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CHANGES IN FLOW REGIME AND ITS IMPACTS ON THE QUALITATIVE AND QUANTITATIVE ASPECTS OF FISH FAUNA OF RIVER TAWI IN THE VICINITY OF JAMMU CITY

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ABSTRACT

Many studies have assessed the effects of large dams on fishes but a few have examined the effects of small obstacles like weirs and barrages. Fish diversity was sampled and environmental variables were characterized at four sites in river Tawi flowing through the heart of Jammu city. A total of four stations were selected, out of which two stations were upstream the ongoing construction of the barrage, one on the site of barrage and one downstream the barrage. The continuous changing of flow regime of river due to ongoing construction of barrage, physical disturbances on the construction site due to heavy machinery and concrete, pollution due to entrance of sewage canals prior to and very near the barrage site, changes in water volume and course in different seasons, indiscriminate fishing and river being notorious for flash floods are also the major contributors to the difference in fish fauna distribution in the river. The reference river exhibited a longitudinal gradient of various physicochemical characteristics but these weren't the only reasons for significant differences in the fish assemblage composition and structure. The continuous changing of flow regime of river due to ongoing construction of barrage, physical disturbances on the construction site due to heavy machinery and concrete, pollution due to entrance of sewage canals prior to and very near the barrage site, changes in water volume and course in different seasons, indiscriminate fishing and river being notorious for flash floods. Studies were carried out in four stations of river Tawi and results were expressed in terms of qualitative and quantitative distribution of fish fauna in the river stretch in the vicinity of Jammu city.

KEYWORDS: barrage, upstream, indiscriminate, flow regime.

INTRODUCTION

Modification of ecosystems by humans either by direct exploitation of natural resources, through activities such as regulating rivers in various ways or by changing the species composition by introduction of invasive exotic species (Reynolds *et al*, 2001, Olden *et al*, 2008). All the major civilizations have thrived on the banks of rivers and in modern world too, most populous cities are located on the banks of rivers. This results in the loss of original integrity of rivers (Jager *et al.,* 2001). One of the most important anthropogenic derogatory actions in riverine ecosystem are fragmentation and loss of aquatic habitat caused by construction of artificial barriers such as dams, weirs, roads or bridges etc. (Saunders *et al*; 1991). Most discussed effect of these hinderances is the obstructions in dispersal and migration of organisms (e.g; Dynesius and Nilsson 1994 Peter, 1998; Nilsson *et al*; 2005). It is directly linked to the loss of populations and entire species of freshwater fishes. Changing the lotic systems to lentic water systems have profound effect on the native fauna thus benefitting the non-native species, disturbance of micro-habitat of organisms in water and degradation of water quality resulting from the high nutrient accumulation and primary production growth. Effects of small obstacles such as weirs, low head dams, road crossings, culverts and bridges on rivers have received less attention than large dams. Most of the studies that have investigated the impact of such small barriers show that they affect fish migrations, cause population isolation and invasion of migratory exotic species. Biodiversity as a whole is threatened by weirs (Bunn & Arthington 2002). Species-environment relationships are a fundamental aspect of community ecology and their patterns reflect underlying species-species microhabitat interactions. Microhabitat use of different species is a compromise between the physiological needs of the animal and biotic interactions within the ecosystem. Current-velocity and water depth set physiological and physical limits to fish distribution. The presence of structures like dams whether small or big, simple or complex, of any type for eg., weirs, road crossings, culverts and bridges is often associated to

local changes in physical structure of rivers, mainly the homogenization of several micro-habitat characteristics such as current, velocity, depth, substrate etc. Any type of change to the habitat stability could alter the life-cycle of fish species and consequently the local structure patterns of its assemblages (Welcomme et al; 2006). Factors like dissolved oxygen or temperature affect the distribution of fish species along running waters on a larger scale. On a smaller scale current velocity and water depth are good predictors of fish distribution. Fish differ in their ability to use microhabitat diversity. Smaller or less mobile species or individuals may be more adapted to small scale variability than the larger or more mobile ones. The native fish fauna of a lotic ecosystem is usually well adapted to natural fluctuations of the environmental conditions. But changes in hydrological regimes, alter the small scale as well as large scale factors thus altering the microhabitat of fishes as a whole. These effects of changes in hydrological regimes is more apparent in rivers with higher population of specialised fish fauna as very clear differences between upstream and downstream fish distribution can be seen as compared to rivers with generalist or tolerant fish fauna where differences between the upstream and downstream fish populations were very low. (Mueller *et al*., 2011).

