J. Mountain Res. ISSN: 0974-3030
Vol. 13, (2018) 51-58

Distribution Pattern of Benthic Macroinvertebrate Community in The Spring Fed Stream of Garhwal Himalaya, India

Pankaj Bahuguna[1]* • Shailza Negi[1]
[1]*Biodiversity Lab, Department of Zoology, A.P.B. Govt. P.G. College Agustyamuni-246421, Uttarakhand, India.*

*Corresponding Author Email: pankajpaurii@gmail.com

Received: 15.11.2018; Revised: 26.11.2018; Accepted: 10.12.2018

Abstract: This paper is based on the study of the macrobenthic community in the first order stream of Kyunja Gad, a spring-fed tributary of river Mandakini. Two sampling sites were chosen for the collection of macrozoobenthos using a Surber Sampler (200 µm mesh). It was noticed that during the study period (October 2017 to September 2018), the maximum macrozoobenthos density was recorded as 145 ind./m^2 in January and minimum density was noticed as 44 ind./m^2 in July. The benthic fauna of the spring-fed stream comprised of 35 genera belonging to 8 orders (Ephemeroptera, Trichoptera, Diptera, Coleoptera, Odonata, Plecoptera, Hemiptera and Acariformes). During the year, 2017-18 in the stream Kyunja Gad, the Shannon-Wiener index ($H^{/}$) for the macrozoobenthos studied was maximum (2.897) in September and a minimum (2.397) was observed in August. The similarity Index showed relatively higher values during favourable months (January and February) and lower during unfavorable months (July and August). During the present work on the physico-chemical parameters in Kyunja Gad streams, the coefficient of correlation (r) and coefficient of determination r^2 for various parameters were compared against Macrozoobenthos.

Keywords: Diversity • Kyunja Gad • Spring fed • Macrozoobenthos • Garhwal

Introduction

Though Freshwater ecosystems occupy a little fraction of the Earth's surface yet they support remarkable biodiversity and abundance of benthic macroinvertebrates (Strayer and Dudgeon, 2010). However, growing human pressure had substantially deteriorated the overall ecological integrity and induced a biodiversity crisis. The population dynamics of Macroinvertebrates is significant community structure that is controlled by a variety of mechanisms at different spatial scales. A number of studies have documented how macroinvertebrate assemblages respond to changing environmental variables. Some studies have shown good relationships among macroinvertebrate assemblages, chemical variables, and the organic energy base. Habitat-related physical factors are widely demonstrated as primary contributors such as substrate composition (Merz and Ochikubo, 2005), flow and current velocity (Nelson and Lieberman, 2002), elevation and stream size (Jiang, et al., 2010) and temperature (Vought, et al., 1998). Some work in Uttarakhand has been carried out by Balodi and Koshal, (2015) on macro-Zoobenthic study in relation to physico-Chemical parameters of Khoh River, Koshal et al., (2017) on benthic

macroinvertebrates communities of stream Rawasan and Singh et al., (2017) on seasonal composition of benthic macroinvertebrates in a spring-fed stream. The present study aimed to survey the benthic macroinvertebrate fauna of a first order Kyunja Gad stream in the Garhwal region of Uttarakhand State, India.

Material and Methods

Study Area: The Kyunja Gad spring-fed hill stream has been selected as the study area. The Kyunja Gad is a tributary of the snow-fed River Mandakani (one of the parent streams forming Ganges at Devprayag, Uttarakhand). It is situated in the Latitude 30° 25' 45" N and Longitude 79° 08' 35" E and receives water from numerous springs, underground seepage and surface runoff. This stream is mainly a *Quercus*-forest based stream. The stream Kyunja Gad (1st order stream) was studied near Senagarsari village at the spot 1 towards the head waters and spot 2 near the Jaykandi (downwards) (Map 1). The first order stream of Kyunja Gad has a stretch of nearly 3.9 Kilometers.

Quantitative Macrozoobenthic Sampling: The macrozoobenthos were collected using a square framed Surber Sampler that enabled the sampling of area of $1m^2$ of the stream bed. On the downstream side of the framed sampler a floating net was held with mesh size of 200 µm. The Surber collecting bag was pushed at the front from time to time to check backwash, loss of organisms and also to avoid smoggering and clogging of the meshes. The macrozoobenthos in quadrate were collected to a depth of about 15cm and immediately placed in 70% alcohol and taken to the laboratory for identification and enumeration. The data represent the combined densities of insect and other larvae and nymphs/m^2. The macrozoobenthos were sorted to the species level wherever possible, otherwise to the lowest possible practical taxonomic level. Specimens were identified to genus or species level mainly according to the standard keys.

