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Pollution status and conservation strategies of Moirang river, Manipur with a note on its aquatic bio-resources

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Abstract: *An attempt has been made to evaluate pollution status and aquatic bio-resources of the Moirang river near its mouth in the Loktak Lake. The river water is considered polluted as it has high concentration of free CO_2 (14.8 mg/l), nitrite-nitrogen (0.040 mg/l), inorganic phosphorus (0.107 mg/l) and faecal coliform bacteria (162 /100 ml). Aquatic bio-resources of the river include 24 species of fishes representing 20 genera of 13 families and 16 species of macrophytes representing 14 genera of 9 families. The floral and faunal compositions of the river were mostly widely distributed forms that can survive in polluted environments. Fishery potential and conservation strategies of the river are discussed.*

Key words: *Moirang river, Pollution, Conservation, Bio-resources*
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Introduction

The aquatic ecosystem consists of several components which are directly or indirectly affected by pollution (CPCB, 1995). Today, due to various anthropogenic activities, the river water usually receives untreated sewage, domestic waste, industrial and agricultural effluents that results in pollution of several rivers in India and abroad. Sand-Jensen (2001), remarked that the nutrient input was highest from the towns and agricultural fields and it has increased dramatically during the last few decades. Assessments of river water quality have been done by various workers in India (Sangu and Sharma, 1985; Das and Sinha, 1993; Jameson and Rana, 1996; Sharma and Agarwal, 1999; Mahanta and Patra, 2000; Baruah and Baruah, 2003; Kumar, 2003; Rajaram *et al.*, 2005; Kulshrestha and Sharma, 2006; Radha Krishnan *et al.*, 2007). In Manipur there are numerous rivers and streams, which are directly or indirectly feeding the important lakes of the state. Many of them enhance the process of eutrophication and pollution in the lake ecosystem as they discharge huge amounts of nutrients and polluted water. Moirang river is one of the most important river, which discharge into the Loktak lake. At present the lake is heavily eutrophic and there is possibility of high nutrient loading into the lake from its tributaries due to soil erosion in the catchment (Singh and Singh, 1994). Some of the important sources of pollutants in the Moirang river are agricultural waste from the surrounding agricultural field, municipal sewage and solid waste from Moirang Town, which is a tourist area in Bishnupur District of Manipur. However, no investigation is so far taken up on the status of the river and its impact on Loktak lake ecosystem. In the present study an attempt has been made to study the pollution status and bio-resources of the Moirang river and few suggestions for conservation of the river are also given.

Materials and Methods

Surface water samples were collected between 9 and 11 in the morning from the down stream of Moirang river near the mouth in Loktak lake on quarterly basis *viz.*, pre-monsoon (March), monsoon (June), post-monsoon (September) and winter (December), during 2000 and 2002. For each season, five replicates of water samples were collected and their physico-chemical and microbiological parameters were analysed following standard methods (APHA *et al.*, 1989; Trivedy and Goyal, 1986). The average of five samples for each parameter studied was considered as one reading. The water temperature, pH, dissolved oxygen (DO) and free CO_2 were determined in the field and other parameters were analysed in the laboratory within 48 hr. Water temperature was measured using a mercury thermometer and pH by digital pH meter. DO was estimated by the azide modification of Winkler's method. Total dissolved solid (TDS) was determined as the residue left after evaporation of filtered sample. Free CO_2, chloride, calcium and magnesium were determined by titration methods. Sodium and potassium were estimated by flame photometer. Nitrite and nitrate were obtained calorimetrically. The total nitrogen was estimated by micro-kjeldahl distillation method. Phosphorus was determined calorimetrically by stannous chloride method. Organic phosphorus was calculated as the difference between the total phosphorus and inorganic phosphorus. Coliform counts were made using membrane filter (MF) technique.

Fishes were identified following Jayaram (1981) and Talwar and Jhingran (1991). Aquatic macrophytes were identified following Adoni *et al.* (1985) and by comparing with the preserved herbaria available in the Loktak Development Authority, Manipur.

Results and Discussion

Physicochemical characteristics:

The results of physico-chemical characteristics of the Moirang river are summarized in Table 1. It indicates that surface water temperature fluctuates from 17.2°C to 29.1°C with an average value of 23.45°C. The pH, dissolved oxygen (DO) and free CO_2 concentrations showed marked seasonal fluctuations (Fig.1). The river water was slightly acidic and lower value of pH was observed during monsoon and post-monsoon periods. Highest value of DO was observed during winter and lowest during monsoon. It was negatively correlated with free carbon dioxide (r = - 0.7716). The free CO_2 concentration was usually high, ranging from 10.6 mg/l to 20.6 mg/l with an average value of 14.8 mg/l. High concentration of free CO_2 may be attributed to the heavy inflow of organic waste from the Moirang Market. Its concentration was highest during monsoon and lowest during winter. Free CO_2 was higher during the monsoon which may be attributed to the heavy inflow of organic waste from the surrounding human settlements and Moirang town.

