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Morphometric and Meristic characterization of Golden Mahseer (*Tor putitora*) from Jiabharali River, Assam, India

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ABSTRACT

Golden mahseer (*Tor putitora*) is one of the endangered species of game and food fish that is found in rapid streams, riverine pools, and lakes in the Himalayan region and southern Asia. Keeping in view, the basic necessity of having a knowledge on the biology of *T. putitora* (Actinopterygii: Cypriniformes: Cyprinidae) indigenous to the highlands of North-Eastern India, coupled with its great economic importance and also because of the gaining popularity of culturing, the present investigation has been undertaken. The results showed considerable differences in several morphometric parameters between male and females of *T. putitora*. The study revealed intra-specific difference as well as sexual dimorphism, at least in some morphometric characters, viz., number of lateral line scales, gape, rostral barbell length, pectoral fin height. The results of the biometric characters for *T. putitora* revealed that eye diameter becomes smaller in relation to head length. The trends of growth of girth in relation to total length were found to be isometric. The growth of head length in relation to total length is allometric in the case of *T. putitora.*

Keywords: Golden mahseer, Morphometry, Meristic coun, Jiabharali River

INTRODUCTION

Morphometric characters are used frequently in the identification of species of fish (Day, 1878, 1889; Jayaram, 1981; Shafi and Quddus, 1982; Bhuiyan and Biswas, 1984; Rahman, 1989; Talwar and Jhingran, 1991). McConnel (1978) stated that the information on morphometric measurements of the fishes and the study of statistical relationships could play an important role in the taxonomic studies of fishes. On the other hand the morphometric characters of wide and medium range contribute in the indication of population of a species inhabiting the different water bodies or in different geographical regions. It is well known that ecological conditions of a water body have great impact on morphometric characters.

The term 'Mahseer' refers to a group of freshwater cyprinid easily distinguishable by relatively larger size of scales on their body compared to the other cyprinid fishes. The members of Mahseer belong to two genera, viz., *Tor* and *Neolissochilus*. They inhabit in the

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mountain streams and distributed in the range throughout Southern Asia to Southeast Asia. Among the Mahseer of the Indian subcontinent, *Tor tor, Tor putitora* is widely distributed in India, Nepal, Bhutan, and Pakistan; while *Neolissochilus hexagonolepis* is distributed in Nepal, Bhutan, North India and Northeast (NE) India (Laskar *et al.,* 2013).

T. putitora has been assessed as Endangered in the IUCN Red List (Jha, IUCN, 2016). The threatened species, viz., *Tor putitora* is regarded as the flagship species in NE India (http://www.nbfgr.res.in/). A few studies suggest that the angling of Mahseer provides superlative thrills than any other sport fishes except European Salmon. They are highly sought-after because of great attraction to recreational anglers and are important components of the Angling-tourism pursuit. (Laskar *et al.*, 2013). *T. putitora* is a highly valued food and game fish. Moreover, it has also been reported to have medicinal values (IUCN Red List of threatened species, 2016).

Keeping in view, the basic necessity to have knowledge on the general biology of the Mahseers indigenous to the North-Eastern India, a study has been undertaken on the identification, biology and propagation of *Tor putitora* at morphometric and meristic levels. The information on morphometric measurements of the fishes and the study of statistical relationships play an important role in the taxonomic studies of fishes. The morphometric characters of wide and medium range contribute in the indication of population of a species inhabiting the different water bodies or in different geographical regions.

Hamilton (1822) first classified mahseers and placed *Tor* species under the genus *Cyprinus*. He recognized three species of mahseers; *Cyprinus tor*, *C. putitora* and *C. mosal*. Gray (1833) created genus *Tor* to accommodate these. Sykes (1838) in his valuable work on "the fishes of Deccan" described three new barbels under the genus *Barbus cuvier* namely *Barbus mussullah*, *Barbus khudree* and *Barbus kolus* of which first two species were subsequently included under genus *Tor gray* while *B. kolus* with its two barbels and an uninterrupted labial groove has been recognized as *Puntius kolus* by the recent taxonomists.

