

Spatial and seasonal distribution of macrobenthic fauna of three rivers of Manipur

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ABSTRACT

Benthic fauna of three important rivers of Manipur state *viz.*, Khuga, Thoubal and Imphal were studied during 1999 - 2000. Macroinvertebrate zoobenthos population was low in all the rivers and was found between 85-1,255 μm^{-2} . In Khuga (129-1,255 μm^{-2}) and Thoubal (173-1,100 μm^{-2}) rivers macroinvertebrate benthos population were poor to medium where as in the Imphal River all the three stretches studied showed lowered macroinvertebrate population (85-390 μm^{-2}). During pre-monsoon period there was maximum benthos density in both the stretches in Thoubal, Khuga and Imphal rivers, whereas in the middle stretches of Imphal River, maximum population was observed in post-monsoon. Upper stretch showed richer benthos population both in terms of density and species composition in Khuga and Thoubal rivers. In the Imphal River distinct spatial variation of macroinvertebrate benthos population was lacking, but species composition was richer in lower stretch. Altogether nine macrozoobenthic groups were observed during the study and the details are presented in this paper.

Keywords: Macrobenthos, Manipur, Rivers, Seasonal variation

Introduction

Benthic organisms play an important role in the trophic budget of water bodies, since they form an important link in the food chain. Benthic community include oligochaetes, nematodes, turbellarians, molluscans (both gastropod snails and bivalves), crustaceans and some insect larvae (Ephemeroptera-mayfly, Plecoptera-stone fly, Trichoptera-caddis fly, Odonata-dragon fly, Diptera-midges, mosquito *etc.* and Coleopteras-beetles). Benthic organisms act as valuable indicators of past and present water quality conditions because of their long life histories and central position in the food chain (Cairns and Dickson, 1971). A number of investigations have been undertaken on the benthic communities both in India and abroad (Raman *et al.*, 1975; Gupta, 1976; Sugunan and Das, 1983; Alley and Anderson, 1968; Milbrink *et al.*, 1974; Darlington, 1977; Edmonds and Ward, 1979; Kaushal and Tyagi, 1989; Steedman and Anderson, 1985; Robinson, *et al.*, 2001). However, in the state of Manipur, practically very little work has been done in this area. The present communication describes spatial and seasonal variations of the qualitative and quantitative abundance of macroinvertebrate benthos in three selected rivers of Manipur.

Materials and methods

Three rivers of Manipur have been selected for the study *viz.*, the Imphal, the Khuga and the Thoubal. Khuga

and Thoubal are basically the tributaries of Imphal River. Two sampling stations each for the Khuga and the Thoubal rivers were selected. This included one upstream and one downstream station. 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 a valley. The upstream sampling site for Thoubal was Litan, 50 km on the way to Ukhrul, while the downstream sampling site was Thoubal Bazaar which is 20 km from Imphal. In case of the Imphal River, three stations: upper (Kaubruleikha, around 32 km from Imphal), middle (Mayang, Imphal) and lower stretches (Sugnu, 45 km from Imphal) were selected.

The study was carried out during January 1999 to December 2000. Samples were collected during winter, pre-monsoon, monsoon and post-monsoon from the selected rivers. In some cases sampling could not be done due to flood and unapproachable river conditions. Ekman dredge (15.2 x 15.2 cm) was used for collection of bottom biota. A metal sieve (no. 40) was used for segregating bigger animals, a piece of organdie cloth was placed below the sieve to retain smaller worms. A pair of fine forceps and a hand lens was used for picking the smaller animals, which were preserved in 10 % formalin for further study. Five samples were collected randomly from each site using Ekman dredge during every collection program and an average of this was considered as the standing crop of the

particular site. Benthic forms were identified up to genera following Edmondson (1959) and Needham and Needham (1966).

