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Diversity and Distribution of Aquatic Insects in Aghanashini River of Central Western Ghats, India

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ABSTRACT

Freshwater insects play important role in ecosystem functioning viz. nutrient cycling, primary production, decomposition and materials translocation. This study deals with diversity and distribution of aquatic insects from nine stations in the Aghanashini River of South-west India. The aquatic insects were sampled systematically and randomly in station-wise habitats, using standard protocols. Genera level diversity varied from station to station. Ephemeropteran (Mayflies) and Coleopterans (beetles) indicative of good water quality were most diverse. Different functional feeding groups such as shredders, scrapers, collector-gatherers and predators have important roles in stream nutrient cycling. Functional feeding groups dominated with scrapers followed by collectors, predators and shredders respectively. Presence of pollution intolerant genera like *Petersulla, Isonychia, Isca, Clypeocaenis*, *Helicopsyche* etc. highlights the good quality of river water. The abundance of organic pollution tolerant *Baetis* and *Hydropsyche* in some downstream stations, nearer to human settlements, is a disconcerting factor. Probably members collected of genera *Isonychia* and *Platybaetis* from tributary streams are likely to be new species, as these genera hitherto were not assigned to any species in India. Routine biomonitoring of hill streams and rivers using aquatic insect indicators will facilitate better conservation of environment.

Keywords: Aquatic insects, diversity, mayflies, bio-indicator and Functional feeding group

1.0 INTRODUCTION

Freshwater insects have important roles in the ecology of running waters. They are vital for riparian and flood plain food webs, processing organic matter and transporting energy along stream channels, laterally to the flood plains and even vertically down into the stream bed. In many forest streams aquatic insects break down leaf litter, supplying nutrients, carbon and energy to the stream and associated ecosystems, may be lake, river and estuaries. Their activities can alter water quality and influence energy flow patterns in different trophic levels; their biological interactions often have significant effects on community structure. So ubiquitous and fundamental to riverine processes are aquatic insects that their diversity, distribution and assemblage are routinely assessed as an indicator of the 'health' of running waters (Boulton and Lake, 2008). The distribution of aquatic insect functional feeding groups in running waters is supposed to reflect process-level aquatic ecosystem attributes. Specialized feeders, such as shredders and scrapers, are presumed to be more sensitive to perturbation, while generalists, like gatherers and filterers, are more tolerant to pollution as indicated by the availability of certain food (Barbour et al., 1996). Therefore, in recent years, functional feeding groups have been used as bio-indicator and biomonitoring organisms.

The Western Ghats has many large rivers and streams and is one of the world's 34 global Biodiversity Hotspots rich in endemic floral and faunal endemism. The Central Western Ghats is recognized as a hot speck in the biodiversity hotspot and forms the northern limit of many endangered ecosystems, sheltering rare trees *Myristica magnifica*, *Semecarpus kathlekanensis*, *Gymnacranthera canarica* and primates like the Endangered *Macaca silenus* (Lion tailed Macaque) etc. Hill stream and river invertebrates, especially insects, which form bulk of the diversity, have not yet been thoroughly documented despite the efforts by earlier workers (Sivaramakrishnan and Job, 1981; Sivaramakrishnan et al., 1996 & 2000; Burton and Sivaramakrishnan, 1993; Martin et al., 2000; Ramachandra et al., 2002; Anbalagan et al., 2004; Subramaniam and Sivaramakrishnan, 2005;, Subramanian et al., 2005;, Dinakaran and Anabalagan, 2007 a & b, 2008; Dinakaran et al. 2009; Gupta and Paliwal, 2010; Selvakumar et al., 2012 and Balachandran et al., 2012. The aquatic insects of Aghanashini River of Central Western Ghats, the subject matter of this paper, were never studied before.

2.0 MATERIALS METHODS

2.1 Study area: The Aghanashini or Tadri River (total length 121 km) originates in the Sirsi taluk of Uttara Kannada district in the Central Western Ghats of Karnataka State. It has two sources – the Bakurhole and Donihalla both situated in the Sirsi taluk. The streams join together forming the Aghanashini River; the latter winding its way through the valleys and gorges of Western Ghats taking a westerly course towards the South Indian west coast, joining the Arabian Sea in the Kumta taluk of Uttara Kannada (Figure 1). One more tributary Bennehole joins the river nearer to the coastal region. The Aghanashini has a catchment area of 2,146 sq. km, and an annual estimated discharge of 966 million cubic meters of water (Kamath, 1985 and Bhat, 2002).

