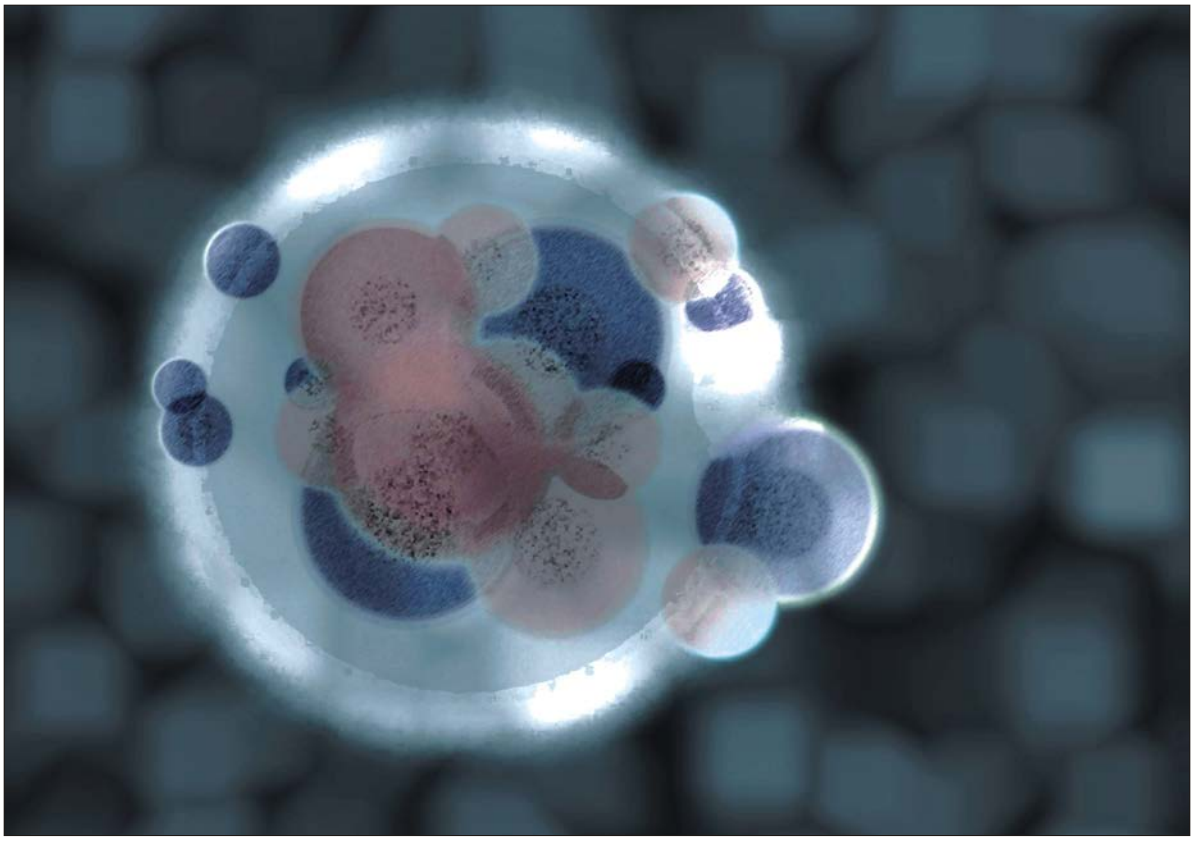

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Analysis of Morphometric Characters of *Schizothorax richardsonii* (Gray, 1832) from the Uttarkashi District of Uttrakhand State, India

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Abstract: A study on morphometric characters of snow trout fish *Schizothorax richardsonii* (Gray) was conducted on the samples collected from Yamuna river of the Uttarakashi district of Uttarakhand State. The morphometric measurements such as total length, standard length, predorsal distance, preventral distance, preanal distance, maximum body depth, minimum body depth, caudal peduncle length, head length, head width, pelvic and anal fin, pectoral, pelvic (ventral), were recorded. All the measurements were calculated in the percentage of total length except those of head width, head depth, interorbital, space, postorbital space and eye diameter, which were calculated in the percentage of head length. After investigation, it was observed that almost all the morphometric characters show high degree of coefficient of correlation ($r>0.90$) and correlation coefficient was significant at $p<0.01$ in all the variables except in the depth of anal fin, which was significant at $p<0.05$. Out of 21 characters studied, 19 characters were found to be genetic controlled 1 character intermediate and 1 character as environmentally controlled.