Results

Khuga River

Seasonal distribution of different groups of macroinvertebrate benthos in both stretches of the Khuga River is summarised in Table 1. In this river, the total macro-invertebrate benthos population fluctuated between 129 - 1,255 μm^2 . The population in the upstream stretches comprised of *Unio* sp., *Viviparus* sp., *Thiara* sp. (Mollusca), Caddis fly nymphs (Trichoptera), Dragonfly nymph, *Culex* sp. (Odonata), Beetle larvae (Coleoptera) and *Abedus* sp. (Hemiptera); where as downstream, *Viviparus* sp., *Lymnaea* sp. (Mollusca), *Branchura* sp. (Oligochaeta), Dragon fly nymph (Odonata) and Caddis fly nymph (Trichoptera) were encountered.

Table 1. Distribution of different groups of macroinvertebrate benthos in the Khuga River.

Seasons	Macrobenthos	Upper stretch (μm^2)	Lower stretch (μm^2)
Winter	Mollusca	60 (10)	41 (9)
	Trichoptera	390 (65)	126 (28)
	Odonata	150 (25)	135 (30)
	Oligochaeta	-	148 (33)
	Total	600	450
Pre-monsoon	Mollusca	43 (3.4)	150 (17.6)
	Trichoptera	1169 (93.2)	300 (35.3)
	Odonata	43 (3.4)	150 (17.6)
	Oligochaeta	-	250 (29.5)
	Total	1255	850
Monsoon	Mollusca	260 (100)	-
	Total	260	-
Post-monsoon	Coleoptera	43 (33.3)	-
	Odonata	43 (33.3)	-
	Hemiptera	43 (33.3)	-
	Oligochaeta	-	130 (100)
	Total	129	130

Figures within parenthesis indicate percentage composition

In the upper stretch of Khuga River, macrobenthos population ranged between 129 - 1,255 μm^2 and was maximum during pre-monsoon and minimum during post-monsoon. During pre-monsoon, it was caddis fly nymph that dominated the whole benthos population (93.2%). During winter, Trichoptera dominated (65%) over Odonata (25%) and Mollusca (10%). Benthos density declined (260 μm^2) during monsoon and Molluscan fauna was the only group encountered during the season. During post-monsoon periods there was equal number (43 μm^2) of Odonata, Coleoptera and Hemiptera represented by single species each. In the lower stretch, benthos population ranged between 130-850 μm^2 . During winter, out of

450 μm^2 , Oligochaeta dominated (33%) over Odonata (30%) and Trichoptera (28%). Molluscan population was low (9%) during winter. Maximum macroinvertebrate benthic fauna was seen during pre-monsoon and the dominant group found was Trichoptera (35.3%) followed by Oligochaeta (29.5%). Mollusca and Odonata were represented in equal numbers of 150 μm^2 (17.6%) during this season. Monsoon sampling could not be done because of flood, but during post-monsoon macroinvertebrate benthos population was low (130 μm^2) and represented by a single species of Oligochaeta (Table 1). Overall, in Khuga River macroinvertebrate benthic fauna was low and upper stretch showed richer benthos population than the lower stretch. Molluscan fauna was omnipresent in both the stretches. Clear seasonality in species composition and population density was seen; with pre-monsoon season having the maximum concentration and post-monsoon season the least.

Thoubal River

In the Thoubal River, benthos population was low and ranged between 173-1,100 μm^2 . Pre-monsoon had maximum benthos density in both the stretches. Seven groups of macroinvertebrate benthic communities were observed during the study, viz., Mollusca, Trichoptera, Diptera, Odonata, Coleoptera, Megaloptera and Ephemeroptera. Distribution of different groups of macroinvertebrate benthos in the Thoubal River is given in Table 2. The macrobenthic fauna encountered upstream comprised, *Lymnaea* sp., *Pisidium* sp., *Viviparus* sp., *Pila* sp. (Mollusca); *Siphonurus* sp., *Cingymula* sp. (Ephemeroptera); *Eulalia* sp. (Diptera); *Hydropsychae* sp., Caddis fly nymph (Trichoptera); Dragonfly nymph (Odonata); Megalopteran nymph (Megaloptera), whereas downstream only : *Lymnaea* sp., *Pisidium* sp., *Digoniostoma* sp. (Mollusc), Dragonfly nymph (Odonata), Caddisfly nymph (Trichoptera); *Sepedon* sp., *Euparyphus* sp. (Diptera) and beetle larvae (Coleoptera) were encountered.

