

Morphological identifications and morphometric measurements of genus *Tenualosa* spp fowler, 1934 (Family *Clupeidae*) in Mon coastal areas, Myanmar

Abstract

Morphometric measurements and identifying morphological characteristics of genus *Tenualosa* spp (Family *Clupeidae*) along Mon Coastal Areas were accomplished during the studied period June–Nov 2018. During the study period, it was designated as ten sampling sites along Mon Coastal Areas for sample collection. The dissimilarities of morphological characters between *Tenualosa* spp (Family *Clupeidae*) found along Mon Coastal Areas were consecutively revealed to particular column in a tabular form. Furthermore, morphometric measurements between the two species of *Tenualosa* spp; *Tenualosa ilisha* (Hamilton, 1822) and *Tenualosa toli* (Valenciennes, 1847) were determined on the specimens to ascertain the possibility of morphological diversification.

Keywords: morphological characteristics, morphometric measurements, Mon coastal areas, *Tenualosa* spp

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Introduction

Tenualosa (tenus=thin, alausa=a fish) is a genus of fish in the *Clupeidae* family and its subfamily *Alosinae* (the shads). There are three Hilsa species found in the Bay of Bengal, *Tenualosa ilisha* and *T. toli*, under the genus *Tenualosa* and *Hilsa kelee* under the *Hilsa* genus. Among them, the majority of Hilsa fish captured belongs to *Tenualosa ilisha*. Hilsa shad (*Tenualosa ilisha*, Hamilton-Buchanan, 1822) is an anadromous fish, ascending the rivers from marine habitats of, Arabian Sea and Persian Gulf.¹ It occurred in the foreshore areas, estuaries, brackish water lakes and freshwater rivers. It ascends the rivers for breeding and returns to the sea after completion of spawning to marine habitats. It feeds and grows mainly in the sea, but migrates to fresh water for spawning.²

The migration of monsoon breeds return to sea from January onwards whereas that of spring breed return from July onwards. The juveniles of monsoon breed make journey to sea from July onwards and that of spring breed from November onwards.³ The upstream migration during the main breeding season depends largely on the commencement of the south-west monsoon and consequent flooding of the major rivers of Bangladesh, Burma and India. The range of Hilsa migration covers a distance of about 1,920rkm (river kilometre) up to Delhi through the Yamuna tributary of the Ganges River, 825rkm up to Mandalay through the Irrawaddy River.⁴ (rkm-Reisskilometer)

The body of *Tenualosa* spp is oblong and compressed having 30-33 spines like scutes on abdomen. Difference between two major *Tenualosa* species is very infinitesimal. In *T. ilisha* dorsal and ventral profile of the body is equally convex, while in *T. toli* abdominal profile is more convex than that of dorsal.⁵ Hilsa is the state fish of West Bengal accounts for 15-20% of the total fish landing.⁶ Major catch of Hilsa about 95% comes from Bangladesh, India and Myanmar. In South East Asia, Myanmar is one of the largest fisheries production countries including domestic and export market. Annual fisheries production rate was 1474.46 thousand tons in 2001-2002 and then up to 3921.97 thousand tons in 2009-2010. Besides that, the rate of fisheries production in 2012-2013 became 4716.20 thousand ton. The number of fishing vessels used in these fisheries production was 2762

containing small boat fishing and offshore fisheries of the whole country Myanmar. (DoF data 2012-2013) Furthermore, the capture for herring fish that rely on man power using motorized vessels (Myaw Pike Hlay) which was introduced in Ayeyawady deltaic areas for herring fish capture had been operated by 6 vessels in the study areas around 1960.

The main gears were drift nets made of nylon with mesh size of 4 3/8". The number of fishing vessel increased from 30 in 1970 to 41 in 1988–89. In 1995–96, the number of fishing vessel decreased and is replaced by modernized purse seine vessels. Drift net fishing vessels are second most important in Myanmar fishery with an average of 860 vessels (43%). Of which, 214 vessels (25%) are operating in Mon State at the present time.⁷

As a result, Hilsa became relatively abundant in the wider areas of the Bay of Bengal, indicating a substantial increase in marine catch in Bangladesh, Myanmar and India.⁸ The annual catches of Hilsa in Bangladesh is 0.5 million tonnes that fetches US\$2 billion, and provides livelihoods to 0.5 million fishermen and 2.5million people in the value chain and distribution.^{9,10} Accordingly, spawning behavior of Hilsa varies in terms of both time and location in the rivers of the Bay of Bengal and Arabian Sea due to fluctuations in rainfall, upstream runoff, sediment input and/or variation in habitat types.