Key words: Morphometric characters, genetically control, *Schizothorax richardsonii*, uttarakhand, environmental control

INTRODUCTION

The members of the genus *Schizothorax* Heckel are widely distributed in Kashmir, Punjab, Afghanistan, Pakistan, Tibet and in Indian subcontinent. They are the inhabitants of fast hillstreams and solely feed on chironomid larvae. There has been a difference of opinion regarding the number of species included in the related genera viz., *Schizothorax* Heckel, *Orenius* McClelland and *Schizothoraichthys* Misra due to several overlapping morphological and meristic characters. Heckel in 1838 established the genus *Schizothorax* and included ten species from Kashmir waters. McClelland in 1839 proposed the genus *Orenius* and included *Schizothorax .richardsonii* (Gray 1832) in the newly erected genus. Misra (1962) decribed another similar genus *Schizothoraichthys* and included eleven species in this genus which were previously placed under the genus *Schizothorax* Heckel (Talwar and Jhingran, 1991). Jayaram (1999) included four species in the genus *Schizothorax* Heckel and Talwar and Jhingran (1991) only two species. Both the workers have employed the characters like colour and two morphometric characters viz., its body depth and head length in the standard length. The cause of variation in the morphometric and meristic characters may range from variability to the intraspecific which is under the influence of environmental parameters (Hubbs, 1921; Vladykov, 1934; McHugh, 1954).

The use of various dependent morphological characters in the percentage of independent characters and meristic characters are in vogue in the temperate countries for the identification of species of the same genus or geographical populations. This concept is based on that habitat, temperature, elevation, slope gradient, stream velocity, food, productivity, sex and age have profound impact on these characters (Hubbs, 1926; Barlow, 1961; Hempel and Blaxter, 1963; Hopkirk, 1973; Kirka, 1974).

Occurrence of homogeneity in the stocks of *Schizothorax richardsonii* (Gray) in the different stretches of Himalayan waters is a big question mark. Lack of detailed information on the morphological and meristic characters of this fish from various water bodies is one of the causative reason, hence, the present study relating to morphometric characters of *Schizothorax richarsonii* (Gary) from the rivers Kamal and Yamuna have been undertaken.

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MATERIALS AND METHODS

Fishes were obtained by regular sampling at monthly intervals for one year i.e., April, 2007- March, 2008 from the Yamuna river of Uttarkashi district (78°05' 36.4" E: 30° 58' 19.8" N; altitude 1375 m. m.s.l.), Uttakhand State, India. Fish samples were collected with the help of cast net having mesh size of 2 cm at different habitats of water bodies under report and preserved in 10% formaldehyde solution . In the laboratory, the fishes were washed in the tap water in order to remove dust particles, mucus and other extraneous matter and again preserved in 10% formaldehyde solution. In the present study twenty one morphometric characters of 70 specimens of this species ranging between 550 mm to 2570 mm total fish length collected. For the morphometric studies, linear measurements were taken on the left side of the body with vernier caliper with accuracy of ±01 mm. Based on the descriptions of Holden and Raitt (1974), following 15 and 4 morphometric characters in total length and head length respectively have been studied in proportion to total length vs Standard Length (SL), predorsal distance (PreDD), postdorsal distance (PsDD), length of dorsal fin (LDF), depth of dorsal fin (DDF), length of pelvic fin (LPF), length of pectoral fin (LPF), length of anal fin (LAF), depth of anal fine (DAF), maximum body depth (MBD), minimum body depth (MiBD), distance between pectoral and pelvic fin (DPP), distance between pelvic and anal fin (DPA) and length of caudal fin (LCF) respectively, in proportion to head length vs preorbital distance (PrOD), postorbital distance (PSOD), Eye Diameters (ED) and Head Depth (HD), respectively. All the measurements were calculated in the percentage of total length except those of head width, head depth, inter-orbital, space, postorbital space and eye diameter, which were calculated in the percentage of head length.