From the years, 1943 to 1944, MacDonald in his series of articles "Circumventing the Mahseer and other sporting fish in India and Burma" described Mahseer from different localities of Assam without any specific scientific names. Menon (1974) in his extensive survey work reported *Tor putitora* (Ham) from Nepal.In 1982, Das and Day described the prevalence of *Tor putitora* (Ham) and *Tor tor* (Ham) in the Jia Bharali river of of Assam. While working on the fish fauna of Meghalaya, Sen (1982) reported *Tor putitora* (Ham) from the rivers Umium and Umtrew and *Tor tor* (Ham) fro the rivers Umium and Simsang. Both the species are locally called as "kha-mahseer". Nath (1986) described *Tor putitora* (Ham) and *Tor tor* (Ham) from the rivers Barak, Chiri, Jiri, Madhura, Jatinga and Sonai of Barak drainages. Das (1989) studied the systematic and bio-ecology of the Ichthyospecies belonging to the genus *Tor gray* from Jia-Bharali drainages of Assam. Dasgupta (1991) carried out Biometry of the Mahseer *Tor putitora* (Hamilton) collected from Garo Hills, Meghalaya. Zafar *et al.* (2002) carried out studies on meristc and morphometric measurements of Mahseer (*Tor putitora*) from a spawning ground of Himalayan foothill river Korang of Islamabad, Pakistan. Langer *et al.* (2013) studied morphometric and meristic study of Golden Mahseer (*Tor putitora*) from Jhajjar Stream (J and K), India and found Positive correlation has been observed between total length and external body parts. Thus, population appeared to be relatively uniform in all the characters examined, thus followed an isometric pattern. However, little is known about identification, characterization and conservation of the *Tor putitora* from Jiabharali river, Assam. Therefore the present study has been conducted for morphometric and meristic characterization of Golden Mahseer *Tor putitora* from Jiabharali River, Assam, India

MATERIALS AND METHODS

The study area: The present study focuses on the morphometric and meristic characterization of the golden Mahseer (*Tor putitora*) in the Jiabharali river (Tributary of River Brahmaputra) of Assam including The GPS location of the study area is $26^{0}48^{/}51^{//}$N latitude and $92^{0}52^{/}05^{//}$E longitude.

Sample collection: Mahseer sampling (*Tor putitora)* was done from March 2018 to May, 2018 (Figure 1). Altogether three survey stations had been selected after straight forward approach of normal random sampling (Rao *et al.*1966) for the river Jia Bharali covering upper (Bhalukpong), middle (Toubhanga) and lower (Chowkighat) reaches amongst all the possible sites including characteristic of bottom conditions. A total of 60 specimens of Mahseer were collected from different sections of Jiabharali river. *Tor putitora* in the size range of 85.0 to 250.0 mm were utilized for the study were collected from the fishermen catch by various types of nets from the three survey stations of the Jiabharali river during the period.

Total weights have also been recorded to the nearest 0.1 gm in a digital balance. The meristic and morphometric measurements were done with the help of magnifying glass model 50 mm. dia (China), stage microscope, electric balance, scales, divider and digital Vernier caliper (Brand- MITUTOYO), weight was taken using digital balance etc.

In the well-equipped Fish and Fishery Biology Laboratory of the Zoology Department of Darrang College, Tezpur, the species were morphologically and morphometrically studied and identified from various authorative sources including Day (1878, 1889), Misra (1959), Menon (1974), Dey (1976) and Jayaram (1981) and classification was followed after Hamilton (1822) and McClelland (1839). For the morphometric and meristic characters the procedures Jayaram (1981) was followed.

Study of phenotypic character

Measurements of various body proportions were taken with utmost care. All are straight point to pint measurements taken with digital calipers and with fine pointed needles and dividers. 22 morphometric characters has been considered for phenotypic characterization of *Tor putitora* (Table 1. Figure 1.)

