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Assessment of anthropogenic activities on the ecology of Ban Ganga Stream, Katra with reference to abiotic and biotic components

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Abstract
The ecology of Ban Ganga stream was investigated to study the impact of anthropogenic activities during the study period, Nov., 2013 to Apr., 2014. The study involved the assessment of various physico-chemical parameters viz. air temperature, water temperature, pH, FCO_2, DO, HCO_3^-, Ca^{2+}, Mg^{2+}, Cl^-, nitrates, phosphates and sulphates whereas the biotic components included the qualitative analysis of planktonic and macrobenthic invertebrate fauna. Zooplanktonic fauna was represented by groups' viz. Protozoa, Ciliata, Rotifera, Cladocera and Copepoda. Among macrobenthic invertebrate fauna, Annelida, Arthropoda and Mollusca were the representative classes.

Keywords: macrobenthic fauna, physico-chemical, phytoplankton and zooplankton

Introduction
The stream Ban Ganga and has great religious significance and flows in district Reasi of Jammu division of J&K. This stream originates from Samkal Springs, located in Trikuta Hills, which are the abode of "Mata Vaishno Devi Shrine". This shrine is a famous pilgrimage centre where large number of pilgrims from within and outside the country visit every year and is the second most visited religious place in India after "Tirumada Venkateswara Temple". This stretch of the stream flanking the path, leading to the shrine is the most celebrated one and is affected by pilgrimage activities. The locals as well as pilgrims take a holy bath in it with having belief in their minds that it would wash their sins away and they would attain salvation. The pilgrimage load which tremendously increased from 44, 32,000 during 2000 to 1,04,95,269 in 2013 has resulted in tremendous pressure over the stream in the form of various anthropogenic activities:

Religious activities by pilgrims
Mass bathing by pilgrims
Dumping of sewage by nearby dhabas, hotels and shops
Dumping of kitchen waste from Gulshan Langar
Dumping of Pony dung waste
Cremation activities
Wastes added by brick manufacturing plants

Hence, the impacts of anthropogenic activities on the ecology of this holy stream have been investigated in the present work. Thus, it is proposed that the detailed investigation will enable a comprehensive and systematic analysis of the monthly physico-chemical fluctuations and biotic diversity of Ban Ganga stream and this baseline data generated would help in planning conservation measures and management of this religiously important water body.

Methodology
Water samples were collected from different stations on each month. Estimation of some Physico-chemical parameters like water temperature, pH, dissolved oxygen, free carbon dioxide, carbonates, bicarbonates, calcium, magnesium and chloride was done on spot, while for sulphates, nitrates and phosphates samples were stored in glass bottles and brought to laboratory for analysis by following standard methods of Adoni (1985) [1] and A.P.H.A (1985) [2].
Plankton were collected by filtering 100 liters of water through plankton net (Nytex 70 µm mesh). The filtrate was preserved in 5 % formalin and examined under microscope for identification. They were identified following Ward and Whipple (1959) [3], Edmondson and Winberg (1971) [4], Pennak (1978) [5], and Adoni (1985) [1].
The bottom samples were collected from all the stations by using Ekman's dredge. The collected sample 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 [3, 6, 1].

Results and Discussions
Physico-chemical parameters are the important constituents of the aquatic system as they reflect the water quality and status of the aquatic system. Persual of Table I reveal the variations in physico-chemical parameters at different stations. Air temperature varied between 14°C-36°C at station I, 14°C- 35°C at station II, 13°C- 34°C at station III and 13°C- 32°C at station IV. It is quite evident from the table I that water temperature closely follows the air temperature. pH remained alkaline throughout the study period and ranged between 7.9-8.7. The higher values of pH in this period can be attributed to low temperature, higher values of DO and carbonates [7]. FCO_2 showed its absence in most of the months. The maxima and

minima for the values of DO is 5.2 mg/l – 6.8 mg/l, 5.2 mg/l – 7.4 mg/l, 5.6mg/l- 8.2 mg/l and 6.8 mg/l – 8.9 mg/l at stations I, II, III and IV respectively. A lower value of phosphates was recorded at all the stations. Lower phosphates resulted from their utilization by the algal planktons for photosynthesis [8]. Presence of nitrates in water indicates the final stage of mineralization. Higher values of nitrates were recorded throughout the study period at all the stations.

Zooplankton in the present study was comprised of Protozoa (3 genera), Ciliata (1 genera), Copepoda (3 genera) and Cladocera (2 genera) (Table- II). Group Protozoa was represented by *Centropyxis aculeate, Centropyxis eucornis* and *Arcella vulgaris.* Sharma *et al.,* (2013) [9] have also recorded the similar zooplanktonic fauna while studying the zooplanktonic diversity of Datte da Talab, pond. One genera of Ciliate viz. *Euglypha ciliate* was also reported during the study period.

Rotifera was represented by *Lepidella ovalis, Colurella adriatica, Branchionus calyciflorus, Brachionus falcatus, Filinia longiseta* and *Philodina* sp. High diversity of rotifers may be attributed to high temperature [10, 11] alkaline pH [12], presence of sediments in suspension [13] and abundant food [14].

Cladocera represented the third group and constituted of *Chydorus sphaericus and Alona sp.* The favourable temperature and availability of food in the form of bacteria, nanoplankton and suspended detritus favours their flourishment. Copepoda was represented by *Eucyclops agilis, Mesocyclops sp., Cyclops sp.* and *Nauplius larvae.* High DO and abundance of phytoplankton favours copepod diversity [11].

