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Original Article

Assessment of aquatic macro-invertebrates communities and water quality parameters of River Zhob, Balochistan, Pakistan

Avaliação das comunidades de macroinvertebrados aquáticos e parâmetros de qualidade da água do rio Zhob, Baluchistão, Paquistão

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Abstract

Environmental stress caused by pollution is often assessed by diversity of macro-invertebrate species in specific aquatic habitat. To find out seasonal fluctuations in various macro-invertebrates communities and different water quality parameters of River Zhob, a research trial was conducted on River Zhob, Balochistan. Samples of macro-invertebrates and water were taken from four different stations of River Zhob. A total 18 taxa of various macro-invertebrates were identified from the area. Phylum Arthropoda constitute 94.8% of the total population followed by Mollusca (3.6%) and Annelida (1.4%). A large number of arthropods were belonged to order Diptera (1148), while the order Trichoptera was stood second with respect to macro-invertebrate´s number (441). The maximum numbers of macro-invertebrates were observed in the month of January. All physico-chemical parameters of River Zhob such as air temperature, water temp, pH, dissolved oxygen (DO) and total dissolved solids (TDS) were within the range, suitable for the healthy growth of macro-invertebrates. Diversified populations of various macro-invertebrates confirm good ecological condition of environment and water in the studied site especially ample concentration of DO in River. The documented data on macro-invertebrates in studied site will provide a baseline for future research.

Keywords: macro-invertebrates, physico-chemical parameters, River Zhob, Balochistan.

Resumo

O estresse ambiental causado pela poluição é frequentemente avaliado pela diversidade de espécies de macroinvertebrados em habitats aquáticos específicos. Para descobrir as flutuações sazonais em várias comunidades de macroinvertebrados e diferentes parâmetros de qualidade da água do rio Zhob, foi realizado um teste de pesquisa no rio Zhob, Baluchistão. Amostras de macroinvertebrados e água foram retiradas de quatro estações diferentes do rio Zhob. Um total de 18 táxons de vários macroinvertebrados foram identificados na área. O filo Arthropoda constitui 94,8% da população total, seguido por Mollusca (3,6%) e Annelida (1,4%). Um grande número de artrópodes pertencia à ordem Diptera (1148), enquanto a ordem Trichoptera ocupava o segundo lugar em número de macroinvertebrados (441). Os números máximos de macroinvertebrados foram observados no mês de janeiro. Todos os parâmetros físico-químicos do rio Zhob, como temperatura do ar, temperatura da água, pH, oxigênio dissolvido (OD) e sólidos dissolvidos totais (TDS), estavam dentro da faixa, adequada para o crescimento saudável de macroinvertebrados. Populações diversificadas de vários macroinvertebrados confirmam boas condições ecológicas do ambiente e da água no local estudado, especialmente a ampla concentração de DO no rio. Os dados documentados sobre macroinvertebrados no local estudado fornecerão uma linha de base para pesquisas futuras.

Palavras-chave: macroinvertebrados, parâmetros físico-químicos, Rio Zhob, Baluchistão.

1. Introduction

Aquatic arthropods, mollusks, annelids and their aquatic larval stages comprise a group of organisms which are called Macro-invertebrates. Macro-invertebrates are very sensitive group of organisms which supposed to be bio-indicators of pollution of aquatic ecosystem caused by anthropogenic activities (Barbour et al., 1996). Bio-indicators are considered to be strong markers of environmental conditions throughout the world (Karr and Chu, 1999; Duran, 2006) and in particular they are assessed to become attentive about the habitat stability (Freund and Petty, 2007).

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The largest numbers of macro-invertebrates are found at the bottom of the rivers and streams because of the availability and abundance of food but at the mouth, their presence is very rare. The presence of waste discharge at rivers mouth in affected areas is one of the major reasons (Idowu and Ugwumba, 2005; Begum et al., 2014). In aquatic communities, macro-invertebrates do mineralization, and re-cycling of nutrients as their crucial functions (George et al., 2009).