Map 1 Sampling site of 1st order stream Kyunja Gad

Diversity Indices: The use of various diversity indices to assess environmental perturbations has been in trend for the past many years. The diversity index used here is Shannon-Wiener function ($H^{/}$). It was calculated as: $H^{/} = - \sum$ (Pi. ln Pi.) Similarity index (s) was also calculated as: S = 2C/A+B Where: A= taxa in A sample, B= taxa in B sample, C= taxa common in both the samples.

Result and discussion

Month wise density and diversity of macrozoobenthos in the Kyunja Gad at the 1st order stream during the year 2017-18 is presented in the Table 1. During the study period of October 2017 to September 2018, in the stream Kyunja Gad the macrozoobenthos density was recorded as maximum during January (145 ind./m^2) while minimum was noticed for the month of July (44 ind./m^2). The benthic fauna consisted of 35 genera belonging to 8 orders (Ephemeroptera, Trichoptera, Diptera, Coleoptera, Odonata, Acariformes, Plecoptera and Hemiptera). Rautela *et. al.* (2006) also observed that the macrozoobenthos showed a maximum population during winter (325) and the minimum (15) during monsoon season. The benthic fauna mostly included Coleoptera *(Berosus indicus, Elmid sp., Hydrophilus sp., Psephenus tenulpes),* Diptera *(Atherix sp., Antocha sp., Tipula sp., Simulium sp.),* Ephemeroptera *(Ameletus sp., Atalophlebie sp., Baeties sp., Caenis sp., Ecdyonurus sp., Ephemerella indica, Heptagenia sp., Prosopistoma sp., Isonychia sp., Platybaetis sp., Crinitella sp.),* Hemiptera *(Gerris sp., Heleocoris vicinus),* Odonata *(Argia sp., Zygonyx sp., Euphaea sp., Gompidictus sp.),* Plecoptera *(Neoperla sp.),* Trichoptera *(Hydropsyche sp., Stenopsyche himalayana, Chimarra sp., Glossosoma caudatum, Rhyacophila similis) and* Acariformes *(Sperchon indicus, S. hirsutus, Torrenticola turkestanica, T.semisuta.)* for 1st order stream Kyunja Gad.

Month wise variation in the I[st] order stream of macrozoobenthic community in the Kyunja Gad stream during the October 2017 to September 2018 are presented in Table 2. Order wise distributional pattern structure of the aquatic macrozoobenthos in 1st order stream was observed by a dominance of Ephemeroptera > Trichoptera > Diptera > Coleoptera > Odonata > Acariformes > Plecoptera > Hemiptera. Shannon-Wiener diversity Index for benthos in the 1st Order Stream of Kyunja during the year 2017-18 is presented in the Table 3. During the year, 2017-18 in the stream Kyunja Gad, the $H^{/}$ for the macrozoobenthos studied was maximum (2.897) in September and a minimum (2.397) was observed in August. There was a reduction in $H^{/}$ values from September (2.897) onwards up to November (2.578). The ($H^{/}$) diversity values for macrozoobenthos within the above ranges were also obtained by Andrews and Minshall (1978). Thus the maximum diversity of benthic populations in the stream studied can be attributed to favourable environmental conditions i.e. high D.O., moderate velocity whereas minimum diversity to the disturbed stream ecology. According to Odum (1971), the lesser number of species and low diversity value in streams are characteristic of stressed communities which is mainly due to extreme of the abiotic environmental variables (e.g., temperature and velocity etc.) often resulting in blanketing bottom effect. The important factors which regulate the occurrence and distribution of river dwelling invertebrates include speed of water, temperature and dissolved substances etc. (Yanygina, 2017 and Siraj, 2018).