These measurements were subjected to correlation and regression analysis using SPSS version 10. The coefficient of correlation (r) and regression (b) were tested for significance. The data was then used to compute the regression equation for each dependent variable to fit the straight line equation (Y= a+bx), where Y is the dependent variable, 'a' the intercept, 'b' the slope of the regression line and x, the independent variable. The various morphometric characters were then classified on the basis of range into genetically (1 - 9.99 or <10%), intermediate (10 - 14.9 or < 15%) and environmentally (>15%) controlled characters (Johal *et al*., 1994). For the calculation of regression equation, standard deviation (SD), coefficient of correlation (r) and graphs, the computer software SPSS version 10 was used.

RESULTS

In proportion to total length: Various body measurements related to total length of *Schizothorax richardsonii* were compared on the basis of statistic r (correlation coefficient) and b (regression coefficient). The most highly correlated body parameters in relation to total length, were standard length (r = 0.986) and pre anal distance (r = 0.981) (Table 1) and least correlated were dorsal fin (r = 0.931) and depth of anal fin (r = 0.951). It has

Table 1: Values of different morphometric characters in *Schizothorax richardsonii* from the Uttarkashi district of Uttarakhand State, India

Parameters	Regression Equation Y= a + bX	Mean and Range in (cm)	SD	Range	Correlation coefficient (r)
In the %age of total length					
Head length	Y = 0.309+0.159X	2.44 (1.2-4.5)	0.688	3.3	0.960**
Standard length	Y = 0.239+0.791X	10.85 (4.6-20.5)	3.332	15.9	0.986**
Pre dorsal distance	Y = 0.470+0.342X	5.06 (2.3-8.8)	1.455	6.5	0.976**
Post dorsal distance	Y = 0.276+0.293X	3.65 (1.5-7.8)	1.244	6.3	0.979**
Pre-anal distance	Y = 0.148+0.579X	7.92 (3.3-15.5)	2.452	12.2	0.981**
Depth of anal fin	Y = -0.210+0.181X	2.21 (0.8-4.0)	0.659	0.4	0.951*
Length of anal fin	Y = -0.046 +0.066X	0.85 (0.3-1.6)	0.291	1.3	0.955**
Depth of dorsal fin	Y = 0.270+0.148X	2.25 (1.0-4.0)	0.660	3.0	0.931**
Length of dorsal fin	Y = 0 .0483+0.105X	1.45 (0.6-2.9)	0.454	2.3	0.962**
Length of pectoral fin	Y = 0.120+0.138X	1.97 (0.8-3.8)	0.593	3.0	0.967**
Length of ventral fin	Y = 0 .011+0.133X	1.770 (0.6-3.6)	0.570	3.0	0.966**
Length of caudal fin	Y = 0.219+0.208X	3.00 (1.3-5.6)	0.893	4.3	0.966**
Length of caudal peduncle	Y = -0.014+0.150X	2.0 (0.8-3.5)	0.656	2.7	0.952**
Distance between Pectoral and ventral fin	Y = 0.095+0.250X	3.255 (1.3-6.5)	1.071	5.2	0.968**
Distance between ventral and anal fin	Y = 0-.203+0.203X	2.518 (0.9-4.8)	0.873	3.9	0.964**
Maximum body depth	Y = 0.0462+0.159X	2.184 (0.9-4.3)	0.685	3.4	0.966**
Minimum body depth	Y = -0.409+0.122X	1.234 (0.4-3.5)	0.343	3.1	0.968**
In the %age of head length					
Head depth	Y = 0.075+0.59X	1.52 (0.6-2.8)	0.423	2.2	0.970**
Eye diameter	Y = 0.224+0.111X	0.49 (0.3-0.7)	0.008	0.4	0.901**
Preorbital distance	Y = -0.082+0.389X	0.87 (0.3-1.6)	0.282	1.3	0.957**
Postorbital distance	Y = 0.053+0.467X	1.19 (0.3-0.7)	0.333	0.4	0.976**

