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Diversity and composition of fresh water fishes of river Ganga [Devprayag to Haridwar]

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ABSTRACT
Present investigation is carried out during December 2012 to April 2013, to assess the diversity and composition of freshwater fishes in river Ganga-Uttarakhand (DevPrayag to Hardiwar). Uttarakhand, a newly created hill state of India, is enriched with aquatic ecosystem of various disciplines like rivers, streams, lakes and reservoirs. The important rivers are Alaknanda, Bhagirathi, Bhilangana, Mandakini, Koshi, Ganga and Yamuna. They all contain a very rich and colourful fish fauna. In the present study we analyse fish diversity of river Ganga at two different locations i.e. Haridwar and Devprayag by this study we explained the effect of human interference and pollution on fish diversity. During the course of study a total of 21 species belonging to 11 families were reported out of these12 species reported in UG1 (Devprayag) and 8 species were reported in UG2 (Haridwar). Some endangered and rare fish fauna are also reported in the present investigation.

Key words-human interference, pollution, fish diversity, endangered

INTRODUCTION

Uttarakhand came into reality as a 27th state of India on November 9, 2000. It is located between latitude $28^0 40' - 31^o 29'$ N and longitude $77^o 35' - 81^o 5'$ E. It covers about 53,483 Km2 area and is populated by 8.5 million (according to 2001 Counting) people. It encompasses thirteen districts i.e. Uttarkashi, Chamoli, Rudraprayag, Tehri Garhwal, Dehradun, Pauri Garhwal, Pithoragarh, Champawat, Almora, Bageshwar, Nainital,Udham Singh Nagar and Haridwar. Uttarakhand is enriched with aquatic ecosystem of various disciplines like rivers, important rivers are Alaknanda, Bhagirathi, Bhilangan, Mandakini, Koshi and Ganga. Beside this there are so many spring fed and snow fed rivers such as Henwal, Hemganga, Song, Suswa and hundreds of rivulets which have very rich flora and fauna .The climate of the region is mainly tropical with a well defined rainy season between June and October, a very mild winter between December and February and a relatively dry pre-monsoon summer between March and May.
In the present we study fish diversity of fresh water fishes of river Ganga at two different location some earlier work on fresh water fishes as follows:

Out of the 2,500 species of freshwater fishes that have been recognised in the Indian subcontinent, 930 are categorized as freshwater species (Jayaram 1999).Much of the early study on the freshwater systems of the Indian subcontinent taking place with the works of British officers working for the East India Company, who took great interest in the natural history of the region. Some early assistance were those of Hamilton-Buchanan in 'The Fishes of the Ganges'(1822) and by others like McClelland (1839), Sykes (1839) and Jerdon (1849). After that studies were made by Francis Day in his Fishes of India (1875–1878). Substantial literature is now available on the identification and systematic of freshwater fishes of India, starting with Hora's assistance between 1920–1950s and the Hora in the 1930s to 1950s addressed the difficulty of the anomalous division of hill stream fishes in peninsular India. Many species belonging to the peninsular part of India were found to be the same to the species found in the North East of India and to some species most recent texts by Talwar & Jhingran (1991), and Jayaram (1999).Though most of these contributions have been taxonomic in nature, there exist some works on the bio geographic distributions of fishes in the region

as well (Jayaram 1974). A sequence of papers published by Introduction Studies of freshwater fishes in the Indian subcontinent have been limited to scattered works on commercial fisheries and even these have been largely restricted to some of the major river systems like the Ganges and the Yamuna.
Taxonomic collections apart, not much work has been done on the study of freshwater fishes in the Northern India mainly in Upper Ganga Region. Given the high levels of faunal diversity observed so far, there is an urgent need to understand the fish diversity and distribution of this region. The need is, in fact, made all the more urgent by the recent spurt of human actions in this region in exploiting its water resources for hydroelectric purposes. Not only are the rivers directly affected by the developmental activities, but they are also affected by other threats like introduction of exotic species, over fishing and the disposal of industrial and domestic wastes from new industries and settlements. Before the rich species diversity of this region of the subcontinent is lost forever, the records of the species found here as well as their distribution is essential; this together with the identification of the threats will help in formulating the needed conservation measures. As an initial step in this direction, the main objective of this study was to collect data on species richness and distributions that could serve as baseline information to monitor the potential Upper Ganga Region show that this region is very high in diversity, one would expect similar trends in the study region as well human impacts. Secondly with the help of this studies on fish diversity on the Northern India we try to answer following questions .What is the diversity of freshwater fishes in this region and how does it compare to rivers of similar dimensions in other parts of the subcontinent? How does this diversity vary at differing spatial scales like entire river systems, the upper and lower reaches in a river?

