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COMPARATIVE MORPHOMETRIC, MERISTIC AND OSTEOLOGICAL STUDIES ON ADULT AND YOUNG HILSA (*TENUALOSA ILISHA*)

Md. Monuar Hosen Talukder[1], Majedul Hoque[2]* and Ismot Ara[1]

[1]Department of Zoology, Jahangirnagar University, Dhaka, Bangladesh
[2]Depatment of Pharmacy, Jahangirnagar University, Dhaka, Bangladesh

**Corresponding author*: majed.pharmju44@gmail.com

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Abstract: *Tenualosa ilisha* (matured/adult) and jatka (immature/young), locally known as Ilish, is designated as the national fish of Bangladesh. Both the stages were collected from different fish markets from Savar, Bangladesh during the exploration. This study was carried out on comparative morphometric, meristic and osteology between the *Tenualosa ilisha* (matured) and jatka (immature/young). The morphometric characteristics were higher in matured *Tenualosa ilisha* than immature jatka and among them head length, pre-dorsal length, postorbital length, the height of anal fin, eye diameter length, and abdominal region length were found significantly different. The proportion of standard length and snout length, head length and snout length, abdominal region length and standard length were significantly different between the two stages. Among the meristic characteristics; number of dorsal fin rays, anal fin rays and scales on the lateral line were found with little differences between matured hilsa and jatka. There are very small differences in the number of scales, scutes and fin rays of different fins between the two stages of fishes. The osteological comparison reveals more or less identical structure. Most of the bones of the skull were similar in structure but differed in size, shape and thickness.

Keywords: Fin, Fish, Jatka, Morphometric, River, Skeleton, *Tenualosa ilisha*.

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INTRODUCTION

Hilsa, *Tenualosa ilisha* (Hamilton, 1822) is an important fish species in South East Asia, especially in Bangladesh. *Hilsa* is considered as the national fish of Bangladesh and now it is a GI product. Jatka is considered as the young or immature hilsa. It contributes significantly to the national economy (Chakraborty *et al*., 2021a and 2021b; Chakraborty and Mome, 2022). Both types of fishes are available almost throughout the year in the major rivers and their tributaries, as well as in the Bay of Bengal (Roy *et al*., 2015). Both of them are members of ray-finned fish (class: Actinopterygii) under the order Clupeiformes

and the family Clupeidae. *Hilsa* fish are rich in Omega-3 fatty acid content that is good to prevent cancer or coronary diseases (Khoddami *et al*., 2009; Mahrus *et al*., 2012).

Morphometric estimations and meristic checks are considered as true strategies for the recognizable proof of a species which is named as morphological systematic (Ismot *et al.,* 2018). Morphometric characteristics are measurable characteristics of a species whereas meristic counts are countable characteristics such as, number of fin rays, spines, branchiostegal rays, scales on lateral line etc. (Ihseen *et al.,* 1981). Morphometric and meristic characteristics are commonly utilized in fisheries and fishery science as effective devices for measuring discreteness and relationship among different taxonomic categories (Nowak *et al*., 2008). Jatka is the juvenile stage of hilsa, *Tenualosa ilisha* (Rahman and Naevdal, 1998).

The morphological characters include the measurable or countable characters of fish, which are general for all fishes. Morphological characteristics of fish are those authoritative characters which provide relevant ways to identify, taxonomic study as well as better understanding of common facts of fishes. The interpretation of morphological structure functions as a stranglehold tool which is applied in the practical field during taxonomy and ecological study (Bohlen, 2008). The measuring constituents of fish anatomy such as body parts or fins are widely applied in systematics or taxonomical studies. The variations in shape testing and graphical representation can be easily practiced by applying this utile technique (Hossain *et al*., 2010).

Morphometric, meristic and osteological characteristics are powerful tools, which can be used for the stock identification, elucidating relationship among populations and to separate physically similar species. The present research will give comprehensive information on the comparative morphometric, meristic and osteology between adult and young hilsa (*Tenualosa ilisha*). This study was carried out to investigate the similarities and dissimilarities of the morphometric, meristic and osteology between the selected two stages of hilsa and to establish the taxonomic differences between their morphometric and meristic characters.

MATERIALS AND METHODS

Collection of samples

Samples of Jatka and Hilsa, *Tenualosa ilisha* were collected from the different fish market in and around Savar, Dhaka. A total of 10 mature and immature hilsa fish were collected. After collecting the specimens, all the good fishes were brought at the laboratory of Limnology and Fishery Sciences, Department of Zoology, Jahangirnagar University, Savar, Dhaka-1342, Bangladesh.