In aquatic habitat, distribution of macro-invertebrates is greatly affected by a large number of a-biotic and biotic factors (Infante et al., 2009). Many physical and biological factors can alter abundance and distribution of macro-invertebrates (Sharma et al., 2013). Their existence in any environment mainly depends on the quantity of dissolved oxygen, pH, and temperature. Quality and quantity of food is also a key factor.

Species diversity, distribution and productivity are greatly affected by physical and chemical parameters of water body (Boyd, 1982). Urbanization and other anthropogenic activities also alter chemical, physical and biological processes by placing ecosystem under great stress (Allan, 1995). To conserve water quality of a specific water body, it is necessary to evaluate the impact of changes on water by regular monitoring (Barbour et al., 1996; Shrestha, 1990; Jha et al., 2010).

Researchers used macro-invertebrates as a tool to monitor different levels of contaminations in water i.e. Vermeulen, (1995),Kasangaki et al. (2006), Ogbeibu, (2001), Hart and Zabbey (2005), Arimoro et al. (2007), George et al. (2009), Esenowo and Ugwumba (2010). Biological sampling in streams can be performed for both fish and benthic macro-invertebrate, but benthic macro-invertebrates are most common (Voshell Junior et al., 1997).

Macro-invertebrate diversity can be sampled quantitatively as well as the known species can be used for bio-assessment by transforming them into a valuable diagnostic and regulatory instrument (Adakole et al., 2003). Species tolerance varies, but under toxic circumstances, a loss in species diversity is the most likely outcome impact that is evident (Edokpayi et al., 2000; Emere, 2000; Olomukoro and Egborge, 2003).

To find out seasonal fluctuations in various macro-invertebrates communities and different water quality parameters in River Zhob, a research trial was conducted on River Zhob, Balochistan. The documented data on macro-invertebrates in studied site will provide a baseline for future research.

2. Materials and Methods

2.1. Sample site

River Zhob has been selected for this study which flows between Qila Saifullah and Muslim Bagh to the northeast of Balochistan. An area of almost 140 kilometers from District Sherani to Muslim Bagh is covered by river Zhob. Four stations (I, II, III and IV) were selected from District Sherani to Muslim Bagh in accessible areas of the river bank. Each selected station covered an area of almost 15 kilometers.

2.2. Animal sampling and handling

All the samples were collected within an area of one square meter (Individual/m^2) on monthly basis. Sampling of the macro-invertebrates was done by using Kick net method. This method involves placement of the net in the direction of flow of the water and by kicking the feet into bottom of the river sweeps organisms into the net. The net was thoroughly rinsed several times in the water to remove excessive sediments. After the removal of excess sediments, the filtrate was then shifted into the bucket half filled with water. Immediate sorting was done after the sample collection. The bucket with sample was stir for even distribution of the organisms and some of the sample was shifted into a plastic tray filled with clean water up to 2 cm. Tray was left for some time so that sample could settled down. The movement in the water was then observed and the moving organisms were carefully removed from the tray. Same organisms were kept in one compartment.

2.3. Water sampling

Water sample was also collected along with macro-invertebrates on monthly basis for analysis of dissolved oxygen (DO) (ppm), water pH, air temperature (°C), water temperature (°C) and total dissolved solids (TDS) (ppm).

2.4. Sample analysis

After the collection and sorting, all the samples were stored in the plastic bottles with 30% ethanol for further analysis. The macro-invertebrates were counted and identified up to the possible taxonomic level. All the collected organisms were identified microscopically and macroscopically with the help of published research papers and keys including, Walker (1995), Kalkmam et al. (1999) and Nesemann et al. (2011). Mostly organisms were identified to the generic level. Statistical analysis of the data was done by using Software Minitab 17.

3. Results

Density of macro-invertebrates (Individual/m^2) at each sampling station is presented in Tables 1a-1b from the month of October to March. Eighteen taxa of macro-invertebrates were identified from the study area. Our observation shows that station IV was highly abundant with respect to species density. Fluctuations were observed in total number of macro-invertebrates collected from each sampling station in each month. Highest number of macro-invertebrates was observed in the month of January at all stations of the study site (Table 2).

