The Pharma Innovation Journal 2018; 7(2): 17-20

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2018; 7(2): 17-20

www.thepharmajournal.com
Received: 10-12-2017
Accepted: 12-01-2018

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Morphometric characterstics of silver carp (*Hypophthalmichthys molitrix*) under captive conditions

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Abstract
A study on morphometric relationship of Silver carp (*Hypophthalmichthys molitrix*) was conducted on the fish specimens followed by estimation of water quality and qualitative assessment of plankton community in a fish farm of Tarai region of Pantnagar, Uttarakhand. The descriptive statistical parameters and correlation coefficient (r) were analysed with independent variable (total length) and dependent variable (other morphometric parameters). The result shows that morphometric parameters are significantly correlated to total length except caudal length. The maximum correlation coefficient of average total length was obtained with fork length having a value of 0.992 and minimum with caudal length with value of 0.323. The average values of Temperature (°C), pH, TDS (mgl^{-1}), DO (mgl^{-1}), CO_2 (mgl^{-1}) were 27.2, 7.5, 287, 6.0 and 1 respectively. The qualitative analysis of the community resulted in 6 and 2 species of phytoplankton and zooplankton respectively. Water quality parameters and diversity of plankton community revealed the conducive environment of the water body.

Keywords: Morphometry, Plankton, Silver carp, Total length, Water quality.

Introduction
Silver carp (*Hypophthalmichthys molitrix*) is one of the most economically important and cultivable cyprinid species. Naturally found in river, reservoir, lake and cultured ponds, the fish has very high market demand and contributes a major portion to the fresh water fish production of India. The fish dwells in temperate conditions (6-28 °C) and its natural distribution is in Asia. It has laterally compressed and deep body with a large head. Silver carp is a filter feeder with sponge like gill rakers used for filtration and feeds largely on phytoplankton. *Hypophthalmichthys sp.* is native to China and Eastern Siberia, but has been introduced to many other countries for culture, sports and controlling algal blooms. China is the largest producer of Silver carp, while India and Bangladesh are also major producers.
Morphometric measurement of fishes is essential for systematic, taxonomic study and growth variability (Tandon *et al.*, 1993) **[14]** and gives substantial information with regard to exact identification key for a particular species. Morphometric study is considered a powerful tool for characterizing stocks which involves detection of subtle variation of shape (Sharma *et al.*, 2015) [13]. The study of morphological divergence is one of the most employed and cost-effective methods of phenotypic characterization for fish stock identification (Chisty, 2002) [3]. Morphometrics have been used in culture studies for assessing population, cohorts, biomass and estimation of health of fish (Gerritsen and McGranth, 2007; Hockaday *et al*., 2000) [4, 6]. Length measurements are often used to construct a length-weight relationship as these can be obtained under a large range of circumstances than weight measurements (Loy *et al.*, 2000) [7]. Body length is often preferred while sampling because it is relatively easy and fast to measure in the field (Sharma, 2000) [12] and it is vital for assessment of weight for individual fish, standing-crop biomass, life history and biological comparisons of fish populations, stock assessment models, study of length classes of fish and conversion of growth-in-length equations for prediction of weight-at-age in fishes from different or same locations (Sharma, 2000) [12]. The present work was taken up for the morphometric study of *Hypophthalmichthys sp*., in a fish farm of Tarai region of Pantnagar, Uttarakhand to collect the information on growth of fish.

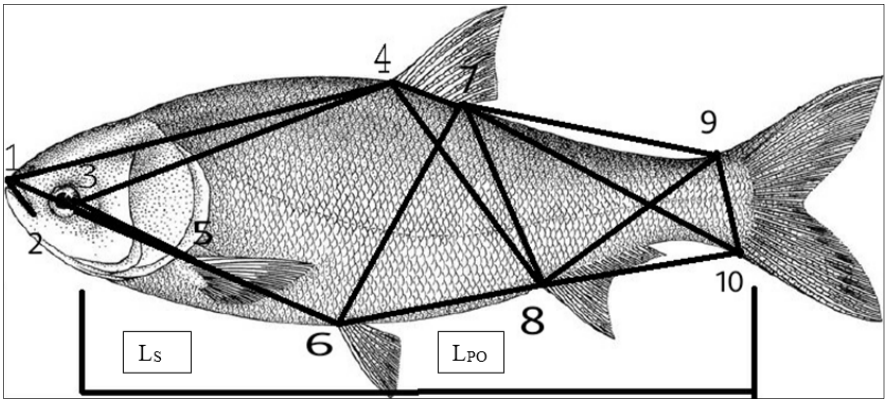
Materials and Methods
Study area
The morphometric data for the present study was collected from the Instructional Fish Farm of College of Fisheries, Govind Ballabh Pant University of Agriculture and Technology,

Pantnagar, Udham Singh Nagar, Utttarakhand, India. The College of Fisheries, Pantnagar is geographically located at 29° N latitude, 79.3° E longitude and an altitude of 243.3 m above mean sea level (MSL), in the *Tarai* belt of Shivalik range of Himalaya.

