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Sewage Discharge: Implications on Water Quality and Macro- Benthic Invertebrate Fauna of River Tawi, Jammu (J & K)

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Abstract
A study was conducted on the sewage discharge point on river Tawi so as to assess the effects of sewage and other effluents of Jammu city on water quality parameters in relation to the macro- benthic invertebrates. When crude sewage is run into a river, its constituents usually undergo oxidation to form simpler and stable end products. The oxidation occurs largely at the expanse of dissolved oxygen and other physico- chemical parameters in the river water and in some circumstances may lead to calamitous effects on the aquatic life inhabiting the stream. Chemical parameters viz; pH, Dissolved oxygen, Free carbon dioxide, Chlorides, Carbonates, Bicarbonates, Calcium, Magnesium, BOD were analyzed and compared to standard values. Benthic invertebrates viz; *Tubifex* sp., *Pentaneura* sp. and *Physa* sp. etc. regarded as the 'pollution indicators' were also collected from the site. Presence or absence of certain benthic groups at the study sites clearly revealed that macro- benthic invertebrates respond strongly to changing water quality and thus proved to be good bio- indicators. Water quality index (WQI) and Shannon- Wiener index also further confirmed the moderately polluted nature of the stream

Keywords: sewage, physico- chemical parameters, water quality, macro- benthic invertebrates, bio-indicators

1. Introduction
It is well known that water bodies have played a crucial role in the growth and development of society. All settlements across the globe have started along water bodies and rivers. Freshwaters have been dammed to provide potable water for urban settlements (Adeogun & Oyebamiji, 2011) [1]. Rivers passing urban settlements are invariably used as depositories for untreated domestic waste, sewage and industrial pollutants all of which can seriously reduce the quality of water and adversely affect vast array of aquatic life (Ahmed, 2004) [2], ranging from organisms those with planktonic existence through pelagic organisms to benthic species (Adeogun, 2004) [3]. The biological response and sensitivity of different organisms to physical and chemical changes of aquatic system can be used as an indicator for the assessment of habitat quality (Karr, 1991) [4]. Biological indicators thus reflect the intensity of anthropogenic stress and have been used as a tool in risk assessment and evaluation of human induced changes in freshwater ecosystem (Toham and Teugels, 1999) [5].

2. Materials and Methods
2.1 Study site
The study was carried out at Gujjar Nagar, under Tawi Bridge on river Tawi in Jammu district, J& K for a period of one year. Besides, being sole source of drinking water to the inhabitants of the old city, the river site is also used for fishery activities, bathing and cattle drinking. The river profusely receives pollution load in the form of sewage discharges, cremation wastes, religious wastes, dumping ground for solid wastes etc. Cattle excreta and human excreta contributed significantly to the pollution load in the river, presented an ugly appearance to the site.

2.2 Methodology
Monthly samples of sub- surface water were collected during first week of every month. Some of the basic physical and chemical parameters of water were determined at the sampling site,

While others were analyzed in the laboratory within 4- 8 hours of collection according to APHA (1985) [6], Adoni (1985) [7]. Utmost care was taken to avoid spilling of water and bubbling of air during sampling in iodine treated polyethylene bottles.

Temperature	:	Mercury bulb thermometer,
P^H	:	Digital pH meter (Hanna, model HI, 98130).
DO	:	Sodium Azide modification of Winkler's method.
FCO_2	:	Titrimetric method
Cl^-	:	Argentometric method
CO_3^{2-}& HCO_3^-	:	Titrimetric method using Phenolphthalein alkalinity and methyl orange alkalinity
Ca^{2+} & Mg^{2+}	:	EDTA-titrimetric method

The bottom soil samples were collected using suitable sampler and sealed in zip locked polythene bags and brought to laboratory. The samples were sieved immediately using Sieve No. 40 mesh size sieve (256 meshes per cm^2). The organisms retained were segregated and preserved using 4% formalin and 90% ethanol. Preserved samples of macro- benthic invertebrates were identified according to Ward and Whipple (1959) [8], Pennak (1978) [9], Tonapi (1980) [10] and Adoni (1985) [7].

3. Results

The variations in the values of physico-chemical parameters have been graphically represented in Figure 1. During the period of present investigations, it was observed that variations in water temperature follow closely that of air temperature. pH was at the alkaline side (8.1) which provided suitable conditions for the flourishing of the benthic groups. The DO concentration recorded (6.0 mg/l) which was at the lower side when compared to the standard values of ISS_{11}. FCO_2 recorded (3.6 mg/l). Carbonates (12.1 mg/l) and Bicarbonates (339.28 mg/l) formed the alkalinity of the system. During the present studies alkalinity was mainly determined by the bicarbonates and was above the permissible limit of $ICMR_{12}$ (120 mg/l). Salinity or the Chloride concentration (26.60 mg/l) was also found to be within the permissible limits of $ICMR_{12}$ during the study period. Hardness is usually determined by the calcium and magnesium ions. Calcium ions (34.86 mg/l) were found to be within permissible limits of ISS_{11} (75 mg/l) but magnesium ions (32.33 mg/l) were found to be little beyond the limit of ISS_{11} (30 mg/l). The biodegradation of organic materials exerts oxygen tension in water and increases the biochemical oxygen demand which during the present study (1.68 mg/l) was near to the permissible limit of ISS_{11} (2mg/l). TSS is a measure of the suspended solids in waste water, effluent, or water bodies. The value of TSS (319.41mg/l) exceeds the permissible limit of ISS_{11} (50mg/l). Nitrate, Phosphate and Sulphate were found to be within the permissible limits of ISS_{11}.