Present study recorded a total of 1946 macro-invertebrates during the study period (Table 3), out of which the Phylum Arthropoda (n=1845 from 24 species) represented maximum number of species, followed by Mollusca (n=72) and Annelida (n=29) from all the sampling stations. Phylum Arthropoda represented 94.8% being

Table 1a. Population density of macro-invertebrates (individual/m²) at each sampling station in River Zhob.

Phylum	Class/Sub-classes/ Order	Sub-order/ Family/Sub-family	Oct					Nov					Dec				
			Stations				Total	Stations				Total	Stations				Total
			1	2	3	4		1	2	3	4		1	2	3	4	
Arthropoda	Diptera	Blephariceridae	15	8	12	0	35	0	6	5	20	31	5	17	0	0	22
		Chironomidae	0	49	8	17	74	19	0	0	3	22	23	28	18	40	109
		Simulidae	12	19	0	0	31	0	3	0	0	3	0	8	0	0	8
	Trichoptera	Limnephilidae	12	57	0	1	70	60	3	12	0	75	0	0	80	0	80
		Philopotamidae	1	0	12	1	14	5	0	12	40	57	0	0	1	1	2
	Odonta	Aniosptera	0	1	0	6	7	0	1	0	0	1	2	1	18	0	21
	Plecoptera	Nemoridae	0	1	2	5	8	0	1	0	1	2	0	1	6	0	7
		capniidae	2	1	1	6	10	1	0	0	2	3	0	0	0	0	0
		Perilidae	0	0	0	0	0	0	2	0	0	2	1	0	0	2	3
		Perilodidae	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Epemeroptera	Heptageniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleoptera	Halipilidae	0	0	1	0	1	0	0	1	1	2	2	0	1	1	4
	Hemiptera	Belostomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Arachnida	pionidae	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1
	Total		**43**	**136**	**36**	**36**	**251**	**86**	**16**	**30**	**67**	**199**	**34**	**55**	**124**	**44**	**257**
Mollusca	Gastropoda	Viviparadae	5	2	0	2	9	0	0	0	0	0	1	0	0	0	1
	Bivalvia	Unionidae	1	6	0	0	7	0	3	0	0	3	5	4	1	1	11
	Total		**6**	**8**	**0**	**2**	**16**	**0**	**3**	**0**	**0**	**3**	**6**	**4**	**1**	**1**	**12**
Annelida	Oligochaeta	Monoligastridae	0	0	1	0	1	0	0	1	0	1	1	0	0	0	1
	Hirudinae	Hirudidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total		**0**	**0**	**1**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**1**

Table 1b. Population density of macro-invertebrates (individual/m²) at each sampling station in River Zhob.

