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Research Article

Reproductive Biology and Feeding Habits of *Sillago sihama* (Forsskal, 1775) and *Sillago mengjialensis* (Gao, Baki, and Saha, 2022) in Bay of Bengal, Bangladesh

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This study investigates the reproductive biology, feeding habits, and growth pattern of *Sillago sihama* ($N = 119$) and *Sillago mengjialensis* ($N = 18$) collected from Cox's Bazar, Bay of Bengal, between August 2022 and October 2023. The total length and body weight of *S. sihama* ranged from 72.19 to 173.50 mm and from 2.49 to 41.32 g, respectively, while they ranged from 78.32 to 159.81 mm and from 3.08 to 27.19 g, in *S. mengjialensis*, respectively. The sex ratio was male-dominated in both species. Peak gonadosomatic index (GSI) values were recorded in March for *S. sihama* (females: 0.653 ± 0.121; males: 0.351 ± 0.022) and in November for *S. mengjialensis* (females: 3.600 ± 0.371; males: 1.068 ± 0.115), indicating distinct and separate spawning seasons. In both species, males matured at smaller size, compared to females, with Lm_{50} estimated at 93.73 and 98.76 mm for male and female *S. sihama*, and 86.00 and 128.14 mm for male and female *S. mengjialensis*, respectively. Histological examination identified immature and mature males and immature and maturing females in *S. sihama*, whereas mature males and fully ripe females were observed in *S. mengjialensis*. Fecundity in *S. mengjialensis* ranged from 8548 to 16,716 eggs per ovary. Feeding analysis revealed omnivory in *S. sihama* (RLG: 1.12) and carnivory in *S. mengjialensis* (RLG: 0.75). Length–weight relationships indicated positive allometric growth ($b = 3.453$) in *S. sihama* and isometric growth ($b = 3.08$) in *S. mengjialensis*. These findings provide important baseline data for future management, conservation, and stock assessment of these species.

Keywords: fecundity; GSI; length at first maturity; length–weight relationship; relative length of gut; swimbladder

1. Introduction

Fishes of the family Sillaginidae Richardson, 1846 (Order Perciformes) are commonly known as Ladyfish/sandwhitings, primarily inhabiting inshore waters with sandy substrate or estuarine areas throughout the Indo-West Pacific Ocean [1–3]. The family includes 41 species under five genera, i.e., *Sillaginodes*, *Sillaginopsis*, *Sillaginops*, *Sillaginopodys*, and *Sillago*. Five species of sandwhitings are reported from Bangladesh seawater, i.e., *Sillago sihama*, *Sillago soringa*, *Sillago muktijoddhai*, *Sillago mengjialensis*, and *Sillaginopsis domina* [4]. The similarities in morphological features and coloration among these Sillaginids make it difficult to identify each of the species without the swimbladder examination [5]. The structural differences in the swimbladder and the division of the vertebrae at the abdominal, hemal, and caudal positions were important for the taxonomic identification of these cryptic *Sillago* species. However, certain sibling species such as *Sillago shaoi* and *S. sihama* have very similar morphological characteristics even in swim bladder structure, making the identification challenging [6–11]. For example, the previously identified *S. sihama* has revealed the presence of four species such as true *S. sihama*, *S. mengjialensis*, *S. muktijoddhai*, and *S. soringa* in Bangladesh [4].

Due to the close morphological resemblance among *Sillago* species, accurate identification can be challenging without detailed anatomical examination, especially of the swimbladder structure [5, 6, 9]. Notably, *S. sihama* was previously considered a single species but has since been revealed to include cryptic species such as *S. mengjialensis*, *S. muktijoddhai*, and *S. soringa* in Bangladesh [12]. The present study followed the diagnostic features described by Saha et al. [12, 13] for precise species identification.

Studies on reproductive biology and sex ratio constitute successful reproduction and stock assessment in fish populations both in nature and in artificial breeding grounds [14–17]. In addition, studies on sex ratio can reveal segregation or aggregation of males and females [18]. Furthermore, the gonadosomatic index (GSI) has been used widely to describe the timing and duration of the spawning season [19].

The investigation into the diet and feeding practices based on stomach contents examination are important factors in developing aquaculture and comprehending fish ecology [20]. Information on their diet provides further support on practices of aquatic management, especially agriculture, aquaculture, and conservation [21]. The study of food and feeding habits helps in the study of length–weight relationship (LWR), reproductive biology, as well as fecundity.

The effective management of any fishery requires considerable knowledge of population parameters such as LWR, condition factor, etc., and these parameters are very important for comparative growth studies [22]. Besides, LWR provides valuable information on the habitat where the fish lives and is important in parameterizing yield equations, in estimation of stock size and in determining condition factor in which it can measure the change in robustness of fish over time [23–25], while condition factor of fish is an indicator of physiological state in relation to its welfare [26, 27]. Moreover, condition factor is important in understanding the life cycle of fish species and it contributes to adequate management of the species, hence maintaining the equilibrium in the ecosystem [28].

The importance of understanding fish biology, particularly in relation to morphometry, condition factors, reproduction, food & feeding, and the length–weight correlation preferences is widely recognized in managing aquaculture [29]. Therefore, the present study was designed to identify these fishes accurately first and then investigate the breeding biology and food and feeding habit of *S. sihama* and *S. mengjialensis*. Aside from this, the study aimed to determine LWR as well as condition factor of these two species.

2. Materials and Methods

2.1. Fish Sampling and Measurements. Fish specimens were collected primarily from local fishermen, as well as from two local markets—Baharchara Kacha Bazar and Kolatoli Bazar in Cox's Bazar (Figure 1). The sampling period lasted from August 2022 to October 2023. After collection, the specimens were temporarily placed in cooling boxes filled with ice

Figure 1: Map of the study area.

and transported to the Fishery Laboratory, Department of Zoology, Jagannath University, Dhaka, for further analysis.