2.2 Sampling methods: The study was conducted during the post monsoon period of the year 2011. Nine sampling stations, viz. Gavingudde, Kelagina Sarkuli, Balur, Sampakhanda, Mavinhole, Bennehole, Mastimane, Devalli and Katgal, were selected in the Aghanashini River and its tributaries (Figure 1). Earlier studies elsewhere in Western Ghats have shown that aquatic insects are best studied during this period (Sivaramakrishanan et al., 2000). At each sampling locality, three important habitats - riffle, pool and edges were chosen for collection of aquatic insects. In each station, all these three habitats were sampled in three replicates. In the riffle area, insects were trapped in kick-net samples (1 x 1 m area, mesh size 500 μm); Insects were collected in pool habitat with "D" frame pond net. The edges, often overgrown with plants, or strewn with rocks etc. and difficult for application of any net method, were randomly surveyed using appropriate collection methods. The insects collected from all the three samples from each habitat type were pooled together and stored in 70% alcohol. The specimens were sorted, observed and identified up to the best possible taxonomic level using appropriate field keys (Dudgeon, 1999; Merritt and Cummins, 1988; Subramanian and Sivaramakrishnan, 2007; Balachandran et al., 2011). Functional feeding categorization of aquatic insects was made in accordance with Dudgeon (1999) and Merritt and Cummins (1988).

2.3 Data analysis: Species diversity indices such as Shannon-Weiner, Simpson's, Evenness, and Margalef were computed to understand the biotic community of each study station. Shannon-Weiner diversity index helps in species relative abundance, Simpson's diversity index points towards abundance of the most common species. Evenness index is used for the degree to which the abundances are equal among the species present in a sample or community. Margalef index is having a good discriminating ability and is sensitive to sample size; it is a measure of the number of species present for a given number of individuals. Cluster analysis of Ward's method of distance was used to compare the distribution of aquatic insect community between the sampling stations.

3.0 RESULTS AND DISCUSSION

Altogether 1223 individuals of aquatic insects were collected during the study period from nine sampling stations in Aghanashini River. These belong to 38 genera under 28 families and 8 orders (Table 2). Generic richness of aquatic insects was highest (21) in Bennehole sampling station and decreased towards Kelagina Sarkuli (19), Mastimane (18), Balur (15), Mavinhole (12), Sampakhanda (11), Katgal (10), Gavingudde (8) and Devalli (7) (Figure 2). Ephemeoptera (15) was found to be the predominant group in the studied sites followed by Coleoptera, Trichoptera, Diptera (6), Odanata (4), Hemiptera (2), Plecoptera and Megaloptera (1). Two of the 38 genera, *Neoperla* and *Choroterpes,* were found to be present in all sampling sites, whereas 14 genera [*Notophlebia, Edmundsula, Petersula, Ephemerella (Torleya), Ephemerella (Drunella), Clypocaenis, Wormaldia, Stenocolus, Dineutus, Laccobius, Heliogomphus, Lamelligomphus and Hexatoma*] had single station distribution only. Eleven genera (*Helicopsyche, Thraulus, Isca, Thalerosphyrus, Caenis, Psychomyia, Micronecta, Orectochilus, Crocothemis, Coridalus)* had presence in two stations each. The genera *Cinygmina, Naucoris, Pilaria, Chironomus* and *Isonychia* occurred in three sampling stations each, whereas *Afronurus, Platybaetis, Cheumatopsyche, Lepidostoma* occurred in four stations each. A single genus *Eubrianax* was found in five out of nine stations while two genera *Euphaea* and *Simulium* occurred in six stations. The genera *Hydropsyche* and *Baetis* were found to be present in seven and eight sampling stations respectively.

The Shannon and Simpson diversity indices were highest at Bennehole (2.754 and 0.9142) and lowest at Katgal (0.852) and Devalli (0.3799) respectively. The Evenness and Margalef indices were highest at Balur (0.7772) and Bennehole (4.662) and lowest at Katgal (0.2344) and Devalli (1.237) respectively (Table 1). Aquatic insect diversity of Aghanashini river system is comparatively higher when compared to other well studied river systems such as Sharavathi in Uttara Kannada (Ramachandra et al., 2002), Kunthipuzha in Silent Valley in Kerala (Burton and Sivaramkrishanan), Tamiraparani River in Tamil Nadu (Martin, 2000) and Yamuna River studied in Firozabad district in Uttar Pradesh by Gupta and Paliwal (2010). The highest richness and diversity values were observed for Bennehole, Kelagina Sarkuli and Mastimane areas. High numerical abundance of the more organic pollution tolerant *Baetis* and *Hydropsyche* in the downstream sampling stations Devalli and Katgal is indicative of higher human disturbances. Families Hydropsychidae (to which

Hydropsyche belongs) and Baetidae (of genus *Baetis*) are known to be tolerant towards organic pollution and other human disturbances (Sivaramakrishanan, 1996, Selvakumar et al., 2012).