Preservation of samples

The samples were analyzed in fresh condition and without using any preservative for qualitative data. Afterwards, dead fish samples were anesthetized, labeled and preserved in refrigerator to prevent decomposition and used for further study.

Morphometric data measurement

This deals with the different measurements of various measurable characteristics of the samples (Fig. 1). The study was conducted after the method described by (Lagler *et al.*, 1977). A brief description of the attributes measured during the study is as following:

a) Total Length (TL): Measured from the tip of the snout to the last point of the caudal fin.
b) Standard Length (SL): Standard length was measured in the same way of total length from the tip of the snout to the end of hypurals.
c) Head length (HL): Measured from tip of the snout to the end of the operculum.
d) Eye diameter (ED): It was measured from the diameter of eyes.
e) Snout length (SnL): It was measured from the tip of the snout to the anterior part of the eyes/orbit.
f) Post orbital length (PoL): It was measured from posterior region of the orbit to the end of the operculum.
g) Pre dorsal length (PdL): Pre-dorsal length was measured from the tip of the mouth to the anterior end of the dorsal fin base.

h) Caudal peduncle length (CP): It was measured from the posterior end of anal fin to the caudal fin.

I) Abdominal region length (AbL): It was measured from posterior end of pectoral fin to the anal fin.

j) Dorsal fin base length (DFB): It was measured the base of dorsal fin.

k) Anal fin base (AFB): It was measured the base of anal fin.

l) Upper jaw length (UJ): It was measured from the tip of the snout to end of upper jaw.

Fig. 1: Morphometric measurement of *Hilsa*.

Fig.2: Morphometric measurement of Jatka.

Besides, the total length has been used more frequently as a standard for comparing the other measurements. The relationship between total length and various attributes as well as total length and various fin base lengths were established by using the following formula:

$$Iny = a + blnx$$

Where,

a = constant

b = constant

x = total length

y = various attributes

ln = natural logarithm

Meristic data measurement

The countable characteristics such as number of dorsal spine or dorsal fin rays, number of pectoral fin rays, number of anal spine or anal fin rays, caudal fin rays (excluding rudiments), number of pelvic fin rays (excluding the spine), number of scale above and below lateral line, number of scale on abdominal scutes were taken into consideration.

Taxonomic formula: The taxonomic formula of adult (Fig.1) and jatka (Fig. 2) are presented according to Lagler *et al.* (1977) for comparing later with the present observation.

Adult hilsa: Br. VI; D. 17-19; P1. 15; P2. 8; A. 19-22; C. 19-20; Ll. 44-48; Ltr. 16-19; Scute (17-18) + (13-15)

Young hilsa: Br. VI; D. 14-19; P1.13- 15; P2. 8-9; A. 18-20; C. 19; Ll.43- 46; Ltr. 15-17; Scute (14-16) + (12-15)

Osteological study

Osteology includes the study of the form, structure and development of bones. The osteological terminology followed in the present study was that of Gregory (1933), Ford (1946), Vasanith and Reddy (1984) and James (1985).

Defrosting: For osteological arrangement, solidified protected tests were kept out from the fridge and were cleared out for 3-4 hours at the room temperature for defrosting.

Washing: After defrosting the samples were to begin with washed by the tap water to evacuate overabundance sludge, clay, and other grimy objects from the angles. At the point, they were once more washed by saline water for evacuating additional microorganisms.

Boiling: For boiling the washed specimens were submerged in hot water at 60°C to which potassium hydroxide (KOH) and bleaching powder was included at the proportion of 1:10. The fishes were kept in hot water and dying solution for 5-10 minutes. They were at that point evacuated from the arrangement.

De-fleshing: The boiled samples were de-fleshed by forceps and needle carefully. All the muscles

were evacuated from the cranium and vertebrae because it was conceivable. The skeleton with the rest of the muscle was kept on the floor for organic treatment i.e. permits the ants to devastate the muscles.

Disarticulation: The skeletons of each species were disarticulated by forceps exceptionally carefully as one bone of any assortment was not blended with the others. Each bone of two assortment of the same portion were separated and compared at the same time. All bones of neurocranium, axial and appendicular skeleton were carefully disarticulated and captured utilizing Olympus computerized camera (Demonstrate No E-PLT, Olympus imaging corp., Republic of Korea).

Cleaning: The disarticulated bones were cleaned by needle exceptionally delicately so that the bones did not misplace its own criteria.