A declined riverine Hilsa catch has been attributed to a combination of factors such as the closure of migratory routes, river siltation, overfishing, indiscriminate harvesting of broods and juveniles, use of fishing nets with small mesh sizes, mechanization of fishing, increasing numbers of fishermen and efforts, aquatic pollution and climatic variability.¹¹

In general, marine catch of hilsa is 72% and the river catch shares 28%. The maritime zones of Bangladesh, Myanmar, India, Iran and Kuwait are suitable for marine catch, and the habitats of Meghna, Hooghly, Indus, Irrawaddy and Euphrates are suitable for river catch. Typical hilsa fishing gears include drift gill, fixed gill and seine nets. Gear characteristics as well as length, breadth, mesh and mode of operation depend on water current, depth, tidal phase, seasonality and weather condition. Drift gillnet moves with water current, whereas

fixed gillnet is set in specific location of the river/ sea. The seine net encircles shallow water areas to trap school of hilsa and other fishes. Although hilsa fishery, by now, has expanded over the Rakhine Basin along the Myanmar and Thailand coasts, there are limited catch data or export statistics in that context.^{7,9}

Hilsa fishery was the second largest production in top ten categories of fishery product of Myanmar (2012-2013). It was exported 17,952 ton valued at US\$ 39.53 million.¹¹ Interestingly, Myanmar has undertaken a registration scheme for all the small fishing craft and this model can be useful for Bangladesh and India where no such scheme exists.⁸ Recently, a road map for Hilsa fishery management plan has been laid out among Bangladesh, India and Myanmar (BoBP-IGO, 2008), where scientific networking among Bangladesh, India, Myanmar and Norway has now been established for jointly developing and managing the Hilsa fishery.¹²

Forasmuch as, the objectives of analyzing by morphometric measurements and morphological identifications of genus *Tenualosa* spp. (Family Clupeidae) in Mon Coastal Areas are as following: 1) To identify the individual morphological patterns between two *Tenualosa* spp.; *T. ilisha* (Hamilton, 1822) and *T. toli* (Valenciennes, 1847) and 2) To clarify some scrutinizing morphometric characters of *Tenualosa ilisha*, Hilsa shad and *Tenualosa toli*, Toli shad found in studied area.

Materials and methods

Description of study area

The sample collection of *Tenualosa* species for identification was carried out under the main ten sampling sites along Mon coastal areas during June to November 2018. Under the main ten sampling sites, three sampling sites under the Thein Za Yat Township; 1) Seik Kan Thar village (17° 30' N, Long. 96° 52' E), 2) Sittaung Village (17°27' N, Long. 96° 52' E) and 3) Kyouk Seik Village(17°26' N, Long. 96°52' E), 4) Sat Pa Nu village (17° 23' N, Long. 96° 53' E) in Kyaikhto Township, 5) Zokkali village (17° 07' N, Long. 97°08' E) in Bilin Township, 6) Wal Pa Tan Village (16° 30' N, Long. 97°21' E) in Paung Township, 7) Sepala Village (Lat. 16°14' N, Long. 97°32' E) in Chaung Sone Township, 8) Kyauktan Village (Lat. 16°26'N, Long. 97°37' E) in Mawlamyine Township, 9) Kyar Seik fish landing site in Kyeikkami Township and 10) Zee Phyu Thauung Village (Lat. 15°11'N, Long. 97°46' E) in Ye Township were fixed as sampling sites to collect samples. In which the first five sampling sites are situated on the bank of the Sittaung River, Zokkali Village between the lower part of Sittaung and Bilin River, Kyauktan Village on the Thanlwin River bank, Kyar Seik landing site on the mouth of Thanlwin River and the last Zee Phyu Thauung landing site on the mouth of Ye River. The location of the study sites along Mon Coastal areas was described in the following figure.

