

## Taxonomic composition and function of benthic macroinvertebrate fauna in the headwaters of Vindhyan rivers

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### Abstract

Study was performed to determine the taxonomic composition and functional feeding groups of benthic macroinvertebrate fauna in the Vindhyan rivers; Ken, Pasiuni and Tons. Ephemeroptera (may fly) predominated in winter (Ken), and summer (Ken, Paisuni). Caenidae and Leptophlebiidae together were responsible for the temporal trends of mayflies in the Ken and Paisuni. In the Tons Diptera as Chironomidae was highly abundant only in winter and Mesogastropod as Thiaridae predominated during summer. The scrapers and collectors (gathering and filtering) were the major functional feeding groups in macroinvertebrate fauna in the rivers of Vindhyan region.

**Keywords:** Macroinvertebrate, Bundelkhand, Collectors, Taxonomic composition

### Introduction

The streams are characterized by unidirectional flow of solute, detritus, sediments and organism are constantly delivered from upstream to downstream areas (Cooper *et al.*, 1990). A fundamental characteristic of stream ecosystem is the unidirectional movement of water, nutrients, inorganic materials and organic matter down altitudinal gradients from headwater mountain streams to low land rivers (Suren 1994). Many studies have been performed for the spatial and temporal knowledge for benthic macroinvertebrate fauna in the various part of the world (Corkum 1990, González *et al.* 2003, Milesi *et al.* 2009, Mesa 2010, Ezekiel *et al.* 2011). However such studies are limited in India (Singh *et al.* 1994, Johal & Rawal 2005, Mishra *et al.* 2013, Mishra & Nautiyal 2011, Nautiyal & Mishra 2012, Mishra & Nautiyal 2013a, Sivaramakrishnan *et al.* 1995). In view of present scenario, no study is available in the headwaters rivers of the Central Indians rivers. Though only one study is available in the in headwater of Doon valley rivers (Nautiyal *et al.* 2013).

### Materials and Methods

#### Study area

The Vindhyan are 1400 million years old (Unni 1996). The Vindhyan system is a vast stratified formation of sand stones, shales and lime stones, which form the dividing ridge between Hindustan proper and Deccan, known as the 'Vindhyan mountains'. The climatic condition of the Vindhyan region is mainly semi-arid to dry sub-humid with hot summers and moderately cold winters. The mean annual rain fall varies between 1000-1600 mm (Bhattacharyya 2000).

The stream Ken, Paisuni and Tons selected for the present study lie between latitude 23°30' to 26° N and longitude 78°30' to 82°30' E (Figure 1). These streams flow north from low latitude (north of Narmada, around Tropic of Cancer) to high latitude along southern fringe of the Indo-Gangetic Plains. The headwater section of the river Ken and Tons lie almost equal altitude, while the differ greatly. In the headwater section of the rivers, agriculture is the major landuse along the banks of the Ken and the Tons, and hence lacks shading, though there is some

vegetation cover in the Ken but none in the Tons. Thus both are ‘open’ streams. The Paisuni is a ‘shaded’ stream due to dense forest on both banks (Table 1).

**Table 1 The physico-chemical characteristics in the Vindhayn rivers. The substrate types are arranged in order of their decreasing proportion based on eye estimation.**

**Acronyms:** S- Shahnagar, A- Anusuya, AM- Amdara, , Ag+Vill. - Agriculture and Village, F- Forest, T- Temple, R-Rock, B- Boulder (<254 mm), C- Cobble (64 - 128 mm), P- Pebble (32 - 64 mm), G- Gravel (16 - 32 mm), S – Sand, Si- Silt, Cl- Clay. The substrate is more prismatic (sharp edges) in the Plateau streams.