Fish Sample collection

20 specimens of silver carp of both the sexes were randomly collected from a stocking pond of Instructional fish farm of the College. Measurements of the collected fishes were taken with the help of a measuring board fitted with a meter scale.

Morphometric measurements



Points refer to:

1. Snout
2. End point of upper lip
3. Posterior point of the eye
4. Origin of dorsal fin
5. Origin of pectoral fin
6. Origin of pelvic fin
7. Posterior end of dorsal fin
8. Origin of anal fin
9. Dorsal attachment of caudal fin to tail
10. Ventral attachment of the caudal fin to the tail

L_S- Standard Length

L_{PO}- Post Orbital Length

Water sampling

Water sampling was performed at 10 days interval for 50 days from the mid of March to the end of April. Water samples were collected in cleaned and rinsed sterile plastic bottles. Physical parameters including water temperature and Total Dissolved Solids (TDS) and chemical parameters including water pH, dissolved oxygen (DO) and free carbon dioxide (CO_2) were estimated from the water samples. Sampling of plankton including both phytoplankton and zooplankton was performed by using fine meshed plankton net.

Water quality and Plankton analysis

Water temperature and TDS was measured using TDS and Temperature Meter (HM Digitals) respectively and other water quality parameters were measured following (APHA, 2005). Planktons were preserved using 5% formalin and observed under microscope for the qualitative analysis of zooplankton under 10X and phytoplankton under 40X. Plankton were identified following water quality manual (Onsoy, 2011) [10].

Statistical analysis

The relationship of various logarithm transformed morphometric parameters on total length was obtained by using R software. The regression equation was calculated using the equation Y = a + b X where 'Y' is the dependent variable (other morphometric parameters like standard length, head length etc.), 'a' is the intercept value, 'b' is the regression coefficient and X is the independent variable (total length).

Results and Discussion

Twenty five morphometric characters of Silver carp samples collected from the stocking pond of the fish farm were studied during the investigation period. The morphometric measurements for Silver carp is presented in Table-1.The table depicts that the average value of total length, standard length, fork length, post orbital length, snout length, snout to origin of dorsal fin, snout to origin of pelvic fin, posterior point of eye to origin of dorsal fin, posterior point of eye to origin of pectoral fin, posterior point of eye to origin of pelvic fin, origin of dorsal fin to origin of pectoral fin, body depth, dorsal fin length, origin of dorsal fin to origin of anal fin, origin of pectoral fin to origin of pelvic fin, origin of pelvic fin to posterior end of dorsal fin, distance between pelvic and anal fin, posterior end of dorsal fin to origin of anal fin, caudal peduncle length, caudal length, posterior end of dorsal fin to ventral attachment of caudal fin to the tail, origin of anal fin to dorsal attachment of caudal fin to the tail, origin of anal fin to ventral attachment of caudal fin to the tail and caudal depth and were 44.25, 37.06, 40.44, 32.22, 2.99, 19.02, 16.45, 15.50, 6.08, 13.83, 12.94, 11.80, 4.59, 12.14, 7.86, 12.73, 9.18, 10.33, 14.08, 7.18, 15.34, 12.48, 10.69 and 5.52 cm respectively whereas the average value of body weight was 0.81 kg. The total length (independent variable) was kept on y-axis while other morphometric parameters (dependent variable) on x-axis and it was observed that significant correlations exist in all the morphometric parameters except with caudal length ($p<0.05$). The maximum correlation coefficient of average total length was obtained with fork length having a value of 0.992 and minimum with caudal length with value of 0.323. Significant correlation of the morphometric parameters with total length was reported in *Hypophthalmichthys sp*. from Pantnagar farm of Uttarakhand. Similar results were also observed by Negi and Negi, 2010 [9] in *S. richardsonii* from Uttarkashi district of Uttarakhand and

from two Different Ponds of Vadodara City, Gujarat (Pathak *et al.*, 2013) [11].

Water quality can be regarded as a network of variables that are linked and co linked; any changes in these physical and chemical variables can affect aquatic biota in a variety of ways (Wagle *et al.*, 2015) [15]. The measured abiotic factors were found in optimum range for supporting fish growth. The average values of Temperature (°C), pH, TDS (mgl^{-1}), DO (mgl^{-1}), CO_2 (mgl^{-1}) were recorded 27.2, 7.5, 287, 6.0 and 1 respectively. According to Goswami and Dasgupta, 2007 [5] the environment influences morphometric characters of fish and environmentally induced phenotypic variations have advantages in the fish stock structure.The qualitative analysis of the community resulted in 6 and 2 species of phytoplankton and zooplankton respectively. Phytoplankton community included *Scenedesmus sp., Navicula sp., Euglena sp., Synedra sp., Melosira sp., Nitzchia sp.,* whereas Zooplankton community included *Cyclops sp. and Daphnia sp.* Optimum temperature and TDS also promoted the growth of phytoplankton community in the selected ecosystem which are vital as they are preferred natural food of Silver carp. The results are also supported by Ansari *et al.*, 2015 [1] who worked in a pond in Hazira.

