Cibtech Journal of Bio-Protocols ISSN: 2319–3840 (Online)
An Online International Journal Available at http://www.cibtech.org/cjbp.htm
2013 Vol. 2 (1) January-April, pp.58-62/Das and Nath
Research Article

ECO-TOXICOLOGICAL IMPACTS OF NAGAON PAPER MILL EFFLUENTS WITH REFERENCE TO FRESH WATER MICRO-BIOTA

***K. Das[1] and R. Nath[2]**
[1]*Life Sciences Division, Institute of Advanced Study in Science and Technology (IASST), Guwahati-35, Assam, India*
[2]*Department of Zoology, Dhing College, Nagaon, Assam*
**Author for Correspondence*

ABSTRACT
An experiment was carried out for determining eco-toxicological impacts of Nagaon Paper Mill effluents in fresh water Micro-biota. Abnormal changes were observed in the biota abundance in the Nagaon Paper Mill catchment areas especially in agricultural wetlands and river Taranga. However, when ecosystems become contaminated, effects usually ripple through the fabric of the entire community, as natural assemblages of species are altered substantially. There were abrupt changes in the natural diversity of planktons in the experimental site No III where in the effluents discharged from the Paper Mill directly and in site No II where partially treated effluents are released. The site No I was experimental area of paddy field and the site No IV was the confluence area of treated and partially treated effluent released site. It was observed that site No I and IV was less effected in comparison to site No II and III ever though they were still below the tolerable limits. Only a few tolerable plankter species *viz.* Oscillatoria, Spirogyra, Nitzchia, Cyclops, and Euglena could be found in those experimental sites of the Nagaon Paper Mill catchment area.The species diversity index (Shannon and Weaver, 1964) compared to standard (Wilhm and Dorris, 1968) indicated that the plankters were under eco-toxicological stress and hence resulted in a rapid diminution in the catchment aquatic ecosystem of Nagaon Paper Mill. This obviously suggested that the Nagaon Paper Mill effluents are exerting eco-toxicological stress on the aquatic biota and other animals in the catchment areas at an increasing trend resulting in deletion of some species from that wetland ecosystem.

Key Words: *Paper Mill, Toxicological Impacts**, Microbiota,** Oscillatoria, Spirogyra, Nitzchia, Cyclops, Euglena*

INTRODUCTION
The synthetic science of eco-toxicology has begun to mature with the development of these new techniques of risk assessment, especially with capabilities to measure the effects of environmental mixtures (Giesy *et al.*, 1994). Recent work and modeling have greatly refined our understandings of mechanisms of chemical movements in the environment (Clark *et al.*, 1988). Monitoring of aquatic ecosystem of a region receiving industrial effluents is importance in environmental status estimation. Plankton communities are highly variable in space and time as well as in presence or absence of pollutants. So, the seasonal water quality variation study can be clearly demonstrated pollution monitoring. The species diversity is the ratio between the number of species and importance values (number and biomass of individuals), Odum (1971). The diversity indices could provide one of the best means to detect and evaluate pollution status of a water body (Dorris and Wilhm, 1968). The indicator species of plankters are very much susceptible to water pollution and hence their diversity indices can provide easy evaluation of water quality (Needham and Needham, 1988).
In the present studies, an attempt has been made to evaluate the water quality of Nagaon Paper Mill catchment areas with the help of plankters diversity indices. The study area is situated at $26^0$4'N latitude and $92^0$5'E longitude, 54 km east of Guwahati under Morigaon district of Assam, India. The catchment area covers approximately 105 acres of dry and wetland fed from the beel flows towards the river Taraga and then to Kolong river and finally pours it out to the almighty Brahmaputra.

