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Impact of water quality on distribution of macro-invertebrate in Jutial nallah, Gilgit-Baltistan, Pakistan

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Abstract

The macro- invertebrate fauna of river have a large biological significance and these organisms may be used to find out the water quality of streams. This study was carried out to know the benthic macro-invertebrates composition and to know its relationship with physical and chemical of water in the Jutial Nala. Benthic animals and water samples were collected from four different sites by D-frame net and samples were preserved by using alcohol. Most of the macro invertebrates collected were recognized to the species level. During the sampling a total of 1614 individuals were collected. From these individuals 1050 (65.06%) were found in station third, 273(17.91%) in station fourth, 179 (11.09%) in station 1 and 110 (6.82%) in second station. Jutial nullah was dominated by Diptera (68.65%) followed by Anopla (12.89%), Ehemeroptera (10.10%), Plecoptera (5.14%), Tricoptera (2.17%), Oligochaeta (0.86%, Coleoptera (0.12%), and Arachnida (0.06%) respectively. It was observed that the water of this water are slightly alkaline (pH=7.5), non-turbid (6.19NTU), and non-saline in nature (EC=161.25µS/cm) while the mean temperature of water was 14°C.

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Introduction

Water is the basic element for life. Three-quarters of earth's surface is cover by water. Water molecules pass regularly through solid, liquid, and gaseous phases during their cycle between lethola, hydro and atmosphere, but its overall supply remains constant. Nearly 97% of the world's water supply by volume is held in the oceans. The ground water (4%) and glacers and icecaps (2%) are the other big reserves, while all other water bodies together accounting 1%. Fresh water accounts for only 6 percent of the world's water supply, but it is essential for human uses such as drinking, manufacturing, agriculture and sanitation (Scanlon *et al.*, 2007) activities. The significant freshwater wealth are rivers and these water bodies sustain and hold up the micro- and macro- ecosystems which take water from mountains to the oceans (Karr, 1999). Rivers contain large number of fauna that have a groups with difficult organization while rivers become weak and susceptible to environmental changes due to its typology (Beasley and Kneale, 2003; Dahla *et al.*, 2004). Due to increase in industrialization and population, human societies affect rivers, their ecosystem structure and functions in an ever alarming way (Roy *et al.,* 2003).

The macro-invertebrates are the individuals with no back bone but can be seen with naked eye. The habitats for these tiny animals are lakes, rivers, swampland and streams (Davis *et al.*, 1997). Macro-invertebrates are useful as a food resource for marine life and birds are also very important for decomposition of organic rusting debris on the bottom of water bodies. They can also be used as health detectors of water (Voshell and Reese, 2002). They are comprise of crustaceans like crayfish, leeches, annelids, water insects (mayfly and stonefly), and molluscs (snails and clams, etc). They are of three types, some are sensitive to pollution like mayflies, some are pollution tolerant like Dragonflies, Dames flies and some are pollution tolerant like aquatic worms (Benetti and Garrido, 2010; Davis *et al.*, 2003).

Benthic macro invertebrates are those organisms that live at the bottom of a water body (Barnes and Hughes, 1988). Mostly the quality of water has been measured by using chemical techniques however recently benthic fauna are also used for this purpose (Pawlak, 1999). They are excellent indicator of habitats and quality indicator of biodiversity such as that odonata nymphs are inhabitant of fresh water with rich oxygen absorption (Calisto *et al.,* 2005). Their occurrence depends on the type of river system. These organisms play vital role in identification of water quality (Bailey *et al.*, 2003). Based on the literature the present study was initiated with objectives to study the impact of water quality on the benthic macro invertebrates distribution of water in Jutial Nallah

Material and methods

Study area

Gilgit-Baltistan is located at 72 to 77 east and 34 to 40 north latitudes. The four major Nallah around the Gilgit are Konadaas, Jutial, Kargah and Danyore. Jutial is urbanized inhabited system of Gilgit city. It is divided into upper and Lower Jutial. Jutial Nullah is located at the back side of the Serena Hotel. It supplies large amount of water for irrigation and consumption of the inhabitants of Gilgit city.

Fig. 1. Map of jutial nalla.

Sample collection and preservation

Samples were collected from four selected stations of Jutial Nallah on 25 April, 2014. Macro invertebrates were collected by using the D-Frame Kick net method as per procedure Plonikkoff, (1998).

