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Relative abundance of benthic Macro-invertebrates in relation to abiotic environment in Hussainabad nallah, Hunza, Gilgit Baltistan, Pakistan

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Abstract

Benthic macro-invertebrates have been extensively used as bio-indicators of ecosystem structure. The presence of particular species, taxa or community in the ecosystem reflects the history of that environment as well as the condition of that area. The samples of macro-invertebrates were collected from Hussainabad nallah on 26th April 2014 with the help of D-frame kick net. Total of five stations were selected keeping in view the accessibility to stations. At each station 100 meter area was allocated which was further divided in to five sub stations. A total of 930 macro invertebrates were collected from Hussainabad nallah. Highest density of macro-invertebrates were recorded from Station 2 (45.16%) followed by station 4 (30.86%), station1 (10.75%), station 3 (10.53%) and station 5 (2.68%) respectively. Hussainabad nallah was dominated by ephemeroptera (57.82%), followed by diptera (27.96%), plecoptera (9.68%), tricoptera (3.01%) and coleoptera (0.54%). Highest percentage of ephemeroptera is an indication for fresh environment. The mean value of turbidity was (7.03NTU), pH (6.88), temperature (14°C) and conductivity (372µS/cm) at Hussainabad nallah. Our findings indicated that, the most abundant macro-invertebrate fauna in Hussainabad nallah was ephemeroptera; that may lead to the fact that this order flourish well in fresh environment.

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Introduction

Water is one of the most important and best gifts given by the nature to all living organisms. It is very important for the growth and maintenance of human body as well as for many other biological functions. It works as a universal solvent and play important role in the survival of all form of life present on the Earth (Ali *et al.*, 2012).A river is a natural course of usually fresh water, begins from the source towards a lake, a sea, an ocean or another river. River is the vital part of hydrological cycle. Water collects in a river from various sources like from precipitation through a drainage basin, from the release of stored water in natural ice and snow packs, from surface run-off and other sources such as groundwater recharge and springs. The scientific study of rivers is called Potamology. Rivers are a great source of food as they are rich sources of many fish species, that's why major cities of world are situated along rivers (Anonymous, 2014a).

Macro-invertebrates are small animals present in rivers, streams, lakes and wetlands (Willis, 1982). These animals include crustaceans, insects, molluscs, annelids and arachnids. The term macro-invertebrate means those organisms which do not possess backbone and they can be seen with naked eye. Most aquatic macro-invertebrates are small while some are quite large such as freshwater crayfish. Invertebrate which are captured on a 0.25mm mesh net are generally termed macro-invertebrates. They are very sensitive to different physical and chemical conditions, their community change when a pollutant enters into the water or due to the change of water quality. Therefore the water body which is rich with macro-invertebrate community can be used to provide an estimate of water body health (Ward, 1992).

Benthic macro-invertebrates are the organisms living on the base of rivers, or they may be inside the substratum as well as in them. These are the organisms having 1mm of their body size. Benthic macro-invertebrates comprise ephemeroptera (mayflies), plecoptera (stoneflies), tricoptera (caddisflies), coleoptera (beetles), diptera (true flies) and so on.

They have some characteristics like, they are very dissimilar as well as rich as a community, very sensitive to environmental changes; they reveal their habitat and have limited mobility as individuals, they are more pinpointing of local habitat situation, they can be recognize easily and they have short life cycle (Plafkin *et al.*, 1989). These organisms cannot survive in the upper surface of water column, which are adapted to the deep-water pressure. The pressure difference is significant for these organisms because light does not reach to the deep ocean water. Organic matter is the energy source for the deep benthic ecosystem which comes from the higher up in water column and then drift down to the depth. The food chain of benthic is sustained by this dead and decaying matter. Most of the benthos are detrivores or scavengers (Anonymous, 2014b).

A bio indicator can be defined as specie or a group of species that readily reflects the abiotic or biotic state of an environment, represents the impact of environmental change on a habitat, community or ecosystem. Benthic macro-invertebrates have been used extensively as bio indicators of ecosystem structure, function and integrity because they are ubiquitous, diverse, sedentary and the presence of particular species, taxa or community reflects the history of that environment as well as the condition of that area. Invertebrates can indicate changes in the environment through their responses at different levels of organization ranging from the individual organism to the total invertebrate community (Fureder *et al.*, 2006).

