized on biological monitoring as a method to evaluate the degree of pollution based mostly on the ecology and physiology of the flora and has recommended the use of species diversity index as an indication of pollution.

Palmer (1967) emphasises that the factors affecting algal growth are many and the only evidence of the action of a single factor may sometimes be manifested in a sudden spurt of growth.He proposed assessment of pollution on the basis of algal flora.

Zafar (1967), George (1966) and Jana and Sarkar (1971) have reported a direct relationship between physico chemical variables of aquatic habitat and its algal flora.

It has been suggested by most of these workers that diatoms are associated with low temperatures, high oxygen concentrations and low organic matter although Rao (1977) states that low oxygen content may be beneficial to diatoms. Round (1964) states that the uptake of silica in diatoms is an aerobic process and hence diatom growth is limited in oxygen deficient waters. Similarly Myxophycean and Chlorophycean forms have been reported to reflect specific state of aquatic habitats.Very little attempts have been made to assess the status of pollution of water bodies on the basis of Nygaard's indices (Ragothaman and Jaiswal, 1995; Mishra *et al.,* 2001; Somani and Pejaver, 2007), hence an efforts has been made to apply the indices and find out the trophic status of the habitat as a part of biomonitoring of the habitat.

MATERIALS AND METHODS

Study area

The experimental site Hatia Dam is located in the industrial campus of HEC, Hatia, Ranchi. The area of the water body is 3763600 m^2 and average depth is approximately 11m. The study area experiences three distinct seasons *i.e.* summer, rainy and winter. The water body does not have any inlet bringing polluted water or effluent. The catchment area of the dam is comparatively clean and the water body does not receive agricultural run off. The water body used as drinking water source is the centre of water supply for a vast population of Ranchi.

Methods

For phytoplankton population 10L of water was filtered through plankton net made up of bolting silk cloth (Trivedy and Goel, 1986). The plankton samples were collected from the dam near the surface between 8 to 10 a.m. for 12 months period from January to December 2007 on sunny days.

Filtered phytoplankton samples were fixed and preserved in 4% formalin and the final volume was made to 10 mL by addition of distilled water. The algae were identified using the keys provided by Prescott (1982), Desikachary (1959), Randhawa (1959), Gandhi (1967), Philipose (1967) and Gonzalves (1981). For counting phytoplankton a Sedgwick Rafter Plankton Counting Cell was used and algal population was counted as described by Trivedy and Goel (1986). The population data was expressed as no/L.

Data analysis

From the basic biological data various pollution indices suggested by Nygaard (1949) as detailed below were caculated

$$\text{Myxophycean} = \frac{\text{Myxophyceae}}{\text{Desmideae}}$$

$$\text{Chlorophycean} = \frac{\text{Chlorococcales}}{\text{Desmideae}}$$

$$\text{Diatom} = \frac{\text{Centric Diatoms}}{\text{Pennate diatoms}}$$

$$\text{Euglenophycean} = \frac{\text{Euglenophyta}}{\text{Myxophyceae} + \text{Chlorococcales}}$$

$$\text{Compound} = \frac{\text{Myxophyceae} + \text{Chlorococcales} + \text{Centric Diatoms} + \text{Eglenophyta}}{\text{Desmideae}}$$

on the basis of population data generated during 2007 to quantify the trophic status of the water body.

The method applied during the present study is routine survey of the various algal species occurring in the dam, in order to evaluate the biological health or biological integrity of the resource surveyed. This type of survey prepares the base of biomonitoring or biosurveying.

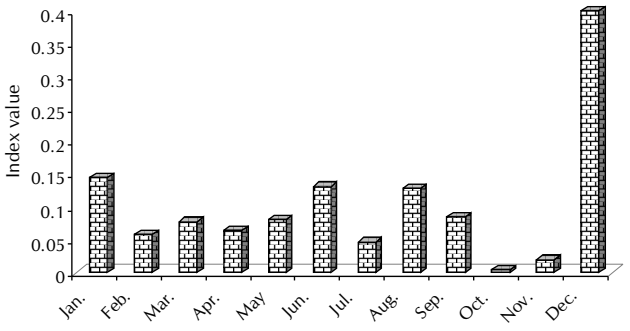

Figure 1: Monthly variation in Myxophycean index during 2007 in Hatia Dam

RESULTS AND DISCUSSION

The results obtained during the year long biosurvey of algal flora have been summarized in Table 1 and 2. The pollution indices calculated have been presented through Figs. 1 to 4. A total of 51 species were recorded during the present study as listed in Table 1. The number of species and the total number of individuals on monthly basis have been shown in Table 2. The occurrence of species in a particular month was never more than 84.41% (June 2007). The minimum occurrence was 31.40% in the month of November 2007. Highest population density of planktonic algae was recorded as 152/ L represented by 41 species while the lowest was only 48/L (November 2007) constituted by 16 species. The S: N (species