After arriving at the laboratory, the fish specimens were sorted based on their total length (TL) and sex. TL was measured to the nearest millimeter using a digital caliper. Sex was determined through visual examination of the gonads during dissection.

2.2. Taxonomical Identification of Fish

2.2.1. External Morphological Characters. In the present study, the observed morphomeristic characters included TL, standard length (SL), number of rays of dorsal fin (first and second), pectoral fin, pelvic fin, anal fin, and caudal fin, as well as the black dots on dorsal fin, anal fin, and below the lateral line were noted. In addition, some descriptive characters such as body and fin coloration were also observed.

2.2.2. Swimbladder. The present study focused on the structure of the swimbladder, which is crucial for these species' identification and all the individuals were confirmed by examining the swimbladder. The terms, i.e., anterior extension, posterior extension, lateral process, anterolateral extension, duct-like process, etc., used to describe appendages of the swimbladder followed other researchers [30, 31].

The key morphological and anatomical features distinguishing *S. sihama* and *S. mengjialensis*, based on both current observations and comparative references [12, 13], are summarized in Table 1 and Figures 2 and 3.

2.3. Analysis of Data

2.3.1. Sex Ratio. Sex ratio was determined from the ratio of 1:1 male to female in the total population by using a chi-square goodness-of-fit test at 95% significance level. The equation for chi-square analysis is $\sum (O - E)^2/E$.

Where O = observed frequency of males/females and E = expected frequency of males/females.

2.3.2. GSI. For calculating GSI, the weight of the individual fish was noted. The gonads were removed carefully and weighed on an electronic balance [32].

Table 1: Diagnostic characteristics distinguishing *Sillago sihama* and *Sillago mengjialensis*.

Feature	***Sillago sihama***	***Sillago mengjialensis***
Body coloration (fresh)	Brownish dorsally, silver ventrally; faint mid-lateral brown stripe	Light olive green dorsally, silver ventrally; black spots below lateral line
Anal fin	Light yellowish to whitish, without black dots	Light yellowish to whitish, with black dots
Swimbladder	Long; 2 anterior and 2 posterior extensions, no lacuna at base; anterior extension forms short blind tubule; posterior one kinked, long and complex; 10–11 lateral processes; duct-like process originates anteriorly at the swimbladder end	Long; 2 anterior and 2 posterior extensions, no lacuna; anterior forms short blind tubule; posterior kinked, long and thin; 9–10 lateral processes; duct-like process originates at the termination of swimbladder

Figure 2: Morphology of *S. sihama* (A) sample fish and (B) swimbladder.

Figure 3: Morphology of *S. mengjialensis* (A) sample fish and (B) swimbladder.

$$\mathrm{GSI} = \left(\frac{Gonadal\ Weight}{Total\ weight}\right) \times 100. \quad (1)$$

2.4. Length at First Maturity (Lm_{50}). Length at first maturity (Lm_{50}) is the length at which 50% of the fish have reached maturity. In the present study, length at first maturity (Lm_{50}) was estimated for male and female specimens of *S. sihama* and male *S. mengjialensis*. The presence of large, whitish testes and yellowish-orange ovaries indicates sexual maturity. These mature gonads were associated with increased GSI values. The L50 was estimated by [33]

$$\mathrm{TL} = \frac{a}{-b}, \quad (2)$$

where a = intercept and b = slope of regression.

2.5. Study of Gonad. The specimens were dissected to check the reproductive status. Gonads were collected from the specimen of both genders. Gonads were macroscopically examined to enable determination of sex based on the presence of ovaries or testes. Gonadal length and weight of individual fish samples were recorded. Stages of maturity were determined from the weight, color, shape, and transparency of the gonads' ova diameters and consistency of the ovary.

2.5.1. Histological Study. For the histological study of the gonads and determining different stages of sexual maturation, small pieces of the gonad from initial, middle, and final parts were sampled and fixed into Bouin's solution for 48 h. After dehydration and bleaching in alcohol and xylene solution, the tissues were embedded in paraffin and the samples were sliced into 5 μm thickness using a rotary microtome. Then, they were stained with hematoxylin and eosin, taken on the slides, sealed with a cover slip using DPX glue, and observed under a microscope (Nikon ECLIPSE €200 in 100 ×).

2.6. Fecundity. To estimate absolute fecundity, the number of eggs in the ovaries was counted by gravimetric method. Three subsamples were taken from the anterior, middle, and posterior parts of the ovary. Samples were weighed, average number of eggs in each subsample was directly counted, and the mean value was considered with the equation given below

$$F = n \times \frac{G}{g}, \quad (3)$$

where F = absolute fecundity, n = average number of eggs in each subsample, g = subsample weight (g), and G = ovarian dry weight (g).

Relative fecundity was calculated by the following equation:

$$R = \frac{F}{\mathrm{TW}}, \quad (4)$$

where R = relative fecundity, F = absolute fecundity, and TW = total body weight (g).

2.7. Study of Feeding Organs. An investigation on feeding habits was done thorough examination of the mouth, jaws, and teeth. Utilizing the techniques outlined by Keast and Webb [34], the height and width of the mouth aperture, lower jaw extensibility, and premaxillary protrusability, as well as the morphology of the alimentary tract, gill rakers were described. The stomach's contents were emptied into Petri dishes and examined under the microscope.

Premaxillary protrusability and lower jaw extensibility were calculated as follows:

$$\text{Premaxillary protrusability} = \frac{(a' - a)}{a} \times 100,$$
$$\text{Lower jaw extensibility} = \frac{b' - b}{b} \times 100, \quad (5)$$

where a' = measurement after premaxillary protrusion; a = initial measurement; b' = measurement after lower jaw extension, and b = the initial measurement.

2.8. Relative Length of Gut (RLG). The relationship between RLG was used to ascertain the feeding pattern of the fish. RLG > 3 denotes herbivore, RLG < 1 denotes carnivore, and RLG 1–3 denotes omnivore [35].

