Study of Zoo benthic diversity in river Gomti at Lucknow Uttar Pradesh

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Abstract

Population explosion along with urbanization and industrialization has created innumerable ecological problems including water pollution. High anthropogenic activity in river Gomti at Lucknow (U.P.) caused a deteriorated condition. Although the rivers exhibit a property of self purification, but Gomti from upstream to downstream in the vicinity of Lucknow appears to be completely polluted because of the presence of distillery and sugar industries in upstream at Sitapur and other industrial units downwards. As a result self purification process does not exhibit in this zone and the deteriorating condition of water has reached to the critical alarming stage which is depicted of its Zoo-benthic population.

KEYWORDS: - Zoo-benthos, anthropogenic activities, urbanization, industrialization, biomass, population density.

Introduction

Water in an essential requisite for all living organisms. Polluted water due to poor environmental sanitation has been the major cause of various water borne diseases. Human activities are one of the major sources of water pollution. Different industries & factories discharging chemicals in water bodies and the chemicals used in agricultural fields are the source of water pollution. Almost all the major rivers of the country are facing the pollution problems. The notable contributions in this field are of Mathur (1965), George *et al.*. (1966), Verma & Mathur (1971) and Verma & Dalela (1975).

Water polluted with organic matter has a highly restricted fauna which is capable of thriving in various concentrations of dissolved and particulate organic matter. Sometimes bottom of polluted river is covered with tubificids and flagellates. At certain distance below the entry of domestic pollutant a river enter a zone of 'recovery' in which the dissolved oxygen progressively increases and the polluting materials are oxidised or otherwise sufficiently removed from the water as a result of bacterial action so the river fauna slowly reduces the pollution.

The world depends on self sustaining system which includes many kinds of organisms. This needs the conservation of biodiversity, regarding which our knowledge is still very poor. Only about $1/10^{th}$ of the world's species are presently known. Thus serious efforts are needed to assess the taxonomic diversity and the process and biological implications responsible for the changes in it. Degraded water quality affects the faunal quality and population in the river.

Usefulness of benthos in pollution monitoring programme to ascertain the river health is well established. There are various reasons in using benthos as indicator of ecosystem changes. Firstly their longevity which provides long term exposure to toxic substances secondly they live in close contact with the sediment which enhances

their intimacy with many pollutants and lastly the in faunal organisms reflect the situation not only at the time of sampling but also during the entire year.

Eyre *et al.*. (2005) worked on the macro invertebrate species and assemblages of head water streams of river Tyne at northern England in relation to land cover and other environmental variables. He classified the invertebrates and traced their relationships with the environmental variables.

Water quality characteristics and benthic macro invertebrates of three first order streams in south-west Nigeria were investigated to assess the effect of refined petroleum, five months after spillage by Chukwu & Nwachukwu (2005). Sharma *et al.*. (2005) analyzed that the most abundant groups of macro invertebrates among the total collection were of the family Chironomidae (53.5%) followed by Ephemeropetra (36%) and Trichoptera (5%) in river Tinau, Nepal.

Ogunwenmu *et al.*. (2005) collected benthic samples during two periods December 1999 – May 2000 and April, 2002 – September 2002 at Okobaba, a saw mill site at Iddo, a sewage dominated site in an open estuarine lagoon in south-western Nigeria. They noticed that the physical stress has resulted in alteration of the environment and community structure and a consequent change in density and diversity of fauna.

Materials and Methods –

River Gomti, garlanding the city of Lucknow is one of the significant tributaries of the Ganga river system. According to the result Jal Nigam Report the pollution level of Gomti is very high at Lucknow. The sewage pollution level of river Gomti has reached to an alarming level. After through survey of the river from upstream to downstream in Lucknow 6 sampling were decided.

1. Maa Chandrika Devi – One of the sacred temple in the city situated about 35 kms from Lucknow on Sitapur road was the upstream station.
2. Daliganj – It is situated in the vicinity of the city close to Bovaru Industry was identified as industrial effluent dominated station.
3. Ambedkar Park – Ambedkar Park is situated opposite to five star hotel " Taj Residency" dominated with domestic sewage discharges was selected as third sampling station.
4. Aquaduct – It lies in the out skirts of the city, where a barrage is constructed on the river has been identified as recovery zone in downstream.