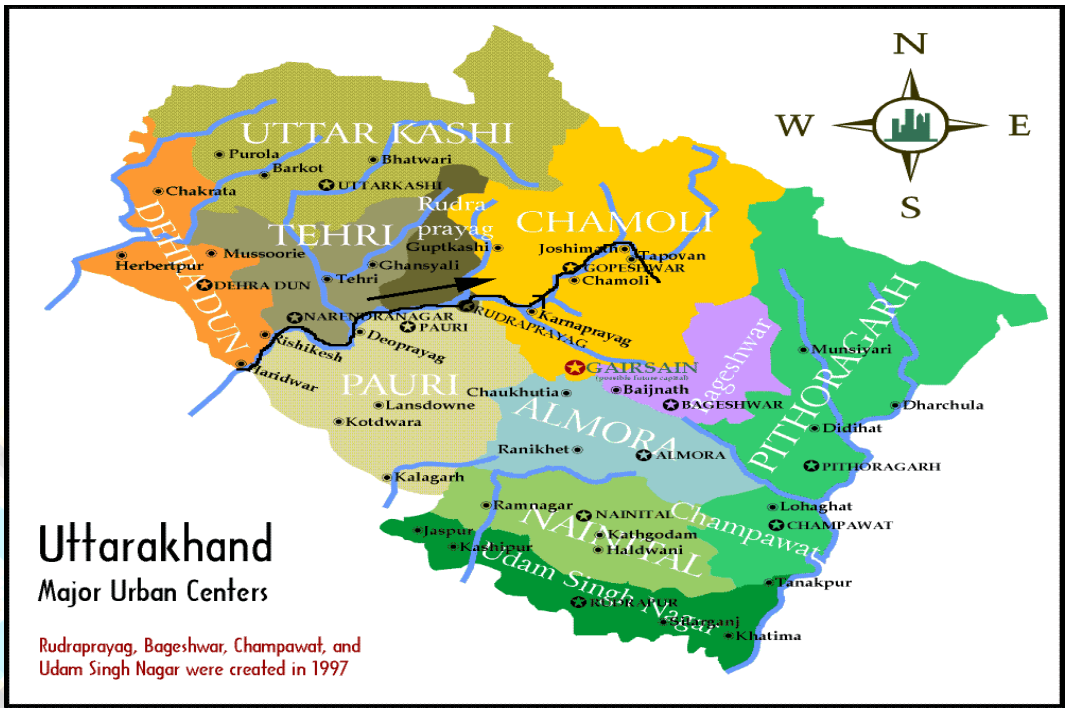
STUDY AREA

The study was conducted in UttaraKhand (Devprayag to Haridwar). Uttarakhand came into existence as a 27th state of India on November 9, 2000. It is located between latitude $28^{0}40' - 31^{o}\ 29'$ N and longitude $77^{o}\ 35' - 81^{o}\ 5'$ E. It covers about53,483 Km2 area and is inhabited by 8.5 million (according to 2001 Counting) people. It encompasses thirteen districts i.e. Uttarkashi,Chamoli, Rudraprayag, Tehri Garhwal,Dehradun, Pauri Garhwal, Pithoragarh,Champawat, Almora, Bageshwar, Nainital,Udham Singh Nagar and Haridwar. Uttarakhand is enriched with aquatic ecosystem of various disciplines like rivers, streams, lakes and rivulets,which have very rich flora and fauna .. The climate of the region is mainly tropical with a well defined rainy season between June and October, a very mild winter between December and February and a relatively dry pre-monsoon summer between March and May.

