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Resolution of confusion in systematics of two major clupeid fish species in Bangladesh

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Abstract

A comparative study between pre-juvenile hilsa shad (*Tenualosa ilisha*) and Indian river shad (*Gudusia chapra*) using systematics study (morphometric measurements, meristic counts and external morphology) was conducted and significant differences were found between them. The findings of the present study will act as a catalogue to distinguish pre-juvenile hilsa shad and Indian river shad, which ultimately will help to sustain the hilsa population in Indian sub-continent waters.

Keywords: Bangladesh, Hilsa shad, Indian river shad, Meristic, Morphometric.
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Introduction

Hilsa shad, *Tenualosa ilisha* (Hamilton and Buchanan, 1822) and Indian river shad, *Gudusia chapra* (Hamilton and Buchanan, 1822) are widely distributed in the Indian sub-continent waters and are two major clupeid fish species in Bangladesh. Hilsa shad is the national flag fish of Bangladesh and plays a vital role in its economy, employment and the supply of protein. Among 260 freshwater fish species of Bangladesh, 143 species are considered small indigenous species (SIS) and Indian river shad is one of the easily available and nutritionally enriched SIS (Thilsted et al. 1997). In spite of having enormous significance of *T. ilisha* and *G. chapra* in fisheries sector, these two clupeid fish species are under serious human exploitation.

In Bangladesh, pre-juvenile Hilsa shad locally known as Jatka and Indian river shad which is known as Chapila are often mixed with each other as the appearance of pre-juvenile hilsa shad and Indian river shad is almost similar (Fig. 1). Though Bangladesh Government imposed rigorous ban on pre-juvenile Hilsa shad catch, rather rampant catch is underway by a kind of dishonest fishers. When those fishers are being challenged by retail consumers, or fish law enforcing agencies, often they are resorted to unacceptable argument with them challenging that the fish are Indian river shad (Chapila). This usually leads to social chaos creating huge confusion and conflict as they often fail to distinguish between pre-juvenile Hilsa shad and Indian river shad due to lack of a good field guide and keys of these two commercially important species in Bangladesh. To overcome this disability, a comparative study is urgent.

Several studies has already been done on morphomertic and meristic characters of these two species separately based on a few characters (Day 1880; Pillay et al. 1957; Chondar et al. 1976; Jayaram 1981; Whitehead et al. 1985; Rahman 1989; Najero et al. 2008). However, no research has yet been conducted to determine the main distinguishing characteristics between pre-juvenile Hilsa shad and Indian river shad. That is why major problems are facing in their identification in field level. The main aim of this study is, therefore, to conduct a systematics study (morphometric measurements, meristic counts and external morphology) of pre-juvenile Hilsa shad and Indian river shad. Therefore, the present findings will provides keys and field guides to facilitate identification of pre-juvenile Hilsa shad and Indian river shad.

Material and Methods

Sample collection: Samples of pre-juvenile hilsa shad were collected from the Meghna and Tentulia rivers and Indian river shad samples from the Old Brahmaputra River and L-shape pond of Bangladesh Agricultural

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Figure 1. (a) Pre-juvenile hilsa shad (63.1 mm TL) and (b) Indian river shad (64.0 mm TL) having similar external appearance.

University. The samples were immediately preserved with ice and then fixed into 10% buffered formalin upon arrival at the laboratory.

Morphometric measurements: A total of 26 measurements, including total length (TL), standard length (SL), fork length (FL), pre-orbital length (PrOL), pos-orbital length (PoOL), head length (HL), eye diameter (horizontal and vertical) (ED.H) and (ED.V), body depth, (BD), head depth (HD), head length (HL), operculum length (OmL), pre-dorsal length (PrDL), post-dorsal length (PrDL), dorsal fin base length (DFBL), pre-pelvic length (PvL), pelvic fin base length (PvFBL), pre-anal fin length (AnL), anal fin base length (AnFBL), prepectoral fin length (PcL), pectoral fin base length (PcFBL), caudal fin base length (CFBL), mouth length (ML), mouth width (MW), length of caudal peduncle (LCPd), and anus length (AL) were made based on of Hubbs and Lagler (1947) and Motomura (2004) to the nearest 0.01 mm using digital slide calipers (Table 1).