Data collections and methods used

Data collections of Hilsa shads were taken on both major and minor fish landing sites of Mon State, Seik Kan Thar, Sittaung, Kyouk Seik, Sat Pa Nu, Kyeik Ka Thar, Zokkali, Wal Pa Tan, Sebalar, Kyauktan, Kyar Seik, Zee Phyu Thauung during June 2018 to November 2018. In inshore fishery, drift nets were mainly used for herring fishery along the Mon coastal waters, extending from the mouth of the Sittaung River and west of Bilukyun up to the northwestern part of Kyungikyun, mainly the waters depth range of 13-18m, within 16.09km (usually at 11.26km) from the shore. In offshore fishery, fishing was carried

out mainly in the waters depth range of 18m–60m, within 160.93km (usually at the depth of 36m, which is about 32.19km off the shore). According to local fishermen, the main fishing ground for herring in inshore fishery was the waters region from western to southern part of Bilukyun, the opposite area of the Sittaung estuary, and areas along the eastern coast of Yangon Region. Another major fishing grounds were recorded in the water area south-west of Kyeikkhami near the light house; in area west of Kalagote Kyun and waters area around west of Ye estuary, north-west of Kyungyi Kyun. Offshore fishery starts from March and end in mid May. During these periods, fishing activities were carried out in the water areas located about 144.83 km (usually within 160.93km) from the shore south-west of Kyeikkhami. Especially, drift gill nets, trammel nets, purse seines and sometimes cast net in Sittaung areas which has 3-5.6 inches mesh size; the specimens were collected from various kinds of net from the local fishing boats.

In the fishing methods, several kinds of fishing boats possessing different lengths are used, especially fishing boats are constructed with the length of 16meters (according to Myanmar measurement; 8 lan). Occasionally, taking the fishery transaction start the distance 25 nautical miles from the land to the open sea and at least it has 6 hours long in time of the day. Fishing in the study area is also operated at a distance 8-10 nautical miles from the coast and at a depth of 20m. Fishing is carried out 2 hauls per days. Almost through the year, in the fishery sector of Zee Phyu Thauung landing site, they use several kinds of nets girded with various units of mesh size according to the fish size, for the open sea. In the Wal Pa Tan, Kyeikkhami, Zee Phyu Thauung sampling sites, samples were collected mostly by trammel nets, fence nets and drift gill nets commonly called the blue nets, plastic nets, Anu-myu nets and ma-yan-byar nets. Anu-myu nets need the lengths that include from the twenty yards to 182.88m (200 yards) to catch for one time.

More than that, the total body length (from the snout to the hind tip of the upper caudal lobe) or TL of collected fish was measured by using measuring tape, measuring board, vanier clipper and digital balance. The standard works operate for identification and classification of the species.^{3,13} Conventional abbreviations for the various fins in the reporting of numbers of fin rays were: dorsal, D; anal, A; caudal, C; pectoral, P1 and pelvic, P2 (Figure 1-3).

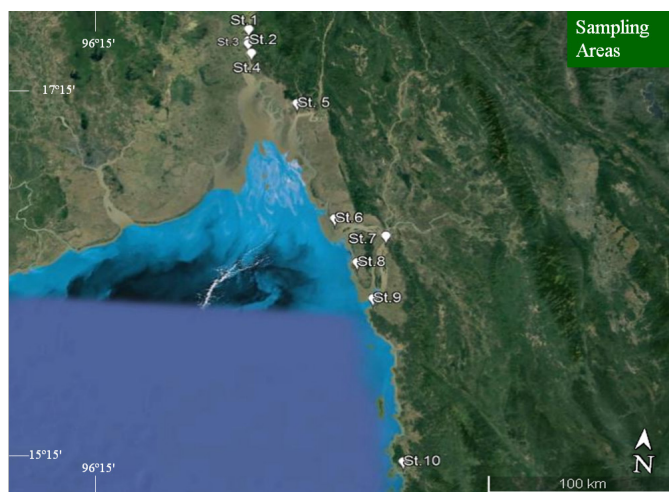


Figure 1 Satellite image of sampling areas in Mon Coastal Areas, Myanmar. (Source: Google Map)