The following technique was used to measure the RLG:

$$\text{RLG} = \frac{\text{Length of gut}}{\text{Length of the total body}}. \quad (6)$$

2.9. LWR. All the samples were tagged, and photos were taken. The TL, SL, and gut length of the specimens were measured with a digital caliper to the nearest 0.1 mm (length, *L*) and weight with a digital balance to the nearest 0.01 g (weight, *W*).

Calculations for male and female fish species were done separately and combined using the conventional formula described by Cren [26]:

$$W = aL^b, \quad (7)$$

where W = (g), L = Length of fish (mm), a = intercept, and b = slope.

Log-transformed data were used to give a regression equation:

$$\text{Log}\ (W) = \log(a) + b \log(L). \quad (8)$$

Based on the constant b and the statistically significant difference, the growth pattern was identified as $b = 3$ for the isometric growth (I), $b > 3$ for the positive allometric growth (+), and b less than 3 for negative allometric growth (−).

2.10. Condition Factor

2.10.1. Relative Condition Factor. The relative weight condition factor (kn) was calculated as

$$K_R = \frac{\text{Wo}}{\text{Wc}}, \quad (9)$$

where Wo is the observed total weight of fish and Wc is the calculated (or predicted) total weight of respective fish as Wc = aLb [26]. Good growth condition of the fish is deduced when Kn 1, while the organism is in poor growth condition compared to an average individual with the same length when Kn < 1.

2.11. Fulton's Condition Factor. Fulton's condition factor (kc) was estimated as [36]

$$K_F = 100 * \frac{W}{L^3}, \quad (10)$$

where W is the total weight of the fish and L is its TL.

2.12. Statistical Analysis. Regression analysis was used to determine the relationships between length and weight; TL and SL; and fecundity and TL. To assess differences in gonad weight and GSI values among different maturity stages of male and female fish, one-way ANOVA and independent samples t-tests were conducted. Prior to conducting parametric tests, the Shapiro–Wilk test was applied to assess the normality of the fecundity data for *S. mengjialensis*. The result ($p = 0.636$) confirmed that the data were normally distributed, thus satisfying the assumption for parametric analysis. All statistical analyses were performed using IBM SPSS Statistics version 25 and Microsoft Excel 2010.

3. Results

3.1. Sex Ratio. In both species, the males formed a slightly higher percentage of catches than females in smaller size groups, whereas females were dominant in larger size group with no significant difference in the expected 1:1 ratio ($p > 0.05$). The overall sex ratio was in favor of males, and only within the 101–110 mm size range, the sexes were evenly distributed (Table 2).

3.2. GSI. The GSI for *S. sihama* peaked in March, with females exhibiting a mean GSI of 0.653 ± 0.121 and males showing a mean GSI of 0.351 ± 0.022. In *S. mengjialensis*, the highest mean GSI was observed in November, with females reaching 3.600 ± 0.371 and males 1.068 ± 0.115.

3.3. Length at First Maturity (Lm_{50}). The length at first maturity (Lm_{50}) was estimated using binary logistic regression analysis for both male and female specimens of *S. sihama* and *S. mengjialensis* (Figures 4 and 5). The Lm_{50} value for male *S. sihama* was determined as 93.73 mm, while that for females was slightly higher at 98.76 mm. In the case of *S. mengjialensis*, males exhibited an Lm_{50} of 86.00 mm, whereas females matured at a significantly larger size, with an Lm_{50} of 128.14 mm.

3.4. Gonad Development. Two stages of maturity for *S. sihama* and one stage for *S. mengjialensis* were identified through external analysis of gonads and histological study (Table 3 and Figures 6, 7, and 8).

3.5. Fecundity. The fecundity of *S. mengjialensis* in the present study ranged from 8548 to 16458 eggs with the mean fecundity of 12,831.49 ± 1625.86. The minimum fecundity 8548 was found in a fish having a TL of 150.79 mm, body

Table 2: Sex ratio (male:female) of *S. sihama* and *S. mengjialensis* in different size groups.

Size range TL (mm)	M:F	Proportion of male	X^2
S. sihama			
71–80	9:1	0.9	5
81–90	18:9	0.667	3
91–100	11:12	0.478	0.043
101–110	10:10	0.5	—
111–120	4:10	0.286	2.57
121–130	6:6	0.5	—
131–140	2:7	0.222	2.778
141–150	1:2	0.333	0.333
151–160	0	0	0
161–170	0	0	0
171–180	0:1	0	1
Total	61:58	1.0517	0.076
S. mengjialensis			
71–80	3:1	0.75	1
81–90	4:1	0.8	1.8
91–100	1:0	1	1
101–110	1:1	0.5	—
111–120	1:0	1	1
121–130	0:0	0	0
131–140	0:0	0	0
141–150	0:0	0	0
151–160	1:4	0.2	1.8
Total	11:7	1.571	0.889