Knowing the importance of macro-invertebrates and their role as bio indicator the present study was aimed to establish baseline data of macro-invertebrates and to evaluate the benthic distribution in relation to existing habitat conditions and limnological conditions of Hussainabad nallah.

Materials and methods

Study Area

Hussainabad is situated at the left bank of Hunza river in Hunza, Pakistan. It is facing Rakaposhi Mountain in South consists of 170 households. It is situated in lower Hunza and has an altitude of 1800m.

There are lots of tourist attraction spots. Geologic and glaciological sites are breath taking. They have their beauty round the year soothing eyes at any time of year.

Fig. 1. Map of Hussainabad Hunza.

Sample Collection and Preservation

Samples were collected from Hussianabad nallah on 26th April, 2014. Five stations were selected for sampling. Macro-invertebrates were collected by using the D-Frame Kick net method. D-frame Kick net is the most efficient sampler for sampling cobble substrate (i.e., riffles and runs) where velocity of water transport dislodged organisms into net. It is designed to sample 1m² of substrate at a time and can be used in any depth from a few centimeters to just below 1m. Stream bed was disturbed with feet which resulted into an upheaval of macro-invertebrates with plume. The plume passed through the net and all the benthoses were collected on the Kick net and labeled (Plonikkoff, 1998).

Sampling

The sampling was carried out by gathering the samples on the net. An area of 100m stretch was allocated first. That area was further divided into five more sub-areas. For each sub-area a site was selected, where a small riffle occurs. First, larger rocks were lifted in the collection area and scrubbed underwater with fingers to dislodge organisms. After scrubbing, feet were used to kick and stir up the riverbed for five minutes which created a plume. The plume was collected on the net. The net was carried out of the water and laid on a flat surface for macro-invertebrate removal and identification. The net was washed with flowing water, and samples were collected by picking them with forceps. The samples were put into collecting jars and were immediately labeled. Fig 23-26.

Preservation

Initially, the samples were preserved in alcohol (85% formalin). The sample jars were filled to the top with the formalin solution. They were left for 24 hours. After 24 hours the solution was removed and was refilled with fresh formalin (85%) (Plonikoff, 1998).

Sorting and Identification

Macro-invertebrates were sorted with a forcep and were observed under the stereomicroscope and were identified to the specie level using dichotomous taxonomic key (Bouchard, 2004).

Taxonomic Identification

Using their prominent features, which were visible under stereomicroscope and which could be seen with naked eye as well, were taken as a base for their hierarchical identification and were identified to the generic level (Bouchard, 2004).

Laboratory methodology for measuring physicochemical properties of water

Water pH of each sample from all five stations, was measured using pH meter as per procedure described by Mclean, 1982. Water Turbidity of each sample was measured with the help of turbidity meter. Salts concentration in each sample was measured with the help of Electrical conductivity meter by adopting the method of Richard, 1954. Samples temperature was measured during the sampling with the help of a simple thermometer.

Results and discussions

Benthic Macro-invertebrates Compositions

All the benthic macro-invertebrates collected from five stations were recognized to the species level of classification as presented in Table 1. A total of 930 macro-invertebrates were collected, which were comprised of 13 species, 11 families and 5 classes. Highest density was found at station 2 with 420 individuals, followed by station 4 with 287individuals, station 1 with 100individuals, station 3 with 98individuals and station 5 with 25 individuals. Ephemeroptera was the dominant taxa at the study area and was most abundant at station 2.

The second dominant taxon was diptera followed by plecoptera, tricoptera and coleopteran. Hussainabad Nallah was dominated by ephemeroptera (57.82%), followed bydiptera (27.96%), plecoptera (9.68%), tricoptera (3.01%) and coleoptera (0.54%) respectively (Table 2).

Table 1. Macroinvertebrates distribution/taxa for each sampling station of Hussainabad nallah.