River	Ken	Paisuni	Tons
Station	Shahnagar	Anusuya	Amdara
Landuse	Ag+Vill	F+T	Ag
Latitude (°N)	23°59'29"	25°04'25"	24°6'31"
Longitude (°E)	80°18'2"	80°52'05"	80°36'11"
Altitude (m)	365	180	360
River width (m)	38	42	30
Depth (cm)	22-60	10-60	20-56
Distance from source (Km.)	5	10	20
Substrate type	R>B>C> Si	R>B>C> P	Cl> S>G

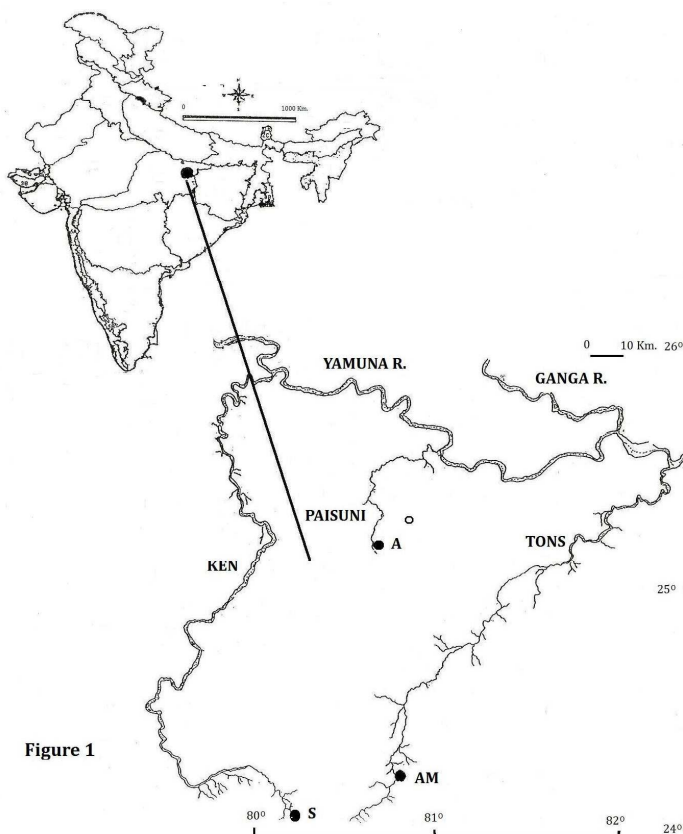


Figure 1

**Figure 1** Relative position/location of the upper sections of the Ken, Paisuni and Tons. The sampling stations are Shahnagar (S), Anusuiya (A) and Amdara (AM) in the rivers Ken, Paisuni and Tons, respectively in the Vindhyan region

### Sampling rationale

The streams Ken, Paisuni and Tons were sampled seasonally between October – January (winter), February - May (summer) and June - September (monsoon) during 2007 to 2008. The benthic macroinvertebrate fauna was collected through lifting of stones and sieving of soft substratum from 1ft<sup>2</sup> area from the headwater section of both rivers. The communities were obtained from 5 quadrates in a 50 m stretch at each station. Each quadrate is placed in a different microhabitat created by heterogeneity of substrate and flow i. e. large boulder (<254 mm), cobble (64 - 128 mm), pebble (32 - 64 mm, 16 - 32 mm) and some other type of microhabitat like sand, silt, and clay (Table 1). The sampled substrate like boulder, cobble etc is more prismatic (sharp edges) in the Central Indian streams. The collected samples were preserved in 5% formalin for laboratory analysis. The counts data was used for computing percentage composition and functional feeding group (FFG). Standard literature (Edmondson 1959, Macan 1979, Edington & Hildrew 1995) was used to identify the benthic macroinvertebrate fauna at

family level. Counts were used to compute for percentage composition FFG (Ramusino *et al* 1995).