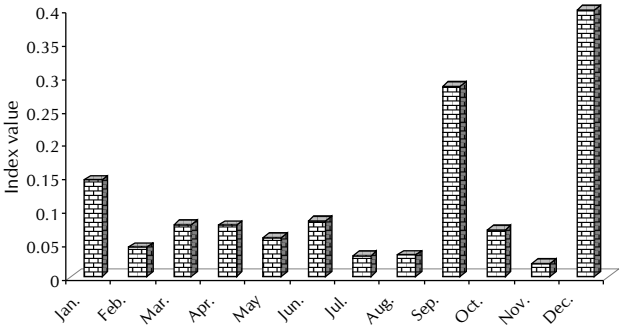

Figure 2: Monthly variation in Chlorophycean index during 2007 in Hatia Dam

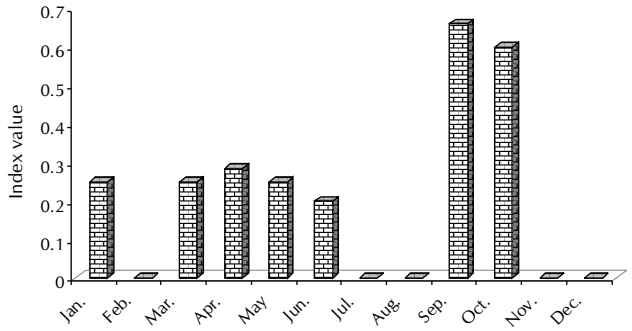

Figure 3: Monthly variation in Diatoms index during 2007 in Hatia Dam

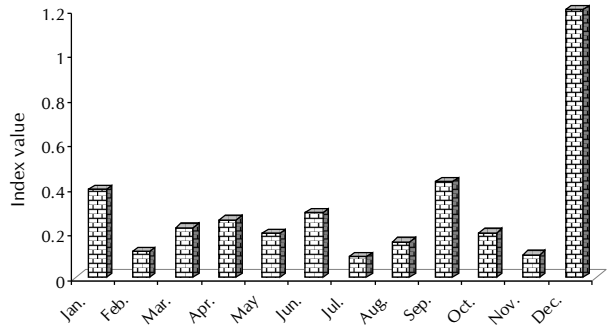

Figure 4: Monthly variation in Compound index during 2007 in Hatia Dam

Table 1: Population density of different algal species (No/L of Dam water) during 2007 of Hatia Dam