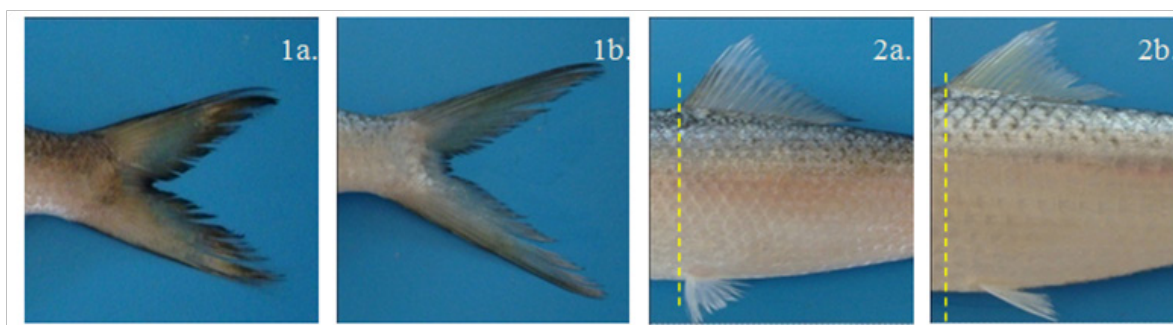


Figure 2 Differences between *Tenualosa ilisha* and *Tenualosa toli*.

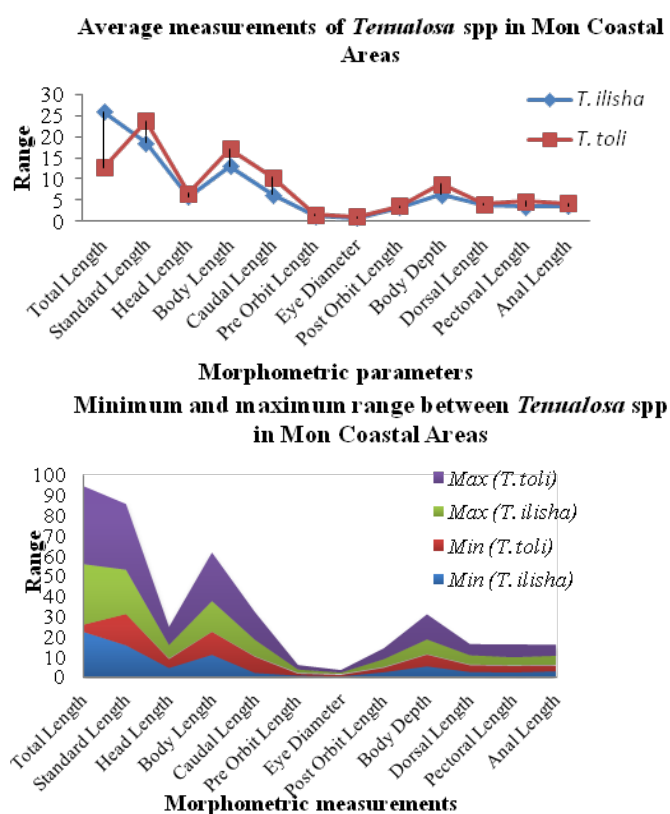


Figure 3 Morphometric measurements.

Discussion

Morphometric measurements and identifying morphological characteristics of genus *Tenualosa* spp (Family Clupeidae) along Mon Coastal Areas were accomplished during the studied period June–Nov 2018. The dissimilarities of morphological characters of *Tenualosa* spp (Family Clupeidae) found along Mon Coastal Areas from designated as ten sampling sites were consecutively revealed to particular column in a tabular form. These two species were migratory and anadromous species.^{5,13} Occurrence of *Tenualosa ilisha* (Hamilton, 1822) and *Tenualosa toli* (Valenciennes, 1847) in Mon Coastal Areas during June–November 2018 were studied. The occurrence of *T. ilisha* (Hilsa Shad) was only found from September, sometimes August, to November in Seik Kan Thar, Sittaung, Kyar Seik, and Sat Pa Nu whilst it was found in August at Zokali. In Wal Pa Tan sampling sites, additionally, it was found in July during the studied period. At that time, the occurrence of