The Ekman grab of 0.1 m^2 area was used for collection of benthic samples. The sediment collected by grab was sieved through a 500 µ standard sieve. The samples collected in the sieve were preserved in 5% formalin and rose Bengal in wide mouthed polythene jars. Stained and preserved samples were labeled and brought to the laboratory for analysis (Elefteriou & Holme, 1984).

After initial sieving, the samples were sieved with plentiful supply of fresh water until all traces of mud and debris were washed out. The sample was taken in a clean petridish. Contrasting background color was given to facilitate identification of different type of organisms from the residue. The sediment samples were screened thoroughly with the help of binocular microscope and forceps. The organisms were picked out from sediment residues by hand sorting using forceps and magnifying

glass. The animals were identified with the help of standard monograph and identification key (Needham & Needham 1962, Tonapi 1980 and Adoni *et al.* 1985).

Biomass and Population Density

All the individuals belonging to the same genus were identified and counted. The population density and biomass were estimated following the method of Crisp (1984).

Biomass is the weight of all living materials present in a unit area at a given time and gives an idea of productivity of system. The animals were sorted out into different groups. The wet weight of all individuals of each group present in every sample was measured after mopping off all the external moisture by blotting paper. The shells of molluscs were excluded before weighing and the biomass is presented on wet weight basis. The biomass and population density per square meter were calculated for each station.

Biodiversity Indices

Communities subjected to harsh or unfavorable environmental conditions where physical conditions are severe continuously or occasionally or periodically tend to have a small number of species, which are in abundance in favorable environment, the number of species is large but none of them is abundant. Species diversity may be taken to denote the number of species in a given area or as the number of species among total number of individuals of all species present. This relationship may be expressed numerically as the diversity index. The number of species in a community becomes more stable in severe disturbances causes a marked decline in the diversity. A great diversity also indicates the availability of large number of niches. In the present study the following diversity indices were calculated.

Shannon Weaver Index (H')

In the present study Shannon Weaver Index of diversity of diversity is used. It was originally given by Shannon and Weaver as a measure of the information content of code and is being widely used by ecologists (Shannon-Weaver, 1963). The Information diversity index (Shannon-Weaver) is calculated as

$$H' = -\sum_{i=1}^{S} (Pi \ln Pi)$$

Where Pi=ni/N

Pi = Proportion of i^{th} Species

n_i = number of individuals

N = Total number of organisms

The different values of H' have been divided as indicator of pollution

H' value	**Pollution status**
>3	Unpolluted

1-3	Moderately polluted
<1	Heavily polluted

Simpson Dominance Index (SI)

It is a measurement that accounts for the richness and the percent of each species from a biodiversity sample within a local community. The index assumes that the proportion of individual in an area indicate its importance to diversity. This has been defined in three different ways in published ecological researches. This first step for all three is to calculate Pi, which is the number of given species, divided by the total number of organisms observed.

The probability of two randomly selected individuals in community belonging to the same category (e.g. species) is given by Simpson's Index (Simpson, 1949).

$$SI = \square (P_i^2)$$

Simpson's Reciprocal Index (1/SI)

The number of equally common categories (e.g. species) that will produce the observed Simpson's index.

Mcintosh's Index (Mc)

Mcintosh's Index (Mcintosh, 1967) is focusing on number of species in relation to number of individuals.

$$Mc = 1 - SI$$

Species Dominance Index (D)

Species dominance index (Berger and Parker, 1970) is sensitive to abundance of most common species rather than species richness.

$$D = P_{max}$$

Taxonomic Richness

Taxonomic richness is total number of organisms (Taxon) present. It does not take into account the proportion of distribution of each species within the local community.

Results & Discussion

Various factors like competition, food availability, space, predator and environmental factors regulate the biomass. (Dwivedi, 1975 and Sunil Kumar, 2002) was not consistent. The highest biomass was observed during monsoon at Maa Chandrika Devi (61.37 m^{-2}) Ambedkar Park (21.77 m^{-2}), Daliganj (39.02m^{-2}) and Aqua -duct (29.49 m^{-2}) stations during post-monsoon. The lowest biomass was noticed in Maa Chandrika Devi, in monsoon at Daliganj and in pre monsoon at Aquaduct.

Highest population density was observed at Daliganj (24, 490 m^{-2}) may be due to high nutrients contributed by sewage and industrial effluents (Varshney, 1982). The

density was comparable to Auranga, Ambika, Purna and Mindola the rivers of south Gujrat in deteriorated environment dominated with organic load (Govindan *et al.*., 1983).

