

Water Quality Monitoring Using Aquatic Benthic Macro Invertebrates

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Abstract

Use of benthic macro-invertebrate fauna show extreme sensitivity to ascertain the suitability of water quality and to link the desired quality level to the water quality level for various designated best-uses of stretch of River Ganga from Rishikesh to Narora.

Presence of pollution sensitive fauna (Ephemeroptera, Plecoptera and Trichoptera) supported the clean water quality at Rishikesh and Haridwar.

Keywords: *Benthic, Macroinvertebrates, water quality.*

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Introduction

Rivers have got very important place in Indian culture and tradition. They are the lifeline of majority of population in cities, towns and villages and most of these are considered sacred. Every river stretch has a distinct water use like bathing, drinking, municipal supply, navigation, irrigation and fishing. When water quality degrades, changes to plant, invertebrate, and fish communities may occur and affect the entire food chain. Like other water bodies, streams and rivers are specialized habitats of plants and animals. Water quality management thus is very important to maintain and restore the wholesomeness of rivers. Biological monitoring or biomonitoring, is the use of living organisms to determine the condition of the environment. In rivers biomonitoring can be done with benthic macro invertebrates, fish and periphyton, but benthos are generally the assemblage of choice. They have several characteristics that make them particularly useful for biomonitoring. Benthic macro invertebrates are commonly used as indicators in the evaluation of impacts to stream ecology.

Materials and Methods

Five locations namely, Rishikesh, Hardwar, Bijnor, Garhmukteshwar and Narora, have been selected on a 295 km stretch of River Ganga for present study. Based on substratum composition of river

bed of River Ganga, various sampling devices were used for collection of benthic macro-invertebrates.

Stony River bed: At Rishikesh and Hardwar, the river bed substratum composed of mainly, boulders, cobbles, pebbles and gravels. Benthic macro-invertebrates were collected by picking up large boulders and cobbles randomly from the fast flowing shallow stream, and placing the sampling net firmly on the stream bed against the flow and kicking up the stream bed by foot for collection of animals in the net.

Sandy, mud and silty bed: At Bijnor, Garhmukteshwar and Narora, grab samples were picked up by shovel, from the river bed and the samples were washed in the sieve, by river water.

Water Plants: At Garhmukteshwar downstream and Narora barrage, the floating and submerged plants were uprooted and collected into sampling net and placed on sieve for collection of benthic invertebrates

Benthic macro-invertebrates were identified up to family/genus level for Saprobic score and Diversity Score for water quality evaluation using Biological Water Quality Criteria (LATS/13/(1998-99).

Results

A 295 km stretch of River Ganga between Rishikesh and Narora area covered under the study is about 16,780

Kms in U.P. and Uttarakhand states. Bio-monitoring of River Ganga has been carried out in the 295 km stretch from Rishikesh to Narora in order to assess the wholesomeness of water quality.

Use of Benthic Macro – invertebrates for Water Quality Assessment-

Macro invertebrates are useful bio indicators providing a more accurate understanding of changing aquatic conditions than chemical and microbiological data, which at least give short term fluctuations (Ravera, 1998, 2000; Ikomi, *et.al.*, 2005). Odiete, 1999 stated that most popular biological method in assessment of fresh water bodies receiving domestic and industrial waste waters in the use of benthic macro invertebrates(George, *et.al.*, 2010).

They make good indicators of water shed health because they

- live in water for all or most of their lives
- stay in areas suitable for their survival
- are easy to collect
- differ in their tolerance to amount and types of pollution
- are easy to identify in laboratory
- often live for more than one year
- have limited mobility

· are integrators of environmental conditions

Because these organisms are easy to collect and identify, and tend to stay in one area unless environmental conditions change. Some macroinvertebrates are highly sensitive to pollution, while others tolerate it. Certain taxa such as stone flies (Plecoptera) are known to be more sensitive to pollutants or other stressors (De walt, *et.al.*, 2005) and their presence is often considered as indicator of an healthy stream. However, insects are often dominant group of benthic macro invertebrates in both absolute numbers and species diversity.

Aquatic Macroinvertebrates – Highly Sensitive to Pollution-

Certain macroinvertebrates serve as bioindicators of good water quality.

These organisms tend to require high dissolved oxygen levels. When present in large numbers, these macroinvertebrates suggest the stream is in good condition. If these organisms were once abundant, but subsequent sampling shows a decline in numbers, it may indicate that a pollution incident occurred. These organisms include:-

Taxonomical Group	Taxonomical Families
Ephemeroptera	Siphonuridae
	Heptageniidae
	Leptophlebiidae
	Ephemerellidae
	Pothamintidae
	Ephemeridae
	Neoepemeridae
	Prosopistomatidae
Plecoptera	Taeniopterygidae
	Leuctridae
	Capniidae
	Perlodidae
	Perlidae
Hemiptera	Aphelecheiridae
Trichoptera	Leptoceridae
	Goeridae
	Lepidostomatidae
	Brachycentridae
	Sericostomatidae
	Glossomatidae

