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Diversity Index of Planktons and Status of Water Quality of Imphal, Thoubal and Khuga Rivers of Manipur

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Abstract

Plankton species diversity index of different stretches of Imphal, Thoubal and Khuga rivers were studied during 1999—2002 by applying Shanon and Weaver index and found to be within favorable range. Evenness value for all the rivers were near unity.

Key words : Plankton, Species diversity, Rivers, Water quality.

Manipur is situated at the eastern threshold of India. With an expanse of 22,327 km^2, the state is situated between 23.83^{0}N and 25.68^{0}N latitude and 93.002^{0}E and 94.98^{0}E longitude. The state has about 92% area under hilly terrain, enclosing a central Valley and the infamous Loktak lake is situated in the lowest part. Manipur is drained by two important drainage systems. The Barak-Brahmaputra and the Chindwin Irrawaddy. The Chindwin Irrawaddy drains the Imphal/ Manipur River, its tributaries and hill streams of Ukhrul and Tamenglong districts. The Imphal river is the only outlet, which drains Manipur valley and is associated with number of lakes and swamps. The principal tributaries of the Manipur river are the Iril, the Thoubal, the Khuga and the Chakpi. For many years, algae have been used as bio-indicators for water quality monitoring. It enables quick, easy and authentic information even at the micro level of impurity. The importance of algae as bio-indicators for different types of water has attracted global attention in recent years. Besides, using plankton as an index of water quality, in respect of industrial and municipal waste, have also been carried out by many workers (1—4). Plankton is highly sensitive to the environment they live in, and as such any alternation in it leads to the change in the plankton communities in terms of tolerance, abundance, diversity and dominance in the habitat. Evidently, a better understanding of plankton diversity can successfully be used as a reliable tool in biomonitoring studies of aquatic systems. One such device is the diversity indices, which provide one of the best ways to detect and evaluate the status of the water quality.

Methods

Three rivers of Manipur were selected for the study viz. the Imphal, the Khuga and the Thoubal. Two sampling station each for the Khuga and the Thoubal rivers were selected. These included one up and one downstream station. In the Imphal river three stations : Upper, middle and downstream were selected. The upstream station for the Khuga river was in Churachandpur (55 km from Imphal) near the Khuga dam. The downstream station is at Kumbi around 35 km from Imphal where the rivers come to valley. The selected sampling site for upstream of Thoubal was Litan, 50 km on the way to Ukhrul, while the downstream sampling site was Thoubal bazar which is 20 km from Imphal city. For the Imphal river sampling points were : Upstream Kaubruleikha, around 32 km from Imphal midstream Mayang Imphal and downstream at Sugnu, 45 km from Imphal after joining all the tributaries and before entering Myanmar.

The study was carried out during January 1999 to December 2002. Samples from the rivers were collected seasonally i.e., winter, pre-monsoon, monsoon and post-monsoon. Plankton samples were collected by using conical plankton net made up of bolting silk cloth (Nylobolt No. 25) by filtering 100 liter of river

Table 1. Percentage contribution of different groups of plankton in the Khuga river.

Plankton groups	Upper stretch (%)	Lower stretch (%)
Myxophyceae	1.6—13.9	6.7—13.6
Bacillariophyceae	23.7—91.2	6.7—13.8
Dinophyceae	0.0	0.0—13.8
Chlorophyceae	2.5—70.0	9.1—76.6
Zooplankton	4.4—13.9	10.0—77.3
Plankton count (u/liter)	43—363	22—30

Table 2. Species diversity and evenness indices of plankton in three rivers of Manipur.

Name of the rivers	Location	Number of sps.	Species diversity index	Evenness index
Khuga	Upper stretch	33	3.7	0.74
	lower stretch	22	4.0	0.91
Thoubal	Upper stretch	68	4.3	0.93
	Lower stretch	32	4.1	0.83
Imphal	Upper stretch	41	4.1	0.92
	Middle stretch	18	4.0	0.96
	Lower stretch	22	4.2	0.78

water and preserved in 4% formalin and brought to the laboratory for analysis. Counting was done by drop methods taking one drop in each slide at least for five times and forms were identified up to genera with the help Edmondson (5); Needham and Needham (6) and ICAR (7) monograph series on algae.

Species diversity is the ratio of the number of species and importance value of individual (8). It tends to be low in physically control ecosystem and high in biologically controlled ecosystem. Such bio-mathematical tools now a day become complementary to the convenient physico-chemical techniques for characterising the aquatic ecosystem. Species diversity of plankton was calculated by applying the Shannon and Weaver diversity index (9).