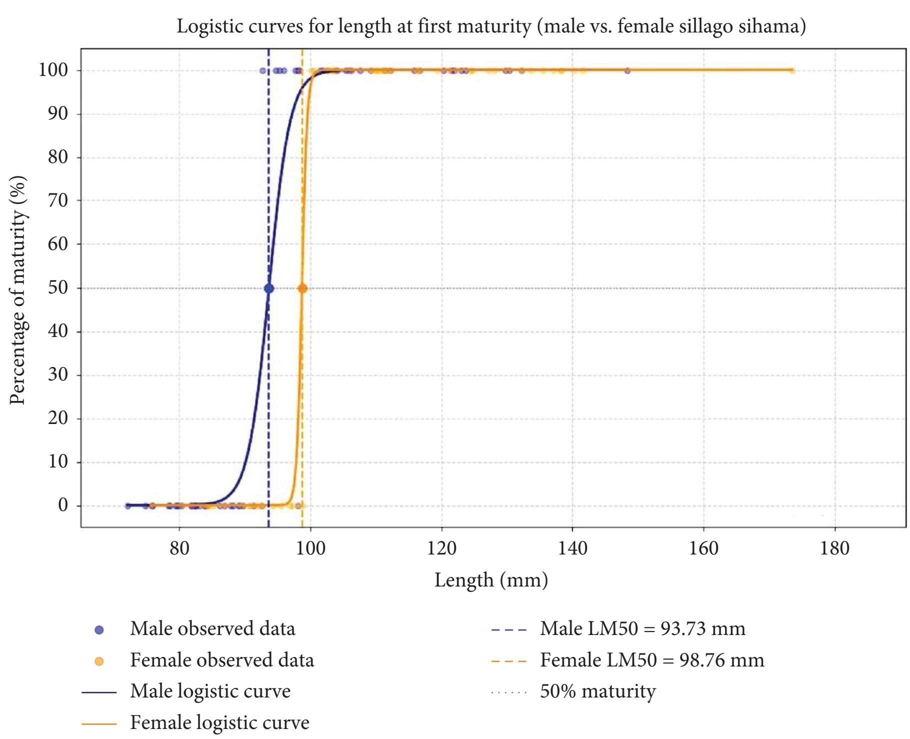


Figure 4: Relationship between percentage composition of proportion of maturity and size groups of male and female *Sillago sihama*.

weight of 26.22 g, and ovary weight of 1.05 g, while the maximum fecundity 16,458.77 was observed in a fish with a TL of 159.81 mm, body weight 27.19 g, and gonad weight of 1.36 g. The relative fecundity ranged between 326.025 and 605.324 eggs per gram. A positive correlation was found between fecundity and TL (Figure 9).

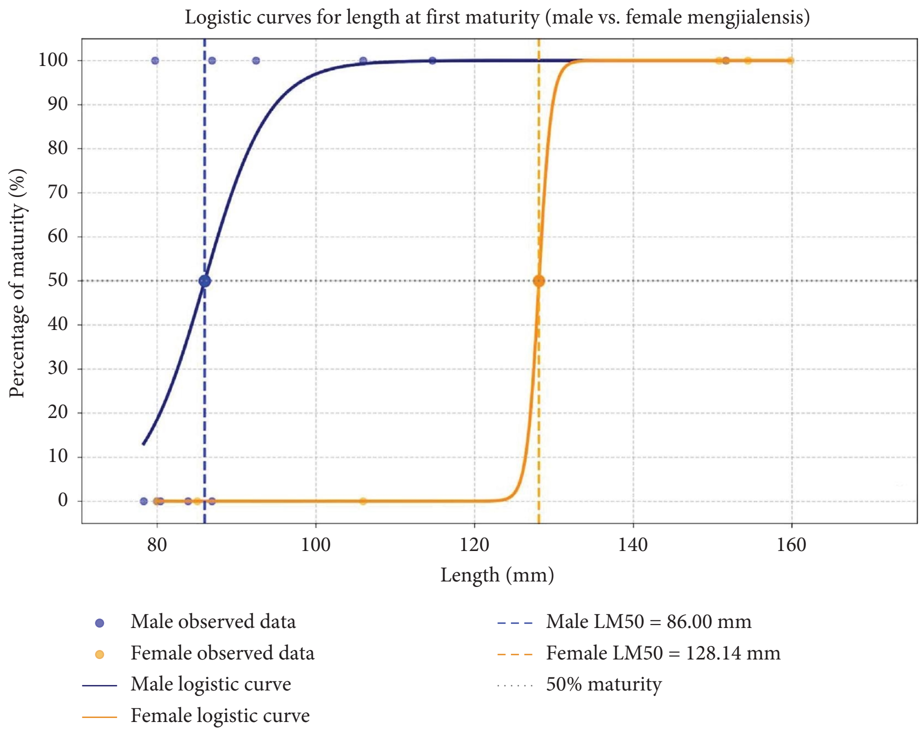


FIGURE 5: Relationship between percentage composition of proportion of maturity and size groups of male and female *Sillago mengjialensis*.

3.5.1. Structure of Feeding Organs. The body forms of the two species were very similar and were classified as compressed fusiform using the criteria of Keast and Webb [34]. In both, the head tapers anteriorly to a long conical snout. Mouth structure parameters of *S. sihama* and *S. mengjialensis* are given in Table 4.

In *S. sihama*, villiform teeth present in jaws and on vomer and in *S. mengjialensis*, the villiform teeth were scattered all over the jaw, pharyngeal teeth were sharp and recurved inward. Additionally, the gill rakers on the first gill arch of small individuals in both species were longer and more filamentous.

3.5.2. Structure of the Digestive Tract. The structure of the digestive tract of both *S. sihama* and *S. mengjialensis* were observed. In *S. sihama*, pyloric cecum was absent, but present in *S. mengjialensis* (Figure 10).

3.6. Food Items. The stomach contents of *S. sihama* revealed a diverse range of food items, including phytoplankton, crustaceans, polychaetes, nematodes, broken bivalve shells, sand grains, digested matter, and unidentified items. Similarly, in *S. mengjialensis*, the digestive tracts contained various food items such as zooplankton, nematodes, crabs, indigestible bivalve, gastropod shells, sand, mud, as well as semidigested and digested matter (Figures 11(a), and 11(b)).

3.7. Relative Length of Gut(RLG). The mean RLG value in *S. sihama* was 1.12, and in *S. mengjialensis*, it was 0.75, which indicate their omnivorous and carnivorous feeding behavior, respectively.

3.8. LWR. The study analyzed specimens from two Sillaginids species. Descriptive statistics for length and weight is presented in Table 5. The 95% confidence interval values of the exponent "b" in the relationship varied between 3.346 and 3.565 for *S. sihama* and 2.941 and 3.234 for *S. mengjialensis*. In *S. sihama*, both males and females were analyzed separately and combinedly. The results showed that all groups exhibited a positive allometric growth pattern ($b > 3$) and significant correlation ($p < 0.05$). In *S. mengjialensis*, the variations in b values from "3" were not statistically significant ($p > 0.05$) and indicated an isometric growth for all the groups. There was a strong correlation between the length and weight of these two species (Table 5).