The minimum and maximum average values of water temperature were noted as 12.8ºC and 21.5ºC in January and July respectively. The lowest and highest average pH values recorded were 7.6 in July and 8.2 in January. The minimum and maximum average water velocity calculated during 2017-18 was 0.268 m/sec. in November and 0.656 m/sec. in August. The average value of dissolved oxygen during 2017-18 showed its higher–lower limits in January and July being 9.4 and 7.4 mg/l respectively.

The minimum and maximum average values of the total alkalinity were 80.2 and 109.9 mg/l in July and February respectively. The average highest range of total hardness was 134.5 mg/l in the month of January and a lowest range 87.3 mg/l was seen in the month of July (Figure 1 to 6). Statistical modeling between ecological data and benthos is presented in the Table 5. During the present work on the physico-chemical

parameters in Kyunja Gad streams, the coefficient of correlation (r) and coefficient of determination r^2 for various parameters were compared against Macrozoobenthos. In stream Kyunja Gad, the benthos and water temperature, pH, velocity, Total alkalinity, Total Hardness and dissolved oxygen showed positive correlation.

Macrozoobenthic similarity index (S) between taxa of different months during 2017-18 is presented in the Table 4. The similarity Index showed relatively higher values during favourable months (January and February) and lower during unfavorable months (July and August). Balodi (2000) worked out that the similarity coefficient for Eastern and Western Nayar was observed to be high (0.98 – 1.0) for the taxa dwelling during November to April and low (0.6-0.9) for the rest of the months Rautela et al. (2006) on the basis of similarity index, reported that there was a close similarity in the macrozoobenthic taxa during ecologically calm months (December to May, S = 0.97-1.0) and during August to September, the similarity was low (S=0.75) due to ecological disturbances. Kumar et. al. (1998) observed that the macrozoobenthic density can be influenced by the heterogeneity in substratum. Pridmore and Roper (1985) opinioned that benthic aquatic invertebrates are found in highest density in riffle habitats and lowest in pools. The results obtained in present study were in consensus with the maximum number of macrozoobenthos noticed in riffles.

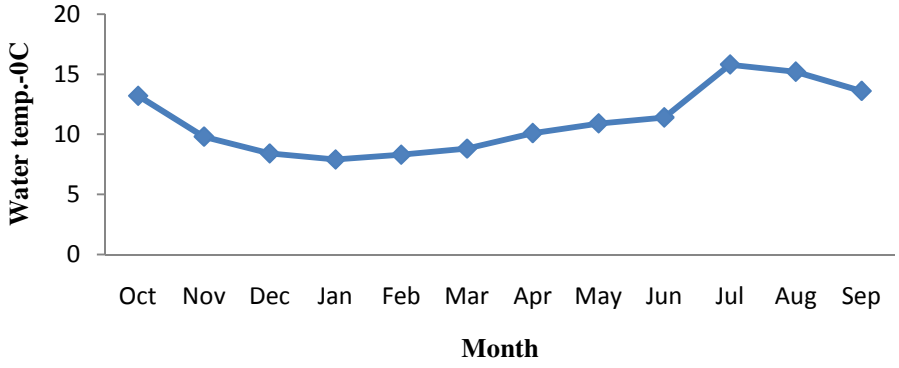

Figure 1 Monthly variation of water temperature during October 2017 to September 2018.

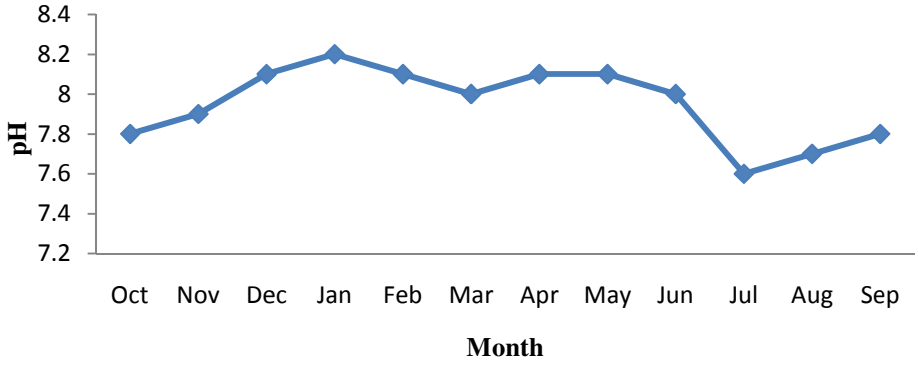

Figure 2 Monthly variation of water pH during October 2017 to September 2018.