Drying: Each bone of the skeleton was permitted to dry gradually in an open place, care ought to be taken not to uncover it to coordinate warmth, which tends to break the bones. Amid the drying handle all the bones were kept beneath the nets since cats and mice are adversaries of this work. After drying the cruel length and width of all the bones of the examples were taken and compared.

Storing: All the dried bones and skeletons of skulls and vertebrae were put away within the boxes with naphthalene or any insects repellent.

Statistical analyses: The statistical programs used were Microsoft Excel and statistical program for social science (SPSS 11.5). All parameters for inter group differences were analyzed by one way ANOVA and then post hoc comparisons, LSD (least significant difference) and DMRT (Duncan's multiple range test) at $P<0.05$ level.

RESULTS

Morphometric Characteristics

Mean values of morphometric characteristics of adult hilsa and jatka have been presented in Table 1. As the morphometric variations may come from age, food and physiological conditions of fish, the proportion between morphometric characters as well as meristic characters need to be justified for the accuracy of taxonomic identity of the species. There was significant difference between the proportion of standard length and head length in the two varieties (Table 2).

Table 1: Mean values of morphometric characteristics of matured *Hilsa* and Jatka.

Characteristics	Mean ± SD(cm)	
	Matured (*Hilsa*)	Immature (Jatka)
Total Length (TL)	33.6±1.98	14.92 ±1.43
Fork Length (FL)	31.3±2.07	12.79±0.91
Standard Length (SL)	28.7±1.98	12.66±1.02
Caudal Peduncle Length (CPL)	29.6±1.91	11.20±0.88
Head Length (HL)	7.94±0.38	2.58±0.23
Eye Diameter	1.02±0.19	0.90±0.18
Snout Length	1.95±0.20	1.57±0.22
Post orbital Length	3.87±0.17	3.28±0.23
Pre Dorsal Length	11.02±0.70	5.40±0.24
Abdominal Region Length	4.04±0.38	3.60±0.24
Dorsal Fin Base Length	4.18±0.51	0.92±0.15
Anal Fin Base Length	4.66±0.42	0.67±0.16
Height of Pectoral Fin	2.93±0.26	0.70±0.14
Height of Ventral Fin	1.95±0.14	0.42±0.12
Upper Jaw Length	2.07±0.32	0.75±0.19

Table 2: Different morphometric proportion of *Hilsa* and Jatka.

Morphometric characters	Matured (*Hilsa*)	Immature Jatka
Total length : Standard length	5.17±1.00	4.19±1.45
Standard length: Head length	3.61±0.19	4.90±4.43
Total length: Fork length	1.07±0.95	1.16±1.57
Standard length : Caudal peduncle length	0.96±1.03	1.13±1.15
Head length: Snout length	0.27±0.19	0.20±0.22
Head Length: Post orbital length	2.05±2.23	0.78±1
Head length : Dorsal fin base length	1.89±0.74	2.80±1.53
Head length : Eye diameter	7.78±2	2.86±1.27
Standard length : Snout length	14.7±9.9	8.06±4.63
Standard length : Abdominal region length	7.10±5.21	3.51±4.25
Head length : upper jaw length	3.83±1.18	3.44±1.21
Dorsal fin base length : Anal fin base length	0.89±1.21	1.37±0.93

Table 3: Various meristic characteristics of *Hilsa* and Jatka.

Characteristics	Matured (*Hilsa*)	Immature (Jatka)
Dorsal fin rays (D)	17-19 (19)	14-19 (17)
Pectoral fin rays (P1)	15	13-15
Pelvic fin rays (P2)	8	8-9
Anal fin rays (A)	19- 22	18- 20
Caudal fin rays (C)	19-20	19
Lateral line scales (L)	44-48	43-46
Lateral line transverse	16-19	15-17
Branchiostegal (Br)	vi	vi
Scutes	(17-18)+ (13-15)	(14-16)+(12-15)
Perpelvic scutes	16- 17	14-16
Postpelvic scutes	12 -15	11-14

From the result it was also found that the proportion of upper jaw length with that of mean Head length were 3.83±1.18 and 3.44±1.21 in case of matured hilsa and immature jatka. The proportion of dorsal fin base with that of head length for matured hilsa was 1.89 ±0.74and 2.80±1.53 for immature jatka. The proportion of eye diameter (ED) and mean Head length between two varieties of matured hilsa and immature jatka was 7.78±2.00 and 2.86±1.27 (Table 2). There is no structural difference between both the fishes.