Study area

In view of above perspectives, studies on the impact of the construction of a barrage across on the ecology of river Tawi were undertaken.

River Tawi, also known as "Surya Putri" passes through the heart of Jammu city and is one of the major left bank tributaries of River Chenab. It is one of the main sources of drinking water for the inhabitants of the city. It is located at a latitude 32^0 35'-33^0 5' N and longitude 74^0 35'-74^0 45' E The catchment area of the river up to Indian border (Jammu) is 2168 km² and falls in District Jammu, Udhampur and a small part of Doda in the state of Jammu & Kashmir, India. The length of the river at bridge sites in Jammu city is about 300m. In recent years, the flow of river has been on a decrement as the source glacier (Kali Kundi glacier) has been retreating.

Tourism being an important industry in the Jammu & Kashmir state brings a number of social and economic benefits. One such scheme started by the then Govt. Of Jammu & Kashmir was the development of an artificial lake on river Tawi at Jammu which is the winter capital of the state. For the aesthetic development of the city and recreational services like aqua sports, the creation of lake of about 1570 meters length and 450 meters average width on River Tawi was started. Five bridges have been built on river Tawi. 5^{th} bridge is located downstream of the other four. By way of constructing auto mechanically cum manually operated fully gated barrage of 4 meters height near the 5th bridge on river Tawi, a lentic water system of 14,13,000 cum (0.0011 MAF) is being created by obstructing the flow of Tawi. The surplus water shall be allowed to flow in the Tawi River again. Entire riverbed base near 5th bridge which is nearest to this barrage which is about 30 mts in width, has been made concrete and a slanted structure on the river bed near bridge (upward side) has been raised so as to slow down the flow of flood water and weaken the currents so as to protect the base and pillars of bridge. Sluice gates will be used to allow discharge of dirty water and flush out silt etc and in case of rains and flood, all the gates will be opened. At present, no permanent standing water system has been created but construction of pillars for the installation of gates is already done. Several changes in flow regime of river are induced so as to prevent hinderance from regular water currents in construction process. For this small and large sized lentic water systems are created by bunding in the river bed which stay like that for months. The study was carried out during the period of one year August 2013 to July 2014 on specified four stations on the river Tawi, two upstream stations: Gujjar Nagar bridge (Station-I) & Near Mosque (Station-II), one on the site of barrage (Station-III) and one downstream the barrage ahead of Bhagwati Nagar bridge (Station-IV).

MATERIALS AND METHODS

Collection of specimen: Fishes were captured monthly from their natural habitat in river Tawi from selected four stations, with the help of cast net, drag net, gill net etc.

Population studies: The collected specimens were sorted at species level and all the species obtained were counted.

At every site, three nettings were attempted and one or two specimens of each species were preserved in 10% formalin and carried to laboratory for the purpose of identification (Day, 1958 and Jayaram, 1999). The remaining specimens were released back into the river at the same site.

OBSERVATIONS

Table A: Following fish species were reported from the river Tawi from during the time period August 2013 to July 2014.

S. No.	Fish Species	Family
1	*Cyprinus carpio* (Ham Buch)	Cyprinidae
2	*Cirrhinus mrigala* (Ham Buch)	Cyprinidae
3	*Danio rerio* (Ham Buch)	Cyprinidae
4	*Rasbora rasbora*	Cyprinidae
5	*Tor tor* (Ham Buch)	Cyprinidae
6	*Tor putitora* (Ham Buch)	Cyprinidae
7	*Labeo rohita* (Ham Buch)	Cyprinidae
8	*Labeo bata* (Ham Buch)	Cyprinidae
9	*Labeo boga* (Ham Buch)	Cyprinidae
10	*Puntius sophore* (Ham Buch)	Cyprinidae
11	*Puntius ticto* (Ham Buch)	Cyprinidae
12	*Puntius conchonius* (Ham Buch)	Cyprinidae
13	*Aspidoparia morar* (Ham Buch)	Cyprinidae
14	*Garra gotyla* (Gray)	Cyprinidae
15	*Nemachilus botia* (Ham Buch)	Nemacheilidae
16	*Mastacembelus armatus* (Lacepede)	Mastacembelidae
17	*Mystus seenghala* (Skyes)	Bagridae
18	*Xenentodon cancila*	Belonidae