The concentration of potassium was highest during the pre-monsoon period and declined during the monsoon and post-monsoon periods. The concentration of calcium, sodium, chloride, and magnesium was observed within the tolerance limits of ISI (1982).

The concentration of nitrogen and phosphorus in the river water were also high. They were higher in winter and pre-monsoon, lower in the monsoon season and lowest during post-monsoon. The nitrite-nitrogen concentration ranged from 0.018 - 0.076 mg/l with an average value of 0.040 mg/l, that suggests organic pollution in the river water. The average concentration of inorganic

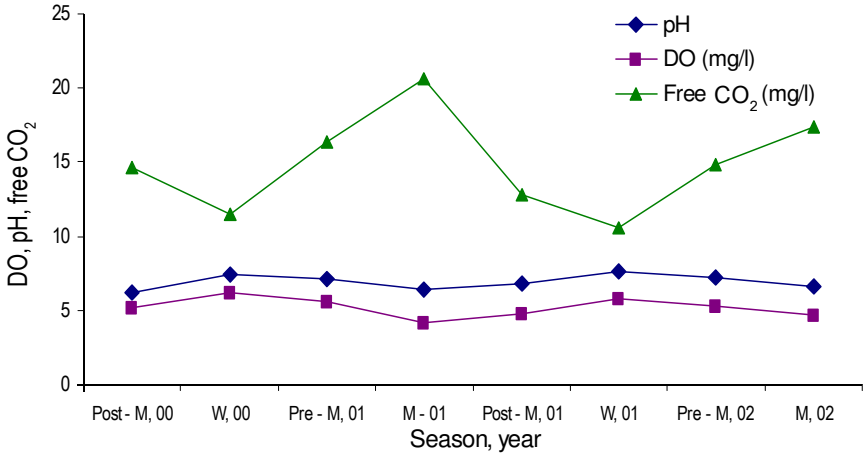

Fig. 1: Seasonal variations in pH, dissolved oxygen (DO) and free CO_2 of Moirang river during September, 2000 - June, 2002 (M = Monsoon, W = Winter)

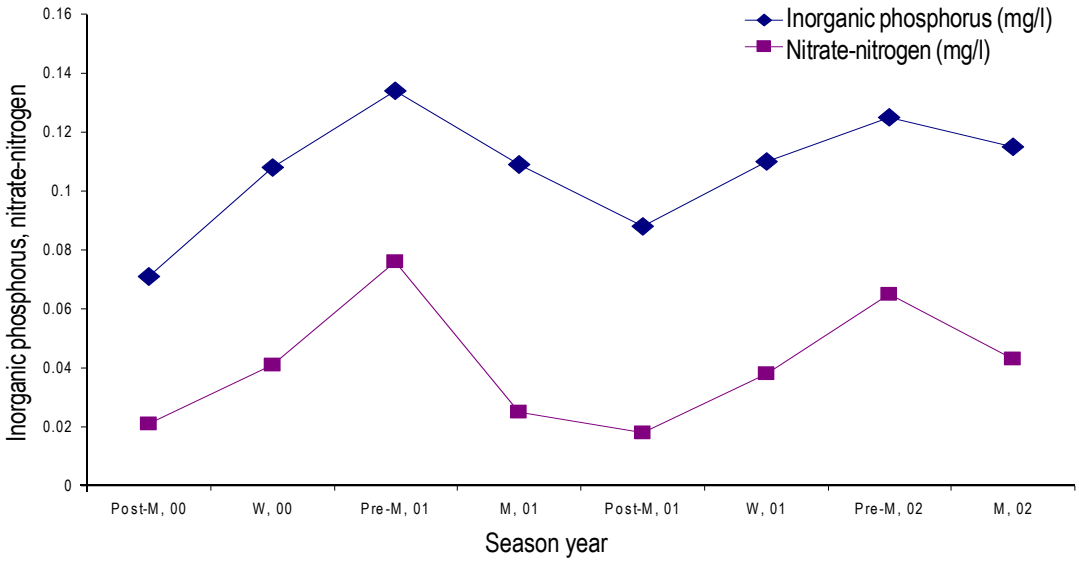

Fig. 2: Seasonal variations in inorganic phosphorus and nitrite - nitrogen of Moirang river during September, 2000 - June, 2002 (M = Monsoon, W = Winter)

phosphorus (0.107 mg/l) in the present investigation was found to be higher than the standard permissible limit (50 µg/l) recommended by USEPA (1976), for any tributary discharging to a lake (Trivedy and Goyal, 1986). Both nitrite and inorganic phosphorus concentration was highest during pre-monsoon and lowest during post-monsoon period (Fig. 2). The high concentration of nutrients in the river water may be attributed to the fact that the river receives huge amount of domestic and municipal sewage and solid waste from the Moirang market apart from the surface runoff and effluents discharging from the catchment area and surrounding agricultural fields.