Meristic Characters

Authors examined carefully several meristic characters such as scales on the lateral line, scutes counts, pectoral fin rays, pelvic fin rays, dorsal fin rays, anal fin rays and caudal fin rays in both the cases. Results are shown in table 3.

Osteological Characters

The main feature of the skeleton in the adult hilsa and jatka included the exoskeletons and endoskeleton. Exoskeleton focused the structure of scale and fin rays. A wide extent of formative events comes full circle within the last structure and morphology of the grown-up skeleton. Precise recognizable proof of skeletal arrangement in vertebrate provides an insight into skeletal differences.

DISCUSSION

Adult hilsa was found to have a wide range of variation in size. Regarding the morphometric and meristic characteristics, the present study establishes the possible relationship among the different attributes and even the degree of well-being between two mentioned varieties studied. The mean total length (TL) of adult hilsa was found 33.6 ±1.98 cm, whereas the TL of jatka was found 14.92 ±1.43 cm. The difference in mean standard length (SL) was 28.7 ± 1.98 cm in adult hilsa and 12.66±1.02 cm in jatka. Most of the other morphometric characteristics differed significantly between the two varieties having greater value in adult hilsa among which head length, predorsal length, postorbital length, height of anal fin and eye diameter were correlated in jatka.

Though in every case, values were higher in adult hilsa than the jatka. Snout length of the matured hilsa was 1.95 ± 0.20 cm and 1.57 ± 0.22 cm in immature jatka. In the present study, among the morphometric characteristics, standard length, head length, body depth and eye diameter were found very similar to the observation of Hassan (2004) and Hassan (2005). However, total length slightly differed from Hassan (2005) but was same to the result of Hassan (2004).

As the morphometric variations may come from age, food and physiological conditions of fish, the proportion between morphometric characters need to be justified for the accuracy of taxonomic identity of the species. Between the matured hilsa and jatka the growth rates of different morphometric attributes in relation to increase in total length were not significantly different. In case of each variety, increment of standard length, head length, predorsal length, and caudal peduncle length showed relation to increase in total length. Again their increment of eye diameter, height of anal fin, height of pelvic fin, height of pectoral fin of each variety were increased in relation to increase in total length in contrast to that of the every type hilsa. But these differences were very negligible, whereas, considering growth rates were almost similar in both matured hilsa and immature jatka. Bhuiyan and Biswas (1982) also observed a similar type of result in *Puntius chola* and *Mastacembelus aculeatus*.

From the findings in all of the cases, it has been seen that the rate of increase of different morphometric characters with regard to the overall length is greater as compared to *Tenualosa ilisha*. It is evident that such variations might be due to the ecological condition of the habitat or hereditary effects etc. Similarly, very small differences have been observed in the number of scales and different fin rays in adult hilsa and jatka.

Comparative osteological characteristics of adult hilsa and jatka (young), reveals that there is no basic difference among them. The skulls of these fishes were small and compressed but, high in comparison to body ridges. The neurocranium is shaped by vomers and nuchal spine at the front and posterior end separately. On the dorsal side, the two noticeable supraorbital hard edges, which emerge at the internal pair of more or less articulated post nasal spines, run posteriorly in a meeting way and frame the external borders of the nuchal spine.

The vertebral column is well ossified and curved in the anterior half of the body. It consists of amphicoelous vertebrae and can be divided into three distinct regions namely the trunk region, the pre-caudal region and caudal region. Adult hilsa has 24 trunk vertebrae, 5 pre-caudal vertebrae (25th, 26th, 27th, 28th and 29th) and 17 caudal vertebrae. The jatka consisted of the same number of vertebrae. So, it has been found that, comparatively more relation have seen in the skeleton of adult hilsa and jatka.

CONCLUSION

The study was primarily focused on three areas of matured hilsa and jatka (*Tenualosa ilisha*) *namely* morphological, meristic features and osteology. So, from the present research work; it has been observed that, regarding the morphometric, meristic, and osteological characters, there is rarely differences between the two. It has been further found that except the growth of different morphometric characters and body weight with respect to the total length, there's no significant distinction within the relationship of diverse body extent with the whole length of both the fishes. There are small differences in the number of scales, scutes and fin rays of different fins

among the fishes. It can be concluded that the name jatka undoubtedly the juvenile stage of *Tenualos ailisha*. At the same time suggestion can also be made for further research considering the genetic point of view of these fishes.

CONFLICT OF INTEREST

There is no conflict of interest regarding this exploration and research article.

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