Based on Ward's method of distance, 9 sampling stations were clustered into two major groups (Figure 3). Balur, Kelagina Sarkuli and Bennehole formed one group and the remaining 6 sites formed the second group. In the second group, the sampling station of Mastimane differed from other sampling stations. The first group was mainly clustered with higher taxa distribution ranging from 15 to 21 for each station; this taxa rich cluster is significant for the presence of sensitive genera like *Isonychia*, *Helicopsyche*, *Isca* and *Neoperla.* In the second group of six stations five had low diversity (7-12 genera); the station Mastimane towards the foothills showed higher diversity (18 genera) due to the combined presence of pollution sensitive genera and tolerant ones indicative of moderate disturbances. Notable sensitive organisms found here were *Notophlebia, Edmundsula, Afronurus, Ephemerella (Torleya)* and *Clypocaenis*. Rest of the sampling sites of second group with 7 to 12 taxa each, had all cosmopolitan taxa like *Baetis, Choroterpes, Neoperla, Platybaetis, Eubrianax, Orectochilus, Euphaea,* and *Simulium*. The results of cluster analysis on Ward's methods of distance clearly showed close variance between the Bennehole, Kelagina Sarkuli and Balur sampling stations, indicating similarity in species composition due to similar stream vegetation profile. The aquatic insect taxa like *Helicopsyche, Petersula, Isca* and *Isonychia* are intolerant to pollution and habitat disturbance, and hence, their presence indicates pristine habitats including the rich forests adjoining these stations.

Functional feeding groups of aquatic insects are shown in Figures 4 and 5. Scraper (50.2 %) was the predominant group in this river followed by collectors (30.39 %), predators (16.71 %), shredders (2.04 %) and piercers (herbivores) (0.66 %). Scraper group population was most abundant in the downstream of river at Devalli (84.38 %) and least abundant at Mastimane (19.51 %). The collector group was dominant at Mastimane and least abundant at Devalli, whereas, the predator group was found to be dominant in Bennehole and least abundant at Sampakhanda and Devalli. The River Continuum Concept (RCC) states that rivers have physical gradients which are influenced by the surrounding environment; natural disturbance regime, local hydrology and upstream conditions in turn impact and define the biological components of the stream (Vannote et al., 1980). Similarly, numerous studies suggest that stream invertebrates demonstrate preferential feeding, which depends on the food resources available (Chaloner and Wipfli, 2002, Burrell and Ledger 2003). However, the classification of stream invertebrates into functional feeding groups is a useful tool that enhances our understanding of stream nutrient cycling and trophic interactions, which impact stream integrity and function. According to RCC, the members of shredder community are predominant in the upstream of riverine ecosystem, gradually decreasing towards downstream, where collectors and collector gatherers become dominant. In the present study, the shredder community was sufficiently represented in the upstream areas. Shredding of fallen plant materials in the stream is pre-requisite for microbial degradation for the furtherance of the nutrient cycle in water. Whereas the absence of shredders in the downstream stations is in conformity with the RCC, their scarcity in the upstream areas highlights the need and for yearlong surveys so as to get full profile of the functioning of stream aquatic foodwebs.

4.0 CONCLUSION

The present study reveals that the aquatic insects play a vital role in the ecological structure and ecosystem functions of Aghanashini River. The good representation of pollution sensitive taxa like *Isonychia, Helicopsyche, Isca, Petersula,* and *Ephemerella* emphasizes the importance of pristine rivers and streams, like Aghanashini and its tributaries, still present in the Western Ghats, one of the global biodiversity hotspots, increasingly falling prey to anthropogenic pressures. Aquatic insects not only enhance stream nutrient cycling through their feeding strategies, but also support communities of larger organisms like fish, frog and others. The water-bodies of Western Ghats being the main centres of especially aquatic faunal endemism, such as of fishes and amphibians, biomonitoring of more number of streams and rivers, using aquatic insect community, and working for their holistic conservation, incorporating also the catchment area natural vegetation, deserve to be prioritized by conservationists (Martin, 2000; Sreekantha et al., 2007; Gururaja et al., 2008 and Chandran et al., 2010). The integrity of stream insect communities heavily relies upon the structural integrity of the streams and processes associated with their physical habitats which stretch even much beyond them.