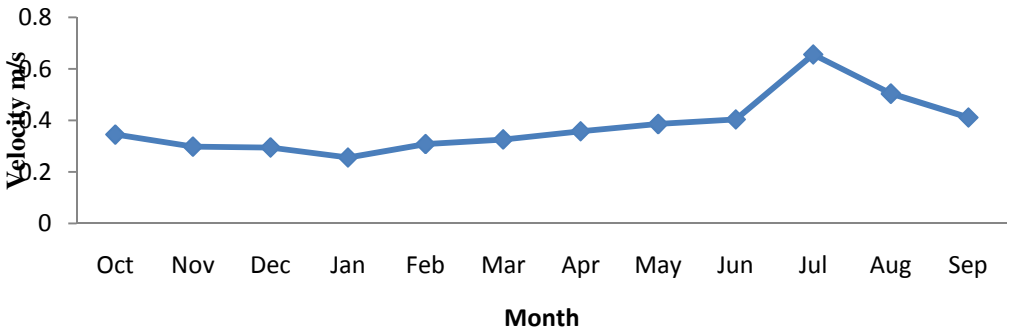

Figure 3 Monthly variation of water velocity during October 2017 to September 2018.

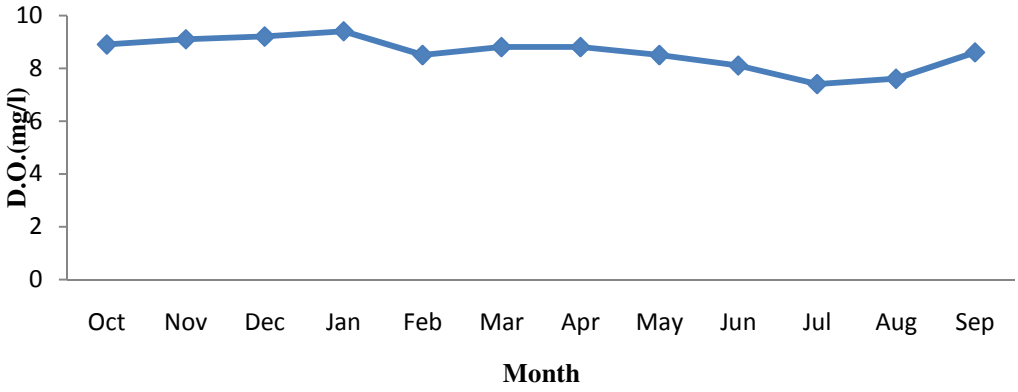

Figure 4 Monthly variation of D.O. during October 2017 to September 2018.

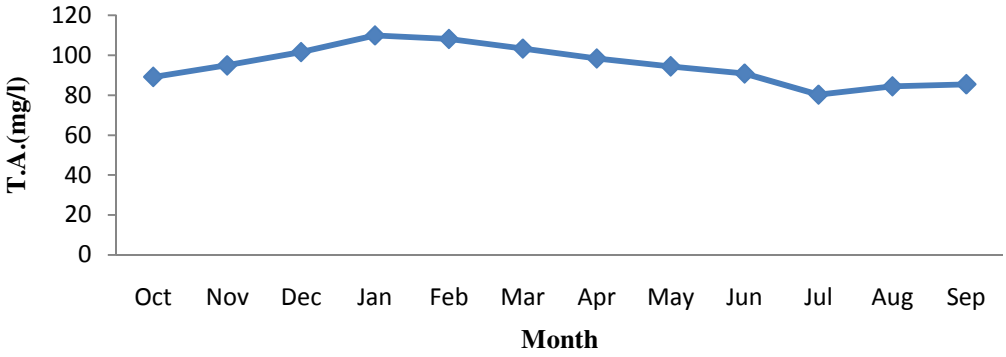

Figure 5 Monthly variation of water total alkalinity during October 2017 to September 2018.