At each station before sampling an area of 100m stretch was allocated first. That area was further divided into four more sub-areas. For each sub-area a site was chosen, where a small riffle occurs. First, larger rocks were lifted from the collection area & scrubbed underwater with fingers to dislodge organisms. After scrubbing, feet were used to kick & stir up the riverbed for five minute.

This created a plume. This plume was collected on the net. The net was carried out of the water & laid on a flat surface for macro invertebrates 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. The samples were preserved in alcohol (85% ethanol). The sample jars were filled to the top with the alcohol solution. They were left for 24 hours. After 24 hours the solution was removed and was refilled with fresh ethanol (85%).

Sorting and identification

Macro-invertebrates were sorted with a forceps and were observed under the stereomicroscope and were identified to the specie level using dichotomous taxonomic key. Based on their prominent features 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.

Measurement of physico-chemical characteristics of water

The pH od water sample was measured by pH meter using the procedure of 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 EC meter by the method of Richard, 1954. Samples temperature was measured during the sampling with the help of a simple thermometer.

Results and discussions

Station wise benthic Macro-invertebrates compositions

Most of the macro invertebrates collected were recognized to the species level. A total of 1614 individuals were collected comprising of 13 species and 14 families. The overall macroinvertebrats abundance, composition and distribution at the study area (Jutial Nullah) of four stations are shown in Table 1. From these individuals 1050 (65.06%) were found at station third, 273(17.91%) at station fourth, 179 (11.09%) at station 1 and 110 (6.82%) at second station. In addition 13 families were recognized and of these, four families belonged to the order plecoptera (Capniidae 2.42%, Perlidae 1.36%, Nemouridae 0.99%, Perlodidae 0.37%), three families belonged to the order Tricoptera (Limne Philidae 1.55%, Helicopsychidae 0.56%, philopotamidae 0.06%), 3 families belonged to Diptera (Chironomidae 60.47%, Blephariceridae 8.05%, Simuliidae 0.12%), three families belonged to the order Ephemeroptera (Metretopodidae 5.70%, Baetidae 4.40%) and one family belong to Coleoptera (Elmidae 0.12%), one family belong to Arachnid (Arrenuridae 0.006%). Oligochaeta and Nemertea were also present which could not be identified up to family level.

Diptera (68.64%) was dominant order followed by Nemertea (12.8%), Ehemeroptera (10.09%), Plecoptera (5.14%), Tricoptera (2.17%), Oligochaeta (0.86%, Coleoptera (0.12%), and Arachnid (0.06%) respectively (Table 2). Furthermore it was found that, Chironomidae (60.47%) was the dominant family followed by Blephariceridae (8.05%). Metretopodidae (5.70%), Baetidae (4.40%), Capniidae (2.42%), Limne philidae (1.55%), Perlidae (1.36%), Nemouridae (0.99%), Helicopsychidae (0.56%), Perlodidae (0.37%o), Simuliidae (0.12%), Hydrophllidae (0.12), Philopotamidae (0.06%), Elmidae (0.25%), Arrenuridae (0.06%) while 13.51% of the organisms were not identified to family level (Table 3).

Table 1. Macro-invertebrates Distribution/Taxa for Each Sampling Station.

Order /Class	Family	Spp. Name	Stations				
			1	2	3	4	Total
Plecoptera	Nemouridae	*Zapada haysi*	1	15	0	0	16
	Capniidae	*Baetis*	9	0	0	0	9
	Perlodidae	*Isoperla fulva*	0	6	0	0	6
	Perlidae	*Eccoptura Xanthenes*	0	1	10	11	22
	Capniidae	*Allocapnia Vivipara*	0	0	0	30	30
Diptera	Blephariceridae	*Philorus Californicus*	84	9	4	27	124
	Simuliidae		0	2	0	0	2
	Blephariceridae	*Simulium Venustum*	4	0	2	0	6
	Chironomidae	*Ablabesmyia*	0	7	921	48	976
Anopla	Not identified		34	43	70	61	208
Ephemeroptera	Baetidae		30	14	4	23	71
	Metretopodidae	*Siphloplecton*	15	1	39	37	92
Oligochaeta	Not identified		0	10	0	4	14
Tricoptera	LimnePhilidae		1	0	0	0	1
	philopotamidae	*Chimarra*	1	0	0	0	1
		Hesperophylax					
	LimnePhilidae	*Designatus*	0	0	0	24	24
	Helicopsychidae	*Helicopsyche*	0	0	0	9	9
Coleoptera	Elmidae	*Berosus*	0	2	0	0	2
Arachnid	Arrenuridae		0	0	0	1	1
Total			179	110	1050	275	1614