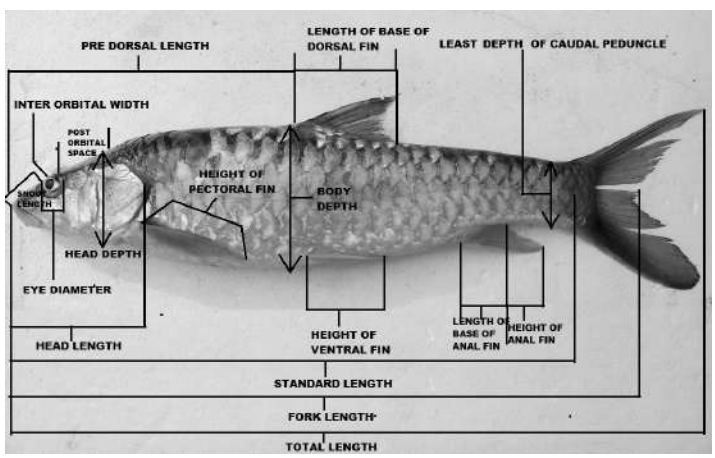

Figure 1. Morphometric parameters followed for study of *Tor putitora*

Morphometric Characters

Table 1. The morphological characters measured

Sl No.	Characters	Description
1	Total length (TL)	Distance from the tip of the snout to the end of the caudal fin
2	Standard Length (SL)	Distance from the anterior part of the head to the end of vertebral column
3	Head length (HL)	Distance from the tip of the snout to the posterior margin of the opercula
4	Pre dorsal length (PDL)	Distance from the snout tip to the anterior base of the dorsal fin
5	Snout length (SL)	Distance from the tip of the snout to the front margin of the orbit
6	Eye diameter (ED)	Distance between margins of the eye ball across the cornea
7	Post-orbital space	Distance from hind margin of the orbit to the posterior edge of the opercular bone.
8	Inter-orbital width	The least bony width from orbit to orbit
9	Length of upper jaw	Distance from the anterior most point of the premaxillary to the posterior point of the maxillary.
10	Gape	Distance between the upper and lower jaw with the mouth widely open
11	Length of the barbels	Distance from base to the proximal end of the barbels
12	Head depth	Vertical distance from the end of the nape to the ventral side of the head
13	Body depth	Vertical distance between the dorsal and ventral surface to the body at its greatest depth
14	Least height of the body	Shortest vertical distance between the dorsal and the ventral surface of the caudal peduncle.
15	Length of the dorsal fin	Distance between the anterior and posterior end of the dorsal fin taken along the base
16	Length of free margin of dorsal fin	Distance from the anterior to posterior end of the dorsal fin taken along the free margin
17	Height of dorsal fin	Height of the longest fin ray of the dorsal fin
18	Height of pectoral fin	Height of the longest fin ray of the pectoral fin
19	Height of the ventral fin	Height of the longest fin ray of the ventral fin
20	Height of the anal fin	Height of the longest fin ray of the anal fin
21	Length of the base of the anal fin	Distance between the anterior and posterior end of the anal fin taken along the base
22	Girth	Circumference of the body at its deepest point

Meristic Characters: The following meristic counts were made according to methods as outlined by Jayaram (1981).

a) Number of rays in the dorsal fin; b) Number of rays in the pectoral fin; c) Number of rays in the ventral fin; d) Number of rays in the anal fin; e) Number of rays in the caudal fin; f) Number of lateral line scales; It represents the member of pored scales on the lateral line. The count was taken from the scale in contact with the shoulder girdle, to the structural caudal base; and g) Number of lateral line transverse scales: Scales above lateral line have been counted from the origin of the' dorsal fin and counted downward and backward to (but not including) the lateral line scale. Scales below the lateral line have been counted upward and forward from the origin of the anal fin.

All the above mentioned measurements and counts were made on the left side of the fish. The specimens of all the three species taken up for the present study were grouped into 50.0 mm length groups for convenience sake by pooling the data together, viz., Group I: 50,0 - 100.0 mm, Group II: 101 - 15-0 mm and so on. However, only 4 groups of *T. putitora* could be made.

Biometric Index

The number of times each character went into the reference length of the fish was considered as the Biometric Index (Tobor, 1974). The characters taken were: Head length (H.L), Inter-orbital length (I.O.L), Eye-diameter (E.D), Gape (G), and Girth, for each characters a mean index for each 50.0 mm length group has been calculated to see whether it is constant or varying with the increase in total length, Biometric index was calculated for *T. putitora.*

RESULTS AND DISCUSSION

A total of 60 specimens of Mahseer were collected from different sections of Jiabharali river. A monthly average of 20 specimens of *Tor putitora* utilized for the study were collected from the fishermen catch by various types of nets from the three survey stations of the Jiabharali river during the period.

