International Journal of Fisheries and Aquatic Studies 2025; 13(2): 204-209

E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2025; 13(2): 204-209

www.fisheriesjournal.com
Received: 20-02-2025
Accepted: 21-03-2025

Dr. Indrani Sarkar
Professor, Department of Zoology, Vidyasagar College, Kolkata, West Bengal, India

Riya Denria
Student, Department of Zoology, Vidyasagar College Postgraduate Campus, Saltlake, Kolkata, West Bengal, India

Tania Das
Student, Department of Zoology, Vidyasagar College Postgraduate Campus, Saltlake, Kolkata, West Bengal, India

Corresponding Author:
Dr. Indrani Sarkar
Professor, Department of Zoology, Vidyasagar College, Kolkata, West Bengal, India

Studies of reproductive biology of indian minor carp silver hatchet chela, *Chela cachius* (Hamilton, 1822) in small tributaries, Ronoriver of Mahanadi, Orissa

Indrani Sarkar, Riya Denria and Tania Das

DOI: https://www.doi.org/10.22271/fish.2025.v13.i2c.3066

Abstract
The Silver Hatchet Chela, *Chela cachius* (Hamilton, 1822), a minor carp species of the Cyprinidae family, indigenous to Northern India, this species holds significance as a food source and an ornamental fish. The study was carried out in the small tributaries of the Rono River in Orissa, India, where 80 fish specimens underwent thorough examination to comprehend various aspects of their reproductive biology. The collected fish ranged in length from 10cm to 14cm. The absolute fecundity of the fish ranged from 268 to 365. Female fish exhibited a gonadsomatic index (GSI) suggesting an extended spawning period, fluctuating between 1.72 and 1.79 while the hepatosomatic index (HSI) varied from 2.26 to 2.58. Ovarian histological observation identifying the different stages of ovarian development. There is no evidence of induced breeding of Chela fish. Still, it did observe a decline in the population due to unregulated capture, habitat destruction and the use of pesticides in paddy fields.

Keywords: Hepatosomatic index (HSI), gonadosomatic index (GSI), fecundity, histological examination.

1. Introduction
The silver hatchet chela, *Chela cachius* (Hamilton, 1822) [12], is a freshwater cyprinid that has widespread distribution in South Asia, encompassing countries such as India, Myanmar Bangladesh and Pakistan (Froese, 2010) [11]. The common name of this fish is silver hatchet chela in India This benthopelagic fish, as documented by Menon (1999) [17], primarily sustains itself by consuming phytoplankton (Butt and Khan, 1987; Ahmed *et al.*, 2004) [6, 3] and is commonly found inhabiting ponds, ditches and rivers located in plains and submontane regions. Notably, this species is prevalent in nearly all inland habitats and is subject to substantial capture in the subsistence and artisan fisheries of the region (Craig *et al*., 2004; Kibria and Ahmed, 2004) [8, 16]. Recognised as a small Indigenous fish, *C. cachius* represents a significant source of animal protein, vitamins and crucial micronutrients, effectively contributing to the mitigation of malnutrition, particularly among economically disadvantaged women and children in Bangladesh (Thilsted *et al*., 1997; Ross *et al*., 2003) [25, 22].
The *Chela cachius* species is characterised by a predominant bright silver coloured line on its body starting from back of the head to tail peduncle, with a light olive hue on its dorsal aspect and a whitish shade ventrally. A distinct greenish stripe runs dorsally along its body from the level of the dorsal fin and its fins exhibit a transparent appearance. The body is elongated, deep and laterally compressed, featuring a slightly oblique mouth anterior to the nostril. Notably, Its length is between 10cm to 12cm and weight is between 8gm to 20 gm in our experiment and the complete and gracefully curved downward lateral line boasts 51-56 scales along its course (Talwar and Jhingran 1991) [24]. This particular species is typically found in flowing waters, such as in plains and submontane regions (Talwar and Jhingran, 1991) [24]. It primarily occupies the surface layer of canals, beels, oxbow lakes and rivers (Shafi and Quddus, 2001) [23]. Additionally, it reproduces freely in ponds, tanks and small streams (Talwar and Jhingran, 1991) [24], *i.e.* it can bred in lotic as well as lentic conditions.
To evaluate the commercial potential of fish stock, along with their life history, practical culture and fishery management (Rahimibashar *et al*., 2012) [20], it is essential to estimate a