Phylum	Class/Sub-classes/Order	Sub-order/Family/Sub-family	Jan					Feb					Mar				
			Stations				Total	Stations				Total	Stations				Total
			1	2	3	4		1	2	3	4		1	2	3	4	
Arthropoda	Diptera	Blephariceridae	30	28	48	18	124	17	0	0	80	97	3	0	0	40	43
		Chironomidae	55	40	50	60	205	0	29	45	13	87	2	22	25	0	49
		Simulidae	18	2	0	103	123	0	1	0	0	1	0	0	40	44	84
	Trichoptera	Limnephilidae	0	19	2	0	21	0	0	1	48	49	18	0	1	1	20
		Philopotamidae	0	0	1	0	1	2	18	1	0	21	25	6	0	0	31
	Odonta	Aniosptera	55	17	3	15	90	1	1	1	5	8	0	5	1	15	21
	Plecoptera	Nemoridae	0	0	0	1	1	0	0	0	1	1	1	0	0	0	1
		capniidae	0	7	0	2	9	5	6	0	0	11	1	2	0	0	3
		Perilidae	6	3	8	2	19	0	0	0	0	0	0	0	0	1	1
		Perilodidae	0	0	3	0	3	0	1	0	0	1	0	0	0	0	0
	Epemeroptera	Heptageniidae	2	0	0	6	8	0	0	0	0	0	0	0	0	0	0
	Coleoptera	Halipilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hemiptera	Belostomatidae	1	0	1	1	3	0	0	0	0	0	0	0	0	0	0
	Arachnida	pionidae	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0
	Total		**167**	**116**	**116**	**210**	**609**	**25**	**56**	**48**	**147**	**276**	**50**	**35**	**67**	**101**	**253**
Mollusca	Gastropoda	Viviparadae	3	0	0	28	31	4	0	0	1	5	0	0	0	0	0
	Bivalvia	Unionidae	0	0	1	0	1	2	0	0	0	2	0	0	0	2	2
	Total		**3**	**0**	**1**	**28**	**32**	**6**	**0**	**0**	**1**	**7**	**0**	**0**	**0**	**2**	**2**
Annelida	Oligochaeta	Monoligastridae	1	6	2	5	14	1	0	0	0	1	0	0	1	0	1
	Hirudinae	Hirudidae	1	0	5	0	6	0	0	0	4	4	0	0	0	0	0
	Total		**2**	**6**	**7**	**5**	**20**	**1**	**0**	**0**	**4**	**5**	**0**	**0**	**1**	**0**	**1**

Table 2. Monthly individual contribution of each station with reference to number of macro-invertebrates per m²sum at River Zhob.

Month	Station				Total
	1	2	3	4	
Oct	49	144	37	38	268
Nov	86	19	31	67	203
Dec	41	59	125	45	270
Jan	172	122	123	243	661
Feb	32	56	48	152	288
Mar	50	35	68	103	256
Total	**430**	**435**	**432**	**648**	**1946**

Table 3. Percentage of all classes/sub-classes/orders observed at four different stations of River Zhob.

Phylum	Class/Sub-class / Order	Number	Total Numbers	Percentage (%)	Phylum Percentage (%)
Arthropoda	Diptera	1148	**1845**	58.9	**94.8**
	Trichoptera	441		22.6	
	Odonta	148		7.6	
	Plecoptera	86		4.4	
	Emeroptera	8		0.4	
	Coleopteran	7		0.3	
	Hemiptera	3		0.1	
	Arachnida	4		0.2	
Mollusca	Gastropoda	46	**72**	2.3	**3.6**
	Bivalvia	26		1.3	
Annelida	Oligocheata	19	**29**	0.9	**1.4**
	Hirudinae	10		0.5	
	Total	**1946**	**1946**	**100**	**100**

the highest amongst the total population while Mollusca represented 3.6%. The lowest number of species was recorded from phylum Annelida that represented 1.4% of the total population.

According to identification results, most of the arthropods were belonged to the order Diptera (1148), followed by order Trichoptera (441), while order Hemipteran (3) represented lowest number of macro-organisms. Moreover, the molluscs represented the highest number of organisms from class Gastropoda (46), while class Bivalvia comprised second highest score according to number of identified species (26) in this study. However, in annelids highest numbers of organisms belong to sub-class Oligocheata (19).

Monthly distributions of all classes/sub-classes/orders observed at studied sites of River Zhob are presented in Tables 4-5. In Arthropods, order Dipetera constituted 39.3% (452) of its population in the month of Jan. This study suggested that January was the most favourable month for arthropods because orders like Odonata, Plecoptera, Emeroptera, Hemiptera and class Arachnida contributed 60.8% (90), 37.2% (32), 100% (8), 50% (2), and 100% (3) respectively to the total population in this month.

Similar results were observed in molluscs and annelids as highest number of organisms were observed from class Gastropoda 31 (67.3%) and in sub-class oligocheata 14 (73.6%) respectively during the month of January. Figures 1-3 represents individual contribution of the organisms belonged to each class/sub-class/order of phylum Arthropoda, Mollusca and Annelida.