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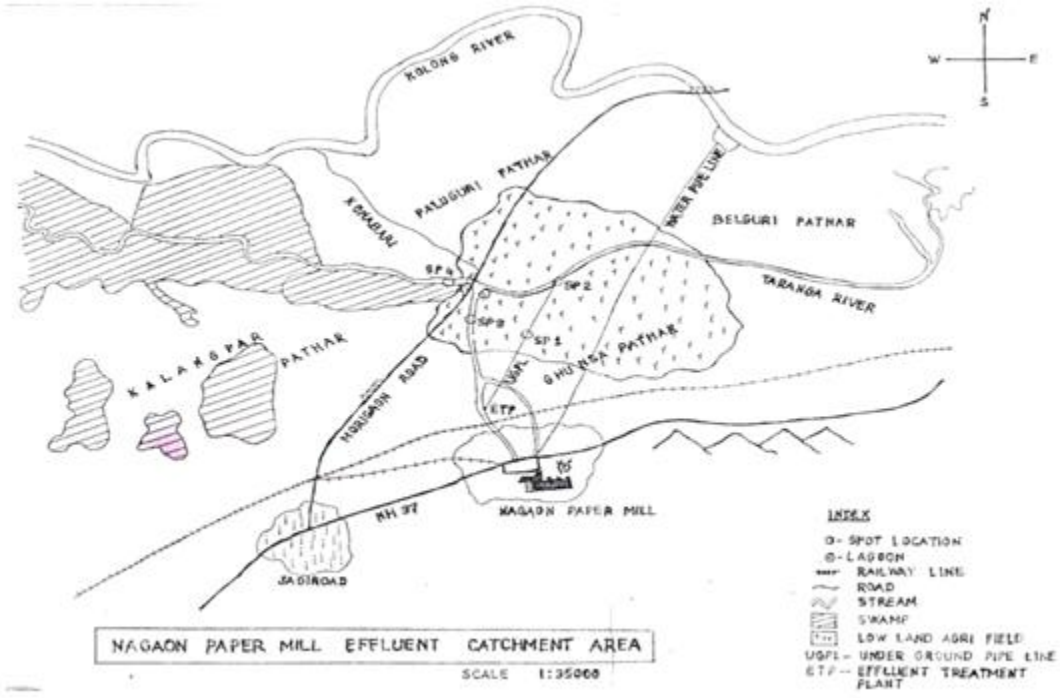

Figure1: Map showing the sampling sites and catchment areas of Nagaon Paper Mill

MATERIALS AND METHODS

The plankters have been used as bio-indicator to evaluate water quality. Samples were collected from four random sites. The site No I was the paddy field area where effluence found spilling; site No II was the treated effluent discharge site at Taranga river, site No III was the untreated effluent discharged nullah connecting Taranga river and site No IV was the treatment plant discharges and raw effluent mixing area in Taranga river. Plankton samples were collected from the samples sites during Oct'2010 to Jan'2011 and analyzed for Pi. The water samples were analysed following standard methods (Trivedy and Goel, 1986). Plankton collections were made using 60 µ mesh plankton net from bottom depth following Jhingran *et al.*, 1969).

Index of diversity $\overline{d}$ was calculated following Shannon and Weaver (1964).

$$\text{Formula used} = \overline{d} = -\sum Pi \log_2 Pi$$

Where, $\overline{d}$ = diversity index

Pi= ni/N= importance probability for each species

ni= Importance values for each species

N= Total of importance value.

The values of diversity index obtained were compared with the Dorris and Wilhm (1968) standard values given:

$\overline{d}$	Condition
(Wq)>3	Clear water
(Wq)1-3	Moderately polluted water
(Wq)<1	Heavily polluted water

RESULTS AND DISCUSSION

The hinterland (wetland) catchment area of Nagaon Paper Mill yielded 10 species of phytoplankton and 24 species of zooplanktons that were identified and placed in seven groups *viz.* Myxophyceae,

Chlorophyceae, Bacillariophyceae, Protozoa, Crustaceans, Rotifers and Desmids. The species diversity indices of the identified species were calculated taking two seasons of their appearance i.e. retreating monsoon and winter. The results are presented in the Table 1.

Table 1: Season-wise plankters diversity index during investigation period

Plankters group	Site No I		Site No II		Site No III		Site No IV	
	Retreating Monsoon	Winter	Retreating Monsoon	Winter	Retreating Monsoon	Winter	Retreating Monsoon	Winter
Myxophyceae	0.0595	0.0552	0.1283	0.1092	0.1319	0.0877	0.0799	0.1591
Chlorophyceae	0.0869	0.0789	-	-	-	-	0.1591	0.1591
Bacillariophyceae	0.0631	0.0415	0.1062	0.0621	-	-	-	-
Protozoa	0.1593	0.1597	-	-	-	-	0.0800	-
Crustacean	0.1590	0.1557	0.1538	0.1515	-	-	-	-
Rotifer	0.0969	0.1071	-	-	0.1595	0.1469	-	-
Desmid	0.0399	0.0453	-	-	-	-	-	0.1506

Values presented in the table are mean of three replications

The overall diversity indices of phytoplankton in the four sites surveyed were 0.3851; 0.4058; 0.2196; 0.5572 and that of zooplanktons were 0.9229; 0.3053; 0.3064; 0.1506 respectively. The results showed that the diversity indices of the plankters ranged between 0.0399 and 0.1595. The calculated overall diversity index of zooplankters was 1.765 and that of plankters was 1.5677. The diversity indices were being below 2, it indicated that the ecosystem was moderately polluted (Dorris and Wilhm, 1964) while the overall index of plankter was 1.5677 which indicates no productivity. The sites of investigation namely site No II, III and IV indicated heavy pollution whereas site No I, the paddy field was moderately polluted and there was a trend of pollution increase with time.