fish's fecundity and GSI. Fecundity is a critical parameter in fish to determine the reproductive potential of fish species (Zin *et al*., 2011) [29]. Fecundity exhibits periodic variations, long-term fluctuations and correlations with fish size (and hence age) and condition, even within a stock (Horwood *et al*., 1986) [13]. Larger fish lay more eggs both in absolute and relative terms to body mass. Mature fish ova are generally spherical and characterized by a high yolk content (Misra and Saksena, 2012). Consequently, the hepatosomatic index (HSI) has become a widely recognized metric for evaluating energy reserves within the liver (Pollino and Holdway, 2003) [19]. The HSI demonstrates a direct correlation with the gonadosomatic index (GSI) (Chakraborty *et al*., 2024) [7], primarily due to the vitellogenesis process, which involves the synthesis of vitellogenin. In this context, vitellogenin serves as a precursor for yolk synthesis and is produced in the liver of the fish (Cerda, 1996) [9].

Research on reproduction and reproductive strategies is based on the histology of different phases of egg cell development. The reproductive methods of fish are remarkably diverse (West, 1990) [26]. The development of oocytes and the seasons during which they spawn; are indicators of the unique reproductive cycles of each species of fish (Herawati *et al*., 2020) [14]. Oocytes go through various phases of development: initial development (formation of cromatin and perinuclear nucleus), vitellogenesis, cortical alveoli and maturation (Herawati *et al*., 2020; Vitale *et al*., 2006) [14, 27]. Additionally, studies on fish reproduction can yield important information to help conservation and management initiatives that preserve or grow fish populations.

We focused on breeding biology, GSI, fecundity, histological analysis of different stages of over as well as HSI to understand liver activity.

2. Materials and Methods

2.1 Study site

This study focuses on the Ronoriver of Orissa. As a tributary of the Mahanadi, it features a sandy river bed. The banks of the river are lined with diverse vegetation, including banyan and coconut trees. The fertile soil along the riverside supports the growth of various crops, such as paddy and potatoes.

2.2 Fish sampling

On January, March and May 2024, a drag net sampling method was employed to capture a comprehensive representation of the chela population across all size groups. A minimum of 80 specimens were collected for this study. Sampling was conducted randomly and the specimens were promptly preserved in 10% neutralized formalin in small plastic containers to inhibit degradation. The samples were then transported to the Fish Biology and Aquaculture Laboratory of Vidyasagar College at Salt Lake campus, for further analysis. The collected fish were subsequently categorized into three distinct length groups for further examination.

Group - A**:** length is between 10 - 11.5 cm.
Group - B**:** length is between 11.5 - 13 cm.
Group - C**:** length is between 13 - 14 cm.

2.3 Measurement of length and weight

The standard length (SL) of the fish was measured from the tip of the snout (mouth closed) to the posterior margin of the hypural bone, typically identified by the crease formed when the tail is slightly flexed. The overall body weight (BW) was recorded as well. SL measurements were taken to the nearest millimeter using a measuring scale, while BW was determined to the nearest ±0.01g with an electronic digital balance. Additional morphometric parameters included pre-dorsal length (from the snout tip to the base of the dorsal fin), post-dorsal length (from the dorsal fin base to the caudal fin base), body width, eye diameter, snout length, and caudal peduncle length (measured from the anal fin terminus to the caudal fin base).

2.4 Collection of gonads and sex determination

Fish samples' abdomens were cut open with scissors and the gonads were gently extracted using blunt forceps. Blood vessels, muscles, adipose tissues and digestive organs were all appropriately removed. By observing the gonad fish were classified as male or female. Fish contain ovary described as female and fish contain testes as male.

2.5 Gonadosomatic index (GSI)

The gonadosomatic index (GSI) is a widely employed metric for examining the reproductive cycles of species throughout the year, often assessed at monthly intervals or with greater frequency. This index is predicated on the principle that gonadal tissues increase in mass as they advance through maturation. GSI is quantitatively expressed as the ratio of gonadal weight (GW) to the total body weight (BW) of the organism, providing insights into reproductive condition and energy allocation related to reproductive efforts. The GSI of each fish specimen in the study was calculated as GSI = (GW/BW) * 100 (Afonso-Dias *et al.*, 2005) [1].