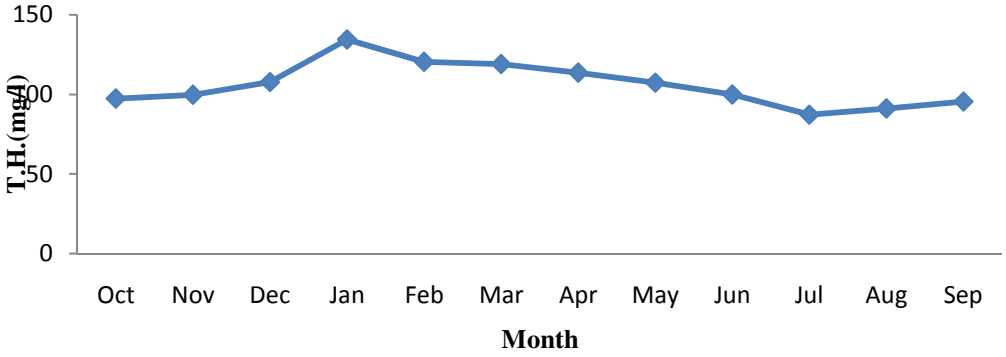

Figure 6 Monthly variation of total alkalinity during October 2017 to September 2018.

Table 1 Month wise density and diversity of Macrozoobenthos in Kyunja Gad at the 1 Order Stream during the year 2017-18.

S.No		Name Of The Order/ Genus/ Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1		Coleoptera												
	A	*Berosus Indicus*	0	0	0	1	2	0	0	1	0	1	0	1
	B	*Elmid (Larva)*	0	1	1	1	2	0	1	0	1	0	0	1
	C	*Hydrophilus*	0	2	2	1	2	0	0	1	0	0	1	1
	D	*Psephenus Tenulpes*	14	18	17	9	12	7	8	10	11	4	6	9
		Total	14	21	20	12	18	7	9	12	12	5	7	12
2		Diptera												
	A	*Atherix*	0	0	0	0	1	0	0	2	0	1	1	1
	B	*Antocha*	0	2	1	1	0	0	1	0	1	2	0	0
	C	*Tipula*	1	2	4	0	2	0	0	2	3	2	3	3
	D	*Simulium*	24	24	18	19	15	15	14	14	10	4	6	11
		Total	25	28	23	20	18	15	15	18	14	9	10	15
3		Ephemeroptera												
	A	*Ameletus*	0	0	0	2	4	6	4	2	2	0	0	3
	B	*Atalophlebie*	0	0	0	0	1	0	0	1	1	0	1	0
	C	*Baeties*	7	11	9	19	17	11	18	18	10	5	7	11
	D	*Caenis*	8	5	11	18	16	8	11	14	12	4	10	9
	E	*Ecdyonurus*	3	2	3	3	4	3	2	5	3	2	1	2
	F	*Ephemerella Indica*	1	0	2	1	0	1	1	2	0	1	0	2
	G	*Heptagenia*	5	7	6	10	8	7	8	7	5	3	4	3
	H	*Prosopistoma*	0	0	0	0	1	0	0	1	1	0	0	1
	I	*Isonychia*	1	1	0	0	1	0	0	0	0	1	0	0
	J	*Platybaetis*	0	1	0	0	0	1	0	1	0	1	0	0
	K	*Crinitella*	0	1	0	1	0	0	0	0	1	1	0	0
		Total	25	28	31	54	52	37	44	51	35	18	23	31
4		Hemiptera												
	A	*Gerris*	1	0	1	1	1	1	2	1	0	0	0	1
	B	*Heleocoris Vicinus*	1	0	0	0	0	2	3	0	1	0	0	0
		Total	2	0	1	1	1	3	5	1	1	0	0	1
5		Odonata												
	A	*Argia*	0	0	1	0	3	0	0	0	0	1	0	2
	B	*Zygonyx*	5	8	9	7	3	7	8	2	0	0	0	2
	C	*Euphaea*	2	3	4	2	1	2	3	0	1	0	1	0
	D	*Gompidictus*	1	2	3	2	0	2	1	1	0	1	0	1
		Total	8	13	17	11	7	11	12	3	1	2	1	5
6		Plecoptera												
	A	*Neoperla*	3	4	3	5	2	3	4	1	1	1	2	3
		Total	3	4	3	5	2	3	4	1	1	1	2	3
7		Trichoptera												
	A	*Hydropsyche*	20	24	18	32	28	21	15	25	15	5	7	14
	B	*Stenopsyche Himalayana*	10	2	2	1	4	3	2	3	2	2	1	6
	C	*Chimarra*	3	2	4	2	1	2	2	0	1	0	0	3
	D	*Glossosoma Caudatum*	4	3	2	2	2	1	3	2	1	0	0	1
	F	*Rhyacophila Similis*	2	2	1	2	1	2	1	1	1	1	0	2
		Total	39	33	27	39	36	29	23	31	20	8	8	26
8		*Acariformes*												
	A	*Sperchon Indicus*	4	1	1	1	3	2	2	2	4	1	2	3
	B	*Sperchon Hirsutus*	2	1	1	1	1	2	3	2	3	0	0	2
	C	*Torrenticola Turkestanica*	1	0	0	0	1	1	0	1	0	0	0	0
	D	*Torrenticola Semisuta*	1	1	2	1	1	1	0	1	1	0	0	1
		Total	8	3	4	3	6	6	5	6	8	1	2	6
		Total Number Of Species	124	130	126	145	140	111	117	123	92	44	53	99