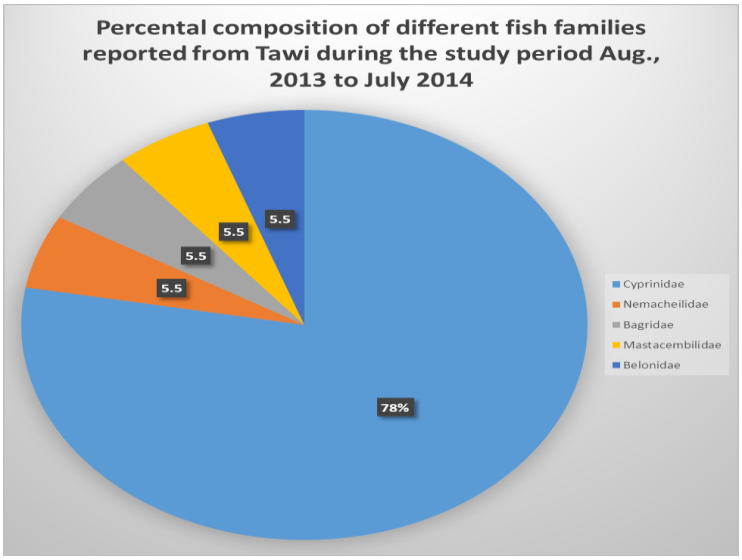

Fig. 1: Pie chart showing the relative dominance of fish families reported from River Tawi during the study period of Aug., 2013 to July 2014.

Table B: A comparison of no. of fishes collected per station during the study period August, 2013 to July 2014.

S. No.	Fish species reported	No. Of fishes collected per station				Total
		Station-I	Station-II	Station-III	Station-IV	
1	*Cyprinus carpio* (Ham Buch)	1	1	0	0	2
2	*Cirrhinus mrigala* (Ham Buch)	1	2	0	0	3
3	*Danio rerio* (Ham Buch)	4	6	1	2	13
4	*Rasbora rasbora*	3	3	1	4	11
5	*Tor tor* (Ham Buch)	5	4	2	6	17
6	*Tor putitora* (Ham Buch)	6	3	1	3	13
7	*Labeo rohita* (Ham Buch)	2	1	0	0	3
8	*Labeo bata* (Ham Buch)	8	7	2	9	26
9	*Labeo boga* (Ham Buch)	9	6	1	7	23
10	*Puntius sophore* (Ham Buch)	10	9	3	15	37
11	*Puntius ticto* (Ham Buch)	11	8	4	10	32

12	*Puntius conchonius* (Ham Buch)	6	8	3	7	24
13	*Aspidoparia morar* (Ham Buch)	5	5	0	8	18
14	*Garra gotyla* (Gray)	7	4	0	0	11
15	*Nemachilus botia* (Ham Buch)	2	3	1	7	13
16	*Mastacembelus armatus* (Lacepede)	1	1	0	7	9
17	*Mystus seenghala* (Skyes)	5	4	0	6	15
18	*Xenentodon cancila*	0	0	0	2	2
	Total	81	75	20	93	269

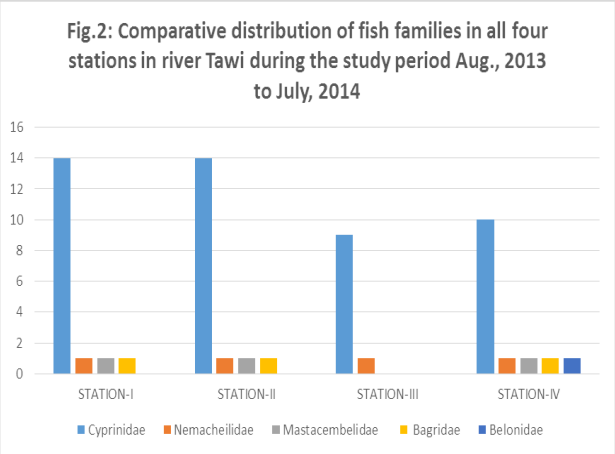

Fig. 2 showing the comparative distribution of fish families in all four study stations on river Tawi during the period Aug., 2013 to July 2014

A picture showing totally dry Station-III due to water diversion as workers continue with construction work at the site of barrage (May, 2014).

