E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2017; 5(3): 45-48

www.fisheriesjournal.com
Received: 10-03-2017
Accepted: 11-04-2017

BPS Kanwal
Department of Zoology, Kumaun University, S.S.J. Campus, Almora, Uttarakhand, India

Correspondence
BPS Kanwal
Department of Zoology, Kumaun University, S.S.J. Campus, Almora, Uttarakhand, India

Environmental impact on morphometry of *Garra lamta* (Hamilton-Buchanan) of Kumaun Himalaya

BPS Kanwal

Abstract
The present paper deals with the environmental impact on different body parts (morphometric character) in respect to total length (TL), standard length (SL) and head length (HL) of a hill stream fish *Garra lamta* collected from Petsal and Sironia garh (Tributaries) of Suyal river in Kumaun Himalaya, Uttarakhand. Most of the characters observed as genetically controlled in respect to TL and SL while environmentally controlled (ecological) in respect to HL. Different body parts show proportionate growth in respect to TL, SL and HL.

Keywords: Morphometry, *Garra lamta*, environment, Himalaya

1. Introduction
Species identification and population discrimination are important in the conservation of biodiversity, natural resources and fishery management. The quantification of specific characteristics of an individual, or group of individual can demonstrate the degree of speciation induced by both biotic and abiotic conditions and contribute to the definition of different stock of species. The morphometric characters have a key role in identification of a species and for detecting variations in the fish population. Two types of characters morphometrics and meristics have been frequently used to delineate stock of fish species [1-6]. Apart from these two main sets of characters some other characters are also important which are related to the shape and size of body, colouration, spots, barbels, adipose fins, adhesive structure etc. For the past 50 years, morphometric investigations have been based on a set of traditional measurements described by Hubbs and Lagler [7]. Important thing is to take and look into each and every morphometric aspects of each and every fish in detail by standard methods. These characters are the external measurement of body parts which vary from species to species due to various causes [8]. This happens because some body parts tend to grow at different rates under varying environmental conditions [2, 3]. The morphometric relationships between various body parts of fish can be used to assess the well being of individuals and to determine possible difference between separate unit stocks of the same species [2, 4]. Fish are very sensitive to environmental changes and quickly adapt themselves by changing necessary morphometrics [2, 5]. Information the morphometric measurements of fishes and the study of statistical relationship among them are essential for taxonomic work [2, 6]. Some authors have realized and practiced that morphometric study can be successfully employed for asserting genetically and environmentally controlled characteristics in fishes [1-3, 5, 6, 9, 10]. As *Garra lamta* is a typical hill stream indigenous fish and play an important role to maintain the ecological balance of Petsal and Sironia garh, the tributaries of Suyal River of Kumaun Himalaya (India) hence study on its conservation and management is very essential. Many investigations have been carried out in India on the morphometric measurements of different fish species [1, 2, 3, 5, 6, 9-14]. However study on morphometry of *Garra lamta* is not available. So, the present study pertains to the morphometry of hill-stream fish *Garra lamta*, a common in habitant of spring-fed hill stream Petsal and Sironia garh of Suyal river in Kumaun Himalaya in relation to environment.

2. Materials and Methods
Fresh fish specimens were identified and collected from the field by visual discrimination with the help of Muslin net, Gwada and Hand grip, experty of local fishermen as regular monthly

task during the period October 2006 to September 2008 from the Petsal garh (elevation 1230msl), and Sironiya garh (elevation 1170msl), tributaries of Suyal river in a stretch of about 5km, which lies between 29°37′46.72″ N latitude and 79°43′38.39″ E longitude, 15 Km away in north from the District Head Quarter, Almora. Freshly living fish specimens were carried to the Zoological laboratory of Kumaun University, Soban Singh Jeena Campus, Almora for recoding the data of different measuremental aspects (24 characters viz. Total length (TL), Standard length (SL), Head length (HL), Length of caudal peduncle (LCP), Body depth (BD), Depth of caudal peduncle (DCP), Snout length (Snout), Pre dorsal length (PreDL), Post dorsal length (PostDL), Length of dorsal fin (LDF), Height of dorsal fin (HDF), Length of pectoral fin (LPcF), Height of pectoral fin (HPcF), Length of pelvic fin (LPvF), Height of pelvic fin (HPvF), Length of anal fin (LAF), Height of anal fin (HAF), Length of caudal fin (LCF), Height of caudal fin (HCF), Distance between pectoral and pelvic fin (Dist. Pc&Pv), Head depth (HD), Head width (HW), Inter orbital distance (IO), Eye diameter (ED)). As the indications were mentioned in the books [15, 16] and specimen were preserved in 5% formalin solution for further study. Statistical analyses of different data were then completed by the Application programme of Microsoft Excel.