UG-1 (Devprayag): Devprayag (Latitude: $30^{o}08'49.5"$N; Longitude: $78^{o}35'51.9"$E; Elevation: 474 m above mean sea level) Devprayag is the convergence point of the rivers Bhagirathi and Alaknanda, and the river Ganga downstream descends at Rishikesh and traverses up to Haridwar in plains. Before reaching Rishikesh it is connected by another tributary Nayar, which is a recognized breeding ground for the most important game fish of Ganga, referred as Mahseer (Tor sp.). The river stretch consists of rapids, riffles and pools. The substrate consists of mature boulders, cobbles and pebbles. Sand is also present at few places in this zone. The river water in this stretch appears clean and clear, and has high transparency with moderate depth. The current velocity ranges between 0.1-3.0 m/s (Kishor, 1998). The water temperature is also moderate and varies between 15-23°C. The flows are significantly fluctuating and the river meanders into few channels at Haridwar d/s of Rishikesh.Water temperatures (in the range 8.5-17.2°C) have also been recorded by Agarwal et al. (2003) and Sharma et al. (2008) at Tehri.

UG-2:(Haridwar): Haridwar (Latitude: 29o57'20.1"N; Longitude: $78^{o}10'56.3"$E; Elevation: 290 m above mean sea level).Haridwar is an ancient city and municipality in the Haridwar district of Uttarakhand, India. The River Ganga, after flowing for 253 km from its source at Gaumukh at the edge of the Gangotri Glacier, enters the Indo-Gangetic Plains of North India for the first time at Haridwar.

Figure-1 Uttarakhand



SAMPLING

Fishes were collected from two sampling sites identified as UG1(Devprayag) & UG2(Haridwar).– details of the length, catchment areas and source of pollution for each river is summarized in Table 1.Fishes on these rivers were sampled regularly over a period of five month (Dec 2012–Apr 2013) (see Table 2 for dates of samplings) on 2 sampling sites (details are tabulated in Appendix 1). The sites were chosen such that: one on the higher elevation zone and one on the lower elevation zones. Thus, regional comparisons along a river were made across the upstream and downstream sites.The fishes were identified and some representative specimens were collected and preserved in (4% formaldehyde solution) in plastic bottles. Identifications done were based on keys for fishes of the Indian subcontinent (Jayaram 1999, Talwar & Jhingran 1991) and also with the help of taxonomic expertise from the Regional Station of the Zoological Survey of India at Chennai.

Table-1: Details of the length, catchment areas and pollution.

	Total area (in km sq)	Elevation(in m)	Source of Pollution
Devprayag	8.2	830	minimal
Haridwar	12.3	314	Sewage, pesticides,

Sampling was carried out on 100–150 m of stretches of the river at each site. Collections of fish samples were taken at every habitat type along each stretch, using all the sampling methods, such that as far as possible, the existing species and relative abundance for that site were obtained in the sampling. A total of 20 samples were collected from the entire study region (including both sites on the river Ganga).

Table-2: Details of seasons, date and time of sampling

Sampling season	Sampling date	Time of Sampling	Duration
Winter	Dec, 2012-Jan,2013	Day	6:00-10:00
Summer	Mar, 2013	Night	17:00-24:00
Pre-monsoon	April,2013	Day	8:00-10:00, 16:00-18:00

DATA ANALYSIS

Earlier species richness and distributions was used as the index for the assessment of species diversity as well as for comparisons of diversity across rivers and regions, as the relative abundance for the species may not give the right abundance for the communities. Adequacy of sampling was assessed using species accumulation curves. In spite of a very exact sampling, there is constantly a option of having missed some rare and cryptic species from the sampling effort. Numerous statistical estimators have been used for manipulating and extrapolating species richness; these take into account the possible proportion of rare species and make usual estimates of the true species richness of an area (Colwell & Coddington 1994). Many parametric and nonparametric methods have been adopted to make these estimates and which have been reviewed in Bunge & Fitzpatrick (1993) and Colwell & Coddington (1994).Out of them some of the commonly used non-parametric estimates are the Jack-knife method described in Heltshe and Forrester (1983), the bootstrap method (derived by Smith & van Belle 1984) and Chao's estimator, Chao 1(Chao 1984). These 3 methods of estimation were valuable on the data collected from the samplings to check for differences in the evaluation of the species richness. Uniformity of distributions of the species across the rivers and sites were plotted for studying the degree of skewness of the data sets. Species richness, as well as compositions, was compared (across rivers) to study the degree of species shared between them and in identifying those found entirely in particular regions in a river.