Table 2. Total Population Density of Macro-invertebrates (class/Order) of Jutial Nallah.

class/Order	Community composition	Percentage of abundance
Diptera	1108	68.64
Anopla	208	12.88
Ephemeroptera	163	10.09
Plecoptera	83	5.14
Tricoptera	35	2.16
Oligochaeta	14	0.86
Coleoptera	2	0.12
Arachnid	1	0.06
Total	1614	------

Table 3. Population Density of Macro-invertebrates Families of Jutial Nallah.

Family	Abundance	Percentage
Chironomidae	976	60.47
not identified	218	13.51
Blephariceridae	130	8.05
Metretopodidae	92	5.70
Baetidae	71	4.40
Capniidae	39	2.42
LimnePhilidae	25	1.55
Perlidae	22	1.36
Nemouridae	16	0.99
Helicopsychidae	9	0.56
Perlodidae	6	0.37
Simuliidae	2	0.12
Hydrophllidae	2	0.12
Philopotamidae	1	0.06
Elmidae	4	0.25
Arrenuridae	1	0.06
Total	1614	---------

Water properties of each station at Jutial Nallah

Result obtained on water properties are presented in Table 4. The maximum value for pH observed was 7.6 at station 1, followed by station 3 (7.5), station 2 (7.5) and station 4 (7.4) respectively. The maximum value for turbidity observed was 2.36 NTU at station 2, followed by station 3 (1.55 NTU), station 1 (1.52 NTU) and station 4 (0.76NTU) respectively. The maximum value for conductivity observed was 170 at station 1, followed by station 4 (161), station 3 (158) and station 2 (156) respectively. The water temperature at all stations was found similar ^{o}(14^{o}C) at all stations.

Table 4. Physical Parameters of water of each station at Jutial Nallah.

Stations	pH	Turbidity (NTU)	Conductivity (µS/cm)	Temperature (^{o}C)
1	7.6	1.52	170	14
4	7.4	0.76	161	14
3	7.5	1.55	158	14
2	7.5	2.36	156	14
Mean	7.5	1.55	161.25	14

Station wise percent composition of benthic macro-invertebrates classes/orders and families of Jutial Nallah

From station 1 of Jutial nllah 179 benthic macroinvertebrates were collected belonging to 5 classes/orders (Fig. 1.) which were dominated by Diptera (49.16%) followed by Ephemeroptera (25.14%), Nemertea (18.99%), Plecoptera (5.59%) and Tricoptera (1.12%) respectively. There were 7 families (Fig. 5.) which were dominated by Blephariceridae (49.16%) followed by Baetidae (16.76%), Metretopodidae (8.38%), Capniidae (5.03%), and Nemouridae (0.56%), Philopotamidae (0.56%) and Limne philidae (0.56%), while 18.99% of individual were not identified to family level.

A total 110 benthic macro invertebrates were collected from station 2 of Jutial nullah belonging to 6 classes/orders (Fig. 2.) in which Nemertea (39.09%) were the most abundant followed by Plecoptera (20.00%), Diptera (16.36), Ephemeroptera (13.64%), Oligochaeta (9.09%) and Coleoptera (1.82%) respectively. The collected organism were belonging to 10 families (Fig. 6.) which was dominated by Nemouridae (13.64%), Baetidae (12.73%), Oligochaeta (9.09%), Blephariceridae (8.18%), Chironomidae (6.36%), Perlodidae (5.45%), Simuliidae (1.82%), Elmidae (1.82%), Metretopodidae (0.91%) and Perlidae (0.91%) while 39.09% were not identified to family level. In station 3 of Jutial nallah a total of 1050 individuals were collected belonging to 4 orders/class (Fig. 3.) which was dominated by Diptera (88.29%) followed by Nemertea (6.67%), Ephemeroptera (4.10%) and Plecoptera (0.95%) respectively. The organisms were belonging to the 5 families (Fig. 7.) which was dominated by Chironomidae (88.29%) followed by Metretopodidae (3.71%), Berlidae (0.95%), Blepharicerdae (0.57%) and Baetidae (0.38%) while 6.67% were not identified to family level.