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
	Gloeocapsa Kuetz												
1	*G. nigrescens* Naeg	3	-	1	2	2	4	.	.	1	1	.	1
	Aphanocapsa Naeg												
2	*A.koordersi* Storm	.	.	1	1	2	3	.	.	1	1	2	1
	Merismopedia Meyen												
3	*M. glauca* (Ehrenb.) Naeg	-	1	.	.	.	1	.	.	.	.	.	.
4	*M. punctata* Meyen												
	Nostoc Vaucher												
5	*N. punctiforme* (Kuetz.) Hariot			1					1				
6	*N. commune* Vaucher	4	.	1	2	1	2	.	2	1	1	.	.
	Synechococcus Naeg												
7	*S. elongatus* Naeg	-	1	.	.	.	1	1	1	.	1	.	.
	Synechocystis Sauvageau												
8	*S. aquatilis* Sauv	-	1	1	.	1	1	2	.	.	1	.	.
	Aphanothece Naeg												
9	*A.pallida* (Kuetz.) Rabenh	-	1	1	.	1							
	Oocystis Naeg												
10	*O. elliptica* West	3	1	2	2	1	1	.	1	.	2	.	.
	Botryococcus Kuetz.												
11	*B. braunii* Kuetz.	2	1	2	.	.	1	.	-	.	1	.	.
	Nephrocytium Naeg												
12	*N. obesum* West	-	-	.	2	2	2	.	.	1	-	.	.
	Kirchneriella Schmidle												
13	*K. obesa* (West) Schmidle	1	.	-	-	2	-	-	.	3	2	.	1
	Pediastrum Meyen												
14	*P. boryanum* (Trup.) Menegh	1	.	2	2	.	3	2	.	3	1	1	.
15	*P. tetras* (Ehrenb.) Ralfs	-	1	.	.	.	.	.	.	3	1	.	1
	Rhizoclonium Kuetz												
16	*R.* sps.	-	1	.	2	3	1	.	2	.	2	.	.
	Ulothrix Kuetz.												
17	*U. zonata* (Web & Moh.) Kuetz	-	.	.	2	.	.	.	2	.	2	.	1
	Pithophora Wittrock												
18	*P. varia* Wille	-	.	2	.	1	.	.	2	.	2	.	1
	Oedogonium Link												
19	*O. landsboroughii* (Hass.) Wittr. ex. Hirn.	-	2	1	3	4	4	1	.	1	2	.	.
20	*O. capitellatum* Wittrock	-	2	1	3	3	4	1	.	1	2	.	1
21	*O. braunii* Hirn	2	1	2	2	2	1	.	2	.	3	1	.
22	*O. consociatum* Collins	2	.	2	.	.	1	.	2	.	2	1	1
23	*O. pusillum* Kirchner	-	.	2	.	.	1	.	.	.	1	.	.
	Spirogyra Link												
24	*S. condensata* (Vauch) Kuetz	2	1	2	3	3	4	1	.	1	2	.	1
25	*S. decimina* (Muell.) Czurda	1	1		3	4	1	2	.	1	2	.	1
26	*S. orientalis* West & West	1		2	3	4	1	1	1	.	3	2	.
27	*S. lagerheimii* Wittrock	-	1	2	.	3	3	1	1	.	2	2	.
28	*S. daedalea* Lagerheim	-	1	2	.	.	2	3	.	.	.	2	.
29	*S. hyalina* Cleve	-			3	.	1	.	.	1	2	.	.
	Zygnema Ag.												
30	*Z. mucigenum* Randhawa	1	-	3	.	1	3	-	-	3	2	1	2
31	*Z. subcruciatum* Transeau	-	1	-	2	2	1	1	1	-	1	.	.
32	*Zygnema cylindrospermum* (West et West) Krieger	-	-	2	2	1	1	-	-	-	2	.	.

Con...Table 1: Population density of different algal species (No/L of Dam water) during 2007 of Hatia Dam

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
	Closterium Nitzsch												
33	*C. acerosum* (Schrank) Ehrenb.	1	-	2	2	3	1	1	.	1	1	-	1
34	*C. navicula* (Breb.) Luetkem	1	.	2	2	1	3	2	.	1	1	-	1
35	*C. abruptum* West	3	1	.	2	4	2	.	.	1	2	.	.
36	*C. leibleinii* Kuetzing	3	1	2	.	.	1	.	1	.	3	.	.
37	*C. parvulum* Naeg	-	.	.	2	4	3	.	1	.	.	3	.
38	*C. tumidum* Johns.	-	1	2	2	.	2	2	1	.	3	2	.
39	*C. moniliferum* (Bory) Ehrenb	-	1	1	2	4	1	.	25	2	2	.	1
40	*C. calosporum* Wittrock	35	57	-	.	2	.	.	.	28	85	.	1
41	*C. pusillum* Hantz. var. *monolithum* Wittr.	-	.	59	57	58	63	56	.	.	.	42	.
	Cosmarium corda												
42	*C. pseudoconnatum* Nordst	3	2	3	2	4	1	-	-	-	1	1	-
43	*C. nitidulum* var. *minutum* Prescott	1	-	2	2	3	1	-	-	-	1	-	-
44	*C. subcostatum* Nordst	1	-	2	1	2	-	-	2	-	1	-	1
45	*C. auriculatum* Reinsch	-	2	1	1	-	2	1	-	1	-	1	-
46	*C. granatum* Breb.	-	2	-	1	1	2	1	-	1	-	-	-
47	*C. subtumidium* Nordst.	-	1	-	1	-	1	-	1	-	-	-	-
48	*Melosira* Ag.	1	-	1	2	1	1	-	-	2	3	-	-
49	*Fragilaria* Lyng	1	-	2	3	2	1	-	-	1	2	1	-
50	*Synedra* Ehrenb.	1	-	2	3	2	1	-	-	1	2	-	1
51	*Navicula* Bory	2	1	-	1	-	3	-	-	1	1	1	1

Table 2: Actual number of species, their abundance, expected number of species and their occurrence during 2007 in Hatia Dam