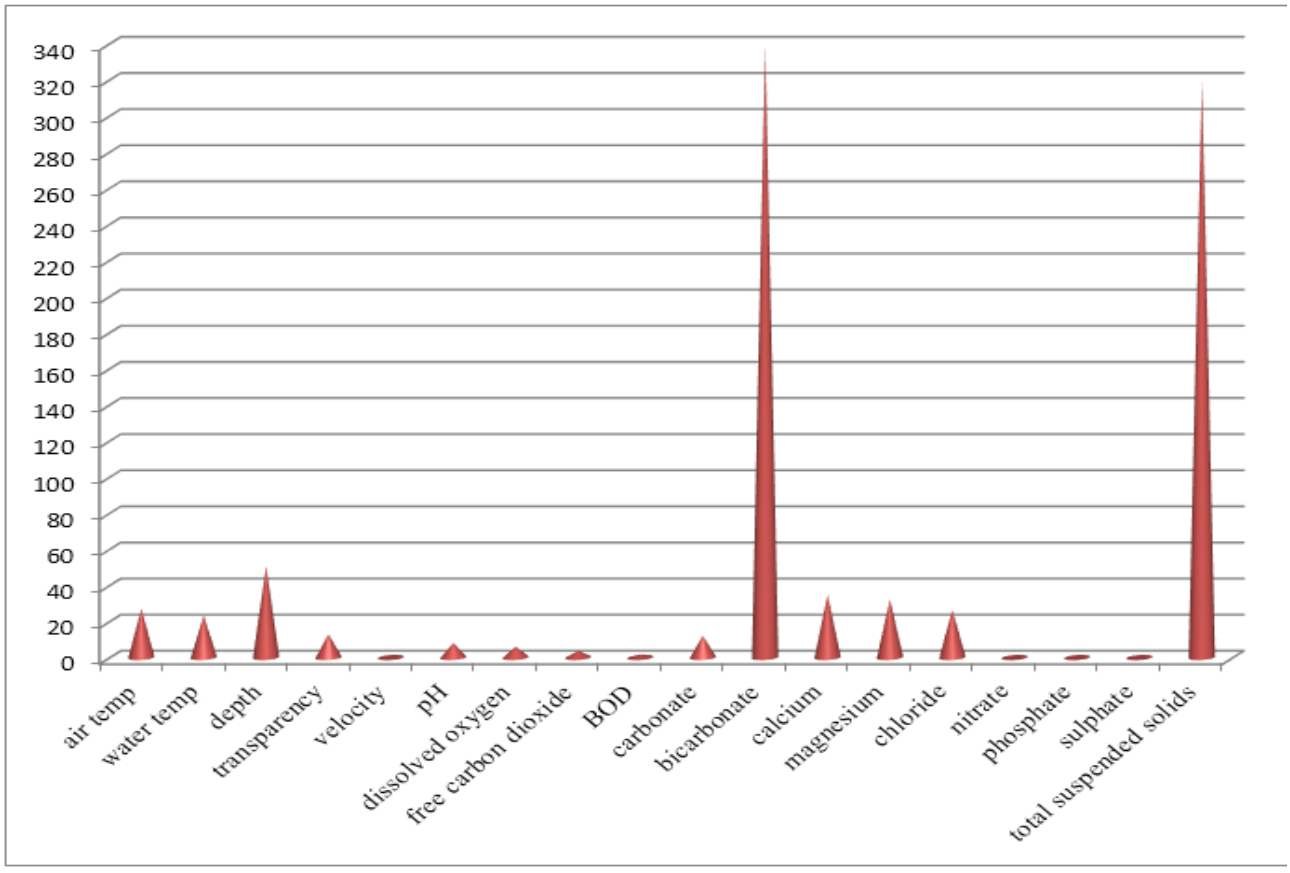

Fig 1: Graphical representation of physico- chemical parameters at sewage receiving site of river Tawi

A total of 9 taxa of macro- benthic invertebrates were recorded during the study period belonging to 3 major phyla i.e. Annelida, Arthropoda and Mollusca as shown in Figure 2. Taxonomic breakdown of macro- benthic invertebrates indicated dominance of *Tubifex* sp. (Annelid) (52.49%), followed by *Pentaneura* sp., (Arthropoda) (26.35%) and *Physa* sp., (Mollusca) (21.16%) (Table 1).