Results and Discussion

Khuga River

In the Khuga river, upper stretch showed richer plankton population (43—363 μ/liter) compared to lower stretch (22—30 μ/liter) (Table 1). Thirty three plankton species belonging to Myxophyceae, Bacillariophyceae, Chlorophyceae and zooplankton were recorded from the upper stretch while it was only 22 species in lower stretch. In upper stretch seasonal fluctuation of plankton both in terms of density and composition was observed whereas in the lower stretch, plankton population remained almost the same throughout the seasons (22—30 μ/liter). A nematode (*Rhabditis*) was recorded restricted to post monsoon, which may be attributed to the influx of municipal waste from domestic areas. Plankton species observed in Khuga rivers were as follows :

Myxophyceae	*Rivularia, Oscillatoria, Phormidium, oelospharium, Anabaena, Spirulina*
Bacillariophyceae	*Nitszchia, Gomphonema, Navicula, Synedra, Cocconeis, Surirella, Fragilaria, Denticula, Caloneis, Gyrosigma, Diatoma, Cymbella, Melosira, Amphora, Pinnularia*
Chlorophyceae	*Cladophora, Geminella, Rhapidonema, Sederocelis, Chlorococcum, Chlorella, Chlorosarcinia, Schizothrix, Ulothrix*
Dinophyceae	*Ceratium*
Cladocera	*Daphnia, Ceriodaphnia, Scapholeberis*
Ciliates	*Cyclochaeta*
Rotifera	*Trichocerca*
Rhizopoda	*Centropyxis, Difflugia, Vorticella*
Copepoda	*Cyclops, Acari*
Turbellaria	*Planeria*
Ephemeroptera	Mayfly nymph

The species diversity index and evenness index at different locations of the rivers are presented in Table 2. Plankton species diversity index ($\bar{H}$) recorded in the upper and lower stretches were 3.7 and 4.0 respectively and the evenness index (J) were 0.74 and 0.91 respectively, indicating near pristine water quality or almost negligible external load. Plankton data from the Khuga river suggest that equal participation of zooplankton and phytoplankton in the biological process. Greater dominance of phytoplankton, relatively low abundance of plankton population (43—363 μ/liter) indicated olligotrophic status of the river, a typical characteristic of hill streams. In the lower stretch, however the scenario was diabolically opposite, such as poor abundance of plankton coupled with greater colonization of zooplankton indicating mild deposition of nutrients.

table 3. Percentage contribution of different groups of plankton in the Thoubal river.

Plankton groups	Upper stretch (%)	Lower stretch (%)
Myxophyceae	0.0—12.0	1.5—11.8
Bacillariophyceae	0.0—29.4	53.6—90.9
Chlorophyceae	64.0—100.0	4.5—33.4
Zooplankton	0—8	0—11.8
Plankton count (μ/liter)	17—26	66—144

Table 4. Percentage contribution of different groups of plankton in the Imphal river.

Plankton groups	Upper stretch (%)	Middle stretch (%)	Lower stretch (%)
Myxophyceae	2—25	0—30	0—8.7
Bacillariophyceae	52—85.5	0—41.7	4.2—57
Dinophyceae	0	0	0—4.3
Chrypsophyceae	0	0	0—4.3
Chlorophyceae	5—21	0—60	0—21.8
Zooplankton	1—4.2	0—63.2	36.5—91.6
Plankton count (μ/liter)	66—480	19—24	40—48

Thoubal River

In upper stretch of the Thoubal river, plankton density was relatively low (17—26 μ/liter) as compared to downstream, 66—144 μ/liter (Table 3). Overall zooplankton contribution was low (0—8.0%) and was represented by rhizopod (Difflugia). The abundance of phytoplankton generally outnumbered zooplankton in the upper stretches of the Thoubal river. Sixty seven plankton species were found in the stretch. In the lower stretch, bacillariophyceae was predominant phytoplankton. The contribution of Myxophyceae was relatively low (1.5—11.8%) in this stretch too. Thirty one plankton species encountered during different seasons. A bacterium species was also encountered during this season as given below :

Myxophyceae	*Rivularia, Oscillatoria, Phormidium, Coelospharium, Spirulina, Anabaena*
Bacillariophyceae	*Navicula, Synedra, Surirella, Fragilaria, Tabellaria, Cymbella, Eucocconeis, Cyclotella, Nitzchia, Gomphonema, Cocconeis, Gyrosigma, Diatoma, Melosira, Achanthis, Sauroneis*
Chlorophyceae	*Mougeotia, Cladophora, Spirogyra, Ulothrix, Desmidium, Protococcus Genicularia, Cladophora, Ankistrodesmus,Chlorococcum,Dactylococcus, Closteriopsis, Chaetophora, Sphaerozosma, Pediastrum, Chlorella, Schizothrix*
Rhizopods	*Difflugia*
Zooflagilates	*Euglena*
Copepoda	*Nauplius, Diaptomus*
Cladocera	*Daphnia*
Bacteria	*Sphaerotilus*

Plankton species diversity index ($\bar{H}$) and (J) of upper and lower stretches of the Thoubal river were 4.3, 4.1 and 0.93, 0.83 respectively (Table 2). Zooplankton contribution increased from upper stretch to lower stretch. Complete dominance of phytoplankton over zooplankton and complete dominance of Chlorophyceae within phytoplankton groups showed eutrophic tendency of the water body in the upper stretch. Among Chlorophyceae *Spirogyra* was the most dominant species, which showed luxurious growth. This may be attributed to the availability of nutrient and light in excess in the litoral zone.