At station 4 of Jutial nallah a total of 275 organisms were collected belonging to 7 class/orders (Fig. 4) which was dominated by Diptera (27.27%), Nemertea (22.18%), Ephemeroptera (21.82%), Plecoptera (14.91%), Tricoptera (12.00%), Oligochaeta (1.45%) and Arachnid (0.36%) respectively. These organisms belong to 9 families (Fig. 8.) which were dominated by Chironomidae (17.45%), Metretopodidae (13.45%), Capniidae (10.91%), Blephariceridae (9.82%), Limnephilidae (8.73%), Baetidae (8.36%), Perlidae (4.00%) Helicopsychidae (3.27%), Oligochaeta (1.45%) and Arrenuridae (0.36%) while 22.18% were not identified to family level.

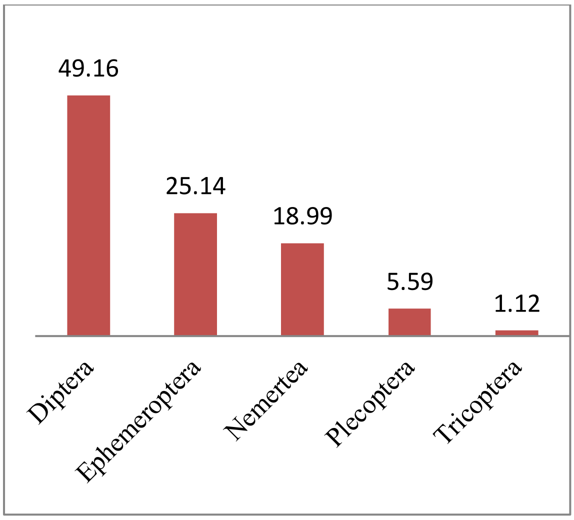


Fig. 1. Class/order wise percent composition of macro-invertebrates at Station 1of Jutial Nallah

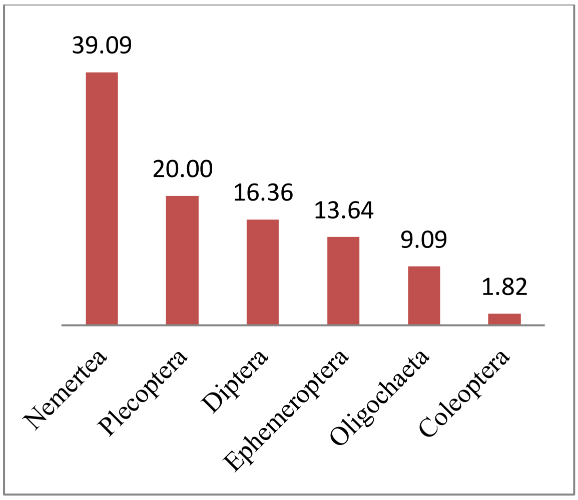


Fig. 2. Class/order wise percent composition of macro-invertebrates at Station 2 of Jutial Nallah

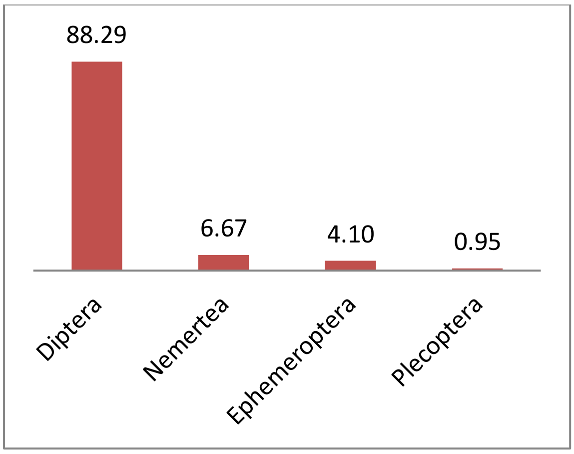


Fig. 3. Class/order wise percent composition of macro-invertebrates at Station 3 of Jutial Nallah

