*International Research Journal of Environment Sciences*_____ ISSN 2319–1414
Vol. **2(5),** 17-24, May **(2013)** *Int. Res. J. Environment Sci.*

Biodiversity and Abundance of Benthic Macro-invertebrates Community of River Tawi in Vicinity of Udhampur City (J&K) INDIA

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Available online at: www.isca.in
Received 8th March 2013, revised 11th April 2013, accepted 13th May 2013

Abstract

Aquatic macro-invertebrates responds to a variety of environmental conditions of rivers and streams and therefore may be used as bio-indicators for assessing water quality parameters. Seasonal variations in macrobenthic invertebrate fauna and selected physico-chemical parameters of river Tawi have been studied on monthly basis for a period of one year (September, 2011 to August, 2012). The benthic macroinvertebrate fauna of river Tawi was represented by thirteen species belonging to three groups viz. Annelida (4 taxa), Arthropoda (6 taxa) and Mollusca (3 taxa). Arthropoda was the dominant group among all and it constitutes 57.24 % of the total macrobenthic invertebrates collected. Annelida was the second dominant group and contributes 25.02% of total macrobenthic population. Whereas group Mollusca was the least abundant among all and it shared 17.72% of total macrobenthic fauna of river Tawi. The relative species diversity, species richness, dominance and evenness were calculated. The value of Simpson index ranged between H'= 0 to 1.07. The maximum species diversity value was obtained in August 2012 whereas its value was 0 in the month of July. The value of Shannon-Weiner index was higher (I= 2.15) in February. Species richness in term of Maraglef's index and Menhinick's index varied between minimum valued R_1= 0 (July) to a maximum value R_1 = 1.94 (Feb.) and a minimum valued R_2= 0 (July) to a maximum value R_2 = 1.00 (March) respectively. The minimum evenness value was observed in July and maximum in May the values being E = 0 and E= 0.96 respectively.

Keywords:

Introduction

Now a day's fresh water has become a scare commodity due to over exploitation and pollution[1]. Hence it is necessary to evaluate quality of water in order to assess its suitability for various uses. The physico-chemical means are used in detecting effect of pollution on the water quality but changes in the trophic status of a water body is reflected in its biotic community-structure including species pattern, distribution and diversity[2] . The abundance of benthic fauna mainly depends on physical and chemical properties of their habitat as they respond more quickly if any changes in water quality occur[3]. Macrobenthic invertebrates can be used as bio-indicators because of their extended residency period in specific habitats and presence or absence of particular benthic species in a particular environment and habitat conditions. They are most frequently used in biomonitoring studies because they significantly respond to various organic and inorganic pollution had also been extensively documented[4-5]. Benthic fauna are especially of great significance for fisheries that they themselves act as food of bottom feeder fishes. Investigation on distribution and assessment of macro-benthic resources in the riverine systems has been well discussed[6-12].

Benthic environments have been and will be adversely impacted by human activities such as over-fishing, bottom trawling and dredging, pollution of water, aquaculture and introduced species and human induced climate change occurring over the last century. The combination of these direct and indirect human impacts on the aquatic environment is inducing unprecedented changes in these ecosystems. So the present study is aimed to generate data about water qualities and macrobenthic fauna of river Tawi in the vicinity of Udhampur,

Material and Methods

Study area: River Tawi originates from base of Kali Kund glacier and adjoining area southwest of Bhadarwah in Doda District of J&K. The study area of river Tawi lies 32°56' North to 75°09' East at an elevation of 624m above sea level and about 4 km away from the Udhampur city as shown in figure 1.

Physico-chemical parameters analysis: The water quality parameters such as temperature, pH, transparency, free CO_2 and dissolved oxygen, carbonates, bicarbonates, chloride, calcium and magnesium were measured in the field. However, for nitrate, phosphate and sulphate samples were bought to the laboratory in glass bottles of 500 ml capacity and analyzed within 6 hours because prolonged storage changes the sample quality due to biological activities. Chemical preservation by 2ml chloroform per litre was also done. For the collection and analysis of various water quality parameters standard methods were followed[13-14].

