J. Mountain Res. ISSN: 0974-3030
Vol. 12, (2017) 13-18

Examining sub-speciation tendencies in the Schizothoracinae stock within Yamuna basin rivers (Yamuna and Tons) of Uttarakhand, India

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Received: 10.07.2017; Revised: 15.09.2017; Accepted: 17.10.2017

Abstract: In the fish species showing restricted distribution, the majority of morphometeric characters show narrow range and are genetically controlled. Fish demonstrate greater variation in morphological traits both within and between populations. The present study is designed to determine variation in the morphometric characters of Schizothoracinae stock, from Yamuna basin Rivers. The sample size consisted of 33 specimens of *S. richardsonii* and 38 of *S. plagiostomus* from the Yamuna, while 34 specimens of *S. richardsonii* and 33 of *S. plagiostomus* from the Tons. Fifteen characters in proportion to total length and five to head length have been studied. Body proportions were tabulated to obtain the range and then classified on the basis of range difference into genetically (<10%), intermediate (10-15%) and environmentally (>15%) controlled characters. In case of *S. richardsonii* 11 characters were genetically controlled and 4 were intermediates in relation to total length in the Yamuna, while in Tons river 12 characters were genetically controlled and 3 were intermediates in relation to total length. In relation to head length 4 characters were genetically controlled, while LOB was environmentally controlled in both rivers. On other hand in case of *S. plagiostomus* 13 characters in relation to TL were genetically controlled, while 2 were intermediate in the Yamuna river whereas in Tons 14 characters were genetically controlled and 1 was intermediate. In relation to head length 4 characters were genetically controlled, LOB was only a character which was environmentally controlled. The study confirmed lack of sub- speciation tendency in both *Schizothorax* species in Yamuna basin.

Keywords: Sub-speciation • Schizothoracinae • Yamuna basin

Introduction

The quantification of specific characteristics of an individual, or group of individuals can demonstrate the degree of speciation induced by both biotic and abiotic conditions, and contribute to the definition of different stock of species (Bailey, 1997). Fishes exhibit a wide range of intra-specific morphological variation that has been shown to be ecologically and evolutionarily important (Robinson and Wilson 1994). Morphometric measurements are widely used to identify differences between fish populations (Tzeng, 2004; Cheng et al., 2005; Buj et al., 2008; Torres et al., 2010). Morphometric variation between stocks can provide a basis for stock structure, and may be applicable for studying short-

term, environmentally induced variation (Murta, 2002; Pinheiro et al., 2005). *Schizothorax* (snow trout) endemic to the Himalayas and, true to its name, occurs in snow-fed stream and lakes. Many species of this genus are remarkably similar in general morphology across the Indian Himalayas (Chandra et al., 2012). A study was conducted to analyze the sub-speciation tendency in Schizothoracinae stocks within Yamuna basin river on the basis of its morphometric analysis.

Materials and Methods

Study area

The Yamuna, Ganga and Kali are major river systems of Ganga river basin in the Indian Himalaya. The Yamuna and the Kali meet the Ganga far down in the mid-gangetic plains. However, some of their tributaries form confluences in the Himalayan domain, some closer to source and some far away from the source. The Yamuna and Tons are two such rivers that are isolated from each other for nearly 200 Km from their source. The exchanges in the snow trout fauna is possible only through the confluence, but the likelihood of this exchange gets reduced for individuals residing/inhabiting the river stretch close to respective source. In order to ensure the isolation of stocks among the rivers forming confluence, the snow trout samples were collected far above their confluence. The Yamuna and Tons were sampled at Barkot and Tyuni (Fig.1). These locations fell in the 1200-1500 m asl altitude range. The fish stock of Yamuna river was compared with Tons stock.