Order/class	Family	Specie	Station 1	Station 2	Station 3	Station 4	Station 5	Total	Percentage
Coleoptera	Gyrinidae	*Dineutus*	2	2	0	0	0	4	0.42
	Hydrophilidae	*Hydrobiomorpha*	0	0	1	0	0	1	0.11
Diptera	Simuliidae	*Simulium venustum*	14	0	0	0	0	14	1.48
	Chironomidae	*Ablabesmyia*	50	0	0	69	0	119	12.58
	Chironomidae	*Procladius*	0	72	32	0	0	104	10.99
	Blephariceridae	*Philorus californicus*	0	1	0	0	0	1	0.11
	Simuliidae	*Simulium venustum*	0	1	1	0	0	2	0.21
	Chironomidae	*Chironomus tentans*	0	0	18	0	0	18	1.90
Ephemeroptera	Sciomyzidae	*Hedria*	0	0	1	0	1	2	1.90
	Baetidae	*Baetis*	23	325	12	175	12	547	57.82
Plecoptera	Perlidae	*Acroneuria carolinensis*	7	0	0	0	0	7	0.74
	Leuctridae	*Leuctra*	2	13	19	41	4	79	8.35
	Nemouridae		0	0	0	0	4	4	0.42
Tricoptera	Limnephilidae	*Hesperophylax designatus*	2	6	14	2	4	28	2.96
	Total		100	420	98	287	25	930	100.00

Table 2. Population density of macro-invertebrates of Hussainabad Nallah.

Order	Station 1	Station 2	Station 3	Station 4	Station 5	Total	Percentage
Ephemeroptera	23	325	12	175	12	547	57.82
Diptera	64	74	52	69	1	260	27.96
Plecoptera	9	13	19	41	8	90	9.68
Tricoptera	2	6	14	2	4	28	3.01
Coleoptera	2	2	1	0	0	5	0.54
	100	420	98	287	25	930	

Population density of families

A total of 12 families recognized and one was not identified to family level. Four families of diptera were recorded chironomidae (25.47%), sciomyzidae (1.90%), simuliidae (1.69%) and blephariceridae (0.11%), followed by three families of plecoptera, leuctridae (8.35%), perlidae (0.74%) and nemouridae (0.42%), two families of coleoptera, gyrinidae (0.42%) and hydrophilidae (0.11%), one family of tricoptera, limnephilidae (2.96%) and one family of ephemeroptera, baetidae (57.82%) respectively. Station 1, 2 and 3 recorded 7 families, station 5 recorded 5 families and station 4 recorded 4 families. Baetidae was the dominated family with 57.94% followed by chironomidae (27.01%), leuctridae (8.37%), limnephilidae (2.97%), simuliidae (1.69%), perlidae (0.74%), gyrinidae (0.42%), nemouridae (0.42%), sciomyzidae (0.21%), hydrophilidae (0.11%) and blephariceridae (0.11%) respectively (Table III).

Table 3. Population density of families of Hussainabad Nallah.

Family	Station 1	Station 2	Station 3	Station 4	Station 5	Total	Percentage
Baetidae	23	325	12	175	12	547	57.94
Chironomidae	50	72	50	69	0	255	27.01
Leuctridae	2	13	19	41	4	79	8.37
Limnephilidae	2	6	14	2	4	28	2.97
Simuliidae	14	1	1	0	0	16	1.69
Perlidae	7	0	0	0	0	7	0.74
Gyrinidae	2	2	0	0	0	4	0.42
Nemouridae	0	0	0	0	4	4	0.42
Sciomyzidae	0	0	1	0	1	2	0.21
Hydrophilidae	0	0	1	0	0	1	0.11
Blephariceridae	0	1	0	0	0	1	0.11

Important Physico-chemical properties of water

The important physical and chemical properties of water in each sampling station are presented in table 4. The maximum value for turbidity observed was 8.93 NTU at station 2, followed by station 5 (8.34 NTU), station 1 (7.52 NTU), station 4 (5.19 NTU) and station 3 (5.18 NTU) respectively.