Table 1: Distribution of Macro- benthic invertebrates (mean and percentage) at sewage receiving site of river Tawi.

Benthic Groups	M± Sd	% Age Of Distribution
Annelida		
Class Oligochaeta		
Family Tubificidae		
Tubifex tubifex	230.83± 665.50	46.19%
Branchiura Sp.	27± 89.54	5.40%
Family Lumbriculidae		
Earthworm	3.75± 12.43	0.75%
Class Hirudinea		
Leech	0.75± 2.48	0.15%
Total Annelids	262.33	52.49%
Arthropoda		
Class Insecta		
Order Coleoptera		
Family Dysticidae		
Hydroglyphus Signatellus	2.25± 7.46	0.45%
Total Coleoptera	2.25	
Order Diptera		
Family Chironomidae		
Pentaneura Sp.	106.16± 197.75	21.24%
Family Tipulidae		
Limnophila Sp.	4.5± 14.92	0.9%
Family Simuliidae		
Simulium Sp.	10.5± 34.82	21.0%
Family Syrphidae		
Erastalis Sp.	8.25± 27.36	1.65%
Total Diptera	129.41	
Total Arthropod	131.66	26.35%
Mollusca		
Class Gasrtropoda		
Order Basommatophora		
Family Lymneadae		
Lymnaea Sp.	18.75± 62.18	3.75%
Family Physiidae		
Physa Sp.	80.25± 153.98	16.05%
Family Planorbidae		
Gyraulus Sp.	6.75± 15.20	1.35%
Total Mollusc	105.75	21.16%
Total Macrobenthos	499.74	

4. Discussion

A close perusal of Figure 1 and Table 1 revealed that the discharge of crude sewage in river Tawi has altered the physico- chemical and biological conditions of the system. Although the physico-chemistry of the fluvial system keeps on changing, yet the biological indicators depict the conditions clearly. Discharge of sewage at river Tawi has considerably decreased the DO content as it is already on records that when crude sewage is run into a river, its constituents usually undergo oxidation to form simpler and stable end products. The oxidation occurs largely at the expanse of dissolved oxygen and other physico-chemical parameters in the river water and in some circumstances may lead to calamitous effects on the aquatic life inhabiting the stream. Johansson (1997) [13], Flemer *et al.* (1999) [11] and Wu (2002) [15] explained that in response to decreasing DO, there are decreases in both species richness and diversity, and the species composition being largely determined by differences in the tolerance of the different species to oxygen deficiency. However, pollution and variations of physico-chemical parameters can restrict the presence of certain organisms favoring others. Groups tolerant to pollution such as Oligochaeta, Chironomidae and Gastropods increased in abundance at sites where human pressures were present in form of anthropogenic stress, municipal sewage, religious run off etc. Oligochaetes favor organically rich conditions and remain dominant in severally polluted conditions (Callisto *et al.*, 2005 [16]; Bouchard, 2004 [17]; Chakraborty and Das, 2006 [18]; Gasim *et al.*, 2006 [19] and Manoharan, 2006 [20]).

Also, Specific abundance of *Pentaneura sp*., indicates the pollution status of stream as Chironomids are known to prefer polluted water with high nutrients and low oxygen as suggested by Callisto *et al.* (2005) [16], Clemente *et al.* (2005) [21], Olomukoro and Ezemony (2006) [22], Manoharan *et al.* (2006) [20] and Sharma *et al.* (2011) [23]. Chatzinikolaou *et al.* (2006) [24] also observed maximum abundance of Diptera (Chironomidae) at sites under human pressure. Bouchard (2004) [17] reported that Gastropods are known to respond to polluted environment by increase in abundance. The present findings also draw support from the works of Adeogun and Fafioye (2011) [25] related the presence of Gastropods to their tolerance of some levels of pollution.

Statistical indices viz; water quality index (WQI) and Shannon- Wiener index were also applied on the data. Application of WQI gives the value of 53 which is an indication of Marginal water quality thus ultimately confirming that water quality of river Tawi at sewage receiving site is frequently impaired and conditions are departed from desirable levels (CCME 2001) [26]. Value of Shannon- Wiener index for the presently studied water body came out to be 1.58 which is further an indication of polluted nature of the system. According to Shekhar *et al.* (2008) [27] Shannon- Weiner diversity index can be utilized to access the status of water body and suggested that value less than 2 reflect heavily polluted water.

5. Conclusion

Benthic macro invertebrates have been extensively used in water quality studies because their community structure shows changes of physical and chemical parameters associated with anthropogenic perturbation and it can integrate environmental conditions over time. Certain environmental conditions favors particular set of organisms eliminating others. Presence and abundance of members of bio- indicator families like Tubificidae (*Tubifex* sp.), Chironomidae (*Chironomous* sp.), Physidae (*Physa* sp.) etc., is a good indication of organic pollution.

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