### Results

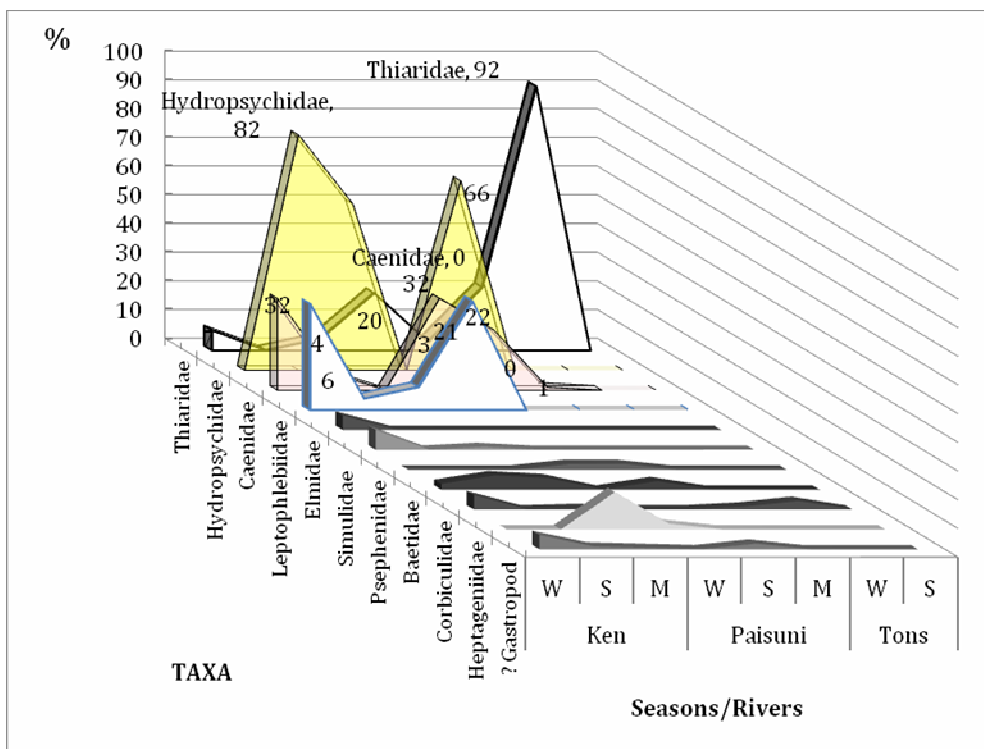
Ephemeroptera (may fly) predominates >70% during winter (Ken), and summer (Ken, Paisuni). In the Ephemeroptera, Caenidae and Leptophlebiidae together are responsible for the temporal trends of mayflies in the Ken and Paisuni. Therefore, composition in the Ken is similar to certain extent during these seasons (except increased abundance of mollusc in summer), but changes radically in monsoon because Trichoptera attains very high abundance (Table 2). Similarly, the caddisfly are abundant during winter and monsoon in the Paisuni and do not occur in the Tons. The high abundances of the caddisfly are due to Hydropsychidae only. In contrast the Diptera as Chironomidae becomes highly abundant only in winter and Mesogastropod as Thiaridae predominates during summer in the Tons. Thus the fauna and their relative abundance of the Tons are very different from other Vindhyan rivers (Table 2, Figure 2).