The maximum value for pH observed was 7.3 at station 5, followed by station 3 (7), station 4 (6.8), station 2 (6.7) and station 1 (6.6) respectively. The maximum value for conductivity observed was 379 at station 2, followed by station 3 (378), station 4 (369), station 5 (368) and station 1 (366) respectively. The value noted for temperature was 14°C at all five stations.

Table 4. Physical and chemical parameters of water of overall Hussainabad nallah.

Stations	Turbidity (NTU)	pH	Temperature (°C)	Conductivity (µS/cm)
1	7.52	6.6	14	366
2	8.93	6.7	14	379
3	5.18	7	14	378
4	5.19	6.8	14	369
5	8.34	7.3	14	368

Community composition of benthic macroinvertebrates of station 1

From station 1 of Hussainabad nallah 100 benthic macro-invertebrates were collected belonging to five classes/orders. This station was dominated by diptera (64%), followed by ephemeroptera (23%), plecoptera (9%), coleoptera (2%) andtricoptera (2%) respectively (Fig. 2). From station 1 of Hussainabad nallah 100 benthic macro-invertebrates were collected belonging to seven families.

The station was dominated by chironomidae (50%), followed by baetidae (23%), simuliidae (14%), perlidae (7%), gyrinidae (2%), leuctridae (2%) and limnephilidae (2%) respectively (Fig.3).

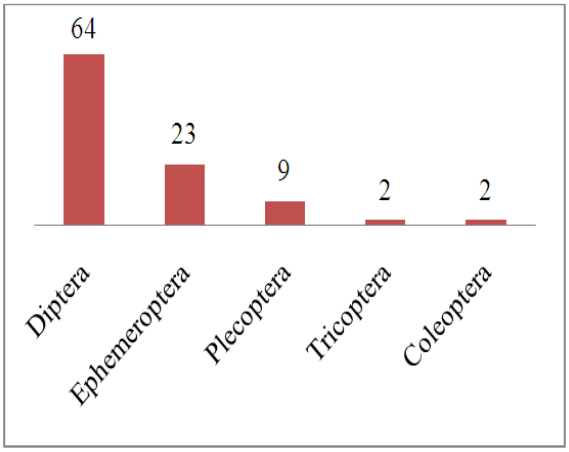

Fig. 2. Percent community composition of benthic macro-invertebrates at station 1.

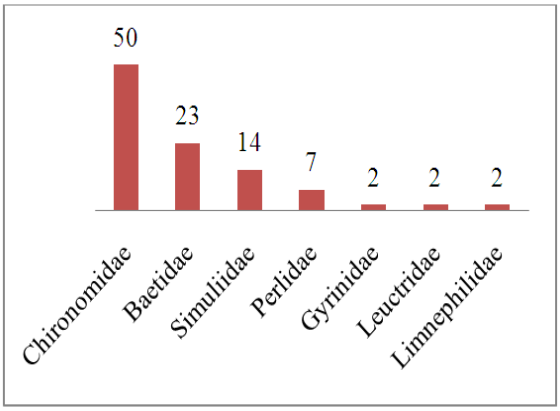

Fig. 3. Percent distribution of benthic macroinvertebrates families at station 1.

Community composition of benthic macro-invertebrates of station 2

From station 2 of Hussainabad nallah 420 benthic macro-invertebrates were collected belonging to five classes/orders. This station was dominated by ephemeroptera (77.38%), followed by diptera (17.62%), plecoptera (3.10%), tricoptera (1.43%) and coleoptera (0.48%) respectively (Fig. 4).

From station 2 of Hussainabad nallah 436 benthic macro-invertebrates were collected belonging to seven families. The station was dominated by baetidae (75%), followed by chironomidae (19.72%), leuctridae (2.98%), limnephilidae (1.38%), gyrinidae (0.46%), blephariceridae (0.23%) and simuliidae (0.23%) respectively (Fig. 5).