Conclusion

In conclusion, the analyses of the present study stated the relationship of total length with other morphological characters of Silver carp population of the selected pond. The results revealed that the total length and other morphometric parameters of Silver carp were significantly correlated. The positive correlation coefficient indicated that there was proportional increase in the morphometric parameters in comparison with the total length. The limnological parameters and planktonic organisms were also analysed and can be said to promote the growth of fishes dwelling in the system. It can also be concluded that the prevailing conditions of the cultured pond are conducive for the better growth of the cultured fish.

Acknowledgement

Authors thank the staff of Department of Fisheries Resource Management and Farm staff, College of Fisheries, Pantnagar for their valuable support during the investigation period.

Table 1: Measured morphometric parameters[#] of Silver carp samples [#]Lengths are measured in centimeter (cm)

S. No.	Parameters	Min- Max	Range	Mean± SD	r	Y=a+b*X
1	Total Length	37.9-58.5	20.6	44.25± 6.27		
2	Standard Length	31.6- 49.3	17.7	37.06± 5.51	0.987	Y= 2.628+ 1.123 X
3	Fork length	34.5-54.6	20.1	40.44±6.11	0.992	Y=3.078+1.018 X
4	Post Orbital Length (LPO)	27.2- 43.2	16.0	32.22± 5.01	0.983	Y= 4.624+ 1.230 X
5	Snout length (1-2)	2.0-4.0	2.0	2.99±0.59	0.658	Y= 23.463+6.945 X
6	Snout to origin of dorsal fin (1-4)	14.8-24.2	9.4	19.02± 2.19	0.857	Y=-2.441+2.454 X
7	Snout to origin of pelvic fin (1-6)	9.2- 23.0	13.8	16.45±4.06	0.863	Y=22.311+1.334 X
8	Posterior point of eye to origin of dorsal fin (3-4)	13.8-21.0	7.2	15.50±2.07	0.951	Y= -0.394+ 2.879 X
9	Posterior point of eye to origin of pectoral fin (3-5)	5.0-7.8	2.8	6.08±0.84	0.764	Y= 9.668+5.688 X
10	Posterior point of eye to origin of pelvic fin (3-6)	10.9- 18.3	7.4	13.83±2.33	0.815	Y= 13.932+2.192 X
11	Origin of dorsal fin to origin of pectoral fin (4-5)	11.2- 16.0	4.8	12.94±1.43	0.807	Y= -1.584+ 3.542 X
12	Body depth (4-6)	9.9-14.2	4.3	11.8±1.32	0.876	Y=-4.740+ 4.152 X
13	Dorsal fin base (4-7)	3.0-6.2	3.2	4.59±0.94	0.905	Y=16.583+6.024 X
14	Origin of dorsal fin to origin of anal fin (4-8)	9.4-15.8	6.4	12.14±1.77	0.946	Y= 3.696+3.339 X
15	Origin of pectoral fin to origin of pelvic fin (5-6)	6.3- 10.3	4.0	7.86±1.05	0.941	Y=0.191+5.601 X
16	Origin of pelvic fin to posterior end of dorsal fin (6-7)	10.2-15.0	4.8	12.73±1.21	0.722	Y=-3.216+3.728 X
17	Distance between pelvic and anal fin (6-8)	7.1- 12.2	5.1	9.18±1.22	0.722	Y= 10.236+ 3.703 X
18	Posterior end of dorsal fin to origin of anal fin (7-8)	8.6-12.3	3.7	10.33±1.06	0.846	Y= -7.372+ 4.996 X
19	Caudal peduncle length (7-9)	10.2-17.5	7.3	14.08±1.89	0.743	Y=9.636+2.457 X
20	Caudal length	4.2-9.4	5.2	7.18±1.46	0.323	Y=34.300+1.385 X
21	Posterior end of dorsal fin to ventral attachment of caudal fin to the tail (7-10)	13.5- 19.8	6.3	15.34±2.04	0.909	Y= 1.387+ 2.793 X
22	Origin of anal fin to dorsal attachment of caudal fin to the tail (8-9)	10.6-15.6	5.0	12.48±1.34	0.918	Y=-9.361+4.296 X
23	Origin of anal fin to ventral attachment of caudal fin to tail (8-10)	8.4-13.6	5.2	10.69±1.43	0.758	Y= 8.904 +3.306 X
24	Caudal depth (9-10)	4.2-7.0	2.8	5.52±0.74	0.842	Y=4.890+7.122 X

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