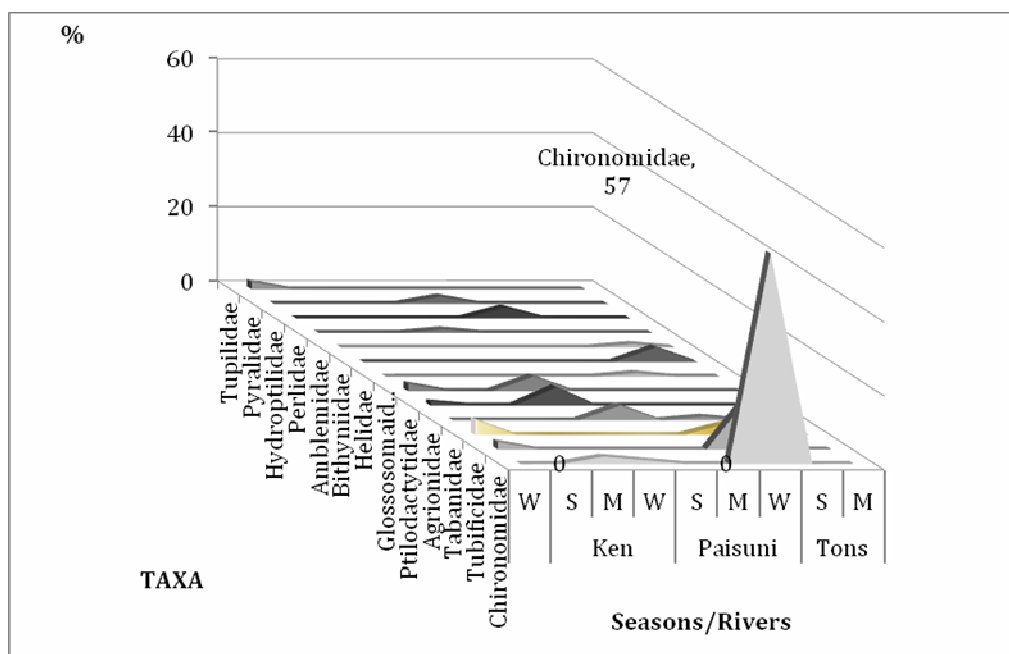
**Table 2 Temporal variation in the taxonomic composition (Orders/Families) of the benthic macroinvertebrate fauna of Bundelkhand Plateau rivers.**

Acronyms: W- Winter, S –Summer, M-Monsoon.

Order/Family	Ken			Paisuni			Tons		
	W	S	M	W	S	M	W	S	M
<b>Plecoptera</b>	-	-	-	<b>1</b>	-	-	-	-	-
1. Perlidae	-	-	-	1	-	-	-	-	-
<b>Ephemeroptera</b>	78	71	15	25	72	24	1	-	-
2. Caenidae	74	32	6	-	32	21	1	-	-
3. Leptophlebiidae	-	37	4	8	38	-	-	-	-
4. Heptageniidae	-	-	-	13	2	-	-	-	-
5. Baetidae	4	2	5	4	-	3	-	-	-
<b>Trichoptera</b>	2	-	82	62	-	69	-	-	-
6. Hydropsychidae	-	-	82	58	-	66	-	-	-
7. Glossosomatidae	2	-	-	4	-	-	-	-	-
8. Hydroptilidae	-	-	-	-	-	3	-	-	-
<b>Diptera</b>	12	7	2	2	-	-	61	-	-
9. Helidae	-	-	-	-	-	-	1	-	-
10. Tabanidae	4	-	-	-	-	-	3	-	-

11. Tupilidae	2	-	-	-	-	-	-	-	-
12. Chironomidae	-	-	2	1	-	-	57	-	-
13. Simuliidae	6	7	-	1	-	-	-	-	-
<b>Coleoptera</b>	4	5	-	5	2	2	-	-	-
14. Elmidae	3	5	-	-	-	-	-	-	-
15. Ptilodactyidae	1	-	-	5	-	-	-	-	-
16. Psephenidae	-	-	-	-	2	2	-	-	-
<b>Odonata</b>	-	-	-	-	4	-	1	-	-
17. Agrionidae	-	-	-	-	4	-	1	-	-
Lepidoptera	-	-	-	-	2	-	-	-	-
18. Pyralidae	-	-	-	-	2	-	-	-	-
<b>Archioligochaeta</b>	2	-	-	-	-	-	14	-	-
19. Tubificidae	2	-	-	-	-	-	14	-	-
<b>Mesogastropoda</b>	2	12	1	4.5	20	5	22	96	-
20. Bithyniidae	-	-	-	-	-	-	-	4	-
21. Thiaridae	1	7	-	4	20	3	22	92	-
22. Unidentified Gastropod	1	5	1	0.5	-	2	-	-	-
<b>Heterodonta</b>	-	5	-	0.5	-	-	1	4	-
23. Corbiculidae	-	5	-	0.5	-	-	1	3	-
24. Amblemidae	-	-	-	-	-	-	-	1	-