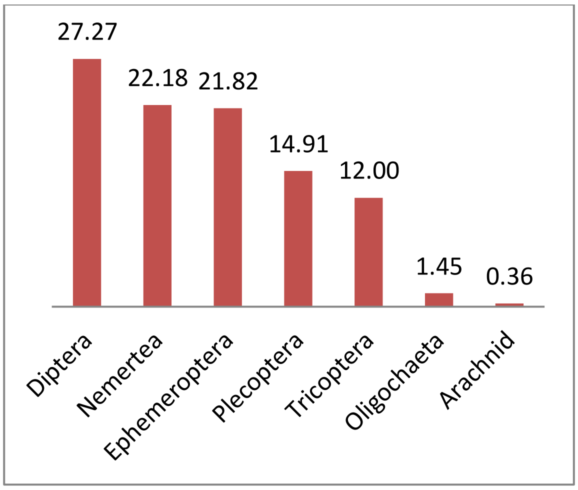


Fig. 4. Class/order wise percent composition of macro-invertebrates at Station 4of Jutial Nallah

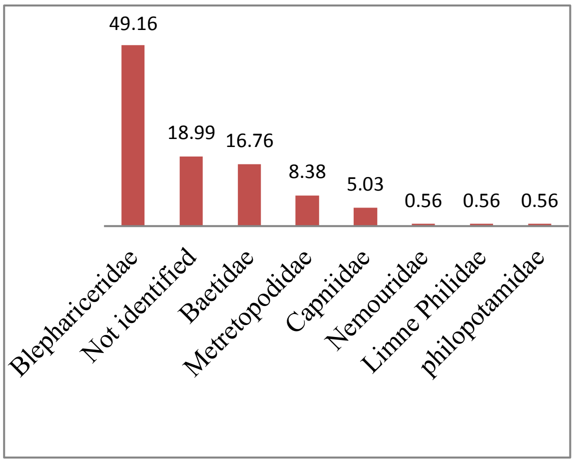


Fig. 5. Family wise percent composition of macro-invertebrates at Station 5 of Jutial Nallah

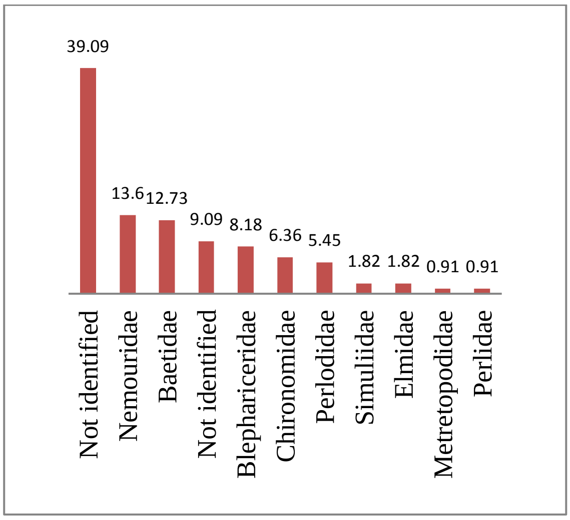


Fig. 6. Family wise percent composition of macro-invertebrates at Station 6 of Jutial Nallah

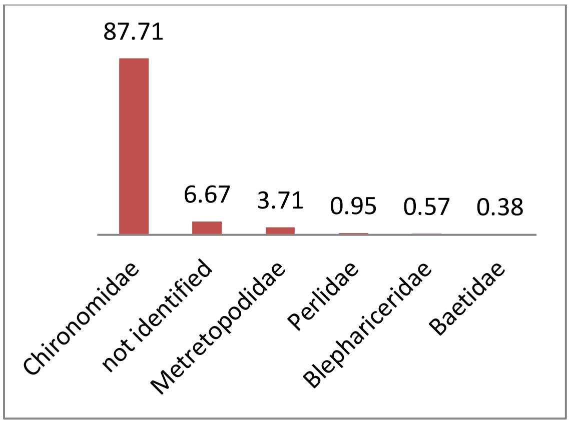
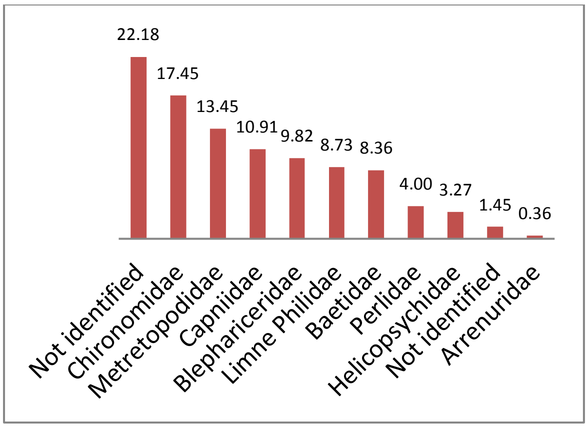