Macrobenthic invertebrates sampling: The samples were collected with the use of an Ekman dredge and the collected samples were washed through sieve no. 40 (256 meshes/ cm^2) and macrobenthic invertebrates thus segregated were transferred to tubes and preserved in 5% formalin for subsequent identification. For qualitative analysis, collected samples were examined using microscope and identified by using standard keys[15-17]. However, for quantitative analysis, were done by counting individuals species-wise in the whole sample or sub sample. The number of benthos per unit area was calculated as follows:

$$\text{Benthos No/m}^2 = \frac{N}{A.S} \times 1000$$

Whereas: N = Number of organism collected per sample, A = Biting area of sampler (15 x 15 cm), S = Number of samples taken.

Statistical analysis: To understand a particular biotic community, it is important to work out various indices. In this case, species diversity and species richness was calculated using Shannon-Weaver Index (H)[18], Simpson's Index (I)[19] Margalef's Index (R_1)[20] and Menhinicks Index respectively. Evenness was calculated by Pielou's index (E)[21].

Results and Discussion

Analysis of water quality parameters: Mean Variations in the physico-chemical parameters of river Tawi is shown in table 2. pH varies in the range of 8.1 to 8.9 which means the pH of water remained alkaline throughout the study period. Dissolved oxygen increased with the decrease of water temperature and found maximum i.e. 9.60 mg/l in the month of December and minimum in 4.75 mg/l (June) when water is quite turbid due to rain and flood. Free carbon dioxide was present throughout the study period and its value ranged between 1.27 mg/l to 6.23 mg/l. Maximum value was seen in the month of December and minimum in March. Bicarbonates were present and their value ranged between 86 mg/l to 146.4mg/l. Chloride value ranged between 2.89 mg/l in February to 22.09mg/l in September. Both calcium and magnesium value decreased from September to November then increased in December and then further decreases. Their values showed the water is hard throughout the study period. The phosphate, sulphate and nitrate do not varied in uniform manner as shown in table 2. The results revealed that there were no significant seasonal variations in physico – chemical parameters and all the parameters were in the normal permissible limit and indicated better quality of water resources.

Qualitative analysis: Qualitatively macrobenthic invertebrates analysis showed the presence of three species of Annelida belonging to two classes Oligochaeta (*Tubifex tubifex, Aeolosoma sp.* and *Metaphire posthuma)* Hirudinea (*Erphobdella anoculata),* six species of Arthropoda belonging to five classes, Diptera (*Chironomous sp. meigen* and *Anopheles meigen)* Odonata (Dragonfly nymph*)* Tardigrada (*Macrobiotus species*) Lepidoptera (Butterfly larva*)* Ephemeroptera (*Callibaetis fluctuans)* and three species of Mollusca belonging to two families Planorbidae (*Gyralus sp. charpentier)* Lymnaedae (*Lumnaea acuminate* and *Lymnaea sp.*).

Table-1
Monthly variations of different species of macro-benthic invertebrates (no. m^{-2}) in river Tawi during study period

S.No	Name of species	Units	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
A.	**ANNELIDA**														
a.	**Oligochaeta**														
1.	*Tubifex tubifex*	No./m^2	-	4	4	4	13	9	9	27	45	139	-	-	254
2.	*Aeolosoma hemprichi*	No./lit.	-	14	7	7	10	14	14	-	-	18	-	-	84
3.	*Metaphire posthuma*	No./m^2	9	9	-	-	-	4	-	-	-	9	-	18	49
b.	**Hirudinea**														
1.	*Erpobdella anoculata*	No./m^2	-	-	-	-	-	-	4	-	-	-	-	-	4
B	**ARTHROPODA**														
a.	**Odonata**														
1.	Dragonfly nymph	No./m^2	-	22	4.5	-	4	13	-	-	13	22	-	-	78.5
b.	**Diptera**														
1.	*Chironomous sp. meigen*	No./m^2	-	-	18	22	22	13	9	18	72	108	-	-	282
2	*Anopheles meigen*	No./m^2	-	72	13	-	-	13	-	-	27	81	-	-	206
c	**Tardigrada**														
1.	*Macrobiotus sp.*	No./lit.	-	-	-	10	13	7	19	-	-	27	-	-	76
	Lepidoptera														
1	Butterfly larva	No./m^2	13	13	22	-	-	-	-	-	-	13	-	-	61
	Ephemeroptera														
1	*Callibaetis fluctuans*	No./m^2	9	13	13	27	-	22	13	-	27	67	-	-	191
C	**MOLLUSCA (Gastropoda)**														
a.	**Planorbidae**														
1	*Gyralus sp.charpentier*	No./m^2	-	4	4	13	9	4	4	9	40	72	-	9	168
b.	**Lymnaedae**														
1	*Lymnaea acuminate*	No./m^2	4	4	9	4	-	-	4	-	31	45	-	-	101
2	*Lymnaea sp.*	No./m^2	-	-	-	-	-	4	4	-	-	-	-	-	8