In the upstream stretches macro-zoobenthic population was 800 μm^2 during winter of which Mollusca (45%) dominated over Trichoptera (40%) and Odonata (15%). During pre-monsoon, benthos density was maximum at 1100 μm^2 and dominant group was Trichoptera (50%) followed by Mollusca (31.8%) and Odonata (18.2%). The benthic population decreased to 216 μm^2 during monsoon season giving the lowest value along this stretch. Mollusc population dominated (60.2%) over Ephemeroptera (39.8%) which were encountered for the first time in this stretch. During post-monsoon, number of species increased while there was not much improvement in total benthic population (433 μm^2). Molluscan fauna dropped down to 30.1% and the dominant group was Megalopteran nymphs,

which constituted 50.1% of the total population. Diptera and Trichoptera were represented by single species each with equal contribution (9.9%).

Table 2. Distribution of macroinvertebrate benthos in the Thoubal River

Seasons	Group	Upper stretch (μm^{-2})	Lower stretch (μm^{-2})
Winter	Mollusca	360 (45)	200 (27)
	Odonata	120 (15)	-
	Trichoptera	320 (40)	90 (12)
	Diptera	-	217 (29)
	Coleoptera	-	243 (32)
	Total	800	750
Pre - monsoon	Mollusca	350 (31.8)	203 (28)
	Odonata	200 (18.2)	43 (4)
	Trichoptera	550 (50)	130 (12)
	Diptera	-	260 (24)
	Coleoptera	-	346 (32)
	Total	1100	1082
Monsoon	Mollusca	130 (60.2)	-
	Ephemeroptera	86 (39.8)	-
	Total	216	-
Post- monsoon	Mollusca	130 (30.1)	173 (100)
	Diptera	43 (9.9)	-
	Trichoptera	43 (9.9)	-
	Megaloptera	217 (50.1)	-
	Total	433	173

Figures within parenthesis indicate percentage composition

Downstream, macroinvertebrate zoobenthic population was $750 \mu\text{m}^{-2}$ during winter. Coleoptera dominated (32%) over Diptera (29%) and Mollusca (27%). Contribution by Trichoptera was low (12%), represented only by caddisfly nymph. During pre-monsoon, the benthos population escalated up to $1,082 \mu\text{m}^{-2}$ along with species diversity. Insect population was represented by caddis larvae (12%), dragonfly nymph (4.0%), Dipteran larvae (24%) and larvae of beetles (32%). Maximum number of individuals was shown by larvae of beetle followed by Mollusca (28%). There was no monsoon sampling due to flood. During post-monsoon, benthic population came down and only a single species of Mollusca (*Bythemia* sp.) represented the whole benthic fauna and its population was $173 \mu\text{m}^{-2}$.

In Thoubal River, benthic fauna in terms of both population and species composition was richer in the upper stretch ($216-1100 \mu\text{m}^{-2}$, 11 species) than in the lower stretch ($173-1082 \mu\text{m}^{-2}$, 8 species). A distinct seasonal pattern both in population and species richness was seen. Presence of representatives of almost all the benthic fauna including the predator groups like Megaloptera, Diptera and Odonata reflects the full utilization of different niches of the habitat. Aquatic beetles, which are xylophagous and highly specialized to utilize the woody debris which contributes a

large portion of total litter fall in the stream was also seen in some seasons. Thoubal River as a whole was rich in predator population in both the stretches, a large number of predators like the mayfly (*Cingymula* sp.), caddisfly, Megalopteran nymph, Dragon fly nymph, Dipterans and Coleoptans were common in the river.