5.0 ACKNOWLEDGEMENT

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Figure 1: Locations of sampling stations in the Aghanashini River

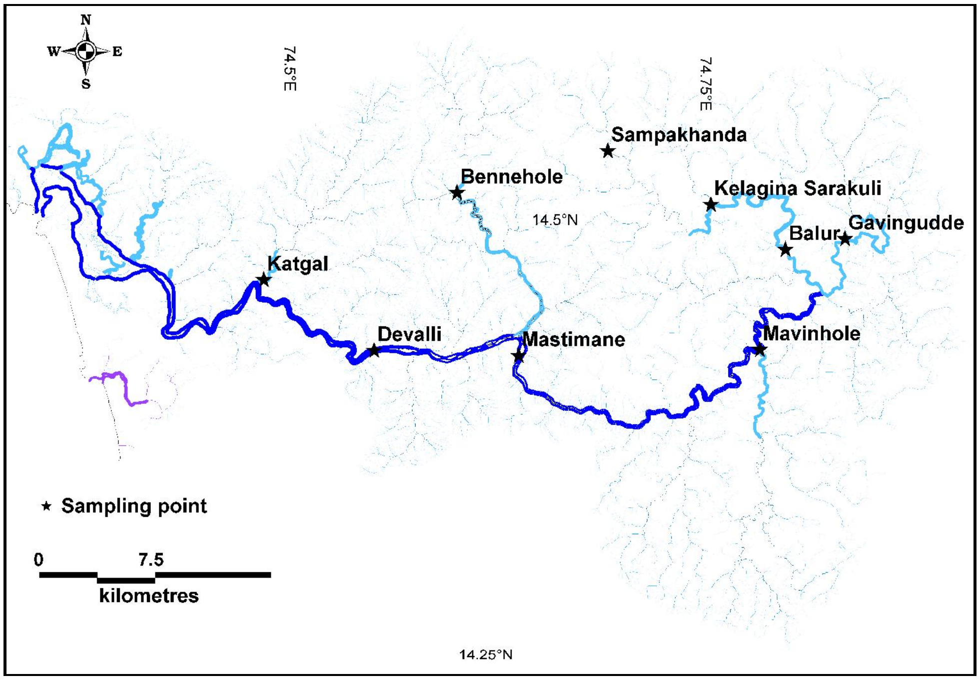

Figure 2: Generic richness of aquatic insect orders in sampling stations of Aghanashini River.