Table-2
Range and average values of various physico-chemical parameters in river Tawi during study period

Parameters	River Tawi	Min.	Max.
Air temp.	27.80 ± 6.88	16.5 (Dec.)	37 (June)
Water temp.	17.41 ± 5.83	9.5 (Dec.)	24 (June)
Transparency	210.58 ± 109.38	45.0 (Aug.)	423 (Sep.)
pH	8.36 ± 0.102	8.2 (Jan.)	8.5 (Oct.)
Dissolved O2	7.76 ± 1.65	1.27 (Feb.)	6.23 (Sep.)
Free CO2	3.95 ± 1.57	4.75 (Sep.)	9.60 (Jan.)
Carbonates	00	00	00
Bicarbonates	118.78 ± 20.35	86.0 (Sept.)	146.4 (April)
Chloride	8.12 ± 4.47	2.89 (Feb.)	22.09 (Sept.)
Calcium	69.44 ± 12.31	42.0 (Oct.)	86.73 (Aug.)
Magnesium	56.92 ± 22.53	20.72 (July)	96.85 (Dec.)
Sulphate	0.078 ± 0.051	0.014 (July)	0.170 (Oct.)
Nitrate	0.155 ± 0.052	0.109 (June)	0.300 (Aug)
phosphate	0.161 ± 0.051	0.086 (Feb.)	0.269 (Aug.)

Figure-1
Aerial view of the study area of river Tawi

Quantitative analysis: A total of 1562 individuals representing 13 taxa were collected from the study area as shown in the table 1. Of these Arthropoda contributed the largest share constituting 57.24% of the total macro-benthic invertebrate fauna, followed by Annelida (25.02%) and Mollusca (17.72%) respectively as shown in the figure 2. Among Annelids, *Tubifex tubifex* was the dominant species represents 64.90% of the total species of Annelids collected from the study area. *Aeolosoma sp.* was the second dominant constituted 21.48% and *Metaphire posthuma* was the third dominant species (12.53%). Whereas *Erphobdella anoculata* was the least abundant among all and was found only once in the month of March during the study period. Monthly variations in the total population of Annelids is shown in figure 3.

Among Arthropods, *Chironomous chironomous* was the dominant species and it contributed 31.52 % to the total Arthropods population. *Anopheles meigen* was the second dominant species (23.02%), followed by *Callibaetis fluctuans* (21.35%), then *Macrobiotus species* (8.49%) and least was the Butterfly larva which represented 6.81% of total Arthropods. Arthropods population showed peak during summer season (June) when the water level was lower and temperature was higher as given in figure-4. Group Mollusca was the third dominant group. Among Molluscs, *Gyralus sp. charpentier* was the dominant species and it contributed 60.64% of total Molluscan fauna collected from the study area, followed by *Lumnaea acuminate* (36.40%) and least was the species *Lymnaea sp.* (2.88%). Molluscan density was observed higher in the month of June (figure-5) which may be due to soft and organically rich bottom, alkaline nature of water and silt matter are known to support thriving populations of macro invertebrates because of reduction in water current and as such the substratum tends to make Mollusks indistinguishable from their typical lentic habitat as also studied[22].