3.9. Condition Factor. The relative condition factor (K_R) was calculated for both species. For *S. sihama*, Kn values were 1.0082 (male), 1.0101 (female), and 1.0663 (combined). As *S. sihama* exhibited allometric growth, only the relative condition factor was considered for accurate assessment. For *Sillago mengjialensis*, which showed isometric growth, both Fulton's condition factor (K_F) and relative condition factor (K_R) were calculated. The K_F values were 0.6715 (male), 0.6978 (female), and 0.6818 (combined), while K_R values were consistently around 1.0027 for all groups (Table 5). These results indicate that both species were in relatively good physiological condition, with K_R values around or slightly above 1.0. In this study, the females showed slightly better condition factor of growth pattern than males in both species.

Table 3: Macroscopic and histological descriptions of the gonad of *S. sihama* and *S. mengjialensis*.

Species	Stages	Month	Macroscopic features		Histological features	
			Testes	Ovaries	Testes	Ovaries
S. sihama	Immature	November	Ovary occupied nearly a third entire abdominal cavity and seen with the naked eye, thin, ribbon like	Oogonia were small rounded cells with relatively clear zone of cytoplasm	The immature testes characterized by the presence of seminiferous lobules, spermatogonia	Oogenesis changes from oogonia to primary oocytes and then secondary oocytes
	Maturing	March	Flat shape, occupying less than one-third of the coelomic cavity	—	Presence of spermatocytes, spermatids (std) and spermatozoa (sz)	—
	Mature	March	—	Wider ovaries, occupying less than one-third of the coelomatic cavity. Pale cream color to whitish-yellow, visible blood vessels	—	Ovaries were oblong, transparent with opaque eggs. Oogonia, cortical alveoli, one or two oil globules present
	Mature	November	Flat shape, occupying less than one-third of the coelomic cavity, whitish color	—	Spermatozoa (sz) present in the lumen of seminiferous tubules and spermatids (st) may be present in the spermatocytes	—
S. mengjialensis	Ripe	November	—	Oval and large shape occupying entire coelomatic cavity, yellowish color, visible oocytes, blood vessels more evident	—	Presence of hydrolyzed yolk granules, primary growth oocytes (pg) as well as oogonia existing in spawning stage

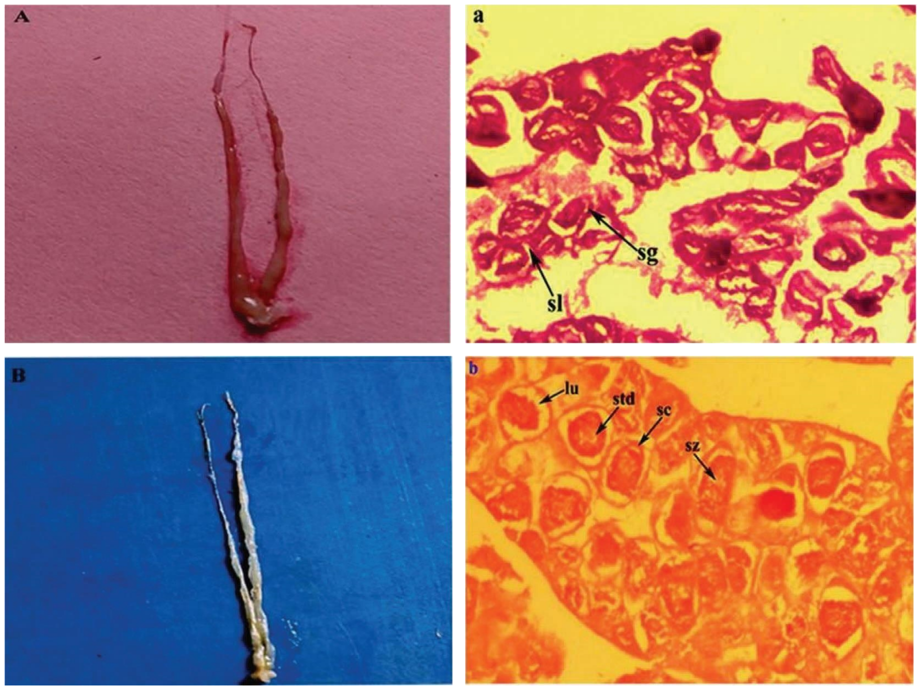


FIGURE 6: Gonad development stages of the male *S. sihama*, (A) immature stage and (B) mature stage); (a) histological section of immature male stage and (b) histological section of mature male stage. Note: sg: spermatogonia, sl: seminiferous lobule, std: spermatids, sz: spermatozoa, and sc: spermatocyte.