2.6 Hepatosomatic Index (HSI)

The Hepatosomatic Index (HSI) of a fish specimen is determined using the formula: HSI = (Liver Weight / Body Weight) × 100 (Rajaguru, 1992) [21]. This index facilitates the assessment of hepatic condition in relation to systemic physiology, potentially uncovering environmental stressors or underlying health issues. Hepatosomatic Index (HSI) is frequently utilized as a biomarker for evaluating the liver's energy reserves and metabolic status.

2.7 Histological examination

Ovaries were preserved in a 10% buffered formalin solution for overnight for histological analysis. The development of the ovaries was assessed through a conventional histological process. A transverse segment from the mid-region of the ovary was excised and dehydrated through graded ethyl alcohol solutions at room temperature (30%, 50%, 70%, 90% and 100%). Tissue impregnation was performed with acetone, followed by two applications of molten paraffin, each for one hour and then melted paraffin at 60°C. The segment was embedded in a clay mold filled with molten paraffin. The resulting paraffin block was sliced into 6 µm thick sections with a microtome. The gonadal sections were subjected to graded alcohol treatment, stained with hematoxylin and eosin and then mount with the DPX Mountant. A coverslip was positioned over the sections prior to microscopic examination.

2.8 Fecundity estimation

Fecundity defined as the total number of oocytes released by a female throughout a spawning season, was assessed through a gravimetric methodology. Oocyte samples were harvested from three distinct regions anterior, middle and posterior across five ovarian lobes. These samples were counted manually using a random sampling method. Individual oocytes were carefully isolated using fine needles and measured along their longest axis under a stereomicroscope to ensure precise dimensional analysis. Fecundity (F) was subsequently calculated using the following formula:

Absolute Fecundity (F) = W $\times$(N1+N2+N3) $\div$ (w1+w2+w3)

Where, W = Ovary Weight,
N1, N2, N3 = Ova counts in the sub-sample,
w1, w2, w3 = Weight of each sub-sample.

3. Results

3.1 Morphometric character of *C. cachius*

Morphometric traits serve as crucial indicators for differentiating fish species and evaluating the heterogeneity or homogeneity of a stock. During the course of this study, approximately 80 specimens were collected for analysis. The associated morphometric data are detailed in the following tables.

Fig 1: *Chela cachius*

Table 1: Morphometric character of *C. cachius*

Expt. No.	Body weight (gm)	Total length (cm)	Standard length (cm)	Pre dorsal length (cm)	Post dorsal length (cm)	Body width (cm)	Eye diameter (cm)	Snout peduncle (cm)	Caudal peduncle length (cm)
1.	20	13.8	11.5	8	5	3	0.9	1.2	13.8
2.	15	12.1	10.1	6.1	4.1	2.5	0.5	0.6	12.1
3.	15	13.1	10.2	7.1	4.6	2.2	0.5	0.3	13.1
4.	12.5	11.6	9.2	6.6	3.9	2	0.7	0.4	11.6
5.	14.5	12.6	10.5	6.9	4.2	2.2	0.6	0.6	12.6
6.	10	12	10.5	7.6	3.5	2.4	0.6	0.5	12
7.	15	12.5	10.3	6.3	4.0	2.3	0.4	0.5	12.5
8.	7.5	12	10.4	3.6	2.3	2.7	0.6	0.5	12
9.	10	12	10.5	2.5	2.4	2.1	0.7	0.6	12
10.	8	10	8.5	2.5	2.3	2.2	0.4	0.3	10
11.	19	12.9	11.3	9	6	2	0.8	1.3	12.9
12.	11.5	10.5	8.2	6.5	3.8	3	0.6	0.3	10.5
13.	13.5	11.6	10	6.7	4.1	2.1	0.5	0.5	11.6
14.	15	13.2	11.5	7.2	4.5	2.2	0.4	0.2	13.2
15.	13	12.5	9.5	6.6	4.2	2.3	0.3	0.3	12.5
16.	8	10.1	8.6	2.4	2.2	2.1	0.3	0.2	10.1
17.	8.5	10.2	8.5	2.2	2.1	2.3	0.2	0.3	10.2
Mean	12.7	11.9	9.9	5.7	3.7	2.3	0.5	0.5	11.9

3.2 Variation in fecundity, GSI and HSI with body length, body weight - The Gonadosomatic Index (GSI) provides a quantifiable measure of gonadal mass in relation to total body mass, serving as a critical indicator of fish spawning density and reproductive maturity. Research indicates that GSI values typically peak during the prime spawning periods of various fish species. A strong positive correlation exists between fecundity, defined as the number of eggs produced and gonadal weight. Conversely, the Hepatosomatic Index (HSI) tends to demonstrate an inverse relationship with GSI, as the liver stores energy that is subsequently utilized for gonadal development. Furthermore, fecundity is often positively correlated with the overall length, body weight and gonadal weight of the fish.