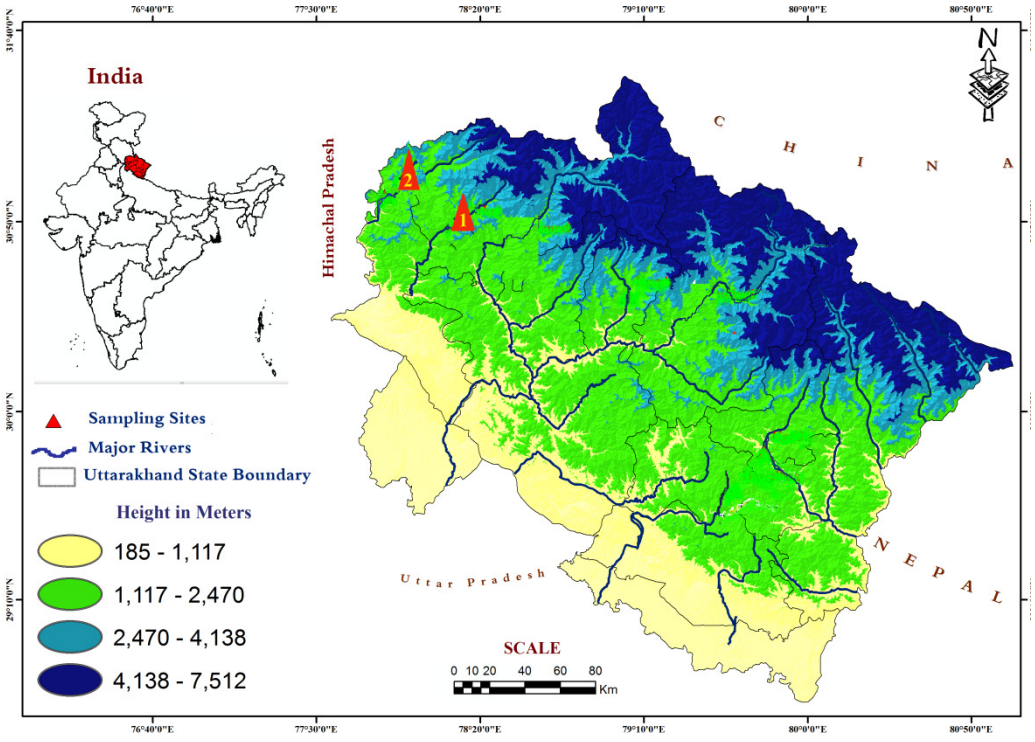

Figure 1 Map of Yamuna river basin showing the sample collection site.

Samples Collection

The snow trout samples were obtained at monthly intervals from April 2014 to April 2015 from the rivers selected for the study. The snow trout catch was obtained from local fishermen who fish for their livelihoods. Since, the fish obtained from them were already dead and consisted mostly of various species of *Schizothorax*, they were preserved in 10% formalin and brought to the laboratory for identifying and segregating *Schizothorax* species. The sample size consisted of 33 specimens of *S. richardsonii* and 38 of *S. plagiostomus* from the

Yamuna, while 34 specimens of *S. richardsonii* and 33 of *S. plagiostomus* from the Tons. The morphometric measurements were made on the basis of description provided by Jayaram (1981) (Fig. 2).

The selected 15 and 5 characters in total and head length respectively have been studied: (a) in proportion to total length (TL) and Head length (HL). Body proportions were tabulated to obtain the range. The various morphometric characters were then classified on the basis of range difference into genetically (<10%), intermediate (10-15%) and environmentally (>15%) controlled characters (Johal et al., 1994).