Because of differences in numbers and kinds of habitats at each site, there were differences in the total sampling effort applied at each site. Comparisons of species richness across various spatial scales (rivers, regions) and diurnal scale (i.e. day and night variations) were carried out using the process of rarefaction – a statistical technique of estimating the expected number of species for a given random sample of size n; species richness is then estimated as the sum of the probabilities that each species will be included in the sample (Sander 1968, Hurlbert 1971). So this method allows for comparisons to be made when sample sizes across two datasets are uneven (due to differences in sampling efforts). The number of species that can be expected in a sample of n individuals (denoted by E(Sn)) drawn from a population of N total individuals distributed among the various species is

$$E(S_n) = \sum_{1}^{n} \left\{ 1 - \left[\binom{N - n_i}{n} \Big/ \binom{N}{n} \right] \right\}$$

Where, ni =number of individuals of the ith species, and N=total number of individuals in a sample Species accumulation curves, including the various estimators, were plotted for making these comparisons; these curves were generated using the Estimate S (version 5) software, which uses Monte Carlo simulations of random samples drawn from the total set of samples for estimating the average species richness. Here, 180 randomisations were run for a given number of samples for the estimation of species richness values and their means were used in plotting the species accumulation curves. The dissimilarity in species richness across rivers tested with the Mann–Whitney U-test.To reduce the chances of type I errors from multiple pairwise comparisons, the Bonferroni method has been applied (Harris 1975). By this method, if the p (probability of error) value for overall comparisons is taken as 0.05, the adjusted 'alpha' (error) value for

each pairwise test is estimated as 0.05/(the number of pairwise tests). Thus, for the comparisons of species richness across the four rivers, 6 pairwise tests were involved and the alpha value for each pairwise test was fixed at 0.007.

RESULTS AND DISCUSSION

During the present study 21 species of fishes belonging to 12 families (as showen in table 4)were reported in belongs to phylum vertebrata .Out of these Tor tor, Tor putitora, Raimas bola were found as endangered fishes while Barilius vagra and Garra gotyla gotyla were found as vulnerable fish species, out of all other fishes Barilius bendelisis, Chagunius chagunio.While Garra lamta, Labeo boga, Labeo dero, Labeo dyocheilus, Puntius chola, Puntius sarana,Puntius sophore, Puntius phutunio, Rasbora daniconius, Esomus danricus, Crossocheilus latius latius, Leploephalus guntea, Noemacheilus botia, Noemacheilus savona, Noemacheilus bevani, Mystus vittatus, Xenentodon cancila,Mastacembelus armatus, Channa gachua,Glyptothorax pectinopterus were found at low risk.

An overall fish survey in the area has revealed a rapid decline in fish diversity. The main reason for decline of fishes is due to over fishing by various destructive fishing methods especially during breeding season. The pollution of the river by flash flood, landslides and soil erosion etc. have also been responsible for the depletion of fish fauna.

CONCLUSION

It may be concluded from the above study that fishes of various rivers of Ganga river system at foothills of Garhwal Himalaya totally depend upon quality of water and pollution free environment. Although all the parameters are found favourable for fish survival but certain parameters such as turbidity which increases due to pollution as in (UG1) which results in increased number of fish mortality due to choking of gills besides this the major problem is illegal fishing which results in declining of fish population in Ganga river system. Hence there is an urgent need of action plan for conservation of fish habitat, fishery development etc., besides this safety measures should be taken to control illegal fishing by total ban on fishing especially in breeding season.

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