Imphal River

In the Imphal River, total macroinvertebrate zoobenthos population was low and ranged from $85-390 \mu\text{m}^{-2}$. Distinct spatial and seasonal variation was lacking during the course of the study. Species richness was also minimum. The macrobenthic fauna in upper stretches comprised Molluscs (*Lymnaea* sp.), Trichoptera (caddisfly nymph) and Ephemeroptera (mayfly nymph). In the middle stretch, *Lymnaea* sp. (Mollusca), Chironomus larvae (Diptera) and dragonfly nymph (Odonata) were encountered. Downstream, even though there was no marked improvement in population density, species composition increased and altogether five animal groups were encountered viz., Mollusca (*Digoniostoma* spp, *Lymnaea* sp.), Coleoptera (*Laccophilus* sp., beetle larvae), Diptera (chironomus larvae), Odonata (*Urothemis* sp.) and Hemiptera (*Hydrometra* sp., *Aphelocheirus* sp.). Distribution of benthic fauna in different stretches of the Imphal River are presented in Table 3.

In the upper stretch, macroinvertebrate zoobenthos population was $250 \mu\text{m}^{-2}$ during winter, represented only by Trichoptera (75%) and Mollusca (25%). During pre-monsoon ($390 \mu\text{m}^{-2}$) the sole representative of benthos was Trichoptera (caddisfly larvae) which are highly specialized in adapting to various niche. During monsoon, only *Lymnaea* (Mollusca) represented the whole benthic population ($85 \mu\text{m}^{-2}$) and during post-monsoon, only mayfly nymph (Ephemeroptera) represented the benthic population ($130 \mu\text{m}^{-2}$). Along the middle stretch, benthos population ranged between $130-216 \mu\text{m}^{-2}$, and maximum population was observed in post-monsoon. As in the case with the upper stretch, species diversity was very low, only three groups represented by a single species each were encountered. During winter, Diptera (60%) dominated over Mollusca (25%) and Odonata (15%). During pre-monsoon, the density of zoobenthos was $130 \mu\text{m}^{-2}$. The available group were Diptera and Gastropods represented by single species each. Chironomids, which are suspension feeders outnumbered (67%) *Lymnaea* sp. (33%). During post-monsoon, it was again Chironomids (60%) which outnumbered Odonata (40%) and total macroinvertebrate benthos population was $216 \mu\text{m}^{-2}$.

In the lower stretch, benthos population ranged between $173-350 \mu\text{m}^{-2}$ and was maximum at pre-monsoon and minimum during monsoon. Diptera (50%) dominated

Table 3. Distribution of different groups of macroinvertebrate benthos in the Imphal River. Figure within parenthesis is the percentage composition

Seasons	Group	Upper stretch (μm^{-2})	Middle stretch (μm^{-2})	Lower stretch (μm^{-2})
Winter	Trichoptera	187 (75)	-	-
	Mollusca	63 (25)	42 (25)	90 (30)
	Diptera	-	102 (60)	150 (50)
	Coleoptera	-	-	60 (20)
	Odonata	-	26 (15)	-
	Total	250	170	300
Pre- monsoon	Trichoptera	390 (100)	-	-
	Diptera	-	86 (67)	200 (60)
	Mollusca	-	43 (33)	150 (40)
	Total	390	130	350
Monsoon	Mollusca	85 (100)	-	86 (50)
	Coleoptera	-	-	87 (50)
	Total	85	No sample	173
Post- monsoon	Ephemeroptera	130 (100)	-	-
	Odonata	-	86 (40)	43 (12.4)
	Coleoptera	-	-	217 (62.8)
	Hemiptera	-	-	43 (24.8)
	Diptera	-	130 (60)	-
	Total	130	216	346