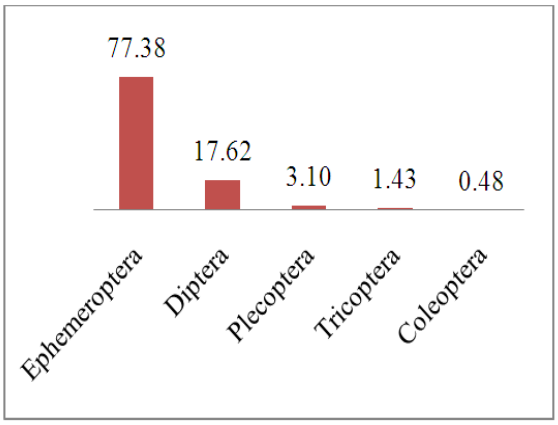

Fig. 4. Percent community composition of benthic macroinvertebrates at station 2.

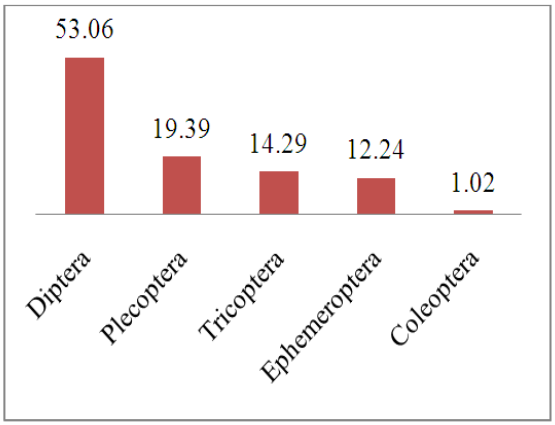

Fig. 6. Percent community composition of benthic macroinvertebrates at station 3.

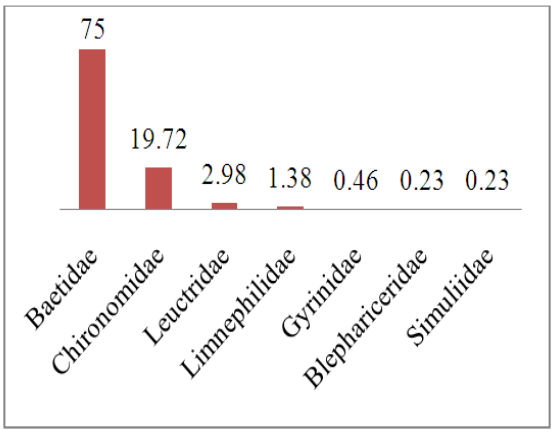

Fig. 5. Percent distribution of benthic macroinvertebrates families at station 2.

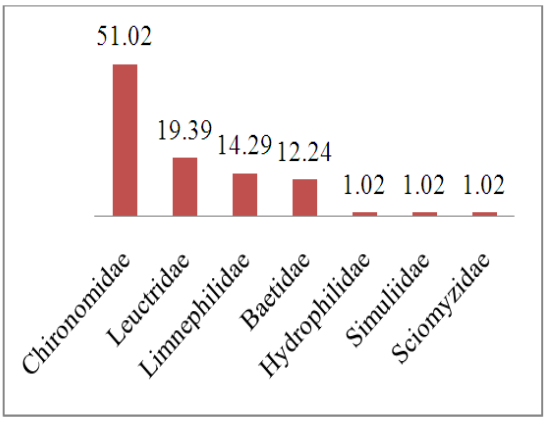

Fig. 7. Percent distribution of benthic macroinvertebrates families at station 3.

Community composition of benthic macro-invertebrates of station 3

From station 3 of Hussainabad nallah 98 benthic macro-invertebrates were collected belonging to five classes/orders. This station was dominated by diptera (53.06%), followed by plecoptera (19.39%), tricoptera (14.29%), ephemeroptera (12.24%) and coleoptera (1.02%) respectively (Fig: 6).

From station 3 of Hussainabad Nallah 98 benthic macro-invertebrates were collected belonging to seven families. The station was dominated by chironomidae (51.02%), followed by leuctridae (19.39%), limnephilidae (14.29%), baetidae (12.24%), hydrophilidae (1.02%), simuliidae (1.02%) and sciomyzidae (1.02%) respectively (Fig: 7).

Community composition of benthic macro-invertebrates of station 4

From station 4 of HussainabadNallah287benthic macro-invertebrates were collected belonging to four classes/orders.