Meristic counts: A total of 9 meristic counts were made based on Hubbs and Lagler (1947) under a stereo microscope (Table 2). Scutes counts (pre-pelvic and pos-pelvic) were done with naked eyes. The numbers of vertebrae were counted through standard single staining method. In this method, specimens were fixed in 10% formalin solution for three days. Then, they washed through several changes of distilled water for two days and placed in 5% NaOH (5 g NaOH and 100 ml distilled water) solution for eight days. The solution was changed and the container was cleaned every two to three days to prevent contamination until inside bone was visible carefully. 5% NaOH treated fishes were moved into a beaker containing Mall's solution (1 g NaOH, 20 ml glycerine and 79 ml distilled water). A few drops of 1% alizarin red S solution (1 g alizarine red S and 100 ml distilled water) were added with fish in Mall's solution. After two days, bones were readily stained with alizarin red S. The stained fishes were then transferred to 70% glycerine solution and two days after the fishes were again changed to 100% glycerine solution. At last very few granules of thymol were added to prevent fermentation. Finally, the numbers of total vertebrae of stained specimens of each species were counted from atlas to urostyl using a stereo microscope.

Results

Tenualosa ilisha (Hamilton, 1822)

English name: Hilsa Shad

Synonyms: *Clupanodon ilisha* Hamilton, 1822, *Clupea ilisha* (Hamilton, 1822), *Clupea palasah* Cuvier, 1829, *Hilsa ilisha* (Hamilton, 1822) and *Macrura ilisha* (Hamilton, 1822).

Material Examined: All from Bangladesh (n=36, 63.1-96.8 mm TL).

Tenualosa ilisha: BCMR 001-020, 20, 46.8-65.1 mm SL; Chandpur: Meghna River, 23°24'N 90°64'E, 05-08 January 2014. - BBTR 001-016, 16, 50.1-76.0 mm SL; Bhola: Tentulia River, 22°48'N 90°65'E, 10-12 January 2014.

Etymology: *Tenualosa:* Latin, tenuis=thin + Latin, alausa=a fish cited by Ausonius and Latin, halec=pickle, dealing with the Greek word hals=salt; it is also the old Saxon name for shad="alli".

Diagnosis: Pre-juvenile hilsa shad is distinguished with following combination of characters: 17-20 dorsal-fin rays; 14-16 pectoral-fin rays; 7-8 pelvic-fin rays; 18-24 anal-fin rays; 22-30 caudal-fin rays; 16-17 pre-pelvic scutes; 14-15 pos-pelvic scutes; 48-49 total vertebrae; fork length 116.54% of SL; body depth 31.83% of SL; head length 31.54% of SL; mouth length 14.98% of SL; length of caudal peduncle 34.83% of SL. Mean total length to mean standard length ratio and fork length to standard length ratio were 1.32:1 and 1.16:1, respectively.

Description: Counts and proportional measurements of pre-juvenile hilsa shad are given in Tables 1 and 2. Characters given in the diagnosis are not repeated. Body covered with bright silver colored scales, their backside slightly green colored, abdominal and back sides equally convex, body deep and equally thick from both side, body covered with big sized scales, eyes smaller in size, eye membranes fatty, head long and anterior part of the head very pointed, mouth small, upper and lower jaw equal, dorsal fin slightly anterior to pectoral fin, tail moderate and not deeply forked, a dark blotch behind gill opening followed by a series of small spots along flank.

Distribution: Hilsa shad has a wide range of distribution and occurs in marine, estuarine and riverine environments. The fish is found in the Persian Gulf, Arabian Sea, Red Sea, Vietnam Sea, China Sea and Bay of Bengal. The riverine habitat covers the Satil Arab, and the Tigris and Euphrates of Iran and Iraq, the Indus of Pakistan, the rivers of Eastern and Western India (Normoda, Purla, Kali, Krisna, Godavari, Hugli, Ganga, Mohanodi etc.), the Irrawaddy of Myanmar, and the Padma, Jamuna, Meghna, Karnafully and other coastal rivers of Bangladesh (Ahsan et al. 2014). Hilsa shad is anadromous in nature. It is capable of withstanding a wide range of salinity and travelling great distances up-stream. It lives in the sea for most of its life but migrates up to 1,200 km inland through rivers in the Indian sub-continent for spawning. Distances of 50-100 km are usually normal in the Bangladeshi rivers.