3. Results

3.1 Natural History

Garra lamta is characterized by short and compressed body with blunt snout, anteriorly depressed head and transverse semi-circular inferior mouth. The upper and lower fleshy lips are continuous without lateral lobes. A semi-cartilaginous adhesive disc is present on the ventral side of the lower lips. Gill openings are restricted to sides. The maxillary and rostral pairs of barbels are present. Sub-cylindrical body, somewhat flattened on under surface, its depth 3.5 to 4.5 times in standard length. Head is short and tip marked off by a deep transverse groove, its length is 3.6 to 4.3 times in standard length, transverse lobe at tip and sides of snout in front of nostrils are covered with horny tubercles of the fish. Barbels are shorter than eye-diameter. Dorsal fin is inserted nearer the tip of snout than to the base of caudal fin of the fish. Pectoral fin is longer than head. Caudal fin is deeply emerginating. Scales are moderate in size, lateral line has 31 to 34 scales; predorsal scales are 8 to 10; breast and belly scaled but scales on breast are much reduced. Live specimen has the upper surface of dusky head, black dark, belly dirty white, a black spot behind angle of the operculum in *Garra lamta* of Petsal and Sironia garh of Kumaun Himalaya. Dorsal and caudal fins are dusky, the lateral fins with an oblique black longitudinal bar on its lower lobe have been observed in the study.

The 240 *G. lamta* specimens were studied for range difference and range proportion in respect to TL, SL and HL as follows:

3.2 Range difference

Different body characters show range difference from 0.08% to 10.90% when compared in the percentage of total length. The lowest range difference was observed in the length of dorsal fin (0.08%) and the highest range difference was observed with the length of caudal fin (10.90%) in *Garra lamta* in the present study. The length of caudal fin satisfied the intermediate controlled character (10-15%) and no environmentally controlled characters (>15%) were there in the case of *Garra lamta*. While other 22 characters out of 23 recorded as genetically controlled in the case of *Garra lamta* of Suyal river in Kumaun Himalaya (Table 1). Body characters when compared in percentage of standard length, out of 23 characters 21 characters have been recorded as genetically controlled in the study. Some 2 characters, intermediate (length of caudal fin and length of anal fin) and no were environmentally controlled in the growth study of *Garra lamta* in Suyal river of Kumaun Himalaya. The lowest range difference was observed in the length of pectoral fin (0.24) while the highest range difference was observed in the length of caudal fin (13.59) of *Garra lamta* of Kumaun Himalaya (Table 1). Comparing head related body measurement of *Garra lamta* with head length, the lowest range difference or no range difference were recorded in the case of eye diameter (0.00) and the highest range difference was observed in inter orbital and snout length of *Garra lamta* (36.0) in the study. Except eye diameter all 5 characters, (out of 6 characters) have been observed as environmentally controlled in the case of *Garra lamta* of Petsal and Sironia garh of Suyal river in Kumaun Himalaya (Table1).

3.3 Range Proportion

It was considered to calculate the ratio of different body parts in respect to total length of the fish. The morphometric case study of *Garra lamta* in Kumaun Himalaya shows the eye diameter found to be the smallest body part in fish in respect to total length (0.041), standard length (0.050) and head length (0.206) separately (Table 1). The standard length was the largest associated body parts in respect of total length of fish, the total length in respect to standard length and the predorsal was observed as the largest associated with head length of fish in the present study (Table 1).

Table 1: Percentage range, mean, standard deviation and proportion of different body parts of *Garra lamta* in relation to total length, Standard length and head length.