T. ilisha at Sepala sampling site was recorded in August but in Kyouk Tan fishing village started in September.

On the other hand, marine Hilsa shad (*T. ilisha*) were occurred the whole studied months, from June to November, at Kyar Seik and Zee Phyu Thaug offshore-fishing landing sites. In comparison with the occurrence of Toli shad (*T. toli*), it was recorded smaller in amount than Toli shad. In comparison with the occurrence of Toli shad (*T. toli*), it was recorded smaller in amount than Toli shad. Identifying the spawning estuaries of the tropical shad, terubok *Tenualosa toli*, using otolith micro chemistry because populations of this culturally and commercially important species have fallen to dangerously low levels during the 1990–1995.¹⁴ The tropical shad, terubok *Tenualosa toli*, is known only from 2 large estuaries and the adjacent coast of northwest Borneo.

T. ilisha (hilsa) was found as a dominant species and was collected from all stations of Mon State, Myanmar.¹⁵ The species in the genus *Tenualosa*, *T. ilisha* were recorded in all study areas and dominant in the catches, while *T. toli* was not collected from the riverine areas such as Mawlamyine, Sittaung and Pathein. Among the species of Clupeoid fish two species of *Tenualosa ilisha* and *T. toli* were collected during the study period from the Kyaikkhami landing center.¹⁶ In this discussion, *Tenualosa toli* was found as dominant species in open sea and was not occur in fresh water. It seemed to be a strictly marine form. In marine capture, the best times for exploitation of Hilsa are September to December and February to March and those of *T. toli* are June to August and January to February.¹⁷

In the present study, significant morphological differences among these two populations of *Tenualosa ilisha* and *Tenualosa toli* were found (t-test, $p < 0.01$). Moreover, descriptive data for the morphometric characters and range (Minimum–Maximum), mean and standard deviation (SD) of length between the two *Tenualosa* spp. was shown in Table 1–3. The present study highlighted that the mean value of total length with standard deviation between *Tenualosa ilisha* and *Tenualosa toli* was 26.05 ± 2.9886 and 12.7833 ± 12.0934 respectively.

Conclusion

According to the present study finding, *Tenualosa* spp., *Tenualosa ilisha* (Hamilton, 1822) and *Tenualosa toli* (Valenciennes, 1847) are economically important species both domestic and foreign markets. They stand high price position of the fisheries sector in Myanmar; especially *Tenualosa ilisha* (Hilsa) is one of the top ten economic important fish in fisheries sector of Myanmar. Similarly, Hilsa shad and Toli shad fisheries are one of the most substantial fisheries marketing in Mon State.

Table 1 Descriptions of morphometry differences between *Tenualosa ilisha* and *Tenualosa toli*



Characters	<i>Tenualosa ilisha</i> (Hamilton, 1822)	<i>Tenualosa toli</i> (Valenciennes, 1847)
		
General body profile	Body fusiform; both dorsal and ventral profiles almost equally arched	Body fusiform; ventral profile more arched than the dorsal profile
Front-parietal length	Extending opercula margin	Extending pre-opercula margin
Body depth	27- 32 % of standard length	30 – 35 % of standard length
Dorsal fin origin	At the midpoint of body	Slightly before the midpoint of body
Scutes	29-34	29-31
Median lateral scales	45-47	40-41
Caudal fin	Almost the same length as that of head	Larger than the length of head, deeply fork-shaped
Coloration	Body silvery; a dark blotch behind gill opening, followed by a series of small spots along flanks in immature ones. These spots gradually disappear in large adults.	Body silvery; a diffuse dark blotch behind gill-opening.