Gudusia chapra (Hamilton, 1822)

English name: Indian River Shad

Synonyms: *Clupanodon chapra* Hamilton, 1822; *Clupea chapra* (Hamilton, 1822); *Clupanodon cagius* Hamilton, 1822; *Clupea indica* Gray, 1834; *Clupea champil* Gray, 1834; *Alausa microlepis* Valenciennes, 1847; *Clupea suhia* Chaudhuri, 1912; *Gudusia godanahiai* Srivastava, 1968.

Material Examined: All from Bangladesh (n=30, 64.0-96.2 mm TL)

Gudusia chapra: BMBR 001-016, 16, 45.1-72.0 mm SL; Mymensingh: Brahmaputra River, 24°75'N 90°43'E, 20-22 January 2014. BMAUP 001-014, 14, 51.9-72.8 mm SL; Mymensingh: Bangladesh Agricultural University Pond, 24°75'N 90°43'E, 25-27 January 2014.

Etymology: *Gudusia*: Sanskrit, Gudus=avid or voracious (Hadiuzzaman et al. 2017).

Diagnosis: A species of Indian river shad with the following combination of characters: 14-16 dorsal-fin rays; 12-14 pectoral-fin rays; 7-8 pelvic-fin rays; 22-24 anal-fin rays; 18-20 caudal-fin rays; 18-19 pre-pelvic scutes;

Table 1. Mmorphometric characters of pre-juvenile hilsa shad (jatka) and Indian river shad (chapila).

Characters	Mean±SD (mm)		Mean % of SL	
	Pre-juvenile hilsa shad	Indian river shad	Pre-juvenile hilsa shad	Indian river shad
TL	77.7±9.3	82.4±10.15	132.44	133.95
SL	58.6±8.06	61.5±8.63	-	-
FL	68.3±8.81	71.7±8.61	116.54	116.5
ED.H	5.5±0.71	6.9±1.20	9.29	11.14
ED.V	4.9±0.46	6.3±1.10	8.34	10.25
PrOL	3.7±0.57	3.4±0.58	6.23	5.44
PoOL	9.6±1.99	10.1±1.24	16.3	16.35
BD	18.7±2.77	19.6±3.05	31.83	31.88
HD	16.0±2.72	19.0±3.14	27.27	30.84
HL	18.5±2.85	20.3±2.84	31.54	32.99
OmL	17.6±2.47	21.2±2.92	29.98	34.43
PrDL	26.9±3.65	28.7±4.19	45.85	46.7
PoDL	38.5±5.09	39.1±5.23	65.63	63.45
DFBL	11.3±1.75	9.9±1.12	19.19	16.08
PvFL	29.5±3.69	32.2±3.43	50.35	52.28
PvFBL	1.5±0.26	1.4±0.26	2.51	2.23
AnFL	44.7±5.07	46.9±5.21	76.29	76.15
AnFBL	10.0±1.42	12.9±1.36	17.04	20.89
PcFL	15.8±2.73	18.1±1.81	26.99	29.44
PcFBL	2.4±0.34	2.7±0.23	4.11	4.34
CFBL	6.2±0.84	6.9±0.72	10.48	11.25
AL	1.3±0.18	1.4±0.19	2.27	2.31
ML	8.8±1.27	10.0±0.82	14.98	16.23
MW	2.9±0.78	3.6±0.92	5.01	5.89
LCPd	20.4±2.84	22.0±2.58	34.83	35.78

9-10 pos-pelvic scutes; 41-43 total vertebrae; fork length 116.5% SL; body depth 31.88% of SL; head length 32.99% of SL; mouth length 16.23% of SL; length of caudal peduncle 35.78% of SL. Mean total length to mean standard length ratio and fork length to standard length ratio were 1.34:1 and 1.16: 1, respectively.

Description: Counts and proportional measurements are given in Tables 1 and 2. Characters given in the diagnosis are not repeated. Body colour silvery with a dark shoulder and back, body thin, abdominal and back sides not equally convex, scales comparatively smaller and numerous in number, mouth wide and upturned, upper and lower jaw not equal, lower jaw comparatively bigger than upper jaw, eye bigger in size, head short and anterior part of the head blunt, tail elongated and deeply forked, dorsal and pelvic fins short and anal fin long, dorsal fin just opposite to pectoral fin, abdominal profile sharp and serrated, abdominal scutes soft, smooth and not sharply keeled.