*Correlation is significant at the 0.05 level ; **Correlation is significant at the 0.01 level

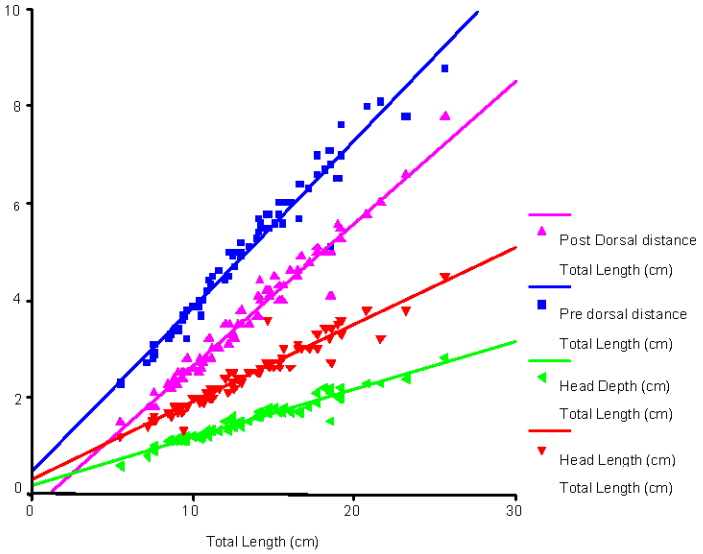

Fig. 1: Relationship between total length (TL) along X-axis and post dorsal distance pre dorsal distance, head depth and head length along Y-axis

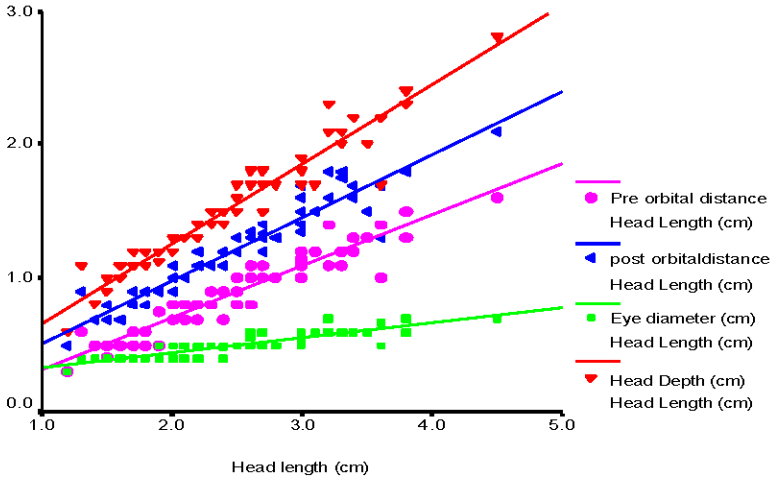

Fig. 2: Relationship between Head Length (HL) along X-axis and post orbital distance, eye diameter and head depth along Y-axis

been observed that all the characters follow linear relationship (Fig. 1) and show high degree of correlation ($r>0.98$) with $p<0.01$ level of significance, indicating that all morphometric characters increase in the direct proportion with each other.

In proportion to head length: The body measurements, postorbital distance and head depth in relation to head length, were the most highly correlated parameters ($r = 0.976$) with $p<0.01$ level of significance and least correlated parameters was the eye diameter ($r = 0.90$). However, all the characters showed correlation with head length and almost all the characters followed linear relation (Fig. 2).

The values of coefficient of correlation (Table 1) have been found to be highly significant at $p<0.01$ for all the morphometric characters, except depth of anal fin which was significant at $p<0.05$, however, in the proportion to head length, all the values have high correlation coefficient ($r = 0.95$) except the eye diameter ($r = 0.90$). From these observations it is evident that most of the characters included in the present studies increase in direct proportion to each other.