Figures within parenthesis indicate percentage composition

upon Mollusca (30%) and Coleoptera (20%) during winter. During pre-monsoon, species composition was low and the representative groups were Mollusca (40%) and Diptera (60%). Mollusca and Coleopterans represented the benthic population, during monsoon. Their contribution to the total population was equal, 50% each, but Molluscan fauna was represented by two species, *Digoniostoma* sp. and *Lymnaea* sp. whereas Coleoptera by only one *viz.*, *Laccophilus* sp. During post-monsoon, benthos population increased to 346 μm^{-2} and Coleoptera (62.8%) dominated Hemiptera (24.8%). Odonata was represented by a single species and percentage contribution was 12.4%. No Mollusca was present during this season.

In the Imphal River, distinct spatial variation of macroinvertebrate benthos population was lacking but it tends to increase from upstream (85-390 μm^{-2}) and middle stretch (130-216 μm^{-2}) to downstream (173-350 μm^{-2}). Benthic animal diversity was low in comparison to other two rivers and was represented by only three groups in both upper stretch and middle stretch whereas downstream, five groups (Mollusca, Diptera, Coleoptera, Odonata and Hemiptera) were encountered. Overall, macrobenthos population and species richness were lower in all the stretches of the Imphal River in comparison to the Khuga and the Thoubal rivers.

Discussion

In the Khuga and the Thoubal rivers, upper reaches have higher population of macroinvertebrate benthos than the lower stretches, where as in the Imphal River benthos

population tends to increase downstream. Such increase in benthos population along downstream was also observed by Burgherr and Ward (2001) in an alpine glacial stream. It was observed that species composition and population of macroinvertebrate benthos changed with season. Pre-monsoon seasons had richer benthos population than any other seasons in all the rivers which are agreement with the findings of Singh and Verma (1990) in a tropical pond in Gangatic plain. Wide seasonal variations in benthic population were observed in Khuga and Thoubal rivers, such variations of macrobenthos in healthy stream was also encountered by Robinson *et al.* (2001) in a glacial stream of Swiss Alps. During monsoon, benthos population run down in all the study sites, which might be due to unfavorable habitat, the predominant species during this season was Mollusca which can sustain flood and other adversities. Such decrease in the macroinvertebrate population during monsoon season might be due to dilution by rain water, which affects the abundance and diversity of macroorganisms. Similar observation on decreased macroinvertebrate benthos population during monsoon was also made by Singh and Verma (1990). Burgherr and Ward (2001) has also seen decrease in macroinvertebrate benthos population during monsoon in an alpine glacial stream. According to him, seasonal shift in source and pathways of water and period of favorable environmental conditions strongly influenced zoobenthic distribution.

In the present study, Trichopterans tend to restrict to upper reaches where as groups like mollusca found to present everywhere except during some seasons.

Abundance in Trichopteran population was seen before monsoon season in all the rivers, and such pattern was also observed by Kaushal and Tyagi (1989) in Govinda Sagar Reservoir. According to David (1996), Trichoptera are widely distributed along the river course and having specialized mandibles are primary grazers of periphyton and eat all parts of leaves which are conditioned after falling in the water.

Chironomids, which was the only species found within Diptera was the predominant group in the middle stretch of the Imphal River and they browse upon algal growth for food, The bottom zone with submerged vegetation provided a suitable medium for their colonization (Payne, 1986). Presence of chironomids in the waters of Imphal and Thoubal rivers reflected some eutrophic tendencies, as chironomids are found in enriched water bodies. Similar observation was made by Banerjee *et al.* (1998) in different stretches of river Damodar. Pathak *et al.* (2001) also recorded similar findings from the tributaries of river Brahmaputra.