Study of benthic fauna is very important because they depict the physico-chemical condition of ecosystem (Rios & Bailey, 2006). The benthic fauna of river Gomti comprises of Oligochaeta, Diptera, Gastropoda, Pelecypoda, Porifera, Odonata, Hemiptera, Decapoda, Nematoda, Ephemeroptera, Coleoptera, Plecopoda, Hirudinea, Hydracarina and fish (Table – 9.6).

Oligochaeta was the most dominant group with a frequency of occurrence of more than 50% at all stations (except Maa Chandrika Devi). Among Oligochaetes *Tubifex tubifex* was the dominant group *Chironomus* and Culicoids were reported from all stations. Gastropods were also observed in all the stations. Few taxas reported occasionally during the study period were Plecoptera, Coleoptera, Hydracarina, Decapoda and Ephemeroptera.

Though the benthic diversity was on higher side due to the presence of worms i.e. Oligochaetes and *Chironomus* larvae at Daliganj, Ambedkar Park and Aquaduct, which may not contribute to the food chain.

The Shannon Weaver Diversity Index (H') of benthic organisms was less than 1.00 for Oligochaetes, Dipterans and Gastropods at Daliganj, Ambedkar Park and Aquaduct. Which indicates a stressed environment.

The Simpson Dominance Index (D), Mcintosh Index (Mc) and Species Dominace Index for all the groups studied at all the station were less than 1.00. Simpson reciprocal Index was always more than 1.00 at all stations.

The highest mean Shannon Weaver diversity Index (H') was 1.89 for Maa Chandrika Devi followed by 0.832 for Ambedkar Park and the lowest for Aquaduct (0.707). Simpson Dominance Index, Mcintosh Index and Species Dominance Index were less than 1.00 for all stations except Simpson reciprocal Index (always more than 1.00 at all stations). Similar observations were reported by Cogerino *et al.* (1995) for European river, Ravera (2001) for Ravell stream, Kozel *et al.* (2003) for Fenholloway river, Kumar and Dobriyal (1993), Garhwal Himalaya hill-streams, Shukla *et al.* (2003) for Gandhi Sagar Reservoir (M.P.) and Anitha *et al.*. (2004) for Alan Lake Hyderabad.

Overall maximum taxonomic richness (genus) noticed at Maa Chandrika Devi and Ambedkar Park (29) followed by Daliganj (24) and Aquaduct (21) frequency of occurrence of taxa at Ambedkar park was poor as compared to Maa Chandrika Devi. The availability of high number of species indicate sufficient space, food and low competition better environment and vice-versa due to adverse conditions.

The organic pollution indicator benthic species reported in river Gomti were *Tubifex* (Oligochaeta) *Chironomus*, Culicoid larvae (Diptera) *Lamellidens, Corbicula* (Pelecypoda), *Lymnaea* (Gastropada) and fresh water leech. Out of these indicator species the Oligochaetes, Tubifex and Dipteran larvae Chironomus were reported from all stations. Bivalve *Lamellidens* were recorded from Maa Chandrika Devi only.

A community dominated by relatively few groups or species would indicate environmental stress that gives very low diversity indices. Community

becomes more dissimilar as stress increases and accordingly species diversity decreases with decreasing water quality. From this study it is evident that the river is highly polluted and has reached an alarming level.

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Table No. 1: Biomass of (gm^{-2}) of river Gomti in Lucknow
Station. 1. Maa Chandrika Devi

Groups	April, 09	May, 09	Jun, 09	July, 09	Aug, 09	Sept, 09	Oct, 09	Nov, 09	Dec, 09	Jan, 10	Feb, 10	Mar, 10	April, 10
Oligochaeta	--	0.255	--	0.042	4.986	--	--	0.008	0.064	0.129	0.127	1.072	--
Diptera	0.641	0.004	--	--	--	--	--	--	--	0.001	0.366	0.246	--
Odonata	--	--	--	--	1.600	--	--	--	--	3.200	--	--	6.4
Plecoptera	--	--	--	--	--	--	--	--	--	1.060	--	--	--
Hyirudinea	--	--	--	--	--	--	--	--	0.100	--	--	--	--
Coleoptera	--	--	--	--	--	--	--	--	--	0.050	--	--	--
Crustacea	--	--	11.980	--	--	--	--	--	--	--	--	--	--
Gastropoda	--	--	0.150	0.150	6.600	--	--	9.900	--	--	--	--	--
Pelecypoda	25.805	30.650	0.030	81.241	47.780	73.600	29.490	12.977	24.570	--	63.060	13.067	76.947
Total	26.446	30.679	12.160	81.433	60.966	73.600	29.490	22.885	24.734	4.440	63.553	14.385	83.347