Microbiological characteristics:

Microbial analysis in terms of most probable number (MPN) of coliform bacteria and fecal coliform per 100 ml ranged from 96 to 424 and 48 to 296 respectively. The concentration was highest during the monsoon and lowest during post-monsoon. The present finding indicates microbial contamination in the river water, so it is not suitable for drinking purposes (BIS, 1991).

Aquatic bio-resources:

Fishes and macrophytes collected and identified during the present study are shown in Table 2 and 3 respectively. The collection includes 24 species of fishes (belonging to 20 genera and 13 families) and 16 species of macrophytes (belonging to 14 genera and 9 families). Most of the flora and fauna were widely distributed forms, which can thrive well in the polluted waters. Heavy infestation of the macrophytes shows that the river is rich in nutrients and they may be considered as nutrient sink.

Table - 1: Physico-chemical and microbiological characteristics of Moirang river during September, 2000-June, 2002
(Total number of months/seasons studied = 8, number of samples used for each month/seasons = 5)

Parameters	Range		Mean	SD
	Min.	Max.		
Water temperature (°C)	17.2	29.1	23.4	4.26
pH	6.2	7.6	6.912	0.49
Dissolved oxygen	4.2	6.2	5.225	0.65
Free CO_2	10.6	20.6	14.837	3.28
Total dissolved solids	108.0	214.0	160.25	37.36
Chloride	7.1	19.2	14.0	4.10
Calcium	4.1	16.8	12.312	3.90
Magnesium	4.4	10.8	7.362	1.88
Sodium	17.0	25.0	21.25	3.57
Potassium	2.0	5.0	3.25	1.28
Nitrite-nitrogen	0.018	0.076	0.040	0.02
Nitrate-nitrogen	0.206	0.979	0.629	0.27
Total nitrogen	1.697	4.984	3.596	1.01
Inorganic phosphorus	0.071	0.134	0.107	0.02
Organic phosphorus	0.226	0.603	0.450	0.11
Total phosphorus	0.314	0.718	0.557	0.12
Coliform bacteria/100 ml	96	424	244	166.3
Fecal coliform/100 ml	48	296	162	125.0

Note: All the values are in mg/l, except temperature, pH, coliform bacteria and fecal coliform

In the present study the live fishes like murrels (*Channa* sp), the cat fishes (*Clarias batrachus* and *Heteropneustes fossilis*) and the climbing perch (*Anabas testudineus*) were abundant in the river. These fishes are widely distributed in many South-East Asian countries. Live fishes are cultured on a large scale in countries like Thailand, Philippines and Indonesia. However, such large scale live fish culture is not done in India even though they fetch higher prices than the major carps (Biswas, 1990). The river water may be considered suitable for fish culture and wild life propagation as the pH and DO values are within the limit of Class D water (ISI, 1982). However, the value of free CO_2 exceeds the tolerance limit (6 mg/l). Therefore, water quality of the river needs to be improved, if it is to be used for fishery purposes.

From the above discussion, it is clear that down stream of the Moirang river is polluted as it has high concentration of nutrients, free CO_2 and coliform organisms. Polluted nature of the river water is further confirmed by the occurrence of flora and fauna that can thrive well in the polluted environment. The river may be considered as a threat to the Loktak lake ecosystem as it its nutrient concentration is exceeding the tolerance limit of any tributaries discharging into a lake. Proper conservation measures should be taken up to save the river and the Loktak lake from further deterioration.

Conservation strategies

From the foregoing account it is evident that Moirang river is polluted and if proper conservation measures are not taken, the river is likely to further deteriorate and may affect the Loktak lake. Some of the measures, which demand immediate attention, are as follows:

Catchment area treatment:

Afforestation is a practical effective means of reducing soil erosion. It would be of great help if afforestation programme is accelerated and positive steps to control over grazing on the steep slopes, which are prone to soil erosion, are taken up. An extensive social forestry programme will effectively check the pressures on denudation of the available forest cover and practice of Jhum (shifting) cultivation should be controlled. This would ultimately help to retain vegetal cover and stop nutrient- rich runoff from such areas.

Treatment of sewage and solid waste:

In many countries the major pollution problem in river is associated with the discharge of untreated municipal wastewaters. Moirang river also receives untreated municipal sewage and solid waste from the Moirang market and surrounding human settlements. Priority should be given to the acceleration of programmes aimed at the proper collection, treatment and disposal of domestic sewage and solid waste. An improved sanitation and waste disposal programme needs to be initiated.