Monthly variations in pH, air temperature (°C), water temperature (°C), TDS and DO at four stations of River Zhob during the study period is presented in Figures 4-8. It was observed, station I has the highest value of pH in the month of February i.e. 8.3, while the lowest pH value was observed at station IV during the month of March (7.6). Station III represented the highest value of TDS (390.9ppm) in the month of December, while the lowest value of TDS (178.9ppm) was observed at the station I during the month of January. Moreover, maximum DO (9.0 ppm) was observed in January at station I and the minimum DO (6.5 ppm) was observed in the month of October at station III.

Table 4. Monthly distribution of all observed classes/sub-classes/ordersfrom all four stations.

Phylum	Class/Sub-class/ Order	Oct	Nov	Dec	Jan	Feb	Mar	Total
Arthropoda	Dipetera	140	56	139	452	185	176	1148
	Trichoptera	84	132	82	22	70	51	441
	Odonata	7	1	21	90	8	21	148
	Plecoptera	19	7	10	32	13	5	86
	Emeroptera	0	0	0	8	0	0	8
	Coleoptera	1	2	4	0	0	0	7
	Hemiptera	0	0	0	3	0	0	3
	Arachnida	0	1	1	2	0	0	4
	Total	**251**	**199**	**257**	**609**	**276**	**253**	**1845**
Mollusca	Gastropoda	9	0	1	31	5	0	46
	Bivalvia	7	3	11	1	2	2	26
	Total	**16**	**3**	**12**	**32**	**7**	**2**	**72**
Annelida	Oligocheata	1	1	1	14	1	1	19
	Hirudinae	0	0	0	6	4	0	10
	Total	**1**	**1**	**1**	**20**	**5**	**1**	**29**

Table 5. Monthly percentage (%) ofall observed classes/sub-classes/ordersfrom all four stations.

Phylum	Class/Sub-class/ Order	Months						Total Percentage (%)
		Oct	Nov	Dec	Jan	Feb	Mar	
Arthropoda	Dipetera	12.4	4.8	12.1	39.3	16.1	15.3	100
	Trichoptera	19.9	29.9	18.5	4.9	15.8	11.5	100
	Odonta	4.7	0.6	14.1	60.8	5.4	14.1	100
	Plecoptera	22.1	8.1	11.6	37.2	15.1	5.81	100
	Emeroptera	0	0	0	100	0	0	100
	Coleoptera	14.2	28.5	57.1	0	0	0	100
	Hemiptera	0	0	0	100	0	0	100
	Arachnida	0	25	25	50	0	0	100
Mollusca	Gastropoda	19.5	0	2.1	67.3	10.8	0	100
	Bivalvia	26.9	11.5	42.3	3.8	7.6	7.6	100
Annelida	Oligocheata	5.2	5.2	5.2	73.6	5.2	5.2	100
	Hirudinea	0	0	0	60	40	0	100

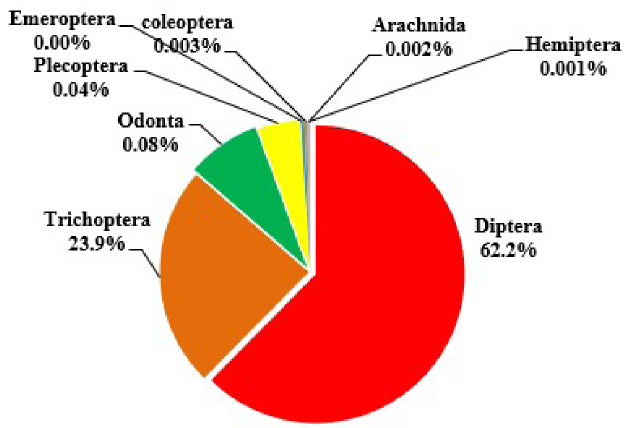

Figure 1. Contribution of each class/order of Phylum Arthropoda at River Zhob.