Qualitative analysis of benthos has been tabulated in the Table III. Persual of the table III clearly indicates that the stream Ban Ganga is populated by three phyla viz. Annelida Arhtropoda and Mollusca. Qualitatively, Arthropoda was the dominant group among all these. Phylum Annelida was composed of class Oligochaeta with genera *Tubifex tubifex, Allosoma sp.* and *Eisenia fetida*.

The presence of these Oligochaetes in Stream Ban Ganga can be attributed to organically rich bottom. Since, this stream is under the influence of anthropogenic stress, which leads in the apparent pollution level. These observations have also been supported by Gopal and Sah (1993) [15] and Sharma (1999) [16]. Also, some leeches from reported from station III.

Qualitative abundance was represented by Arthropoda in which order Diptera was dominated by *Chironomus* sp., *Pentaneura* sp., *Tabanus* sp., *limnophila* sp. and pupa of *chironomus* sp. Order Odonata was represented by *Diphlebia* sp., *Orthetrum* sp. and damsel fly larvae whereas ephemeropterans were composed of *Callibaetis* sp. and *Cingyma* sp. The water quality of the station favours their abundance as the water receives effluents from various sources and pollutants get stranded on the bank thereby making it rich in organic matter [17]. The phylum Mollusca was constituted of class gastropoda with species *Gyralus sp. and Physa acuta.*

Thus, inquisitive qualitative analysis of biotic components clearly reveals the presence of some pollution indicator species among zooplankton and macrobenthic fauna. The pollution indicator species among zooplankton are *Centropyxis aculeate, Centropyxis eucornis, Arcella vulgaris, Branchionus calyciflorus, Brachionus falcatus* and *Filinia longiseta* whereas *tubifex sp., Allosoma sp.,Chironomus sp., Pentaneura sp., Tabanus sp.* and *Physa acuta* are the indicators of pollution among macrobenthic invertebrates.

Observations

Table 1: Physico-chemical variations in different stations of Ban Ganga stream from Nov. 2013 to April, 2014.

S. No	Parameters	Units	Station 1		Station 2		Station 3		Station 4	
			Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	Air temp.	^{0}C	14	36	14	35	13	34	13	32
2	Water temp.	^{0}C	16	18	15	17	11	17.5	11	17.5
3	Transparency	Cm	10	22	15	28	10	29	15	30
4	pH		7.9	8.2	7.9	8.2	8.2	8.7	8.2	8.5
5	Free CO_2	mg/l	0	32	-	-	-	-	-	-
6	DO	mg/l	5.2	7.4	5.2	6.8	5.6	8.2	6.8	8.9
7	Carbonates	mg/l	0	12.0	-	12	8	13	9.2	20
8	Bicarbonates	mg/l	183	192.76	192.76	298.43	183	306.4	186.5	318.4
9	Chloride	mg/l	15	30	15	20	13	30	14	26
10	Calcium	mg/l	35.32	42.05	42.05	46.24	35.32	47.23	35.64	48.24
11	Magnesium	mg/l	36.53	50.94	44.23	58.17	40.02	44.23	36.5	43.02
12	Sulphate	mg/l	.00174	.00176	.001	.016	.0017	.0018	.001	.002
13	Phosphate	mg/l	.01	.02	.011	.014	.02	.08	.01	.09
14	Nitrate	mg/l	.572421	.572473	.57241	.57242	.572422	.572422	.572423	.572431

Table 2: Zooplankton diversity in stream Ban Ganga from Nov.2013 to April, 2014.

S. No.	Zooplanktons Phyla	Name of Species
1	Protozoa	*Centropyxis aculeate, Centropyxis eucornis and Arcella vulgaris.*
2	Ciliate	*Euglypha ciliate*
3	Rotifera	*Lepidella ovalis, Colurella adriatica, Branchionus calyciflorus, Brachionus falcatus and Filinia longiseta.*
4	Cladocera	*Chydorus sphaericus and Alona sp.*
5	Copepod	*Eucyclops agilis, Mesocyclops sp., Cyclops sp.* and *Nauplius larva of Copepod.*

Table 3: Macro-benthic invertebrate diversity in stream Ban Ganga from Nov. 2013 to April, 2014.

S.No.	Phyla	Class	Name of Species
1	Annelida	Oligochaeta	*Tubifex tubifex, Allosoma sp.* and *Eisenia fetida*
		Hirudinea	*Piscicola sp. and Erpobdella sp.*
2	Arthropoda	Insecta	*Chironomous sp., Pentanura sp., Diphlebia sp., Limnophilla sp., Orthetrum sp., Tabanus artatus., Baetis sp., Petrophila sp., Callibaetis sp., Cingyma sp., Damsel fly larvae and pupa of Chironomous*
3	Mollusca	Gastropoda	*Gyralus sp. and Physa acuta.*

Conclusion

Thus, it has been concluded that the various types of anthropogenic activities in stream Ban Ganga has brought about the variations in the ecology of Ban Ganga stream by bringing about variations in physico- chemical as well as biological parameters. It has been recorded that some of the physico-chemical parameters are within the permissible limits while some are at higher level also. Also, the presence of pollution indicator species among zooplankton and macrobenthic invertebrate fauna indicates that this religiously celebrated stream is approaching towards organic pollution and needs proper conservation and management strategies.

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