The table presents data on fish lengths ranging from 10 cm to 11.5 cm. The mean values recorded are as follows: body weight is 9 g, length is 10.2 cm, absolute fecundity is 268.08 oocytes, the gonadosomatic index (GSI) is 1.72, and the hepatosomatic index (HSI) is 2.23.

Table 2: In Length Group- I (10 cm - 11.5 cm)

Specimen	Body weight (gm)	Length (cm)	Absolute fecundity	Gonadosomatic Index (GSI)	Hepatosomatic Index (HSI)
Female	8	10	236.02	1.76	2.25
Female	11.5	10.5	339.20	1.78	2.46
Female	8	10.1	232.06	1.67	2.13
Female	8.5	10.2	265.06	1.76	2.10
Average	9	10.2	268.08	1.72	2.23

Specimens of fish within the length range of 11.5 cm to 13 cm (mean length of 12.2 cm) demonstrated an average body weight of 13 g. Simultaneously, we evaluated reproductive and physiological indices, revealing a mean absolute fecundity of 309.72 oocytes, a gonadosomatic index (GSI) of 1.74, and a hepatosomatic index (HSI) of 2.38. These findings provide important insights into the reproductive investment and liver condition in this specific size class.

Table 3: In Length Group- II (11.5 cm - 13 cm)

Specimen	Body weight (gm)	Length (cm)	Absolute fecundity	Gonadosomatic Index (GSI)	Hepatosomatic Index (HSI)
Female	15	12.1	360.93	1.83	2.04
Female	12.5	11.6	351.00	1.87	2.19
Female	14.5	12.6	293.25	1.54	2.03
Female	10	12	267.70	2.30	3.17
Female	15	12.5	296.47	1.40	2.13
Female	7.5	12	289.74	1.45	2.12
Female	10	12	256.07	1.88	2.14
Female	19	12.9	432.40	1.85	2.02
Female	13.5	11.6	278.25	1.53	3.00
Female	13	12.5	271.35	1.51	2.98
Average	13	12.2	309.72	1.74	2.38

A comprehensive analysis of fish specimens measuring between 13 cm and 14 cm in length (mean length 13.7 cm) yielded the following key metrics: mean body weight was calculated at 16.7 g, with an absolute fecundity of 365.23 oocytes. The mean gonadosomatic index (GSI) was determined to be 1.79, while the mean hepatosomatic index (HSI) was found to be 2.26. These parameters provide valuable insights into the reproductive capacity and physiological condition of individuals within this specific size cohort.

Table 4: In Length Group- III (13 cm - 14 cm)

Specimen	Body weight (gm)	Length (cm)	Absolute fecundity	Gonadosomatic Index (GSI)	Hepatosomatic Index (HSI)
Female	20	13.8	433.40	1.89	2.01
Female	15	13.1	330.15	1.75	2.34
Female	15	13.2	332.15	1.74	2.43
Average	16.7	13.7	365.23	1.79	2.26

3.3 Gonadal Histology

Based on histological examinations of the ovaries in *Chela cachius*, we identified several developmental stages. These stages include the Early Perinucleolus stage, the Yolk Vesicle stage, the Primary Yolk stage, the Tertiary Yolk stage, the Premature stage and the Mature stage.

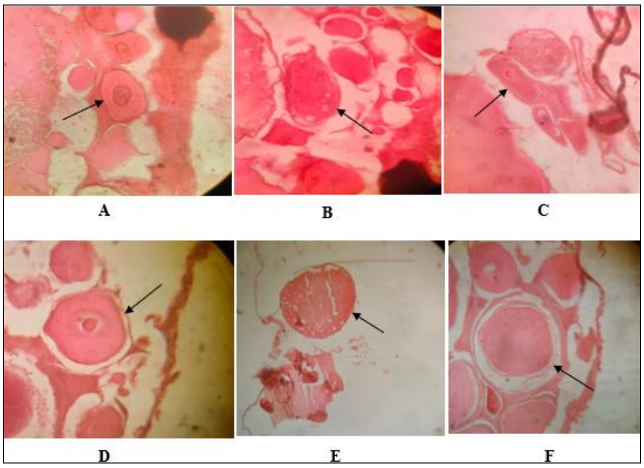

Fig 2: Histological appearance of oocyte development of *Chela cachius* A: Early perinucleolus; B: Yolk vesicle stage; C:Primary yolk Stage; D:Tertiary yolk stage; E:Premature stage; F:Mature stage.