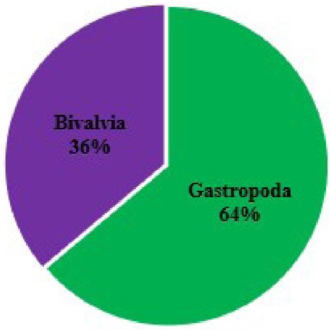

Figure 2. Contribution of each class of Phylum Mollusca at River Zhob.

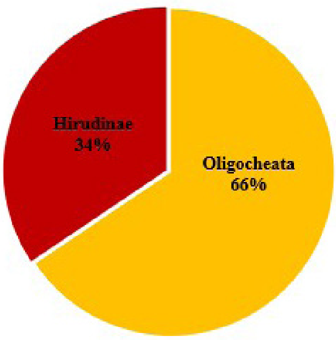

Figure 3. Contribution of each sub-class of phylum Annelida at River Zhob.

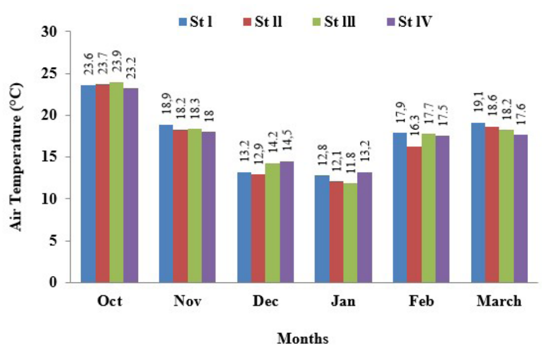

Figure 4. Monthly variations in air temperature (°C) at four stations of River Zhob during whole study period.

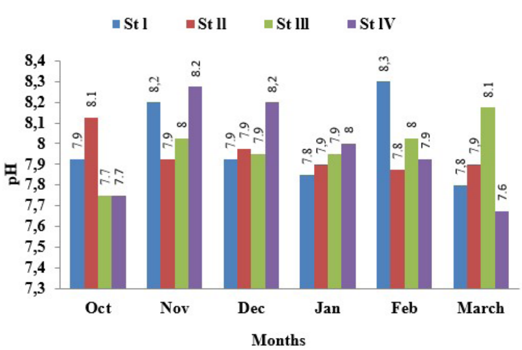

Figure 5. Monthly variations in pH at four stations of River Zhob during whole study period.

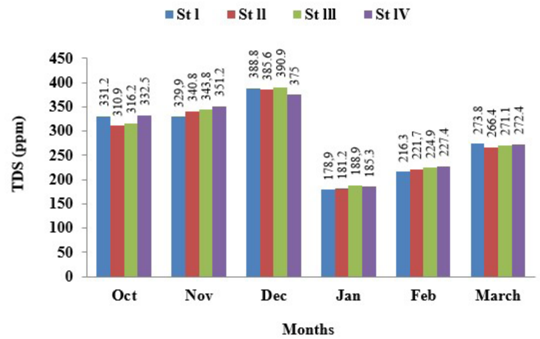

Figure 6. Monthly variations in TDS (ppm) at four stations of River Zhob during whole study period.

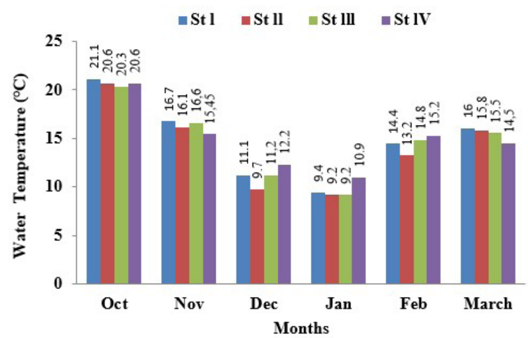

Figure 7. Monthly variations in water temperature (°C) at four stations of River Zhob during whole study period.