Presence of bioindicators, *Chironomus chironomous* larvae and *Tubifex tubifex* indicate the effect of pollution. *Chironomous chironomous* larvae showed its peak during May and June which could be attributed to low water level in the river, less oxygen content (mg/l) along with sluggish movement of water during these months[23-25]. *Tubifex tubifex* dominated the total number of Oligochaetes and showed their peak in the month of June when air and water temperature was higher i.e. 37°C and 24 °C respectively. It was studied that presence of good organic detritus content contributed the maximum quantity of Oligochaetes[26- 29]. The peak of total benthic count remained high during May and June and low during monsoon season. Analysis of coefficient of correlation of macro-benthic invertebrates group, with various water quality parameters, has revealed mostly insignificant results except with the pH (table 3).

The macrobenthic invertebrate fauna was analyzed for species diversity, species richness, dominance and evenness showed varied variations figure 6. The value of Simpson index ranged between H'= 0 to H'=1.07. The maximum species diversity value was obtained in August 2012 whereas its value was 0 in the month of July. The value of Shannon-Weiner index was higher (I=2.15) in February. Species richness in term of Maraglef's index and Menhinick's index varied between minimum valued R_1= 0 (July) to a maximum value R_1 = 1.94 (Feb.) and a minimum valued R_2= 0 (July) to a maximum value R_2 = 1.00 (March) respectively. The minimum evenness value was observed in July and maximum in May the values being E = 0 and E= 0.96 respectively. This showed that maximum species diversity in term of Simpson index and Shannon-Weiner index were seen during August and February respectively. Maximum species richness in term of Maraglef's index and Menhinick's index were seen in month of February and March i.e. during post winter season. Due to anthropogenic stress, municipal sewage, and domestic wastes an escalation of taxa tolerant to pollution such as *Chironomus chironomus and Tubifex tubifex* was observed, These changes in the benthic community composition have already been put in record in other riverine ecosystems, where anthropogenic impacts were most evident[30].

Table-3
Correlation between various physico-chemical parameters and macro-benthic invertebrates during study period

Parameters	Annelida	Arthropoda	Mollusca
Water temp.	0.09	0.15	0.13
Transparency	-0.03	0.03	0.03
pH	0.41	0.42	0.50*
FCO_2	-0.14	-0.14	-0.07
DO	0.001	-0.003	0.05
Bicarbonate	0.27	0.044	0.23
Chloride	-0.09	-0.14	-0.007
Calcium	0.18	-0.041	0.30
Magnesium	-0.18	0.028	-0.18
Phosphate	-0.25	-0.25	-0.32
Sulphate	-0.33	-0.12	-0.43
Nitrate	-0.09	-0.07	-0.08

Significant correlation of 0.05 level ($p<0.05$)