Changes in agriculture practice:

Agriculture is main source of non-point pollutants reaching river ecosystem. It is required to change the agriculture practice in

Table - 2: Fish fauna of Moirang river, Manipur and their fishery potential

Fishes	Local name	Family	Fishery potential
1. *Cyprinus carpio* (Linnaeus)	Puklaobi	Cyprinidae	High
2. *Cirrhinus mrigala* (Hamilton)	Mrigal	Cyprinidae	High
3. *Ctenopharyngodon idellus* (Val.)	Napichabi	Cyprinidae	High
4. *Labeo gonius* (Hamilton)	Kuri	Cyprinidae	Medium
5. *Osteobrama cunma* (Day)	Ngaseksa	Cyprinidae	Low
6. *Puntius chola* (Hamilton)	Phabounga	Cyprinidae	Low
7. *Puntius manipurensis* Menon, Rema and Vishwanath	Ngakha meingangbi	Cyprinidae	Low
8. *Puntius sophore* (Hamilton)	Phabounga	Cyprinidae	Low
9. *Ampblypharyngodon mola* (Hamilton)	Mukanga	Cyprinidae	Medium
10. *Esomus danricus* (Hamilton)	Ngasang	Cyprinidae	Low
11. *Lepidocephalus guntea* (Hamilton)	Ngakijou	Cobitidae	Medium
12. *Mystus bleekeri* (Day)	Ngasep	Bagridae	Medium
13. *Aplocheilus panchax* (Hamilton)	Langmeithanbi	Aplocheilidae	Low
14. *Clarias batrachus* (Linnaeus)	Ngakra	Clariidae	Medium
15. *Heteropneustes fossilis* (Bloch)	Ngachik	Heteropneustidae	Low
16. *Monopterus albus* (Zuiew)	Ngaprum	Symbranchidae	Medium
17. *Chanda nama* (Hamilton)	Ngamhai	Chandidae	Low
18. *Glossogobius giuris* (Hamilton)	Nailon ngamu	Gobiidae	Low
19. *Oreochromis mossambica* (Peters)	Tunghanbi	Cichlidae	Medium
20. *Anabas testudineus* (Bloch)	Ukabi	Anabantidae	Medium
21. *Colisa* sp	Ngabemma	Belontiidae	Low
22. *Channa gachua* (Hamilton)	Meitei ngamu	Channidae	Medium
23. *Channa punctatus* (Hamilton)	Porom	Channidae	Medium
24. *Channa striatus* (Bloch)	Ngamu bogra	Channidae	Medium

Table - 3: Macrophytes of Moirang river and their economic utilisation

Macrophytes	Local name	Family	Economic utilisation
1. *Brachiaria mutica* (Forssk) Stapf	Paragrass	Poaceae	Fodder
2. *Echinochloa stagnina* Retz	Hoop	Poaceae	Fodder
3. *Erianthus procerus* (Roxb.) Raizada	Singnang	Poaceae	Fencing, Fuel
4. *Zizania latifolia* (Turcz) Hand Mazz	Esing kangbong	Poaceae	Fodder
5. *Polygonum barbatum* Linn.	Yelang	Polygonaceae	Food
6. *Polygonum chinense* Linn.	Lilhar/ Angom yensil	Polygonaceae	Food
7. *Argyreia nervosa* (Burm f) Boj.	Uritujombi/ Phum uri	Convolvulaceae	Fodder
8. *Ipomea aquatica* Forsk	Kolamni	Convolvulaceae	Food
9. *Alternanthera pheloxeroides* (Mart) Grised	Kabonapi	Amaranthaceae	Fodder
10. *Eichhornia crassipes* (Mart) Solms.	Kabokang	Pontederiaceae	Fish breeding
11. *Colocasia esculenta* (Linn) Schott.	Lampal	Araceae	Fodder, Food
12. *Pistia stratiotes* Linn.	Kangjao	Araceae	Fish breeding
13. *Hydrilla verticillata* (L.F.) Royle	Charang	Hydrocharitaceae	Fodder
14. *Hydrilla* sp	Charang	Hydrocharitaceae	Fodder
15. *Salvinia natans* Hoffim	Kangkup	Salviniaceae	Fish breeding
16. *Lemna* sp	Kangmacha	Lemnaceae	Fodder

order to reduce the non-point pollutants from this source (Jorgensen, 1990). The use of chemical fertilizers and pesticides on the field particularly those which are adjacent to the river should be controlled and reduced. Organic farming in these areas may be encouraged.

Awareness generation:

Environmental awareness programmes for the local communities can be organized. The local community may be encouraged to participate in the conservation and management activities of the river.

Water quality monitoring:

Water quality data may be collected systematically as a basis for planning and wherever possible, for determining priorities of intervention with suitable control measures or to assess the efficacy of measures put into operation.

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