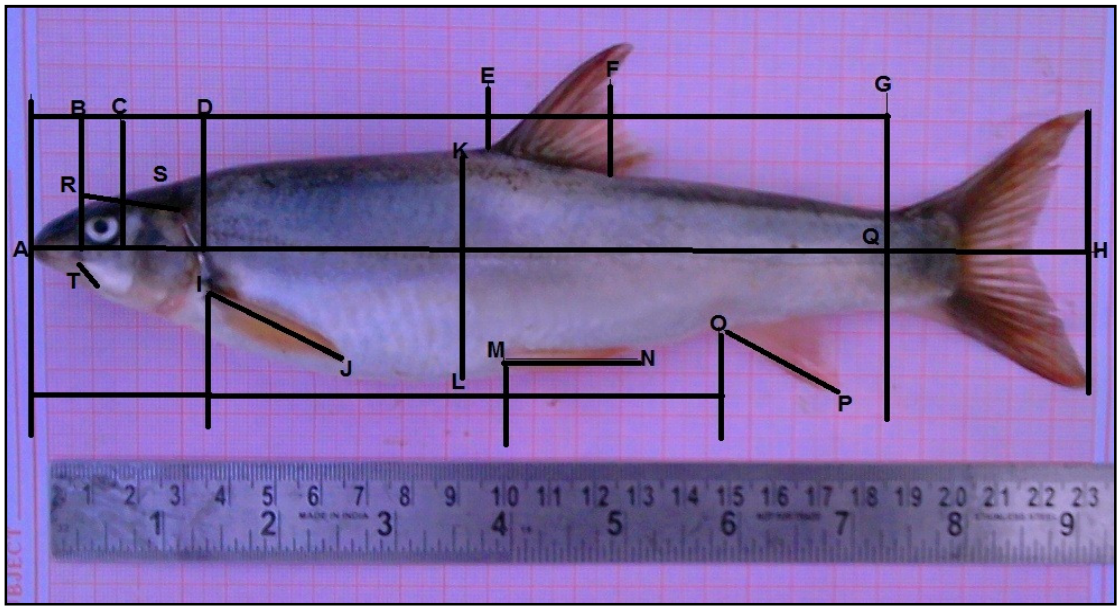

Figure 2 Outline diagram showing morphometric features of snow trout (*Schizothorax* spp.) selected for the study. (AH= Total length(TL); AG= Standard Length (SL); AD= Head Length (HL); AE= Pre Dorsal distance (PreDD); FG= Post Dorsal distance (PostDD); KL= Body depth (BD); IJ= Pectoral Fin length (PFL); MN=Ventral Fin Length (VFL); OP= Anal Fin Length (AFL); EF= Depth of Dorsal fin (DOD); QH= Caudal Fin Length (CFL); AO= Pre Anal Length (PreAL); AM= Pre Ventral Length (PreVL); AI= Pre Pectoral Length (PrePL); IM= Pectoral ventral Distance(PecPelDist); MO= Ventral anal distance (PelAnalDist) and in relation to Head length, BC= Eye diameter (ED); AB= Pre orbital Distance (PreOD); CD= Post orbital Distance (PostOD); T= Length of barbel (LOB) and RS= Head width (HW).

Results

In case of *S. richardsonii* 11 characters out of 15 were genetically controlled and 4 characters (PFL, VFL, AFL and DOD) were intermediates in relation to total length in the Yamuna, while in Tons river 12 characters were genetically controlled and 3 (VFL, AFL, and DOD) were intermediates in relation to total length. In relation to head length 4 characters were genetically controlled, while LOB was environmentally controlled in both rivers. On other hand in case of *S. plagiostomus* 13 characters in relation to TL were genetically controlled, while 2 (VFL and DOD) were intermediate in the Yamuna river whereas in Tons 14 characters were genetically controlled and only one character (VFL) was intermediate. In relation to head length all characters were genetically controlled, except LOB was environmentally controlled in both rivers (Table 1).

Table 1 Comparison of range differences in body parts of *Schizothorax richardsonii and S. plagiostomus* between river Yamuna and Tons.

Nature of characters	Body Parameters	*S. richardsonii*				*S. plagiostomus*			
		Yamuna		Tons		Yamuna		Tons	
In proportion to Total Length		**R**	**RD**	**R**	**RD**	**R**	**RD**	**R**	**RD**
Genetically Controlled	SL	1.2-1.3	1.2	1.2-1.3	1.2	1.2-1.3	1.2	0.71-1.36	1
	HL	5.2-6.7	6	4.7-6.7	5.7	4.8-7.3	6	3.5-7.4	5.5
	PreDD	2.4-2.8	2.6	2.3-2.6	2.5	2.5-2.79	2.6	1.5-2.7	2.1
	PostDD	2.9-4	3.5	2.9-4.1	3.5	2.9-3.7	3.3	1.7-4.2	3
	BD	5-7.9	6.4	5-7.9	6.4	4.7-7.47	6.1	3.9-8.3	6.1
	PFL	-	-	7.4-12.3	9.9	7.0-11.5	9.3	6.5-12.6	9.6
	VFL	-	-	-		-	-	-	-
	AFL	-	-	-	-	7.7-11.8	9.7	4.4-9.5	7
	DOD	-	-	-	-	-	-	6.2-13.2	9.7
	CFL	3.8-5.3	4.6	3.7-5.4	4.6	4.2-5.3	4.7	3.1-5.5	4.3
	PreAL	1.4-1.7	1.5	1.4-1.9	1.7	1.34-1.69	1.5	0.8-1.7	1.2
	PreVL	1.9-3	2.5	1.9-3	2.5	1.91-2.42	2.1	1.2-2.7	2
	PrePL	5-8.1	6.5	5.1-8.1	6.6	5.0-7.1	6.1	3.7-7.8	5.7
	PecPelDist	3.1-5	4	3.1-5	4	3.2-3.8	3.5	1.9-4.0	3
	PelAnalDist	4.3-7.5	5.9	4.4-7.5	5.9	4.1-6.3	5.2	3.2-6.7	4.9
Intermediate	PFL	7.5-12.4	10	-	-	-	-	-	-
	VFL	8.1-12.9	10.5	8.1-12.9	10.5	7.7-12.3	10	6.9-13.2	10
	AFL	8.1-12.9	10.5	7.8-13	10.4	-	-	-	-
	DOD	8.7-12.3	10.5	8.6-12.3	10.5	8.2-12.0	10.1	-	-
Environmental	-	-	-	-	-	-	-	-	-
In proportion to Head Length									
Genetically Controlled	ED	6-8.5	7.2	6.2-9.2	7.7	5-9	7.5	6.4-10.2	8.3
	PreOD	2.1-2.6	2.4	2.2-2.8	2.5	2.3-2.8	2.5	2.3-2.8	2.6
	PostOD	2-2.4	2.2	1.9-2.4	2.1	2-2.3	2.1	1.8-2.2	2
	HW	2-2	2	2-2.8	2.4	2.1-2.7	2.4	2.1-3	2.5
Intermediate	-	-	-	-	-				
Environmental	LOB	10-21	15.5	10-21	15.5	9.6-20	15	10-21.5	16