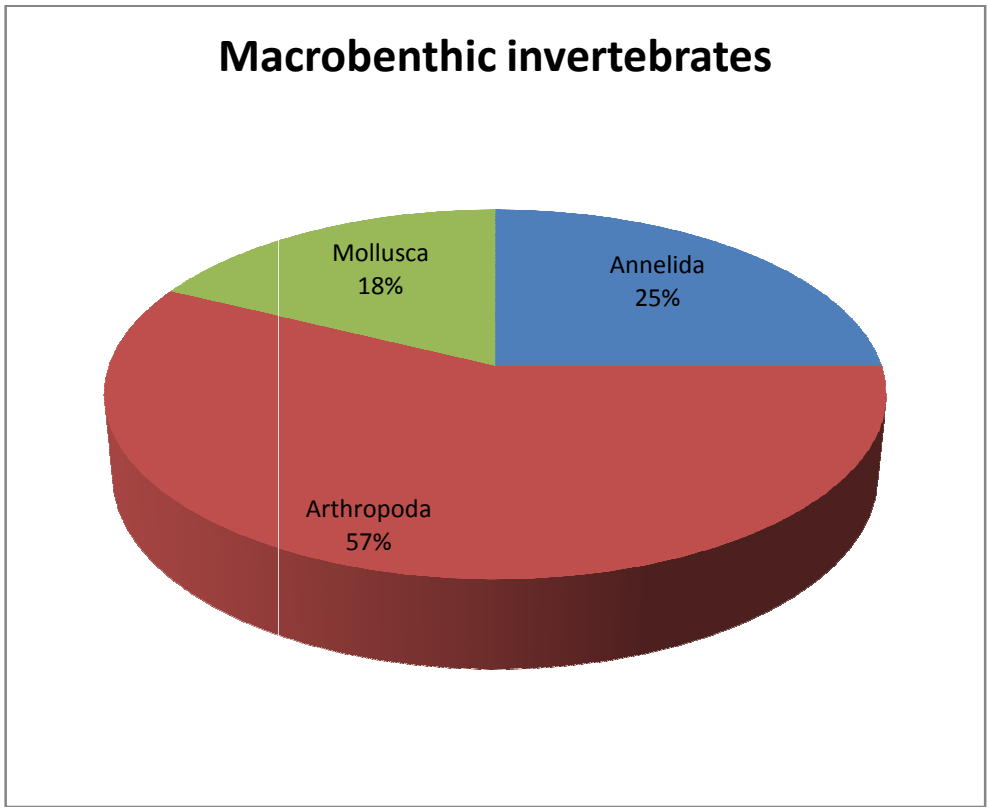

Figure-2
Pie diagram showing the percentage of different groups of macro-benthic invertebrate in the study area

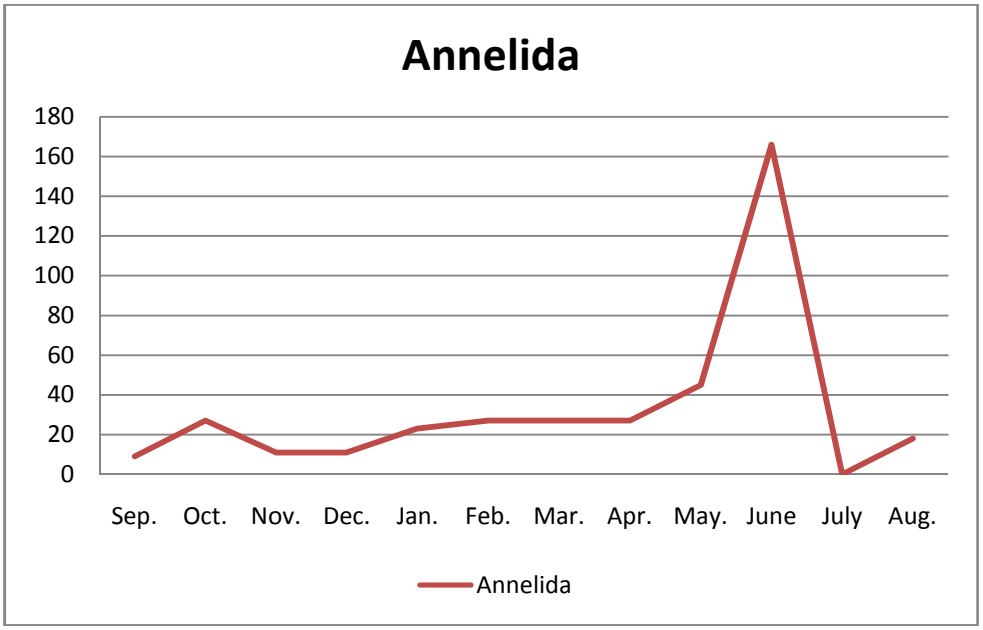

Figure-3
Monthly variations in the number of Annelids in river Tawi during study period of Sept. 2011 to Aug. 2012