Oligochaeta represented by *Branchura* sp. alone formed the bulk of benthos in downstream of the Khuga River. Their abundance in this river might be attributed to the occurrence of soft clayey soil which serves as the most suitable niche for the growth and propagation of Oligochaeta which are efficient deposit feeders (David, 1996). Presence of Oligochaeta in the lower stretches indicated enriched water quality. Odonata, which are good biological indicators of pollution were observed in all the rivers except in the upper stretch of Imphal River and represented by dragonfly nymph, *Culex* and *Urothemis* sp. Maximum contribution was seen during post-monsoon in the middle stretch of Imphal River which otherwise lacked definite seasonal pattern. Ephemeropterans were represented by mayfly nymph, *Siphonurus* sp. and *Cinygmula* sp. This group was concentrated only at upper reaches of the Thoubal and Imphal rivers during monsoon and post-monsoon seasons respectively. They contributed 39.8 % of total benthos population in the Thoubal River. However, in upstream Imphal River mayfly nymphs were the only macroinvertebrate benthos available (100%) during post-monsoon. They have highly specialized mouth parts for scraping as well as cutting and are very much effective in consuming loosely attached diatoms.

Coleoptera were frequently encountered in upper stretch of Khuga and lower stretch of Thoubal and Imphal rivers but lacked seasonal pattern. They have robust mandible capable of slicing away thin strips of wood, but apparently lacks digestive enzymes and result in slow growth and requires 4-6 years to attain maturity (Steedman and Anderson, 1985) which reflects in their lower

contribution in total macroinvertebrate benthos count. Presence of Megalopterans in upper Thoubal and Hemipterans nymph in lower Imphal during postmonsoon in the macroinvertebrate benthos count complete the lotic food web as they belong to predators (macro consumers) having biting and piercing mouth parts. Hemipterans, which are predators of other animals, was represented by *Abedus* sp. contributed only 33.3% in upper stretch of the Khuga River and 24.8% in the lower stretch of the Imphal River during post-monsoon season and have restricted distribution. Mollusca which were omnipresent during the study was the only group observed even during monsoon season as it can withstand the flood owing to strong adhering capacity of radula and with their size. Mollusca were the only group available during monsoon season in the upper stretches of Khuga and Imphal rivers, whereas in the lower stretch of Thoubal River, mollusca were predominant only during post-monsoon. The radula present in this group of animal help in sticking to any substrata and can harvest both adherent and filamentous algae.

During the present study, the macroinvertebrate benthos population was found to be low in all the rivers and ranged between 85-1,255 μm^{-2} . Similar observation of low benthos density (162-290 μm^{-2}) was also made in tributaries of river Brahmaputra by Pathak *et al.* (2001). Further, the present findings supports the observation of Patrick (1970) that the rigorous and unpredictable stream environment is largely responsible for low equitability and low diversity in benthic community. According to Theinemann (1925), a lake bed producing 1000 individuals or less per meter square is usually regarded as poor in production, while a density of 2000 μm^{-2} indicates a productive water body. Therefore, it can be inferred that the three selected rivers of Manipur were poor in macroinvertebrate zoobenthos population. Altogether nine macrozoobenthic groups were observed during the study, Thoubal River had the maximum number (seven groups) where as Khuga River had the lowest number (5 groups). In general, lakes harbor good benthos population than rivers. In comparison to other rivers of India (Banerjee *et al.*, 1998 in Damodar, Pathak *et al.*, 2001 in tributaries of river Brahmaputra) macroinvertebrate benthos population of the present finding was richer which may be probably due to favorable environment. Burgherr and Ward (2001) reported high macro invertebrate benthos population from healthy Alpine glacial stream. The occurrence of Trichoptera in plenty, further supports the view of Marlier (1962), who explain the great abundance of benthic fauna due to availability of large quantity of food in suspension form. The regular features for all the rivers were the presence of eutrophic indicators like Oligochaeta and Chironomids which reflect enrichment of downstream waters. Presence of predatory dragonfly nymph which are

pollution tolerant benthic animals in the present study in all the rivers in both upstream and downstream stretches further indicates that the rivers received effluents from domestic sources.

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