**Figures 2** Spatial and temporal variations in the relative abundance of benthic macroinvertebrate fauna occurring in the streams of Bundelkhand region. The high abundance of Hydropsychidae in the Ken and Paisuni while Thiaridae and Chironomidae in the Tons is noticeable. Caenidae and Leptophlebiidae attain moderate abundance in the streams of this region.

The scrapers and collectors (gathering and filtering) are the major functional feeding groups in macroinvertebrate fauna in the stream of Bundelkhand. The share of scrapers varies from 7- 79% in the Ken, 17.5-56 % in the Paisuni and 23-97% in the Tons. Similarly, collectors vary from 20-93% in the Ken, 38-76.5% in the Paisuni and 3-76% in the Tons. Scrapers decrease from winter to monsoon, while collectors show an inverse trend in the Ken. In the Paisuni scrapers increase from winter to summer and decrease to monsoon, and reverse trend is observed for collectors. During summer, scrapers and collectors occur in almost same proportions in the Ken and Paisuni. However, in the Tons, the trend is similar to the Paisuni from winter to summer. Noticeably, shredders are present only in the Paisuni stream and during summer only.

**Discussion**

The faunal % composition varies seasonally in a different manner in the Vindhyan region,

because different taxa attain abundance. Ephemeroptera predominates >70% in winter and summer in the due to mayfly Caenidae in the Ken, Trichoptera in the Paisuni and Diptera in the Tons during winter. The communities differ when substrate conditions change and inputs vary as in the case of Ken and the Tons, where the landuse is agriculture in both but with small habitation in the Ken and rock-boulder-cobble substrate compared with gravel-sand-silt-clay in the Tons and available flows strongly influence the faunal composition and their abundances. Contrarily, Rundle *et al.* (1993) and Ormerod *et al.* (1994) reported that the invertebrate fauna are often different in streams draining through the different landuse compared with the latter where at least two taxa gain dominance, irrespective of the seasons. Higher abundance of Ephemeroptera was also reported in the Alikhad stream (Joshi 1994) and Gaula (Sunder 1997).

Mishra and Nautiyal (2012) reported the importance of the substratum on the distribution

of benthic macroinvertebrate fauna. It is true that the physical variables and chemical requisites are necessary for the benthic macroinvertebrate assemblage to exist and flourish in a harsh environment such as a mountain stream (Minshall 1988), but once they are fulfilled food becomes the next most important factor (Ulfstrand 1967, Tolkamp 1980, Dudgeon 1984).

The dominance of collectors and scrapers in the headwaters of the Vindhyan region streams receive support from the observation that the relative abundance of scrapers was not always highest in streams without shading, and neither was the relative abundance of detritivore shredders always highest in shaded streams (Hawkins *et al.* 1982). The abundance of filtering collectors during winter is also justified since the Paisuni is a shaded stream and scrapers including the mollusc Thiaridae gain abundance

only during summer when periphyton growth in shallower stream is favoured by higher light intensity. In the Tons the midge Chironomidae predominates during winter and Thiaridae in summer. They function as gathering collector and scraper respectively and indicate the abundance of related food groups coming from allochthonous (agriculture) and autochthonous (periphyton) sources.

While the landuse is same in case of the Ken and the Tons, the kind of substrate and availability of food have stronger influence owing to which their communities differ. Singh and Nautiyal (1990) reported abundance of predators in the headwaters of the river Bhagirathi at Gangotri. Mishra & Nautiyal (2013) reported abundance of the collectors in the headwater section of the Vindhyan streams (Ken, Paisuni and Tons).

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