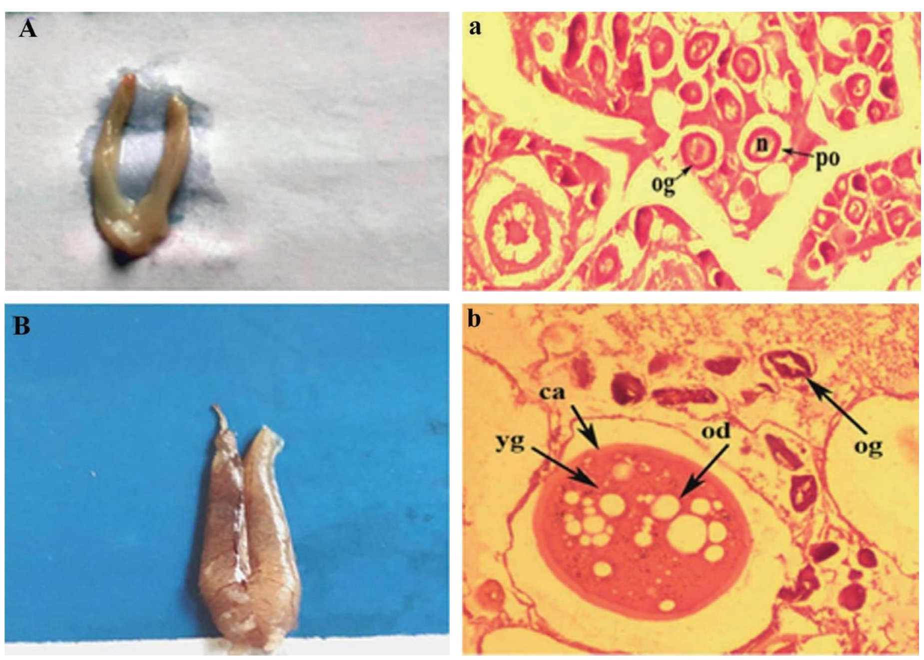


FIGURE 7: Gonad development stages of the female of *S. sihama*, (A) immature stage and (B) mature stage; (a) histological section of female immature stage and (b) histological section of female mature stage. Note: n: nucleus; og: ogonium; po: primary oocyte; ca: cortica alveoli; yg: yolk granules; od: oil droplet.

4. Discussion

In the present study, both species showed male dominance over females. Male dominance was also seen in studies of *S. sihama*, *S. vincenti*, *S. arabica*, *S. atteunta*, *S. indica*, and *Sillaginopodys chondropus* [10, 37–39]. However, female dominance was reported for *S. sihama* and *S. suezensis* [40, 41]. Such sex dominance may result from differences in behavior, fishing methods and equipment, seasonal factors, feeding habits, mortality rates, timing of gonad maturation, spawning grounds, segregation by sex, or greater reproductive effort by females [42, 43].

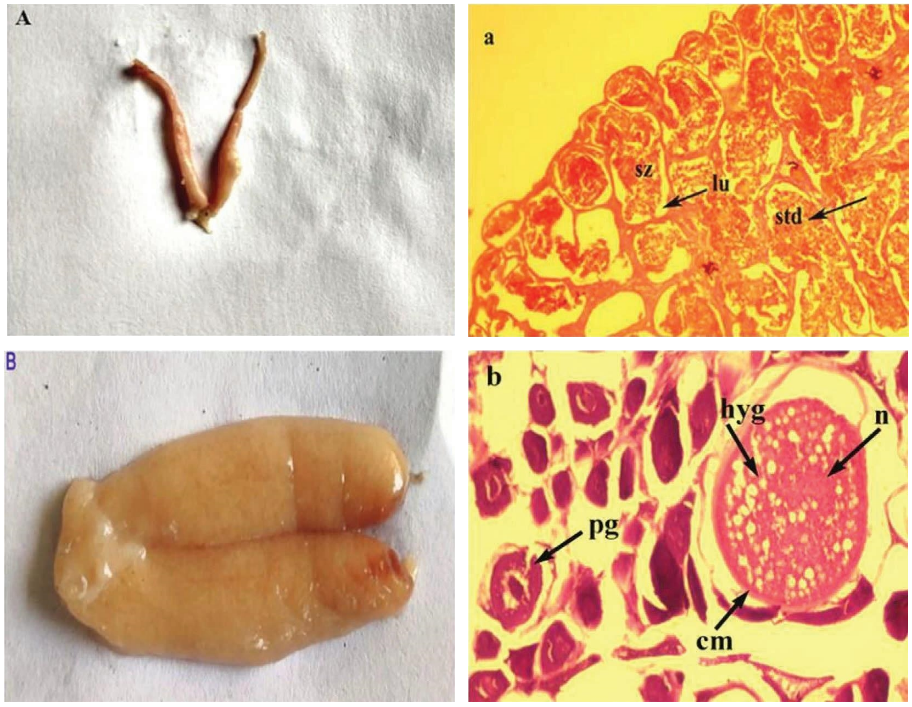


Figure 8: Gonad developmental stages of the male and female *S. mengjialensis*, (A) mature male gonad, (B) ripe female gonad, (a) histological section of mature male gonad, and (b) histological section of ripe female gonad. Note: lu: lumen, std: spermatid, sz: spermatozoa, n: nucleus, cm: cell membrane, hyg: hydrolyzed yolk granules, and pg: primary growth oocyte.

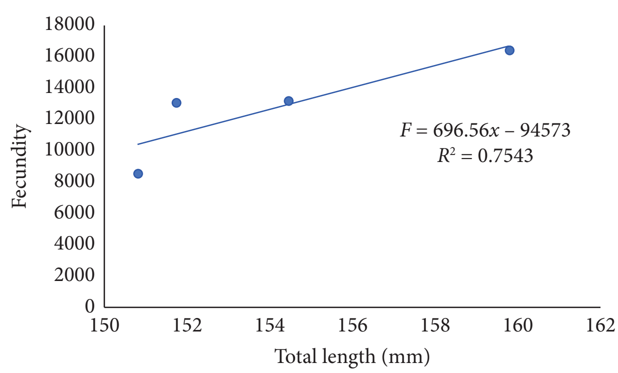


Figure 9: Relationship between fecundity and total length.

Table 4: Mouth structure parameters of *S. sihama* and *S. mengjialensis*.

Parameters	***S. sihama***	***S. mengjialensis***
Premaxillary distensibility	5.34 (2.40–9.68)	4.86 (3.73–5.99)
Lower jaw protrusability	10.40 (5.74–15.45)	7.31 (2.29–11.94)
Mouth aperture width (% of total length)	2.76 (2.59–2.86)	2.59 (2.87–2.35)
Mouth aperture height (% of total length)	5.57 (5.22–5.94)	3.94 (3.41–4.83)

GSI is an indicator of the state of gonadal development [44]. Similar to the current study, the higher GSI of *S. sihama* was also found in March [40]. *S. mengjialensis* showed higher GSI in November similar to *S. sihama* [38, 45, 46]. These differences may be related to changes in water temperature, salinity, and food supply, or perhaps to changes in maturity stage [40].