MORPHOMETRIC AND MERISTIC CHARACTERS OF *Tor putitora*

Morphometric Characters:

The morphometic and meristic observation has been listed in Table 2 & 4. The difference in the morphometric parameters between males and females of *T. putitora* are well defined (Table 3). The Fin formula of *Tor putitora* is found as: D iv 8; A ii 5; P i 16-17; V i 8

Table 2. Morphometric measurements of *Tor putitora.* (N=60)

	Tor putitora	
	% standard length (in mm)	
Parameters	**Mean**	**Range**
Total length	131.32	129.65-137-64
Fork length	12.24	111.88-115.32
Predorsal length	52.89	52.07-56.10
Head length	31.34	29.03-31.99
Head depth	18.46	17.73-23.36
Body depth	25.65	24.52-29.01

Least height of caudal peduncle	11.18	10.22-13.05
Length of caudal peduncle	17.44	15.45-18.29
Dorsal fin length	13.74	13.39-15.17
Length of free margin of dorsal fin	19.29	17.89-21.13
Dorsal fin height	24.05	22.83-28.57
Pectoral fin height	20.24	19.62-24.85
Ventral fin height	17.83	17.73-21.87
Anal fin height	21.05	18.92-23.36
Anal fin base	7.69	6.62-8.92
Girth	61.87	59.05-73.36
	% Head length (in mm)	
Parameters	**Mean**	**Mean**
Snout length	41.31	41.31
Eye diameter	21.21	21.21
Post- orbital head length	46.87	46.87
Inter-orbital length	13.14	13.14
Length of Upper jaw	29.92	29.92
Gape	36.11	36.11
Rostral barbel length	29.09	29.09
Maxillary barbel length	37.57	37.57

MORPHOMETRIC COMPARISION OF THE MALES AND FEMALES OF *Tor putitora*

Table 3. Morphometric analysis of the male and female of *Tor putitora*

PARAMETERS	**% Standard length (in mm)**	
	Male	**Female**
Total length	132.43	133.23
Fork length	114.18	115.21
Predorsal length	54.05	54.80
Head length	31.75	32.00
Head depth	19.59	19.79
Body depth	25.00	25.23
Least height of caudal peduncle	11.48	11.63

Length of caudal peduncle	16.21	17.31
Dorsal fin length	14.86	15.05
Length of free margin of dorsal fin	19.59	19.89
Dorsal fin height	25.00	25.36
Pectoral fin height	20.94	21.25
Ventral fin height	19.59	20.11
Anal fin height	20.94	20.13
Anal fin base	7.43	7.53
Girth	67.56	68.17
Snout length	34.04	34.50
Eye diameter	17.02	17.36
Post- orbital head length	51.06	51.16
Inter-orbital length	38.29	38.51
Length of Upper jaw	31.91	32.05
Gape	40.42	40.53
Rostral barbel length	21.27	21.47
Maxillary barbel length	34.04	35.32

Table 4. Meristic characters of *Tor putitora*

	Tor putitora	
Parameters	**Mean**	**Range**
No. of dorsal fin rays	4/8	4/8 (Const.)
No, of pectoral fin rays	17.50	17-18
No. of ventral fin rays	9	9 (Const.)
No. of anal fin rays	3/5	3/5 (Const.)
No. of caudal fin rays	19	19 (Const.)
No. of lateral line scales	27.6	25-28
No. of lateral line transverse scales	4/2	4/2 (Const.)
Pre-Dorsal scales	11.5	10-13
Circumpeduncular scales	13	12-14

REGRESSION EQUATIONS:

The regression equations for various morphometric parameters studied for *Tor putitora* have been presented in Table 5.