Table 2 Monthly wise variations in the macrozoobenthic communities belonging to different orders in Kyunja Gad (1st order stream) during the October 2017 to September 2018.

Order	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	T.N.S
Ephemeroptera	25	28	31	54	52	37	44	51	35	18	23	31	429
Trichoptera	39	33	27	39	36	29	23	31	20	8	8	26	319
Diptera	25	28	23	20	18	15	15	18	14	9	10	15	210
Coleoptera	14	21	20	12	18	7	9	12	12	5	7	12	149
Odonata	8	13	17	11	7	11	12	3	1	2	1	5	91
Acariformes	8	3	4	3	6	6	5	6	8	1	2	6	58
Plecoptera	3	4	3	5	2	3	4	1	1	1	2	3	32
Hemiptera	2	0	1	1	1	3	5	1	1	0	0	1	16
T.N.S	124	130	126	145	140	111	117	123	92	44	53	99	1304

T.N.S = Total no. of specie

Table 3 Overall Shannon-Wiener diversity Index for benthos in the stream Kyunja at the 1st Order Stream during the year 2017-18.

Stream Order	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr	May	Jun.	Jul.	Aug.	Sep.
1st Order Stream	2.662	2.578	2.754	2.557	2.743	2.739	2.736	2.654	2.684	2.839	2.397	2.897

Table 4 Similarity index (S) between macrozoobenthic taxa of different months during the year 2017-18 at the first Order Stream.

Month	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
Oct	-	0.816	0.857	0.8	0.792	0.916	0.851	0.784	0.75	0.666	0.615	0.784
Nov	-	-	0.88	0.862	0.777	0.775	0.791	0.73	0.816	0.739	0.65	0.769
Dec	-	-	-	0.901	0.814	0.816	0.875	0.769	0.775	0.695	0.65	0.884
Jan	-	-	-	-	0.8	0.84	0.897	0.792	0.8	0.68	0.585	0.867
Feb	-	-	-	-	-	0.754	0.73	0.857	0.792	0.64	0.681	0.892
Mar	-	-	-	-	-	-	0.893	0.823	0.75	0.622	0.564	0.784
Apr	-	-	-	-	-	-	-	0.72	0.765	0.636	0.578	0.76
May	-	-	-	-	-	-	-	-	0.705	0.708	0.666	0.888
Jun	-	-	-	-	-	-	-	-	-	0.577	0.666	0.745
Jul	-	-	-	-	-	-	-	-	-	-	0.666	0.708
Aug	-	-	-	-	-	-	-	-	-	-	-	0.541
Sep	-	-	-	-	-	-	-	-	-	-	-	-

Table 5 Statistical modeling of the data in the Kyunja Gad at the 1st Order Stream during the year 2017-18.