Length at first maturity is an important trait of life history necessary for success of fishery management, fundamental to establishment of the means that avoid exploitation of young specimens and consequential reduction of spawning stock [47]. It seems that there is also differentiation in maturity between the two sexes. Most of the male reached maturity smaller and younger than female which

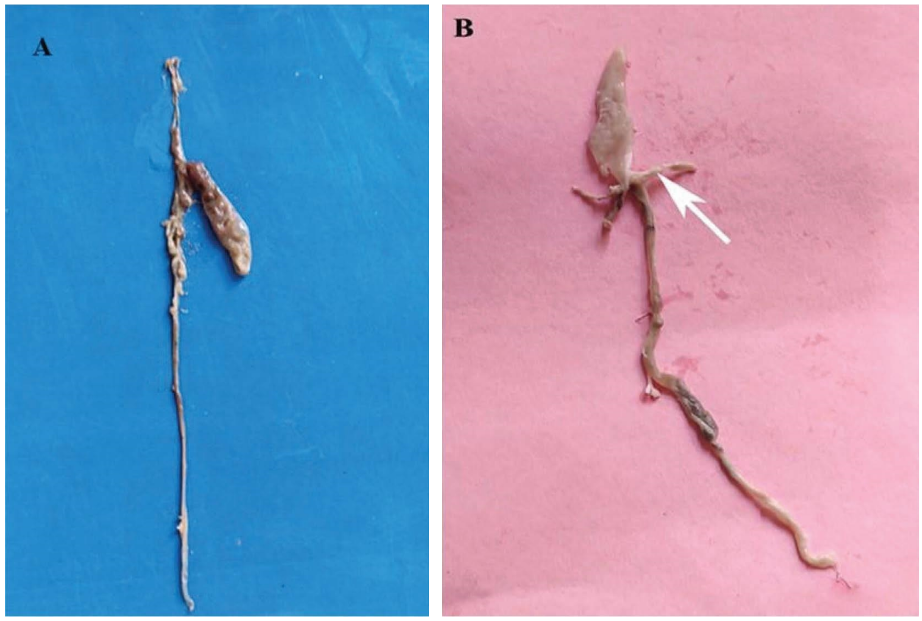
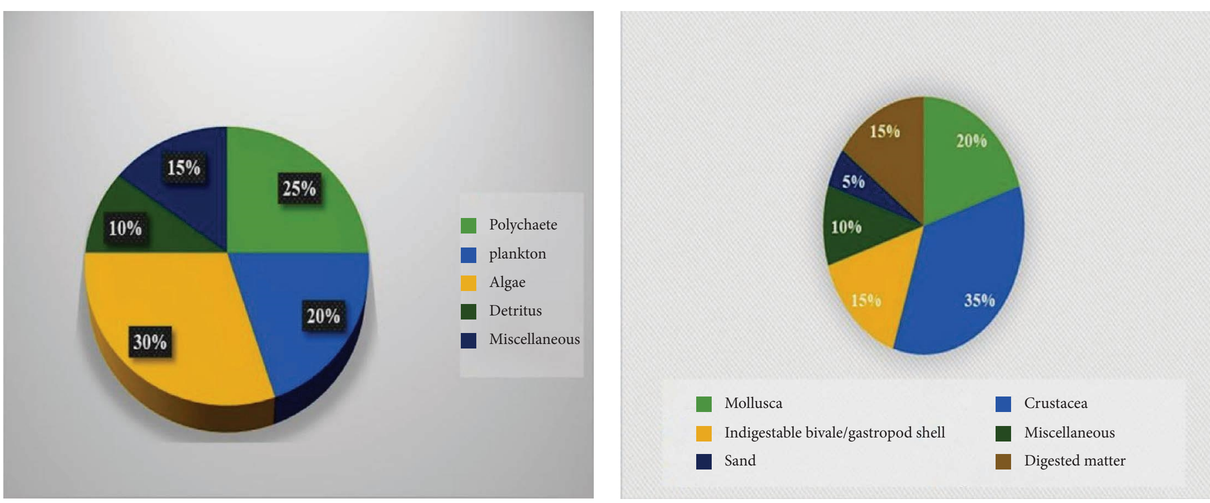


Figure 10: Digestive tract of *S. sihama* ((A) pyloric cecum absent) and *S. mengjialensis* ((B) pyloric cecum present).



(a) (b)

Figure 11: Diet composition of (a) *S. sihama* and (b) *S. mengjialensis*.

explains the greater duration of life of the female that mature later [48]. The size at first maturity (Lm_{50}) estimated in the present study for *S. sihama* was 93.73 mm for males and 98.76 mm for females, which is smaller than the values reported by previous studies, ranging from 130 to 140 mm [40], 155 to 165 mm [49], and 170 to 210 mm [50]. Similarly, for *S. mengjialensis*, the Lm_{50} values were estimated at 86.00 mm for males and 128.14 mm for females. These observed differences in Lm_{50} among studies may be attributed to geographical variation, environmental factors [40].

The ovary of *S. sihama* consists of an ovarian wall and numerous developing oocytes within follicles, which were embedded in a mass of connective tissue [40], which was also evident in *S. sihama* in the present study. Similar to the present study, the immature stage (ovary) of *S. sihama* showed the maximum percentage of oogonia together with immature and maturing oocytes [50]. The immature testis was characterized by the presence of seminiferous lobules, spermatogonia, and spermatocytes in *S. sihama* like other researchers [50].

The fecundity of *S. mengjialensis* ranged from 8548 to 16,716 in this study. There was a significant difference in the determined value of fecundity recorded by different researchers in *S. sihama*, *S. vincenti*, and *Sillaginopsis domina* [39, 44, 49–51]. The variation of fecundity is very common and observed in fishes, and the number of eggs produced by an individual female is dependent on several factors like size, age, and environmental conditions [52].

Similar to the present study, *S. sihama* was also classified as omnivorous in some other studies [38, 53–55]. In the

Table 5: Descriptive statistics, estimated LWR parameters, and condition factor of *S. sihama* and *S. mengjialensis* from the study area.