DISCUSSIONS

Qualitative assessment: During the present investigative period of one year (August 2013 to July 2014) a total of 18 fish species belonging to five families i.e. Cyprinidae, Nemachilidae, Mastacembelidae, Belonidae and Bagridae were reported. In all the study stations Cyprinidae was found to be dominant (78%) with 14 species followed by almost equal distributions of families Mastacembelidae, (5.5%) and Nemacheilidae, (5.5%), Belonidae, (5.5%) and Bagridae (5.5%) with one species each. Thus, ichthyofauna population was dominated by family cyprinidae at all the stations not only quantitatively but also qualitatively. Dominance of Cyprinids is attributed to their high adaptivity and ability to occupy all possible habitats and presence of favourable physicochemical parameters and which is in accordance with the observations of (Dass and Nath, 1966, Dutta and Malhotra, 1984, Dutta *et al*. 2002). Overall family vise reduced diversity i.e very less contribution to diversity from families other than Cyprinidae can be attributed to lowered habitat diversification caused due to irregular and inconsistent flows in small channels which are created from time to time in river bed to diverge or divert the larger mass flows as large mainstream river flow creates difficulties in construction process of barrage as also supported by Ward and Stanford in 1995. Also Station-IV showed maximum diversification of fish fauna as all five reported families were found while Station-III showed least diversification of fauna with the presence of only two families.

Quantitatively, Station-IV showed maxima with total number of 93 individuals and Station-III minima with 20 individuals during the present study period. Minimum number of fish individuals reported from Station-III (Barrage site) is attributed to construction work going on at Station-III, physical disturbance to river bed due to tractors, bulldozers, trucks etc. and irregular flow regime due to temporary standing water systems created throughout the year to aid in construction process along with accumulation of waste (Miranda R *et al.*, 2009).

Single species of cold water fish *Garra gotyla* was reported from Upstream stations Station-I & II (Gujjar Nagar & Near Masjid) whereas downstream station (Bhagwati Nagar Station-IV) showed more abundance of warm water fishes as also supported by (Sharma and Dutta, 2010).

Pollution sensitive species such as *Aspidoparia morar, Labeo bata, Labeo boga* showed sharp decline while the individuals of pollution tolerant fish species such as *Puntius conchonius, Puntius ticto* etc. showed quantitative dominance in all four stations Sharma, K.K., Langer, S. and Sharma, R. (2012). Diversity & Distribution of Ichthyofauna of Behlol Nullah, a tributary of River Tawi, Jammu, J&K,India. International Journal of Environmental Engineering & Management, 3(2): 107-119. Increase in population of pollution tolerant species at all four stations suggests the degrading water quality of the river.

Although in very low numbers, *Cyprinus carpio* an exotic species, was also reported from Stations-I & II

which can be attributed repeated disturbance to flow regime of rivers by shifting of flow from one bank to another to suit the construction work as also supported by the studies of (Gehrke et al., 1995) who reported that invasive freshwater fish species were favoured by river regulation (in the Murray–Darling Basin in Australia) and also by Moyle, 1986 whose studies indicated that artificially created standing water systems or constant flows favour introduced species or by random introduction of fishes by natives and fishermen in upper reaches or a by-chance catch from flood waters as Tawi is very prone to flash floods. As the project is still ongoing so it will take a few more years of extensive studies to gauge the extent of species homogenization and invasion of introduced species as a result of the construction.

CONCLUSION

From the present study it can be concluded that construction of barrage on already polluted river Tawi is having derogatory effects on its fish fauna. Loss of specialist species and dominance of generalist species, disappearance of pollution sensitive species and dominance of pollution tolerant species show a general trend of decreasing water quality owing to anthropogenic disturbances be it pollution from the bridge sites, direct sewage and garbage disposal into the river and the repeated disturbance to natural flow regime. An ecosystem friendly and sustainably planned approach is the need of the hour to protect this river and its fish fauna. Since construction work is still ongoing and no special provisions for combating pollution have still been made more studies in future coupled with actions are needed to work effectively for conservation of river Tawi.

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