Fig. 7. Family wise percent composition of macro-invertebrates at Station 7 of Jutial Nallah



Figs. 8. Family wise percent composition of macro-invertebrates at Station 8 of Jutial Nallah

Discussion

The importance of using macro invertebrates as bio-indicators or water quality of rivers has already been highlighted by several authors (Gooderham *et al.,* 2002). The importance of this group is also reflected in this study because we were able to evaluate water quality using benthic macro invertebrates. During the study at Jutial nullah, a total of 13 families of macro-invertebrates were found from four stations belonging to Diptera, Tricoptera, Coleoptera and Ephemeroptera.

The distribution pattern of benthic macro invertebrates in the study area (Jutial nullah) showed the dominance of Diptera particularly Chironomidae followed by Anopla , Blephariceridae, Metretopodidae and Baetidae, Capniidae, Limne philidae, Perlidae, Nemouridae, Helicopsychidae, Perlodidae, Simuliidae, Hydrophllidae, Philopotamidae respectively.

The Chironomidae is measured forbearing of harsh pollution (Mason, 2002). Their domination signify the very poor water quality. On the other hand, it is possible that Chironomidae species present have a elevated sensitivity to organic pollution (Raunio *et al.*, 2007). The work of Rousch *et al.*, (1997) have indicate that the Chironomidae larvae are affected at lower than 4 pH and to the acid conditions they are tolerant .By decrease in pH Tricoptera and Ephemeroptera are intensely affected (Barbour *et al.*, 1997; Varner, 2001).

The number of individuals richness was recognized in station 3. This result in-agreement with the work of Garrido *et al.,*(2008). They conducted a 10 years research on different rivers, where they found the chironomidae was the dominant taxa. This result was in-agreement with the Wynes *et al.* (1981) finding where they found that density of Chironomidae was higher in study area Little Miami River, Ohio. This result also agree with the work of Syed *et al.* (2012) where the Diptera, Ephemeroptera, Tricoptera, were dominant in river Jhelum.

This study also related 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 Chironomidae was dominant followed by Anopla, Ephemeroptera, while Oligocheta was present in least amount. Our results are also correlated with the findings of Andem, A. B. *et al* (2012), where they found the Chironomus larvae (59.7%) was dominant group, while in this study Chironomidae (60.47%) was the dominated one. In addition, this findings was in contrary to the results from Azrina *et al.* (2006), where they found that the up-stream of Langat river was dominated by ephemeroptera and chironomide, While this study recorded the abundant of chironomidae and Anopla.

In addition, this result also not in-agreement 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, and tricoptera.

This result also not in consonance 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 prior: Channel, backwater and shoreline. The all three habitats were dominated by Nematoda, Oligochaeta and Chironomidae. But this study not contained Nematoda, however contained a low number of Oligochaeta.

This study also in-agreement 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 and like our findings Diptera was dominant in river Rupin. The findings of Miller and Bingham, (1991) are not in closer conformity with the current study. They found the Oligocheate were the dominant taxa in Savannah river with smaller amount of Chironomidae, while in this study the findings were totally opposite. Chironomidae was the dominant with smaller amount of Oligocheate.

Conclusion and recommendations

Our findings indicated that the water of Jutial Nallah was almost fresh in nature. A total of 1614 individuals were collected from four stations of study area comprising of 13 families of macro-invertebrates belonging to Diptera, Tricoptera, Coleoptera and Ephemeroptera in which diptera was the most abundant taxonomic group in terms of abundance pertaining to family chironomidae. Diversified pattern of benthic macro-invertebrates in a particular habitat exhibit a complex food chain which suggest that desirable of fresh aquatic environment having ample amount of dissolved oxygen.

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