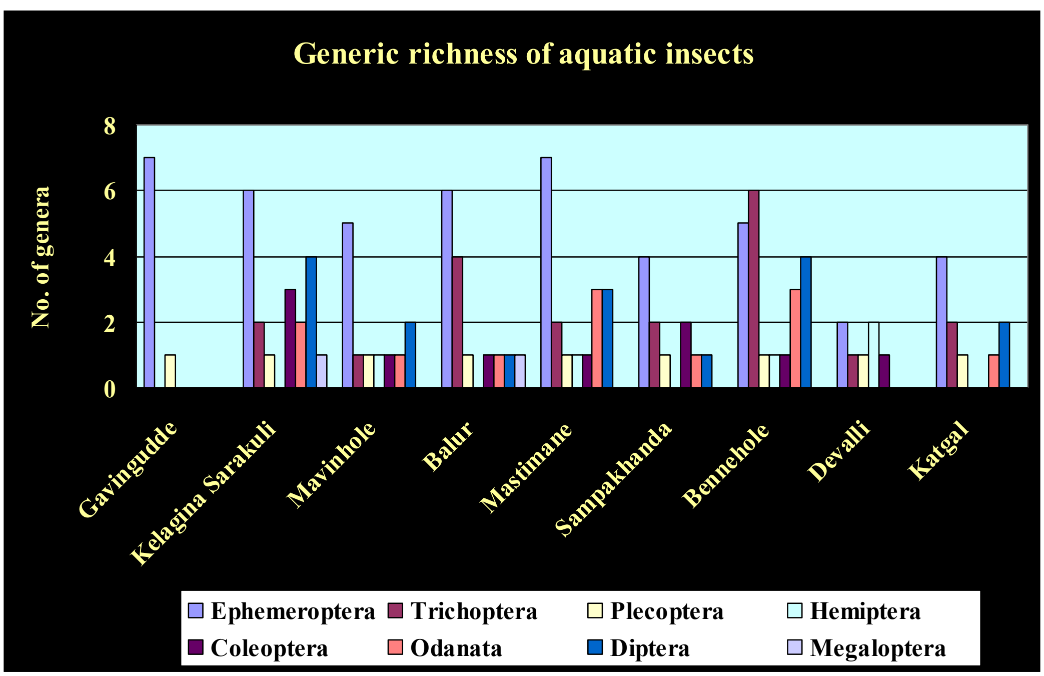

Figure 3: Cluster analysis for sampling sites based on Ward's method of distance.

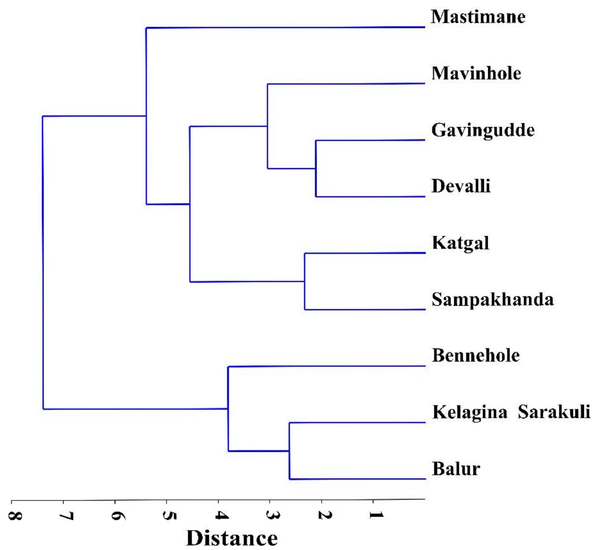

Figure 4: Percentage of Functional Feeding Group of aquatic insects in the sampling stations of Aghanashini River.

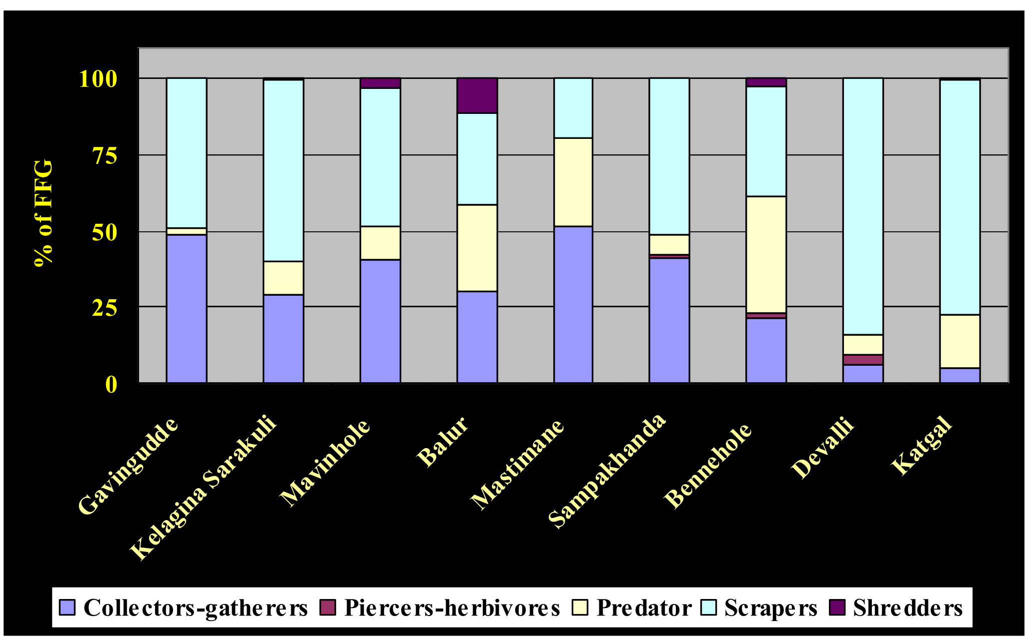

Figure 5: Percentage composition of Functional Feeding Group in Aghanashini River.