Species	Group	Sample size (N)	Total length (mm) Mean ± SD	Standard length (mm) Mean ± SD	Body weight (g) Mean ± SD	Regression parameters a	b	95% CL of a	95% CL of b	r^2	Growth pattern	Condition factor (K) K_R	K_F
S. sihama	Male	61	97.21 ± 17.13	83.97 ± 15.19	7.16 ± 4.81	0.0028	3.362	0.002–0.004	3.223–3.502	0.975	A+	1.00825	
	Female	58	108.54 – 19.72	94.45 ± 17.85	10.96 ± 7.81	0.0021	3.498	0.001–0.003	3.308–3.689	0.960	A+	1.01015	
	Combined	119	102.73 ± 19.22	89.08 ± 17.29	9.013 ± 6.69	0.0023	3.454	0.002–0.003	3.342–3.565	0.969	A+	1.00845	—
S. mengjialensis	Male	11	94.633 ± 22.203	80.96 ± 19.81	6.66 ± 5.76	0.0046	3.065	0.003–0.009	2.778–3.352	0.984	I	1.00271	0.6715
	Female	7	126.857 ± 35.164	110.01 ± 30.82	17.09 ± 11.14	0.0049	3.073	0.003–0.009	2.777–3.373	0.993	I	1.00273	0.6978
	Combined	18	107.15 ± 31.41	92.27 ± 27.88	10.71 ± 9.52	0.0047	3.087	0.002–0.003	2.941–3.234	0.992	I	1.00272	0.6817

Note: (a) intercept, (b) slope, (r^2) coefficient of determination, (K_R) relative condition factor, and (K_F) Fulton condition factor.
Abbreviations: CI, confidence intervals; SD, standard deviation.

Table 6: Comparison of value "*b*" of *S. sihama* and *S. mengjialensis* from Cox's bazar, Bangladesh, with previous studies from different areas of the world.

Literature	Species	Slope '*b*'	Location
Krishnamurthy and Kaliyamurthy [57]		3.08	Pulicat Lake, India
Taskavak and Bilecenoglu [58]	*S. sihama*	3.35	E Mediterranean Coast, Turkey
Daliri [59]		2.73	Northern Persian Gulf
Panhwar et al. [10]		3.21	Northern Arabian Sea coast
Present study		3.45	Cox's Bazar, Bangladesh
Sabbir et al. [60]	*Sillaginopsis panijus*	2.96	Bay of Bengal
Panhwar et al. [10]	*Sillaginopodys chondropus*	2.91	Northern Arabian Sea Coast
Alavi-Yeganeh et al. [61]	*Sillago atteuata*	3.04	Persian Gulf
Akel and Rizkalla [41]	*Sillago suezensis*	2.39	Egyptian Mediterranean Waters
Present study	*Sillago mengjialensis*	3.08	Cox Bazar

present study, *S. sihama* has an RLG of 1.12 and *S. mengjialensis* has the value of 0.76. Hence, it appears that *S. sihama* can be categorized as omnivorous. The presence of sand particles in its digestive contents suggests a bottom-feeding behavior, consistent with previous findings. Similarly, *S. mengjialensis* exhibits a predominantly carnivorous habit, emphasizing its role as a benthic feeder.

The value of slope "b" for *S. sihama* and *S. mengjialensis* was 3.45 and 3.08, respectively. The estimated "b" value was compared with results obtained from related species in other areas worldwide (Table 6). LWR is affected by a number of factors, including sex, gonad maturity, health status, season, habitat, nutrition, environmental conditions such as temperature and salinity, stomach fullness, general fish condition, differences in length range of fish specimens, and collecting gears [56]. Although *S. mengjialensis* exhibited an isometric growth pattern ($b = 3.08$), but limited number of specimens ($n = 18$) may affect the statistical reliability of the growth analysis, and further research with larger sample sizes is recommended.

The condition factor (K) of a fish compares the well-being of a fish based on the hypothesis that heavier fish of a given length are in better condition [62]. In the present study, the higher K value recorded in March for *S. sihama* and November for *S. mengjialensis*. The higher K values recorded for *S. sihama* in June, July–November, June–August, July–February, February, and May in several studies [49, 53, 57, 63, 64]. In *S. japonica*, the highest K value recorded in June–July [65]. The differences in condition factors with different regions are mainly attributed to regional variations in environmental conditions [66]. The lowest K value occurs in the beginning of the reproductive period and the highest at its end [67]. Fishes sufficiently fed would have "K" ≥ 1 but when undernourished "K" is less than 1 [68]. Therefore, it was not possible for us to compare the findings with other studies. In the current study, both species showed the $k \geq 1$ indicated the fishes were in good condition.

5. Conclusion

The present study explored the reproductive biology, feeding ecology, and LWRs of two Sillaginid species. Both *S. sihama* and *S. mengjialensis* showed a male-dominated sex ratio. In *S. sihama*, the highest GSI was recorded in March. The presence of mature ova suggests that spawning likely begins in April. In contrast, *S. mengjialensis* exhibited peak GSI values and spawning activity in November. Dietary analysis indicated that *S. sihama* is omnivorous, while *S. mengjialensis* is carnivorous. Both species had favorable condition factors, reflecting good health. However, there were some limitations for the small sample size of *S. mengjialensis*, such as fishing bans, long-distance sampling constraints, species mixing in consignments, and difficulty in accurate field identification due to morphological similarities; therefore, further research with larger sample sizes is encouraged. The findings of this study provide essential baseline data for future ecological assessments, management strategies, and comparative studies. This will help evaluate detailed information on their life cycles for effective conservation strategies.

Data Availability Statement

The data that support the findings of this study are available upon request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Ethics Statement

All the fish samples were obtained from commercial catches, and the present study was not conducted on live fish. Therefore, no ethical approval is required in this case.

Consent

All authors have reviewed the manuscript and consent to its submission for publication.

Conflicts of Interest

The authors declare no conflicts of interest.

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