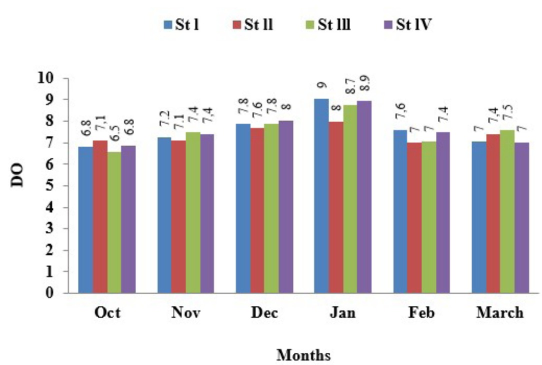

Figure 8. Monthly variations in DO at four stations of River Zhob during whole study period.

Table 6 presents summarized monthly mean values of water quality parameters from all the four stations during study period. Monthly mean values of different water quality parameters were compared by Fisher's least significant different test (LSD) that proved significant dissimilarities in all the water quality parameters like air temperature, water temperature, TDS and DO except pH (Table 7). Results of one-way analysis of variance (ANOVA) between different water quality parameters and months also showed significant P value (P = 0.000) except in the case of pH (Table 8).

Table 6. Monthly mean values of water quality parameters from all four stations during study period.

Month	Air Temperature (°C) ± SE*	Water Temperature (°C) ± SE	pH ± SE	DO (ppm) ± SE	TDS (ppm) ± SE
Oct	23.6 ±0.30	20.7 ±0.3	7.8 ±o.17	6.8 ±0.2	322.7 ±10.7
Nov	18.3 ±0.37	16.2 ±0.5	8.1 ±0.15	7.3 ±0.1	341.4 ±8.8
Dec	13.7 ±0.77	11.1 ±1.0	8.0 ±0.12	7.8 ±0.1	385.1 ±7.0
Jan	12.4 ±0.62	9.7 ±0.8	7.9 ±0.06	8.6 ±0.4	183.6 ±4.4
Feb	17.3 ±0.72	14.4 ±0.8	8.0 ±0.18	7.2 ±0.3	222.6 ±4.7
Mar	18.4 ±0.61	15.4 ±0.6	7.8 ±0.21	7.2 ±0.2	270.9 ±3.1

*SE = Standard Error.

Table 7. Comparision of means among water quality parameters by Fisher's least significant different test (LSD).

Water quality parameters	October	November	December	January	February	March
Air Temperature	23.6 ^{A*}	18.3 ^{B}	13.7 ^{C}	12.4 ^{C}	17.3 ^{B}	18.4 ^{B}
pH	7.8 ^{A}	8.1 ^{A}	8.0 ^{A}	7.9 ^{A}	8.0 ^{A}	7.8 ^{A}
TDS	322.7 ^{C}	341.4 ^{B}	385.1 ^{A}	183.6 ^{F}	222.6 ^{E}	270.9 ^{D}
Water Temperature	20.7 ^{A}	16.2 ^{B}	11.1 ^{D}	9.7 ^{E}	14.4 ^{C}	15.4 ^{BC}
DO	6.8 ^{D}	7.3 ^{C}	7.8 ^{B}	8.6 ^{A}	7.2 ^{C}	7.2 ^{C}

*The different alphabets in a row denote significant values.

Table 8. One-way analysis of means (ANOVA) between water quality parameters and months.

Water quality parameters	r (%)	r^2 (%)	F**	P***
Air Temp X Months	81.15	80.10	77.49	*0.000
pH X Months	6.60	1.41	1.27	0.283
TDS X Months	99.20	99.15	2228.47	*0.000
Water Temp X Months	80.50	79.41	74.30	*0.000
DO X Months	52.03	49.37	19.52	*0.000

*Significant. **F; ANOVA coefficient. ***P; Probability.

Table 9. Pearson correlation among different variables of water quality.

Variables	Air Temp	pH	TDS	Water Temp
pH	-0.08 (0.432)			
TDS	0.23 (*0.019)	0.06 (0.534)		
Water Temp	0.98 (*0.000)	-0.06 (0.541)	0.277 (*0.006)	
DO	-0.70 (*0.000)	0.07 (0.474)	-0.30 (*0.003)	-0.69 (*0.000)

The values under bracket show P- value. *Significant.