This station was dominated by ephemeroptera (60.97%), followed by diptera (24.04%), plecoptera (14.28%) and tricoptera (0.69%) respectively (Fig: 8).From station 4 of Hussainabad nallah 287 benthic macro-invertebrates were collected belonging to four families. The station was dominated by baetidae (60.97%), followed by chironomidae (24.04%), leuctridae (14.29%) and limnephilidae (0.70%) respectively (Fig: 9).

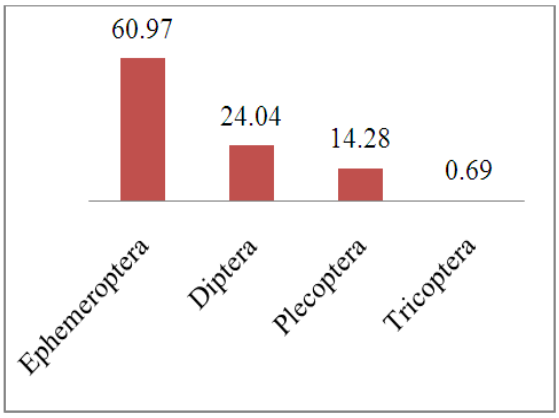

Fig. 8. Percent community composition of benthic macroinvertebrates at station 4.

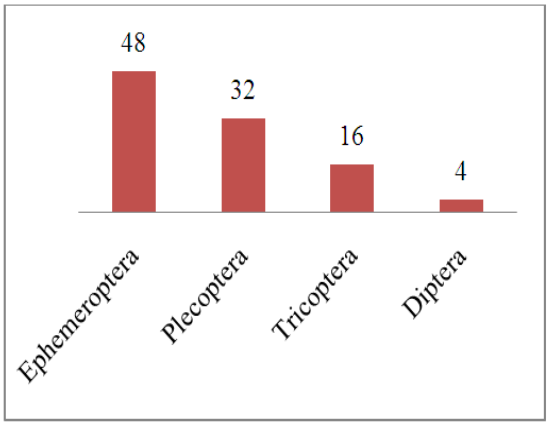

Fig. 10. Percent community composition of benthic macroinvertebrates at station 5.

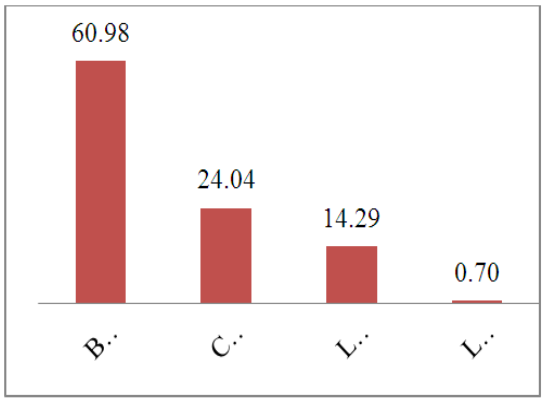

Fig. 9. Percent distribution of benthic macroinvertebrates families at station 4.

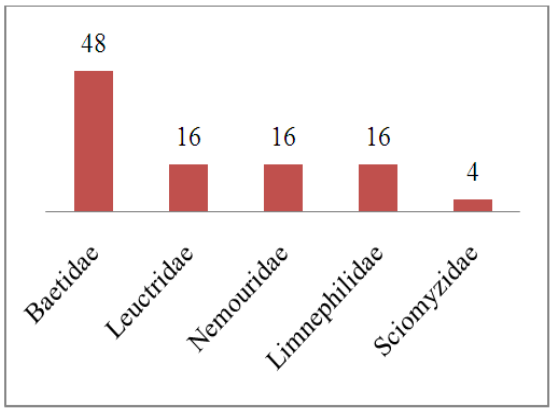

Fig. 11. Percentage distribution of benthic macroinvertebrates families at station 5.

Community composition of benthic macroinvertebrates of station 5

From station 5 of Hussainabad nallah 25 benthic macro-invertebrates were collected belonging to four classes/orders.