Discussion

Vladykov (1934) maintains that in fish species showing restricted distribution, the majority of morphometric characters show a narrow range and are genetically controlled. On the contrary, in species that have a wide range of geographical distribution, most of the characters are strongly influenced by the environment. Based on this criterion snow trout *Schizothorax* spp. has restricted geographical distribution because the majority of the 20 morphometric characters examined show narrow range differences and are genetically controlled in relation to TL and HL respectively. There were no environmentally controlled characters. Thus both stocks despite isolation from each other by virtue of distantly located rivers are stile conservative.

Similarly in the stocks of both rivers also points to the fact the environmental condition in both rivers are similar. Earlier few studies have been performed to examine sub speciation tendency in different fish species. Bhatt et al. (1998) observed no tendency of sub-speciation in *Tor putitora* from the foothill section of the Ganga as >50% characters were genetically controlled. However, Dhasmana, (Unpublished) suggested tendency of sub-speciation in the population of Himalayan mahseer sampled from the Ganga, Alaknanda, Song and Nayar rivers since <50% characters were genetically controlled. Contrary views can be attribute to the inclusion of smaller size in the population may have caused great variation and hence higher range difference. Johal et al. (1994) also found the similar tendency in *Tor putitora* from Govindsagar as >50% characters were

intermediate and environmentally controlled. In the male and female of *B. bendelisis* from spring fed river Khanda also most characters (54.5%) were genetically controlled which was less than *B. vagra* (63.9%) of the same stream suggests relatively wider distribution and greater tendency of sub-speciation in *B. bendelisis* than *B. vagra* (Negi and Nautiyal, 2002). Johal and Chandra (2004) reported the moderate tendency in *Barilius barila* to form the taxonomic categories below species level such as subspecies from some streams of Himachal Pradesh. Negi and Negi (2010) found 15 characters of *Schizothorax richardsonii* were genetically, one was intermediate and one was environmentally controlled in the relation to total length while all characters were genetically controlled in relation to Head length. From Ranjit Sagar Wetland, Onkar and Saima (2015) studied eighteen body parameters of the fish *Crossocheilus latius latius* in relation to total length, from which thirteen characters were genetically controlled, four characters were intermediate and one character was environmentally controlled while in relation to head length all characters were genetically controlled. However, in case of *Garra gotyla gotyla* reported from Ranjit Sagar Wetland (Brraich and Akhter, 2015) eighteen characters have been studied in percentage of total fish length from which three characters were genetically controlled, thirteen characters were intermediate and two characters were environmentally controlled. Thus most fishes in the Himalaya and Sub-Himalaya lack tendency of sub-speciation.

In Yamuna river basin, the despite difference in the location of Yamuna and Tons rivers most of fish's body parameters exhibited conspicuous resemblance, most of which were genetic and intermediate characters. None of the body parameter showed the environmental controlled character in the stocks of *S. richardsonii* and *S. plagiostomus.*

Acknowledgements

The authors acknowledge the Head, Department of Zoology and Biotechnology, HNB Garhwal University for providing lab facilities. The first author also gratefully acknowledge the financial assistance rend by UGC New Delhi for providing UGC-BSR Fellowship for conducting this research work.

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