Table No. 2: Biomass (gm^{-2}) of Zoo-benthos of river Gomti in Lucknow
Station. 2. Daliganj

Groups	April, 09	May, 09	Jun, 09	July, 09	Aug, 09	Sept, 09	Oct, 09	Nov, 09	Dec, 09	Jan, 10	Feb, 10	Mar, 10	April, 10
Nematoda	--	--	--	--	--	--	--	--	--	--	--	--	0.001
Oligochaeta	37.740	0.425	2.975	4.250	17.612	4.369	4.131	24.251	54.468	54.080	21.426	11.110	62.438
Diptera	0.401	0.466	0.545	1.935	--	0.349	--	--	0.139	0.157	1.572	0.053	1.109
Coleoptera	--	--	--	--	--	0.070	--	--	--	--	--	--	--
Gastropoda	2.045	--	--	8.225	--	2.506	8.802	--	--	--	--	--	--
Total	40.186	0.891	3.520	14.410	17.612	7.294	12.933	24.251	54.607	54.237	22.998	11.163	63.547

Table No. 3: Biomass of (gm^{-2}) of river Gomti in Lucknow
Station. 3. Ambedkar Park

Groups	April, 09	May, 09	Jun, 09	July, 09	Aug, 09	Sept, 09	Oct, 09	Nov, 09	Dec, 09	Jan, 10	Feb, 10	Mar, 10	April, 10
Oligochaeta	0.017	0.059	0.076	--	0.042	0.645	--	1.521	8.465	1.232	0.603	45.641	1.734
Hirudinea	--	--	--	0.050	--	--	--	--	--	--	--	--	--
Diptera	--	--	0.021	--	0.009	10.163	0.065	--	0.310	2.194	0.069	0.381	--
Hemiptera	--	0.842	--	--	--	--	--	--	--	--	--	--	--
Ephemeroptera	--	--	--	--	--	0.320	--	--	--	--	--	--	--
Gastropada	--	15.883	0.025	4.652	18.865	--	--	16.702	8.225	7.470	3.300	1.633	--
Fish	--	--	--	--	--	56.220	--	--	--	--	3.370	--	28.268
Total	0.017	16.784	0.122	4.702	18.916	67.348	0.065	18.223	17.000	10.896	7.342	47.655	30.002

Table No. 4 : Biomass (gm^{-2}) of Zoo-benthos of river Gomti in Lucknow
Station. 4. Aquaduct

Groups	April, 09	May, 09	Jun, 09	July, 09	Aug, 09	Sept, 09	Oct, 09	Nov, 09	Dec, 09	Jan, 10	Feb, 10	Mar, 10	April, 10
Porifera	--	--	--	--	--	--	--	--	--	--	--	--	0.056
Oligochaeta	1.581	0.452	2.601	1.198	--	0.059	--	84.125	0.070	0.136	2.006	0.309	--
Diptera	0.798	6.234	0.366	0.002	--	--	--	0.227	--	--	0.263	1.894	7.233
Placoptera	--	--	--	--	--	--	0.530	--	0.070	--	--	--	0.695
Gastropoda	--	--	--	--	--	--	--	--	--	24.222	--	--	0.520
Fish	--	--	--	--	32.834	2.891	--	--	--	6.866	--	--	0.002*
Total	2.379	6.686	2.967	1.200	32.834	2.950	0.530	84.352	0.140	31.224	2.269	2.203	8.506

***- Nematoda**

Table No. 5: Diversity Indices of Zoo-benthos of river Gomti in Lucknow

Stations/Indices	Shannon Weaver Index	Simpson Dominance Index	McIntosh Index	Species Dominance Index	Simpson Reciprocal Index
Maa Chandrika Devi	1.090	0.310	0.535	0.410	2.856
Daliganj	0.830	0.337	0.337	0.730	2.140
Ambedkar Park	0.832	0.577	0.423	0.617	1.926
Aquaduct	0.707	0.674	0.376	0.532	5.692

Table No. 6: Overall variation in Taxonomic Richness

S.N.	Stations	Taxonomic Richness
1.	Maa Chandrika Devi	29
2.	Daliganj	24
3.	Ambedkar Park	29
4.	Aquaduct	21