The diversity indices found, decreased during the winter season. This was probably due to the rise in concentration of pollutants with the decrease in water volume. But during Monsoon due to continuous inflow and outflow of water to and from the beel, the environmental pollution level was diluted and as a result the Zooplankton population increased.

Table 2: Season-wise availability of tolerable species observed in fresh water condition

Tolerable species	Site No I		Site No II		Site No III		Site No IV	
	Retreating Monsoon	Winter	Retreating Monsoon	Winter	Retreating Monsoon	Winter	Retreating Monsoon	Winter
Nitzchia	12	4	5	2	-	-	-	-
Spirogyra	13	10	-	-	-	-	-	-
Oscillatoria	7	-	14	30	20	10	1	1
Cyclops	45	19	15	6	-	-	-	-
Euglena	22	5	-	-	-	-	5	-

Values presented in the table are mean of three replications

The concentration of tolerable species like *Oscillatoria, Spirogyra, Nitzchia, Cyclops, Euglena* were found decreasing in winter season, as the pollution concentration was increases with the decrease in water volume (Shotriya and Dubey, 1987). As a result of the tolerant species found facing heavy eco-toxicological stress and ultimately diminishes. The phytoplankton population in that ecosystem hampered the eco-productivity. As the productivity of the wetland ecosystem gone down, the primary consumer population (zooplankter) also gone down to an observable level. In this process the productivity of the paper mill wetland catchment areas were decreasing with the increasing amount of pollutants are poured in with time.

Correlation Analysis

It was observed that positive correlation were existed between plankters diversity index and tolerable species of site I (r=0.6164, Fig.2a); site II (r=0.4087, Fig.2b); site III (r=0.3178, Fig.2c) and site IV

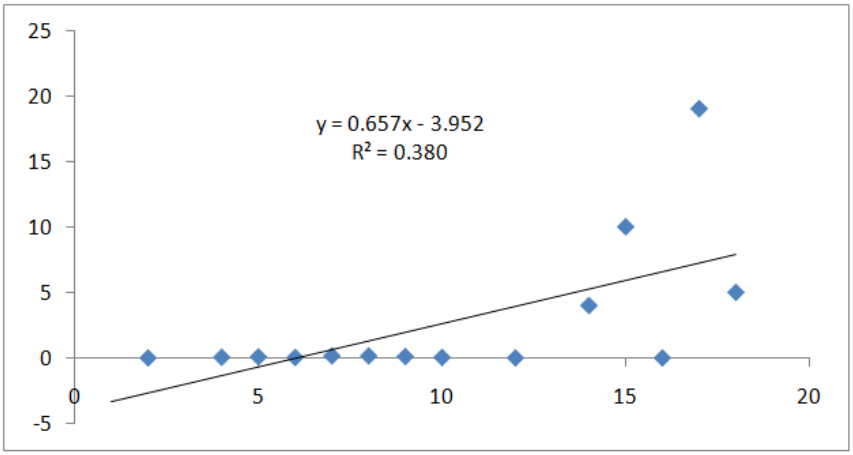

Figure 2a: Correlation between plankters diversity index and tolerable species of site I