S. N.	Character	Range of %			Mean	Range difference	Proportion		
		Min-Max	Mean	D			Max	Min	Avg.
In relation to total length									
1.	SL	81.54-82.98	82.26	±0.72	7.3	1.44	0.894	0.698	0.818
2.	HL	19.23-21.28	20.25	±1.02	1.8	2.05	0.234	0.135	0.197
3.	LCP	12.77-16.92	14.84	±2.08	1.4	4.16	0.205	0.102	0.155
4.	BD	17.02-17.69	17.36	±0.34	1.6	0.67	0.214	0.141	0.179
5.	HD	12.77-14.62	13.69	±0.92	1.3	1.85	0.187	0.100	0.129
6.	HW	10.64-16.15	13.40	±2.76	1.3	5.52	0.200	0.104	0.152
7.	DCP	10.64-12.31	11.47	±0.83	1.1	1.67	0.156	0.092	0.117
8.	IO	8.51-14.62	11.56	±3.05	1.2	6.10	0.164	0.082	0.108
9.	ED	3.85-4.26	4.05	±0.20	0.4	0.41	0.071	0.021	0.041
10.	Snout	8.51-14.62	11.56	±3.05	1.2	6.10	0.216	0.045	0.097
11.	PreDL	40.00-40.43	40.21	±0.21	3.6	0.43	0.456	0.313	0.379

12.	PostDL	48.94-55.38	52.16	±3.22	4.8	6.45	0.559	0.403	0.516
13.	LDF	19.15-19.23	19.19	±0.04	1.7	0.08	0.209	0.163	0.189
14.	HDF	19.15-19.23	19.19	±0.04	1.7	0.08	0.209	0.163	0.189
15.	LPcF	16.92-17.02	16.97	±0.05	1.5	0.10	0.213	0.122	0.176
16.	HPcF	10.64-14.62	12.63	±1.99	1.2	3.98	0.171	0.082	0.123
17.	LPvF	10.64-15.38	13.01	±2.37	1.3	4.75	0.169	0.091	0.143
18.	HPvF	6.38-12.31	9.35	±2.96	1.0	5.92	0.132	0.061	0.106
19.	LAF	6.38-14.62	10.50	±4.12	1.1	8.23	0.167	0.063	0.137
20.	HAF	6.38-11.54	8.96	±2.58	0.9	5.16	0.150	0.061	0.106
21.	LCF	10.64-21.54	16.09	±5.45	1.7	10.90	0.302	0.106	0.182
22.	HCF	21.28-26.92	24.10	±2.82	2.3	5.65	0.347	0.130	0.260
23.	Dist. Pc & Pv	21.28-27.69	24.48	±3.21	2.3	6.42	0.308	0.194	0.244
In relation to standard length									
24	TL	120.51-122.64	121.58	±1.06	8.9	2.13	1.433	1.119	1.223
25	HL	23.58-25.64	24.61	±1.03	1.8	2.06	0.300	0.164	0.240
26	LCP	15.38-20.75	18.07	±2.69	1.4	5.37	0.246	0.125	0.190
27	BD	20.51-21.70	21.11	±0.59	1.6	1.19	0.260	0.167	0.219
28	HD	15.38-17.92	16.65	±1.27	1.3	2.54	0.233	0.123	0.158
29	HW	12.82-19.81	16.32	±3.50	1.3	6.99	0.250	0.085	0.186
30	DCP	12.82-15.09	13.96	±1.14	1.1	2.27	0.194	0.113	0.143
31	IO	10.26-17.92	14.09	±3.83	1.2	7.67	0.200	0.100	0.132
32	ED	4.72-5.13	4.92	±0.21	0.4	0.41	0.085	0.025	0.050
33	Snout	10.26-17.92	14.09	±3.83	1.2	7.67	0.253	0.056	0.118
34	PreDL	48.72-49.06	48.89	±0.17	3.6	0.34	0.581	0.382	0.464
35	PostDL	58.97-67.92	63.45	±4.48	4.8	8.95	0.760	0.500	0.631
36	LDF	23.08-23.58	23.33	±0.25	1.7	0.51	0.283	0.198	0.231
37	HDF	23.08-23.58	23.33	±0.25	1.7	0.51	0.283	0.198	0.231
38	LPcF	20.51-20.75	20.63	±0.12	1.5	0.24	0.283	0.149	0.215
39	HPcF	12.82-17.92	15.37	±2.55	1.2	5.10	0.209	0.096	0.151
40	LPvF	12.82-18.87	15.84	±3.02	1.3	6.05	0.217	0.111	0.175
41	HPvF	7.69-15.09	11.39	±3.70	1.0	7.40	0.164	0.071	0.130
42	LAF	7.69-17.92	12.81	±5.12	1.1	10.23	0.220	0.071	0.167
43	HAF	7.69-14.15	10.92	±3.23	0.9	6.46	0.195	0.071	0.130
44	LCF	12.82-26.42	19.62	±6.80	1.7	13.59	0.433	0.119	0.223
45	HCF	25.64-33.02	29.33	±3.69	2.3	7.38	0.415	0.161	0.317
46	Dist. Pc&Pv	25.64-33.96	29.80	±4.16	2.3	8.32	0.372	0.233	0.299
In relation to head length									
47	HD	60.00-76.00	68.00	±8.00	1.3	16.00	0.944	0.500	0.661
48	HW	50.00-84.00	67.00	±17.00	1.3	34.00	1.250	0.400	0.780
49	IO	40.00-76.00	58.00	±18.00	1.2	36.00	0.786	0.400	0.553
50	ED	20.00-20.00	20.00	±0.00	0.4	0.00	0.417	0.118	0.206
51	Snout	40.00-76.00	58.00	±18.00	1.2	36.00	1.118	0.250	0.492
52	PreDL	190.00-208.00	199.00	±9.00	3.6	18.00	2.909	1.500	1.939
D= Deviation									