This station was dominated by ephemeroptera (48%), followed by plecoptera (32%), tricoptera (16%) and diptera (4%) respectively (Fig: 10). From station 5 of Hussainabad Nallah 25 benthic macro-invertebrates were collected belonging to five families.

The station was dominated by baetidae (48%), followed by leuctridae (16%), nemouridae (16%), limnephilidae (16%) and sciomyzidae (4%) respectively (Fig: 11).

Discussions

All the macro-invertebrates collected were recognized to the species level of classification. A total of 930 individuals were collected comprising 5 classes/orders, 11 families, 13 species and one organism was not identified to specie level (Table 1). The mayflies are well known for a short life time adult stage, which usually lasts from two to three days Hall *et al.,* 2006. Mayflies are most abundant in cool, unpolluted water, but some species can tolerate low dissolved-oxygen levels (e.g. *Callibaetis* spp). Mayfly nymphs tend to be grazers, feeding on algae or detritus Peckarsky *et al.,* 1990. Ephemeroptera was the dominant group; chironomidae was second most abundant group, followed by plecoptera, tricoptera and coleoptera.

The findings were in-agreement with the results of Azrina *et al.,* 2006 where they found that the up-stream of Langat River was dominated by ephemeroptera and chironomide and this study also recorded the abundance of ephemeroptera and chironomidae. This result is also agrees with the results from Hynes, 1970; Singh *et al.,* 1994; Nautiyal *et al.,* 2004. In which they mentioned that the aquatic macro-invertebrate community's major components are ephemeroptera, diptera, tricoptera and plecoptera. These were in the high elevation in rivers along with coleopteran account for > 80% of benthic community of macro-invertebrate. This result also agrees with the work of Syed *et al*., 2012 where the ephemeroptera, diptera, tricoptera, were dominant in River Jhelum. In addition, these findings agree with the results from Principe and Corigliano 2006 where the most common orders of insects were hetroptera, coleoptera, diptera and ephemeroptera in lowland river Ctalamochita, while this study recorded the most common orders recorded were diptera, ephemeroptera, plecoptera, coleoptera and tricoptera. Our study results are somehow similar with the work of Mishra *et al*., 2013. They conducted a research on the Rivers of Indian Himalaya. Tricoptera was higher in Himalaya, ephemeroptera was dominant in Trans-Himalaya diptera was dominat in river Rupin. Whereas in our study ephemeroptera was dominant in Hussianabad Nallah, diptera was second highest, plecoptera was third highest and tricoptera was second last highest group. 1991 are different from our findings. They found the Oligocheate were the dom. The findings of Bingham and Miller 1990inant taxa in Savannah Riverwith smaller amount of Chironomidae, while in our study the findings were totally opposite. Chironomidae was the second dominant group and no oligocheate was there.

This studyisnot in-agreement with the findings of Maret 1988 where they found the chironomidae was the dominant group followed by oligocheta and ephemeroptera from two Bone Creek stations but in this study ephemeroptera was dominant followed by diptera, plecoptera, and coleoptera while tricopterawas present in least amount.

The findings of this study are not correlated with the findings of Andem *et al.,* 2012 where they found the chironomus larvae (59.7%) was dominant group, while in this study chironomidae (25.47%) was the second dominant group. This study is not in-agreement with the findings of Angradi *et al*., 2006. They compared benthic assemblages in upper Mississippi River, USA. They sampled benthos from three habitats defined a prioir: Channel, backwater and shoreline. All three habitats were dominated by nematoda, oligochaeta and chironomidae. But in this study we did not find even a single nematoda and oligochaeta but onlychir-onomidae, which was second most abundant.

Conclusion and recommendations

Results indicated that Hussainabad Nallah was dominated by ephemeroptera (57.82%), followed by diptera (27.96%), plecoptera (9.68%), tricoptera (3.01%) and coleoptera (0.54%) which may lead us to the fact that ephemeropterais known to flourish in fresh environment. Presence of emphemeraptera and tricop-tera shows that the water is not completely polluted yet however, the presence of chironomidae shows that the water is suffering from organic sedimentation. Further exploration of such studies in such area is needed which may lead us to new findings.

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