DISCUSSION

The various morphometric characters have been categorized on the basis of range difference into genetically (<10%), intermediate (10-15%) and environmentally (>15%) controlled characters (Johal *et al*., 1994). Vladykov (1934) considered that morphometric and meristic characters can be divided in to three categories viz.:

- Characters which do not appear to be modified by the environment such as number of fin rays of caudal and ventral fins. These characters are genetically controlled
- Characters which appear to be slightly modified by environment such as pectoral fin rays and gill rackers on the first brachial arch
- Characters which appear to be strongly modified by the environment. It includes morphological characters, metamerism, number of vertebrate, rays in the dorsal and anal fin, colour bars, colour spots and size of the fish

In general, characters belonging to the first category show minimum range of variation, second category moderate and the third category maximum range of variation of characters. On the basis of present investigations more characters could be included in each Vladykov's (1934) category.

During the present investigation, 15 characters such as HL, PrDD, PoDD, DAF, LAF, DDF, LDF, LPF, LVF, LCF, LCP, DBP and VF, DBV and AFM, MXBD, MiBD, in the percentage of total length have been found to be genetically controlled. The characters like standard length and pre- anal distance in the percentage of total length are included in the environmentally and intermediate category respectively. Whereas the other characters like head depth, eye diameter, pre-orbital and post orbital distance in the percentage of head length are included in the genetically controlled category of characters. In a similar study, Johal *et al*. (1994) reported 13 characters in relation to total length to be genetically controlled in *Tor putitora* from Gobindsagar reservoir in Himachal Pradesh.

Pandey and Nautiyal (1997) have studied the statistical evaluation of some meristic and morphometric characters of taxonomic significance in *S. richardsonii* and *Schizothorax plagiostomus* (Heckel) from river of Alaknanda in Srinagar, Garhwal Himalayas and revealed that the anal fin length (AFL) as a character of diagnostic significance ($p<0.05$). The relationship of AFL with A-CFBL (anal to caudal fin base length) in the species was found to be an important feature. They further opined that relatively longer AFL and smaller A-CFBL in the *S. plagiostomus* serve to distinguish it from the *S. richardsonii*. (Misra, 1948; Tilak and Sinha, 1975; Baloni and Tilak, 1986), specially in view of the fact that *S. richardsonii* lack heterogeneity due to sex or season, years and place too (Misra,1982).

Vladykov (1934) maintains that in the fish species showing restricted distribution, the majority of morphometric characters show narrow range and are genetically controlled. On the contrary, in species which have a wide range of zoogeographical distribution, most of the characters are strongly influenced by the environment. *S. richardsonii* have a restricted zoogeographical distribution, because the majority (90%) of their morphometric characters show narrow range differences and are genetically controlled while the environmentally controlled characters are few (10%). In a similar study, Negi and Nautiyal (2002) have revealed that in the *Barilius bendelisis* and *Barilius vagra*, the majority of their morphometric characters showed narrow range and were genetically controlled.

Among the Oriental fishes showing similar distribution, Tandon *et al*. (1993a, b) studied *Cirrhinus reba*, *Tor putitora* from Gobindsagar reservoir and Bhatt *et al*. (1998) studied *Tor putitora* from foothill section of the Ganga. In *C. reba,* 14 out of 19 and in *G. chapra*, 13 out of 18 morphometric characters exhibited wide range differences and were hence environmentally controlled while in *Tor putitora*, 9 were environmentally controlled characters (Tandon *et al*., 1993a, b). According to the criterion of Vladykov they fall in the category of fish showing wide distribution. On contrary, in *Tor putitora* restricted to Himalayan foothills, 13 out of 27 characters were genetically controlled, showing narrow range difference. 12 out of 20 were genetically controlled while 3 were environmentally controlled in the population of *Tor putitora* inhabiting the foothill section of the Ganga (Bhatt *et al*., 1998). Johal *et al*. (1994) studied the population of *Tor putitora* at Ramsar site of Pongdam reservoir in Himachal Pradesh, India and found that 12 out of 22 morphometric characters were genetically controlled while 5 were environmentally controlled. These observations support the hypothesis of Vladykov, that fishes with restricted distribution have greater numbers of genetic characters, as is also evident in present investigation. A perusal of literature have revealed that not much work has been done on morphometric characters of *Schizthorax richardsonii* (Gray), hence, present findings will be helpful in taxonomic identification of species of this genus.

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