4. Discussion

Morphometric characters were classified on the basis of range difference as genetically <10%, intermediate 10-15% and environmentally controlled >10% by Valdykov [17] followed by Johal *et al*. [10] Tondon *et al.* [3], Braich *et al.* [2] and Anupama *et al*. [9]. In the present study out of 23 characters 22 characters were observed to be genetically controlled, one character as intermediate controlled (LCF) and no character observed as environmentally controlled in respect to total length. In respect to standard length no genetically controlled character was recorded and two characters (LAF and LCF) recorded as intermediately controlled and other 21 recorded as genetically controlled. While in respect to head out of 6 characters one character was genetically controlled (ED) and all others were recorded as environmentally controlled character. Similar observation was also recorded by Anupama *et al.* [9] in *Barilius bandelesis* of Garhwal Himalaya. The phenotypic plasticity of fish allows them to respond adaptively to environmental change by modifications in their physiology and behaviour, which lead to changes in their morphology to survive, which mitigate the effect of environmental changes [5, 11]. Most of the genetical characters show that the environment has least impact on fish *Garra lamta* still today in the Petsal and Sironia garh (tributaries) of Kumaun Himalaya. According to Goswami and Dasgupta 2007 [13] morphometric characters of fish can vary under the influence of the environment and, in particular, the thermal factor during the period of incubation and the beginning of larval life. While the head related character depict that head portion of fish is inclined towards environmental effects. Different body proportions of *Cirrhinus Reba* and *Botia dayi* have been studied by Tandon *et al.* [3] Johal *et.al.* [10] and Dobriyal *et al.* [1], respectively. Significant body proportions have been recorded with total length and the value of average proportion ranged from 0.041 ED to 0.818 SL. The standard length has the value of average proportion ranged from 0.050 ED to 1.223 TL (Table 1). The head length has the value of average proportion ranged from 0.206 ED to 1.939 PreDL (Table 1). So, the least growing body part is ED in respect to TL, SL and HL while the most growing part is SL, TL and PreDL, respectively. Various statistical analysis have shown that the *Garra lamta* confirms the proportionate growth among the various body parts beside the fact, the result of the present study also explain that *Garra lamta* living in the

Petsal and Sironia garh of Suyal river, started morphological divergence form its head. It may be due to environmentally induced phenotypic variations, which may have advantages in the fish stock structure, especially when the time is insufficient for significant genetic differentiation to accumulate among populations. Similar observation also reported by Hossain *et.al.* 2010 [5] in *Labio calbasu.*

5. Acknowledgements
The author is thankful to the Head, Department of Zoology, S.S.J. Campus Almora for laboratory facility.

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