Strong correlation between different variables of water quality such as water temperature and air temperature, DO and air temperature and water temperature was observed by the help of Pearson's correlation (Table 9).

4. Discussion

The Macro-invertebrates are considered as important factor in determining chemical, physical and biological suitability of any ecosystem (Barbour et al., 1996; El-Wakeil and Al-Thomail, 2015). Macro-invertebrate's absence from a particular site is considered as an alarming sign which leads to the indication of pollutant in that area. Variety in populations of different macro-invertebrates confirms favourable ecological condition of water and environment in the present studied site especially abundant concentration of DO in the water body.

Our study suggested that order dipetera was the most abundant order (58.9%) amongst arthropods. The dipterans dominancy has also been acknowledged by many other researchers in tropical ecosystem. Dipterans were recorded highest in number by Ogbeibu, (2001) and Hutchinson, (1993) in their studies. Moreover, trichoptera were recorded in moderate number as compared to dipetera. Trichoptera are usually intolerable to pollutants hence considered as biological indicator of water quality (Holzenthal et al., 2015).Similarly, the Ephemeroptera were recorded in lower numbers as Ephemeroptera also have a tendency to live in uncontaminated water, and their lower numbers in this study may be an indication of pollutants present in River Zhob.

The recorded benthic macro-invertebrates of this study were the common inhabitants of freshwater ecosystem. Many studies suggested variation in availability such as, Ajao and Fagade, (2002) reported over sixty species of macro-invertebrates, while, Ganie et al., (2014) recorded only 26 species of macro-invertebrates in a study on Lar Stream, Kashmir.

There are several factors involve in diversity of community composition. As reported by Neckles et al., (1990), Castella et al., (1995) and Growns and Growns (2001) that the community composition is usually altered by any change in movement regimes in the river. These finding are in line with the studies of Ogbeibu and Victor, (1989), Egborge, (1991) and Ogbeibu and Oribhabor, (2002), that reported influence of road construction, river impoundment, and industrial effluents on the macro-invertebrates and plankton communities of Nigerian water bodies.

Occurrence of a large number of limited specific species and reduction in diversity is a common community response against any environmental problem (Fowler, 2002). Decline diversity portrays environmental stress at studied site. Moreover, McIntosh, (2000) observed that the community structure strongly influenced by the relationship amongst biotic factors with the lack of disturbance. Many reported species (oligocheates) are resident of contaminated water (Millbrink, 1994). Occurrence of these species at the studied site may be the consequence of bacterial decomposition of organic matter that requires DO in large quantities, which ultimately affects the volume of oxygen in water as well as the abundance and distribution of macro-invertebrates.

Station IV was found to be the highly abundant and diversified of all the stations that could be a result of minimum anthropogenic interference at the site. This may play an important role in sustaining the ecology of the site with the reduction of pollution load causing material unsuitable for the growth of macro-invertebrates. Subsequently, for sensitive group of macro-invertebrates, highly impacted sites cannot provide suitable habitat.

Physico-chemical parameters of River Zhob like air temperature, water temperature, pH, total dissolved solids (TDS) and dissolved oxygen (DO) were within the suitable range for the healthy growth and development of macro-invertebrates. The highest numbers of macro-invertebrates were reported in the month of January. Hence, it is suggested that the physio-chemical parameters have influence the abundance of these macro-invertebrates at the study site.

Anthropogenic activities has a huge impact on aquatic habitat of an ecosystem consequently, disturbs biodiversity of the macro-invertebrates. Iyagbaye et al. (2017) reported extreme change in species abundance of the benthic fauna in Ovia River of the Nigeria.

Absence of environmental policies, management and conservation strategies of renewable resources at the study site could be the basic reason of this reduced Macro-invertebrates fauna. Formation and implementation of strategies for an effective water resource management is a key to cease depletion and pollution of river ecosystem.

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