Aquatic Macroinvertebrates – Somewhat Tolerant of Pollution-

This group of macroinvertebrates tends to tolerate some degradation of water quality. Their abundance and diversity indicates a stream is in fair to good condition. These macroinvertebrates include

Taxonomical group	Taxonomical families	Taxonomical group	Taxonomical families
Hemiptera	Veliidae	Mollusca	Neritidae
	Hebridae		Viviparidae
	Belastomatidae		Hydrobiidae
	Corixidae		Thiaridae
Coleoptera	Halplidae		Bithynidae
	Hygrobidae		Ancylidae
			Unionidae
	Dytiscidae	Trichoptera	Hydroptilidae
	Gyrinidae	Crustacea	Atyidae
	Hydrophilidae		Gammaridae
	Dryopidae		Palaemonidae
	Elminthidae	Polychaeta	Nereidae
	Noteridae		Nephtyidae
	Psephenidae	Odonata	Agriidae
	Trichoptera	Hydropsychidae	
Diptera	Ecnomidae	Lepidoptera	Pyralidae
	Tipulidae	Planaria	Planariidae
	Culicidae		Dendrocoelidae
	Tabanidae		
	Blepharoceridae		
	Simuliidae		

Aquatic Macroinvertebrates – Pollution Tolerant

Certain macroinvertebrates thrive in poor quality water. An abundance of these organisms suggests environmental conditions in a stream have deteriorated. These are less dependent on dissolved oxygen to breathe. These macroinvertebrates include:

Diptera	Syrphidae
	Chironomidae
	Ephydriidae
Oligochaeta	All families

Evaluation of Benthic Macro Invertebrates (FIG-1, A, B, C)

Taxonomic composition of

benthic macro-invertebrates, in stretches of River Ganga subjected to various water uses, followed a dominance sequence at

• **Rishikesh:** Ephemeroptera> Trichoptera> Coleoptera> Plecoptera

• **Haridwar:** Ephemeroptera> Diptera> Trichoptera

• **Bijnor:** Crustacea> Diptera> Mollusca> Hemiptera=Coleoptera

• **Garhmukteshwar:** Coleoptera> Crustacea> Hemiptera> Mollusca> Diptera> Ephemeroptera

• **Narora:** Mollusca> Hemiptera> Crustacea> Ephemeroptera> Odonata

The taxonomic composition of River Ganga at various locations indicated variation in dominance sequence of taxa of benthic macro-invertebrates both at phylum as well as order level. At Rishikesh, benthic fauna was dominated by phylum arthropoda with a dominance sequence of order ephemeroptera> trichoptera> coleoptera> plecoptera. At Haridwar arthropods were also supported by mollusks communities having dominance of order ephemeroptera> diptera> trichoptera> gastropoda. Further downstream at Bijnor, combination of arthropoda> annelida supported the dominance of order amphipoda> diptera> gastropoda> hemiptera=coleoptera. Number of phylums increased to arthropoda> mollusca> platyhelminthes, at Garhmukteshwar with total change in

dominance sequence of order of coleoptera> amphipoda> hemiptera> gastropoda> bivalvia> diptera> ephemeroptera. At Narora, arthropoda> mollusca> annelida supported the dominance of order: bivalvia> gastropoda> hemiptera> amphipoda> ephemeroptera> odonata> hirudinea.

Clean water quality (Class 'A') in River Ganga was observed at Rishikesh, supported by 20 numbers of families of benthic macro-invertebrates. Slightly polluted water quality (Class 'B') was observed at Haridwar, supported by 19 numbers of families of benthic macro-invertebrates. During mass bathing on religious occasions like Kumbh, ArdhKumbh etc, and huge amount of bleaching powder is added for chlorination of river water for disinfection during bathing (PCRI report, 1998). Such chlorinated compounds are deleterious to the health of aquatic life (Gaur, et al; 2010). Moderate pollution (Class 'C') in biological water quality of River Ganga was observed at Bijnor, Garhmukteshwar and Narora supported by 35 numbers of families.

Taxonomic Identification of pollution sensitive macroinvertebrates-

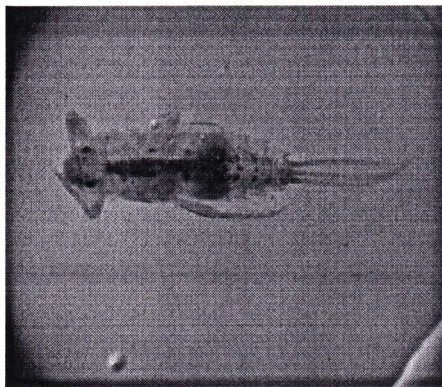
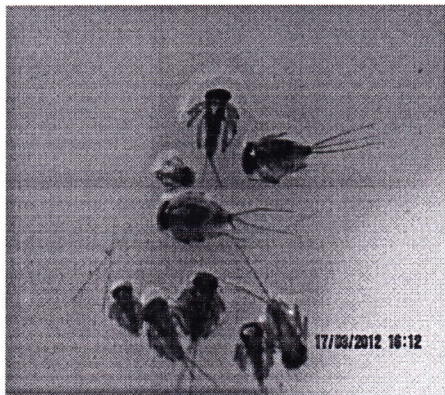
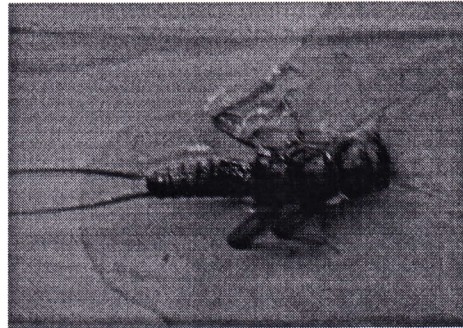
MAYFLIES, ORDER EPHEMEROPTERA-