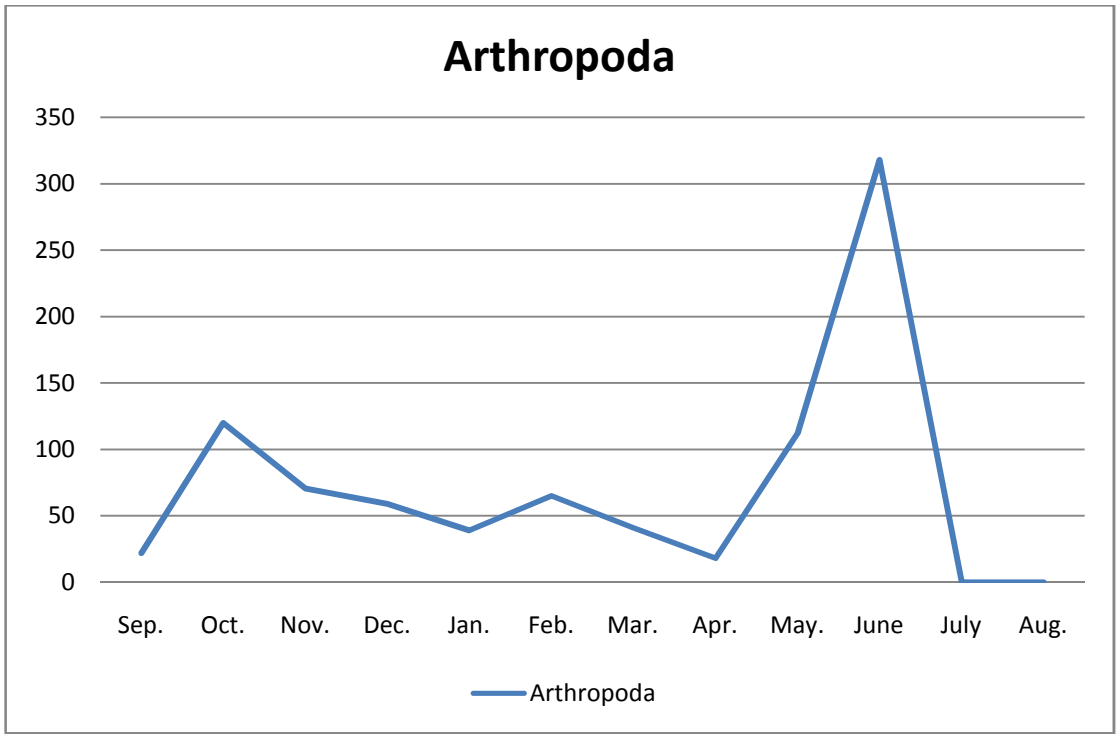

Figure-4
Monthly variations in number of Arthropods in river Tawi during study period of Sept. 2011 to Aug. 2012