S.No	Benthos (Y) =	a + b * x		r	r^2
1	Benthos (Y) =	120.2 - 0.5022	Water temp.	r = 0.6695	r^2 = 0.4483
2	Benthos (Y)=	-985.99 + 137.69	pH	r = 0.8116	r^2 = 0.6587
3	Benthos (Y) =	209.19 - 267.06	Velocity	r = -0.8761	r^2 = 0.8764
4	Benthos (Y) =	-294.65 + 47.035	D.O.	r = 0.9013	r^2 = 0.8125
5	Benthos (Y) =	-151.74 + 2.7401	T.A.	r = 0.8151	r^2 = 0.6644
6	Benthos (Y) =	-74.904 + 1.7289	T.H.	r = 0.7454	r^2 = 0.5557

Acknowledgement

Authors sincerely acknowledge to Prof. A.K.Dobriyal, Head of Zoology and Biotechnology Department, Campus Pauri, H.N.B.Garhwal University (Central University) Srinagar Garhwal for constant encouragement. Authors gratefully acknowledge the financial assistance rendered by Science and Engineering Research Board (SERB) as a major Project F. No. –ECR/2016/001291.

References

Andrews, D.A., Minshall, G.W., (1978). Longitudinal and seasonal distribution of benthic invertebrates in the little Lost River, Idaho. *The American Midland naturalist* 102(2): 225-236.

Balodi, V.P, Koshal Kumar, (2015). Macro-Zoobenthic study in relation to physico-Chemical parameters of Khoh River in Uttarakhand. *Int. J. Sci. Res.* 4 (6): 171-173

Balodi, V.P., (2000). *Ecological studies on the macrozoobenthic communities of the Nayar river system correlated with its fishery environment.* D. Phil. Thesis, HNB Garhwal University, Srinagar Garhwal.

Jiang, X.M., Xiong, J., Qiu, J.W., Wu, J.M., Wang, J.W., Xie, Z.C., (2010). Structure of macroinvertebrate communities in relation to environmental variables in a subtropical Asian river system. *Int. Rev. Hydrobiol.* 95: 42–57.

Koshal Kumar, Jitendra Singh Rana, Anita Rawat Rana, Kotnala, C.B., (2017). Checklist of benthic macroinvertebrate communities of Stream Rawasan in Garhwal region (Central Himalaya), Uttarakhand (India). *J. Mountain Res.* (12): 91-95

Kumar Neeraj, Bhavnesh Kumar, Dobriyal, A.K., (1998). Geomorphic influences on the distribution of benthic diversity in two hill streams of Garhwal Himalaya. *Proceedings INDO-US workshop, Panjab University Chandigarh.*

Merz, J.R., Ochikubo Chan, L.K., (2005). Effects of gravel augmentation on macroinvertebrate assemblages in a regulated California river. *River Res. Appl.* 21: 61–74.

Nelson, S.M., Lieberman, D.M., (2002). The influence of flow and other environmental factors on benthic invertebrates in the Sacramento River, USA. *Hydrobiologia* 489: 117–129.

Odum, E.P., (1971). *Fundamentals of Ecology, 3rd edn.* Saunders , Philadelphia.

Pridmore, R.D., Roper, D.S., (1985). Comparison of the macroinvertebrate faunas of runs and riffles in three NewZealand streams. *NZ J. Mar. Freshwat. Res*. 9: 283-291.

Rautela, Kumkum, Kumar, K., Bisht, K.L., Joshi, V.D., Negi, K.S., Rautela, A.S., Dobriyal, A. K., (2006). Ecological studies on the biodiversity of river Khoh in the foot hills of Garhwal Himalaya, Part-2: Macrozoobenthic analysis. *Aquacult.*7(2):277-283

Singh, J., Rana, J.S., Semalty, B., Gusain, M.P., Gusain, O.P., (2017). Seasonal composition of benthic macroinvertebrates in a spring-fed stream in the Garhwal Himalaya. J. Mountain Res. 12: 31-38

Siraj, S., (2018). Variation in species composition and distribution of macrozoobenthos altitudinal gradient in Sindh River of Kashmir Himalaya. *JK Know. Init.* 2(1):97-107.

Strayer, D.L., Dudgeon, D., (2010). Freshwater biodiversity conservation: Recent progress and future challenges. *J. N. Am. Benthol. Soc.,* 29: 344–358.

Vought, L.B.M., Kullberg, A., Petersen, R.C., (1998). Effect of riparian structure, temperature and channel morphometry on detritus processing in channelized and natural woodland streams in southern Sweden. *Aquat. Conserv. Mar. Freshw. Ecosyst.* 8: 273–285.

Yanygine, L.V., (2017). Macrozoobenthos as an indicator of the ecological state of mountain watercourses. *Russian J. Ecol* 48(2): 185-190.

****