Table 2 Morphometric measurements (cm) of *Tenualosa ilisha* (Hamilton, 1822) and *Tenualosa toli* (Valenciennes, 1847)

Parameters	<i>Tenualosa ilisha</i>			<i>Tenualosa toli</i>			p-value
	Min	Max	Mean±SE	Min	Max	Mean±SE	
Total Length	22.3	30.2	26.05±2.9886	3.4	38.6	12.7833±12.0934	0.00
Standard Length	15.7	22.1	18.625±2.2513	15.3	32.5	23.6944±5.7432	0.02
Head Length	4.7	6.85	5.8563±0.7263	4.3	8.9	6.6056 ±1.4842	0.08
Body Length	11.1	15.3	13.125±1.5432	11.2	24	17.2056±4.4621	0.03
Caudal Length	2.3	8.3	6.2625±1.8533	7.8	13.7	10.4111±1.9731	0.00
Pre Orbit Length	1	1.8	1.2563±0.2499	0.9	2.25	1.5722±0.4430	0.03
Eye Diameter	0.6	0.9	0.7375±0.0954	0.7	1.25	1.0111±0.1799	0.00
Post Orbit Length	2.65	4.1	3.3625±0.5222	2.15	5.4	3.6556±1.0564	0.24
Body Depth	5.45	7.45	6.2938±0.6863	5.7	12.45	8.8389±2.2486	0.01
Dorsal Length	2.75	4.8	3.8563±0.6732	3.25	5.5	4.1056±0.6993	0.14
Pectoral Length	2.5	4.1	3.4125±0.4926	3.2	6.35	4.6833±1.0053	0.00
Anal Length	3.1	4.6	3.6813±0.523	2.8	5.55	4.1778±0.8262	0.04

T-test: Significant at 5% level ($p < 0.05$), a: Highly significant correlation (when $p < 0.01$), NS: Not Significant correlation (when $p > 0.05$).

Table 3 Occurrence of *Tenualosa ilisha* (Hamilton, 1822) and *Tenualosa toli* (Valencinnes, 1847) collected in Mon Coastal Areas during the study period (June – November).

	Seik Kan Thar		Sittaung		Kyouk Seik		Sat Pa Nu		Zokkali		Wal Pa Tan		Sepala		Kyauktan		Kyar Seik		Zee Phyu Thauung	
	<i>T. ilisha</i>	<i>T. toli</i>	<i>T. ilisha</i>	<i>T. toli</i>	<i>T. ilisha</i>	<i>T. toli</i>	<i>T. ilisha</i>	<i>T. toli</i>	<i>T. ilisha</i>	<i>T. toli</i>	<i>T. ilisha</i>	<i>T. toli</i>	<i>T. ilisha</i>	<i>T. toli</i>	<i>T. ilisha</i>	<i>T. toli</i>	<i>T. ilisha</i>	<i>T. toli</i>	<i>T. ilisha</i>	<i>T. toli</i>
Jun	-	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	+	+	+	+
Jul	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+	+	+	+
Aug	-	-	+	-	-	-	+	-	+	-	-	-	+	+	-	+	+	+	+	+
Sep	+	-	+	-	+	-	+	-	-	-	+	+	-	+	+	+	+	+	+	+
Oct	+	-	+	-	+	-	+	-	+	+	+	+	+	+	+	+	+	+	+	+
Nov	+	-	+	-	+	-	-	-	+	+	-	+	+	-	+	+	+	+	+	+

Not oodles, Hilsa shad, *T. ilisha* is found affluently from June to October, during the monsoon, in offshore fisheries like Kyar Seik (Kyaikkami) and Zee Phyu Thauung (Ye) fish landing sites although *T. toli* is found at the domestic markets almost the whole year from the marine offshore fisheries. But in the inland fisheries like the fishing villages along Sittaung River and Kyouk Tan fishing village, Hilsa Fishing activities are started by small scale or artisanal fishing from August to January. Now that the whole year round was operated in inland capture, Hilsa fishing pressure is very high and it is essential to reduce this to obtain more sustained production. In comparison with last five years, it is noted that the catch rate of Hilsa shad and Toli shad fisheries in Myanmar is declined in the following year after year.

Thenceforward, the study on meticulous measurements of various parts of *Tenualosa* spp. is important for identification of specimens and for experimental studies. The morphometric measurements between the two species of genus *Tenualosa* show some variations sufficient to make an agreement that these species were either genetically or morphologically same or different. Such contemplation will be helpful in determining the correlations of these morphological variables with the total length of fish. Detailed study about the morphometric differences can be useful in correct identification of species that have been previously reported as *T. ilisha* and *T. toli* from study areas.

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Conflicts of interest

Author does not have any conflicts of interest.

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