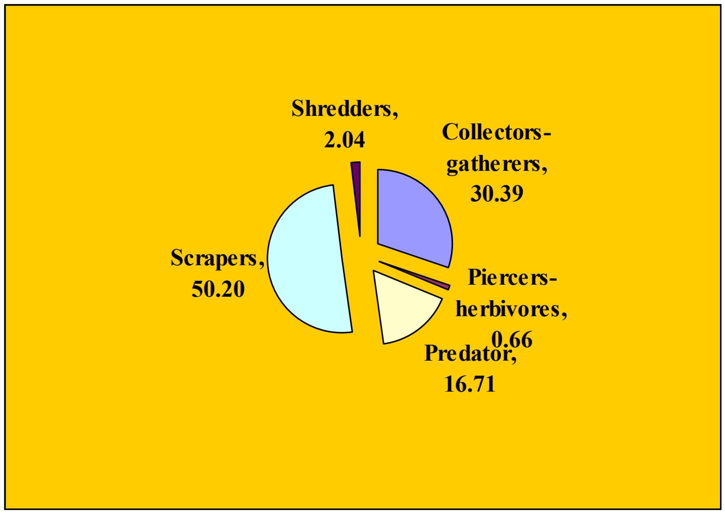

Table 1: Species richness and diversity indices for aquatic insects in sampling stations

Sampling station	Taxa	Simpson	Shannon	Evenness	Margalef
Gavingudde	8	0.7272	1.565	0.5976	1.556
Kelagina Sarakuli	19	0.7794	1.946	0.3686	3.140
Mavinhole	12	0.8311	2.071	0.6609	2.439
Balur	15	0.8940	2.456	0.7772	3.263
Mastimane	18	0.9019	2.557	0.7169	3.837
Sampakhanda	11	0.6703	1.473	0.3965	2.012
Bennehole	21	0.9142	2.754	0.7475	4.662
Devalli	7	0.3799	0.891	0.3483	1.237
Katgal	10	0.3988	0.852	0.2344	1.645

Table 2: Functional Feeding Group-wise classification of insects in Aghanashini River.

Order	Family	Genus	Functional Feeding Group
Ephemeroptera	Isonychidae	*Isonychia* sp	Collectors-filterers
	Leptophelebiidae	*Choroterpes* sp	Scrapers
		Thraulus sp.	Collectors
		Isca sp.	Collectors
		Notophlebia sp.	Collectors
		Edmundsula sp.	Collectors
		Petersula sp.	Collectors

	Heptageniidae	*Afronurus sp.*	Scrapers
		Thalerosphyrus sp.	Scrapers
		Cinygmina sp.	Collectors
	Ephemerellidae	*Ephemerella (Torleya) sp.*	Collectors
		Ephemerella (Drunella) sp.	Collectors
	Baetidae	*Baetis sp.*	Scrapers
		Platybaetis sp.	Scrapers
	Caenidae	*Caenis sp.*	Collectors-gatherers
		Clypocaenis bisetosa	Collectors-filterers
Trichoptera	Hydropsychidae	*Cheumatopsyche sp.*	Collectors-filterers
		Hydropsyche sp.	Collectors-filterers
	Lepidostomatidae	*Lepidostoma sp.*	Shredders
	Helicopsychidae	*Helicopsyche sp.*	Scrapers
	Psychomyiidae	*Psychomyia sp.*	Collectors-gatherers
	Philopotamidae	*Wormaldia sp.*	Collectors-filterers
Plecoptera	Perlidae	*Neoperla sp.*	Predator
Hemiptera	Naucoridae	*Naucoris sp.*	Predator
	Corixidae	*Micronecta sp.*	Piercers-herbivores
Coleoptera	Psephenidae	*Eubrianax sp.*	Scrapers
	Noteridae	*Noterus sp*	Predator
	Ptilodactylidae	*Stenocolus*	Shredders
	Gyrinidae	*Dineutus sp.*	Predator
		Orectochilus sp	Predator
	Hydrophilidae	*Laccobius sp.*	Piercers-herbivores
Odanata	Euphaeidae	*Euphaea sp*	Predator
	Gomphidae	*Heliogomphus sp.*	Predator
		Lamelligomphus sp.	Predator
	Libelluidae	*Crocothemis sp.*	Predator
	Aeshnidae	UN	Predator
Diptera	Tipulidae	*Hexatoma sp.*	Predator
		Pilaria sp.	Predator
	Tapanidae	UN	
	Chironomidae	*Chironomus sp.*	Collectors-gatherers
	Simulidae	*Simulium sp.*	Collectors
	Ephydridae	UN	Scrapers
Megaloptera	Coridalidae	*Coridalus sp.*	Predator