Imphal River

River Imphal showed distinct zonation in respect of plankton density. Upper stretch had the highest concentration of plankton (66—480 μ/liter), followed by lower stretch (40—48 μ/liter) and the middle stretch (19—24 μ/liter) (Table 4). The abundance of phytoplankton generally outnumbered zooplankton in the upper and middle stretches of the river. However, zooplankton completely taken over the phytoplankton population in lower stretch of the river with a contribution ranging between 36.5—91.6%. A bacterium species was also recorded during the study period. Plankton species observed in Imphal river are as follows :

Myxophyceae	*Anabaena, Coelospherium, Oscillatoria, Phormidium,Spirulina*
Bacillariophyceae	*Navicula, Cymbella, Gyrosigm, Eucocconeis, Synedra, Eunotia, Fragilaria, Diatoma, Melosira, Gomphonema, Cocconeis, Surirrella, Melosira, Diatomella, Gomphonies, Eunotia, Tabellaria, Pinnularia, Neidium, Mastogloiea, Frustulia, Anomoneis.*

Chlorophyceae	*Schizogonium, Closterium, Chaetophora, Pleurotanium, Ulothrix, Mougeotia, Protococcus, Crucigenia, Spondylosium, Spirogyra, Zygnema, Gonatozygon, Microspora, Nephrocytris, Chlorococcum, Chlorella, Raphidonema, Schizothrix, Goniochloris, Coelospharium, Chlorochytrium, Ankistrodesmus, Chlorococcum*
Dinophyceae	*Ceratium*
Chrypsophyceae	*Dinobryon, Tribonema*
Zooflagilates	*Polytoma, Chilomonas*
Rhizopoda	*Centropyxi, Arcella*
Ciliates	*Femtonia*
Rotifera	*Horaella, Keratella, Polyartha,* Rotifer sps.
Copepoda	*Cyclops, Mesocyclop*
Cladocera	*Daphnia, Ceriodaphnia*
Bacteria	*Sphaerotilus*

Plankton species diversity and evenness indices of the upper, middle and lower stretches of the Imphal river were 4.2 and 0.78, 4.0 and 0.92, 4.1 and 0.96 respectively (Table 2). Thirteen genera of zooplankton were encountered comprising two each of rhizopods, zooflagilates, cladocerans and copepods and four of rotifers and one ciliate.

Conclusion

The plankton population was relatively low in all the rivers (17—480 μ/liter). An increasing trend in the contribution of zooplankton was also observed from upper to middle and to lower in all the rivers and maximum contribution of zooplankton was found at lower stretch of rivers. Species composition of zooplankton was also varied, in upper stretch of the rivers it was the lower forms of zooplankton (rhizopods, zooflagilates, ciliates) that dominated but in the lower portion the higher form like copepods and cladocerans were the main component. In the present study, species diversity index was high (3.7—4.3) in all the rivers and evenness indices were also near unity (0.74—0.96). Much low values were obtained from many aquatic ecosystems. Acharjee et al. (4) reported $\bar{H}$ value of 1.3—1.9 from a beel in Assam. Khan et al. (10) observed $\bar{H}$ value of 0.2—2.4 in the river Ganga. Similar value was reported from Krishna river by Sugunan (11). These reflect that the water of the three selected rivers of Manipur is more or less free from pollution and still maintaining stable aquatic ecosystem.

In the present study *Oscillatoria, Spirulina, Chlorella, Melosira, Synedra* and *Sphaerotilus* were identified as indicator of organic pollution. Rotifers contribution was highest in the down stream. Rotifers and ciliates were observed to be pollution tolerant among zooplankton. Arora (12) described rotifers as an indicator of organic pollution and their presence in down stream showed enrich water quality. Presence of eutrophy indicator species like *Oscillatoria* and *Anabaena* in negligible quantity besides low Muxophyceae population in all the rivers (0—30%) reflects less load and less enriched nature of the waters. A sewage bacterium (*Sphaerotilus*) observed in the middle and lower stretch of the Thoubal and the Imphal reflected influx of domestic waste from the surrounding areas. But the low plankton density (22—480 μ/liter) and absence or almost negligible contribution of pollution tolerant species and low Myxophyceae count (0—30%) for all the rivers showed more inclination towards olligotrophic rather than eutrophic condition of the water. Presence of *Ceratium* and dinobryon which are the olligotrophic indicating species in the Khuga and the Imphal rivers further support the findings. From the results of the index value and other qualitative and quantitative abundance of plankton, it can be summarized that the water bodies are more or less free from heavy pollution besides presence of some pollution or eutrophy indicator species.

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