	No. of sp. found	Total population	S:N	Minimum number	Maximum number	Expected no. of spices	Equita-bility	occurrence as % of total number
Jan 2007	26	91	0.285	0	55	12	0.461	51.00%
Feb 2007	26	89	0.292	0	57	11	0.423	51.00%
Mar 2007	34	114	0.298	0	59	13	0.382	67.01%
Apr 2007	35	124	0.282	0	72	12	0.342	68.71%
May 2007	34	143	0.237	0	71	15	0.441	67.00%
Jun 2007	43	140	0.307	0	63	13	0.302	84.41%
July 2007	19	81	0.234	0	56	10	0526	37.30%
Aug 2007	18	50	0.360	0	25	12	0.666	35.29%
Sep 2007	25	82	0.304	0	45	11	0.440	49.10%
Oct 2007	41	152	0.269	0	85	15	0.365	80.39%
Nov 2007	16	48	0.333	0	22	12	0.750	31.40%
Dec 2007	18	49	0.367	0	20	15	0.833	35.29%

number and individual number) ratio was calculated to be lowest as 0.234 (July, 2007) and highest as 0.307 (June, 2007).

A bimodal peak pattern was observed during the study which was in the months of May, 2007 and October, 2007. The post monsoon peak was bigger than the post winter peak. This may be due to the impact of accumulation of some nutrients brought in the water body from catchment area during rainy season.

The Chlorophycean algae have been found to dominate the samples throughout the year. No single species is found to have very high density rather most of the recorded species are almost equally dominant which reflects the healthy nature of the habitat which can provide resources to many species.

The diatoms are one of the most ubiquitous of aquatic organisms. Each species of this group is thought to occupy a different niche in the aquatic ecosystem and responds individually to the dynamics of its chemical and physical parameters. Some species have wide tolerance ranges whereas others show a restricted range of tolerance (Lowe, 1974). This ecological feature of the diatoms has made them an interesting group for study both in relation to their geographical and their ecological distribution.

In Nygaard (1949) indices diatoms have central position and

the ralative abundance of diatoms determine the status of the water body. During the present study the Myxophycean index (Fig. 1) was recorded always less than 0.4 showing the water body (Hatia Dam) to be of oligotrophic nature. The Oligotrophic condition of a water body is said to have 30 - 100 mg C/m^2/day production (Rodhe, 1969). Similarly the Chlorophycean index (Fig. 2) was calculated to be always less than 0.07 throughout the year. This index is also indicative of oligotrophic condition of the water body.

The diatom index (Fig. 3) is the ratio of population of centric and pennate population. Except the two months (September and October, 2007) the index values were always less than 0.03 suggesting the same result as the Chlorophycean and Myxophycean indeces.

Except in the month of December 2007 the compound index(Fig. 4) was always less then 0.07 which also suggests the trophic status of lake to be oligotorphic.

So far the applicability of the various indices is concerned, out of 5 suggested indices 4 were calculated in the present study and all provided satisfactory and reliable results. But according to Hutchinson (1967) out of 5 different quotients suggested by Nygaard, only the compound index has been found to be useful and applicable to waters over a wide geographical range. Nygaard's indices have been reliably and extensively used to understand the quality criteria of the water (Ragothaman and Jaiswal, 1995; Somani and Pejaver, 2007)). Somani and Pejaver (2007) calculated Myxophycean index for 11 months. Out of which in 10 sampling months eutrophic status was recorded by them. They calculated Diatom index for 10 months, all showing eutrophic status. Euglenophycean index as well as compound index indicated eutrophic nature too in their study. In the present study, however, Euglenophycean index could not be calculated due to absence of this particular group and rest all indices were within the oligotrophic range.

To evaluate trophic status of a lake, it is important to employ the biological indices considering qualitative as well as quantitative approach. If only one type of index is employed, it may indicate inappropriate results. Any one index which can be applied satisfactorily to phytoplankton data of one particular water body, may not be proved significant for other lakes. Mishra *et al*. (2001), have successfully employed Nygaard's indices to comment on trophic status of Bhoj wetland. However, the index was not sufficient to conclude about trophic status of lake Masunds. The index showed eutrophic nature of this lake, however, the index is solely dependent upon presence of either desmid or centric and pinnate diatoms. As these species were not found consistently in every collection the application of this index might be depicting a confusing picture.The water body under present investigation was found to be oligotrophic and all the four indices showed the same result. The same water body with the same alagl data has been analysed for species diversity indices (Sinha and Sharan, 2009) which also revealed mild or no pollution state of the habitat which is in conformity with the present result obtained by Nygaard's indices.

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