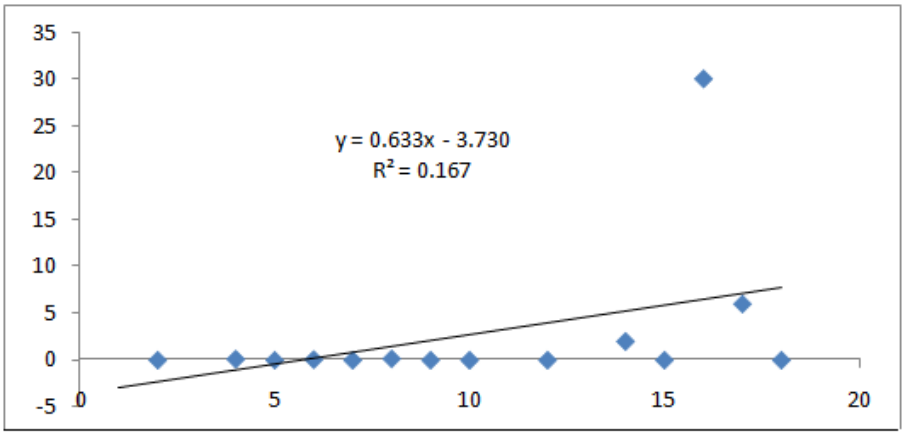

Figure 2b: Correlation between plankters diversity index and tolerable species of site II

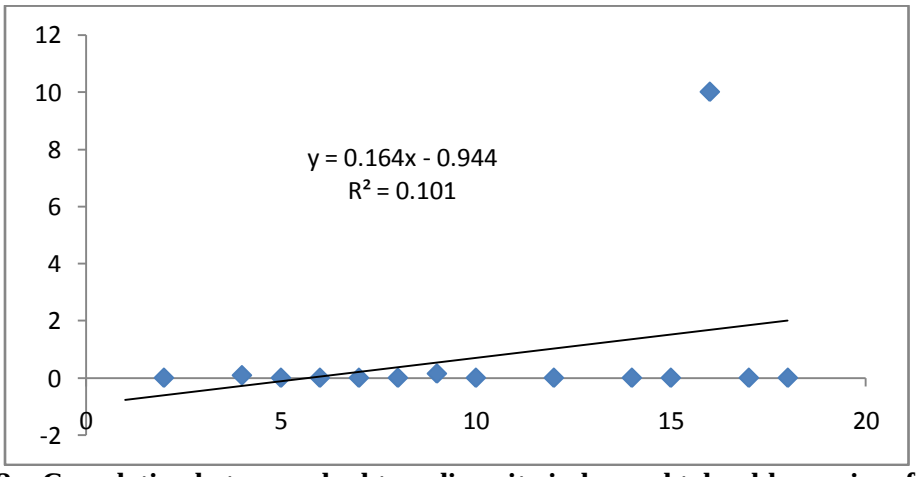

Figure 2c: Correlation between plankters diversity index and tolerable species of site III

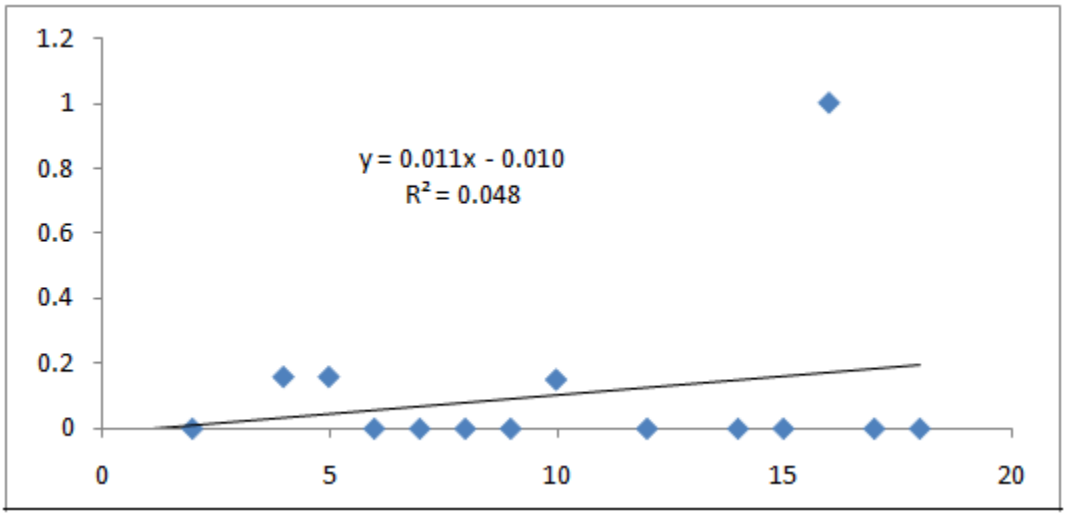

Figure 2d: Correlation between plankters diversity index and tolerable species of site IV

(r=0.2191, Fig.2d). It had indicated that the plankters were under eco-toxicological stress and hence resulted in a rapid diminution in the catchment aquatic ecosystem of Nagaon Paper Mill.

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