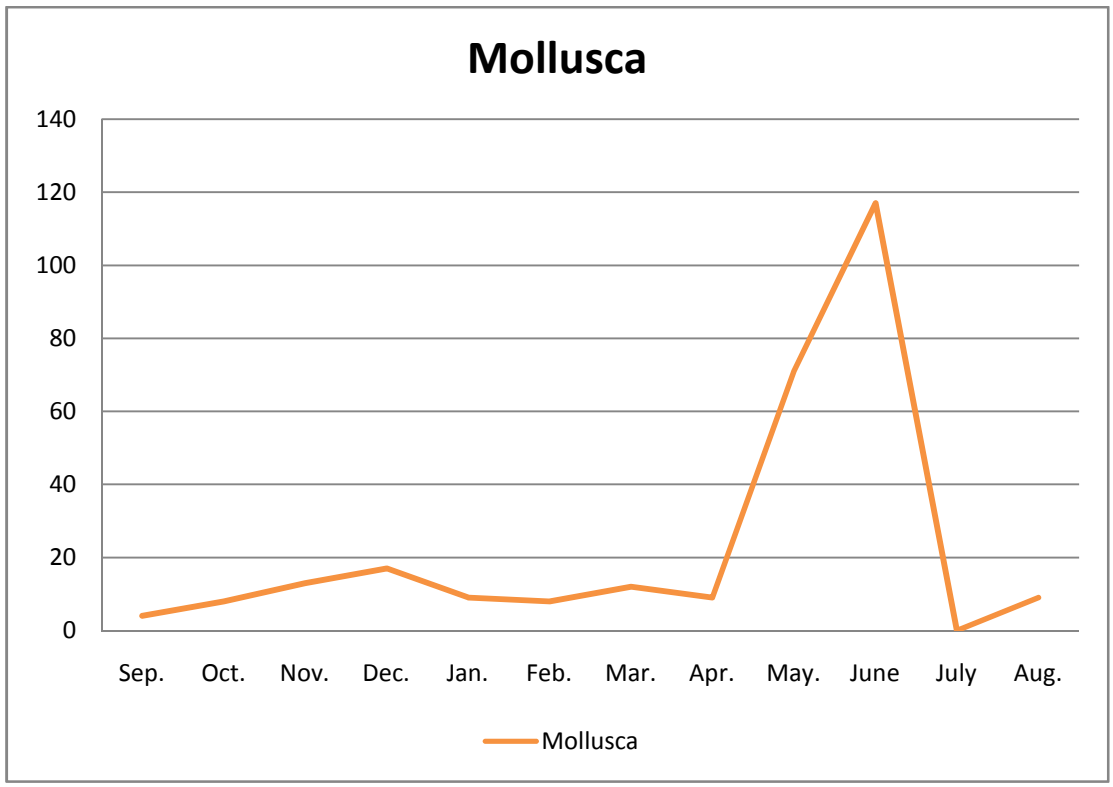

Figure-5
Monthly variations in the number of Mollusca in river Tawi during study period of Sept. 2011 to Aug. 2012

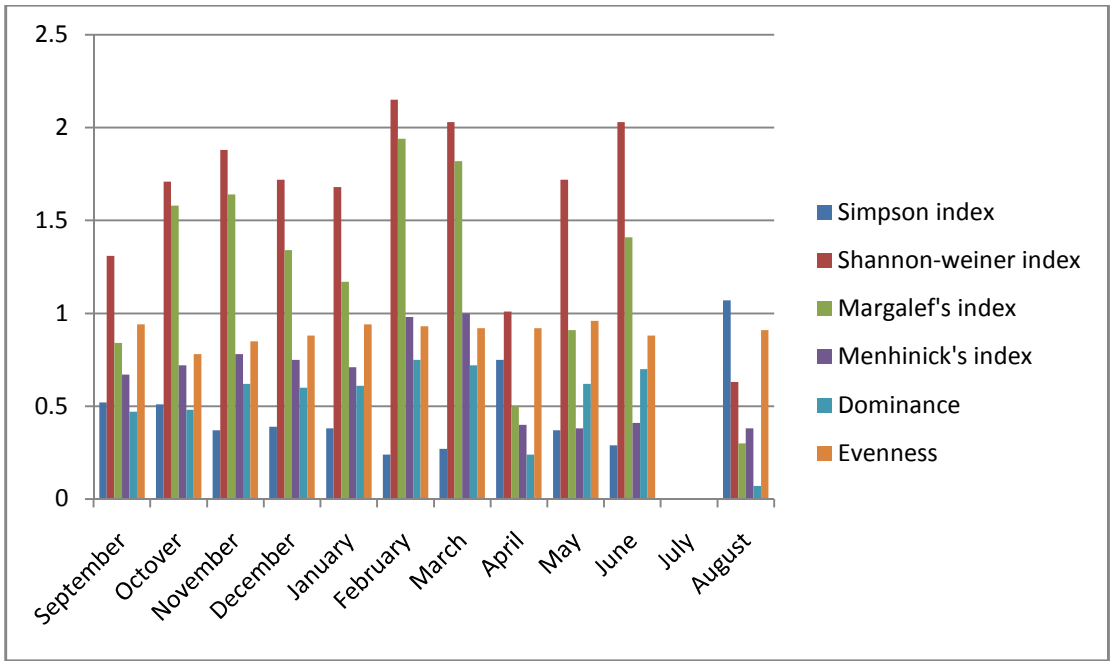

Figure-6
Graphic representation of macrobenthic fauna diversity, evenness and richness during the study period

Conclusion

It is concluded that the during this study it is observed that an increase in the decaying matter during summer enhances the growth of macrobenthic invertebrates. Also the pollution indicator species like *Chironomus chironomus and Tubifex tubifex* showed water is polluted but not to much extent because of their low number in the study area.

Acknowledgement

I am highly thankful to CSIR, New Delhi for financial assistance as Junior Research Fellowship and Head department of Zoology Prof. K. K. Sharma for providing me valuable guidance and laboratory facilities.

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