Distribution: The Indian river shad is a freshwater clupeid fish and widely distributed in the river systems of India and Bangladesh affluent to the Bay of Bengal, mainly in the Ganges and Brahmaputra systems and the River Mahanadi in Orissa (Whitehead 1985). It has also found in Nepal and Pakistan (Shrestha 1994; Menon 1999). The species is pelagic and potamodromous (Riede 2004) and occurs in lakes, ponds, ditches and inundated fields (Rahman 1989). The species is one of the most important clupeid fish species in Bangladesh, and are common component of all inland subsistence and artisanal fisheries. This fish also found in canals, haors, baors, lakes, rivers and flooded paddy fields in Bangladesh (Ahmed et al. 2007; Ahamed et al. 2014).

Comparisons: Although pre-juvenile hilsa resembles Indian river shad, significant comparative morphological characters can be found between these two clupeid fish species. Body of pre-juvenile hilsa shad is thicker than

Table 2. Meristic counts of pre-juvenile hilsa shad (jatka) and Indian river shad (chapila).

	Mean±SD	
Characters	Pre-juvenile hilsa shad	Indian river shad
Dorsal fin rays	18.4±0.52	15.0±0.94
Pectoral fin rays	15.4±0.52	12.4±3.82
Pelvic Fin Rays	7.8±0.42	7.7±0.48
Anal Fin Rays	22.2±1.32	23.5±0.67
Caudal Fin Rays	24.2±1.55	18.7±0.85
Scutes	30.6±0.52	28.2±0.42
Pre-Pelvic Scutes	16.5±0.53	18.4±0.52
Post-Pelvic Scutes	14.1±0.32	9.8±0.42
Vertebral segments	48.6±0.52	42.3±0.48

Indian river shad. The body of pre-juvenile hilsa shad is covered with large sized cycloid scales whereas in Indian river shad body is covered with numerous small sized cycloid scales. In pre-juvenile hilsa shad, head is long and its anterior part very pointed with smaller in size. Whereas, head shape of Indian river shad is short, and its anterior part is blunt. Mouth is big and upturned; upper and lower jaw are not equal, lower jaw is bigger than upper jaw in Indian river shad, and in pre-juvenile hilsa shad, mouth is small; upper and lower jaw are equal in size. Another key morphological variation is presence of dark spots behind gill opening followed by a series of small spots along the flank in pre-juvenile hilsa shad, while these spots are absent in Indian river shad. The tail is moderate and not deeply forked in pre-juvenile hilsa shad as Indian river shad. In pre-juvenile hilsa shad, dorsal fin is slightly anterior to pelvic fin whereas in Indian river shad, dorsal-fin is found in just opposite to pelvic fin.

Discussion

The information on morphometric measurements of fishes are essential for taxonomic work (Mcconnel, 1978). Moreover, to know the origin and separation of stocks, and identification of commercially important species of fishes, morphometric characters are frequently used (Pillay 1957; Royce 1963). Besides, meristic characters are also very important characters to differentiate of species and populations. The analysis of morphometric measurements, meristic counts and morphological features of pre-juvenile hilsa shad and Indian river shad confirmed that significant differences existed between them. Whitehead et al. (1985) reported few morphometric characters of hilsa shad and Indian river shad, e.g. head length and body depth are 28-32% and 25-32% of SL, respectively in hilsa shad and body depth of Indian river shad is 31-39% of SL, which are similarly to the present study. Few differences were observed in meristic counts between the species. Numerous studies on hilsa shad (Pillay et al. 1957; Whitehead et al. 1985; Narejo et al. 2008) and Indian river shad (Day 1880; Chondar 1976; Jayaram 1981; Rahman 1989) reported almost similar meristic counts.

However, a significant morphological differences was found between pre-juvenile hilsa shad and Indian river shad which will help to resolve the controversy of differentiation between pre-juvenile hilsa shad and Indian river shad. The findings of the present study will help to establish the comparison key between pre-juvenile hilsa shad and Indian river shad and will be possible to stop fishers from catching and selling of pre-juvenile hilsa shad, which ultimately help to sustainable conservation of hilsa shad population in Indian sub-continent waters.

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