Table 5. Regression Equations of Morphometric measurements of *Tor putitora.*

Parameters	Regression equations	Correlation -
Total length (Y) on Standard length (X)	Y= 7.8493 + 1.2559 X	0.9994
Fork length (Y) on Standard length (X)	Y= 35.3946+ 1.4643 X	0.9781
Predorsal length (Y) on Standard length (X)	Y= 2.0832+ 0.5278 X	0.9994
Head length (Y) on Standard length (X)	Y= 2.5112 + 0.2787 X	0.9983
Snout length (Y) on Standard length (X)	Y= -0.9645 + 0.2477 X	0.4033
Eye diameter (Y) on Standard length (X)	Y= 2.6924 + 0.0409 X	0.9933
Interorbital dist (Y) on Standard length (X)	Y= 1.5151 + 0.9935 X	0.9935
Gape (Y) on Standard length (X)	Y= 0.8394 + 0.1007 X	0.9351
Rostral barbel length (Y) on Std length (X)	Y= 2.2731 + 0.0615 X	0.9996
Head depth (Y) on Standard length (X)	Y= 4.5722 + 0.1622 X	0.9972
Body depth (Y) on Standard length (X)	Y= 10.0129 + 0.2134 X	0.9501
Length of Caudal peduncle (Y) on Std lngth (X)	Y= -1.5977 + 0.1825 X	0.9837
Dorsal fin length (Y) on Standard length (X)	Y= 1.8418 + 0.1298 X	0.9881
Dorsal fin height (Y) on Standard length (X)	Y= 2.6880 + 0.2458 X	0.9976
Pectoral fin height (Y) on Standard length (X)	Y= 5.6000 + 0.1678 X	0.9964
Anal fin height (Y) on Standard length (X)	Y= 5.3555 + 0.1608 X	0.9933
Anal fin base (Y) on Standard length (X)	Y= 2.5068 + 0.0534 X	0.9699
Girth (Y) on Standard length (X)	Y= 11.9981 + 0.5794 X	0.9975

Biometric index in *T. putitora*:

For each character a mean biometric index for each 50 mm length groups has been calculated and presented in Table 6**.** The growth of girth in relation to total length is isometric whereas the growth of head length in relation to total length and growth of inter-orbital distance and gape in relation to head length is allometric showing wide variations. The growth of eye diameter in relation to head length shows negative allometry with slight variation in length group IV (201-250 mm (Table 6.)

Table 6. Mean biometric indices in different length groups of *Tor putitora*

PARAMETERS	Gr. I 50-100 (mm)	Gr II 101-150 (mm)	Gr. III 151-200 (mm)	Gr. IV 201-250 (mm)
TL/HL	4.30	4.41	6.13	6.92
HL/Sn.L	2.79	2.60	1.89	1.57
HL/POL	2.26	2.41	1.63	1.39
HL/ED	3.91	4.22	1.66	4.50
HL/IOD	2.26	2.95	1.93	1.81
HL/G	2.68	2.95	1.93	1.81
HL/RBL	3.30	3.54	2.76	2.49
HL/MBL	2.98	2.92	2.13	2.21
HL/AFB	3.58	4.04	2.76	2.85
TL/GIRTH	1.88	1.99	1.99	1.99

The results of the present study showed high morphological variation in total length, head length and maxillary barbell lengths between male and female *T. putitora*. In *T. putitora*, the growth of head length in relation to total length is allometric. In *T. putitora* the growth of inter-orbital distance in relation to head length was found to be allometric and showed wide variations.

Nikolsky (1963) stated that males and females often differ in the length and shape of the fins, according to him, in the males of many Cyprinoids, both the paired and the unpaired fins are slightly larger than the females. Hence, such a difference in the morphometric characters of males and females may be regarded as sexual- dimorphic characters. According to Gould (1966) ratios between morphological characters will not necessarily be constant for the organisms of the same species due to variation resulting from differences in sex, race and nutrition and/or other environmental factors, Therefore, in the present study too, variations in morphometric measurements may be attributed to the diverse environmental factors.

Goswami *et al* (2012) reported the commonly found Mahseers belonging to *Tor* species are *: Tor progeneius, Tor putitora, Tor chelynoides, Tor mosal, Tor tor,* and from *Neolissochilus* species are *Neolissochilus hexagonolepis, Neolissochilus hexastichus*. Various authors have shown that morphometric characters of fish can vary under the influence of environments and in particular the thermal factor during the period of incubation and the beginning of larval life (Taning, 1944; Lindsay, 1954; Barlow, 1961). Variations in the body proportions in the same species according to hydrographic conditions have also been recorded by various authors (Hubbs, 1922; Barlow, 1961). They associated these variations with the effect of the duration of periods of growth and

of the relating differentiations which determines the number of vertebrae and of segments. Many authors (Schmidt, 1921; Vladykov, 1934; Barlow, 196I) have reported that meristic characters exhibit plasticity under the influence of environmental factors, as has also been seen in the present study.

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