The order Ephemeroptera includes only the mayflies. Ephemeroptera comes from the Greek *ephemeros*, meaning short-lived,

and *pteron*, meaning wing. Adult mayflies live just one or two days.

- Three or sometimes only two tail filaments (Cerci) on the last abdominal segment.
- Abdomen with plate- or leaf like gills.
- Single claw on feet.

· Two claws on feet.



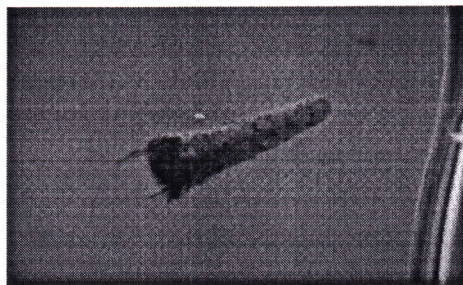
STONEFLIES, ORDER PLECOPTERA

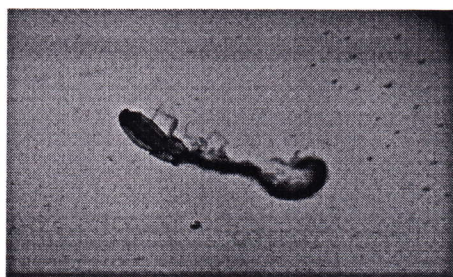
Aquatic stonefly nymphs live only in cool, clean streams, and are an important bioindicator of good water quality.

- Two posterior tail filaments (cerci) on the last abdominal segment.

CADDISFLIES, ORDER TRICHOPTERA

- No abdominal fleshy lobes present but there may be minute gill filaments.
- The end of the abdomen is equipped with a pair of hooks.
- They can be either free living or can make a protective case out of sand, pebbles or twig.
- When not in a case their bodies take the shape of "C".





Order Hemiptera.

· Head prolonged into beak-like structure.

· Forewings modified into wing-cases and not hardened.

· Mouthparts are modified for sucking, take the form of a jointed beak which is directed backwards underneath the head.

Family Aphelocheeridae

· Head as broad as long.

· Rostrum folded under the body, reaching the bases of the posterior legs.

· Length 8 -10 mm.

· Only inhabits hilly regions in fast flowing clean waters .

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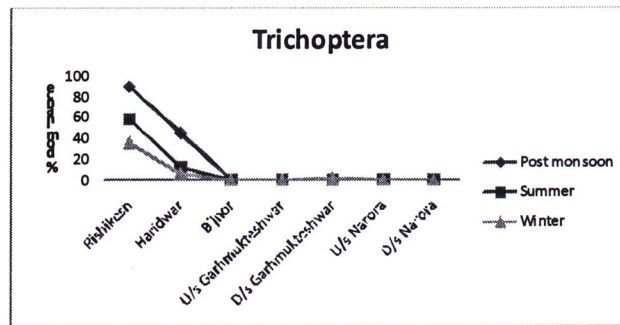
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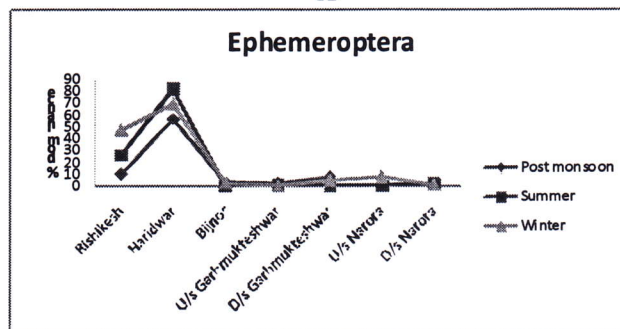
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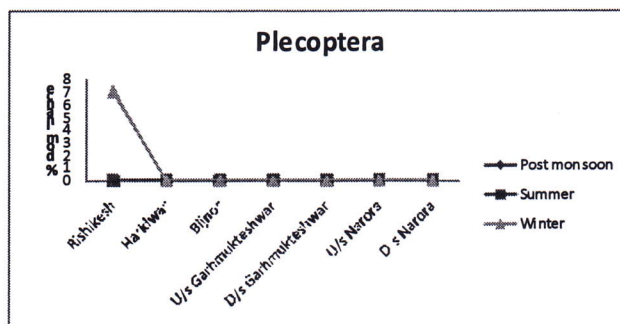
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A



B



C

FIG-1 Evolution of Benthic Macro in Vetre brates