4. Discussion

In our observation length group III shows the highest fecundity. The gonadosomatic index (GSI), which was observed to peak during the period of maximum maturity before declining with age (Ahamed, 2012) [2]. Yeldan and Avsar (2000) [28] noted that GSI is frequently employed, particularly in bony fish, to investigate spawning seasons, as its values are directly related to gonadal development. The results indicated that the average GSI varied across different groups, with Group I averaging 1.72, Group II 1.74 and Group III 1.79. Furthermore, a positive correlation was demonstrated between body length and GSI, with Group III exhibiting the largest length among all groups. Notably, when hepatosomatic index (HSI) values were lowest, GSI values attain their highest value, suggesting that liver weight may decrease during reproduction. This observation implies a mobilization of hepatic reserves to support gonadal maturation (Zin *et al*., 2011) [29]. An elevated HSI typically signifies an improved nutritional status and increased energy reserves, both of which are essential for optimal reproductive health.

Fecundity refers to the potential annual yield of mature yolked oocytes produced by each female, excluding any losses due to atresia (degenerative processes). In the case of *C. cachius*, fecundity assessment involved the enumeration of mature eggs present in both ovaries. Research on *C. cachius* has revealed a wide range of absolute fecundity, ranging from approximately 268.08 to 365.23 oocytes, influenced by factors such as the fish's size and health status. A comprehensive understanding of the relationship between fecundity and variables such as body weight, gonad weight, and environmental conditions is crucial for effective fishery and aquaculture management. Insights gained from these relationships aid in predicting reproductive success and optimizing breeding program management (Islam *et al*., 2008) [15]. The study further indicated a positive correlation between fecundity and overall length, body weight, gonad length and gonad weight of the fish.

Oocyte development in teleosts is characterized by a prevalent strategy observed in several species (Dursun *et al*., 2013; Amin *et al*., 2019) [10, 5]. In this study, oocyte maturation stages have been delineated into nine distinct phases: early perinucleolus, yolk vesicle, primary yolk, tertiary yolk, premature and mature stages. A histological examination of the ovaries in *C. cachius* has been conducted to accurately define these stages of maturation. Early Perinucleolus Stage (EP) at this phase, oocytes exhibit cytoplasm and nucleoli that display a deep stain with haematoxylin, indicating a basophilic state. The nucleus remains non-basophilic, with several peripheral nucleoli visible on the inner side of the spindle-shaped nucleus. Primary Yolk Stage (SY) during this stage, the yolk globules occupy more than half of the oocyte's cytoplasmic volume. Tertiary Yolk Stage (TY) in this phase, there is an increase in the size of the yolk globules, accompanied by the emergence of oil droplets within the cytoplasm. Premature Stage (PM) following nuclear migration, the nuclear membrane undergoes disintegration, a phenomenon known as germinal vesicle breakdown. At this stage, the yolk globules begin to merge and the nucleus becomes indistinguishable, although the follicular layer remains intact. In mature Stage (M) the yolk globules are fully visible, contributing to a significant increase in oocyte translucency, which indicates hydration. Additionally, the follicular layer attains a flattened appearance. This comprehensive categorization of oocyte maturation stages contributes to a better understanding of reproductive biology in *C. cachius* and highlights the intricacies of oocyte development within teleosts. The similar result have been resulted by Ali *et al*., 2021 [4].

5. Conclusion
In light of the GSI value and absolute fecundity, our analysis of the external features of the ovaries, coupled with findings from histological studies, reveals that Group III exhibits the highest GSI and fecundity values, alongwith the lowest HSI value. The histological examination of the various stages of egg cell development is crucial for advancing our understanding of reproductive strategies.

6. References

1. Afonso-Dias I, Reis C, Andrade JP. Reproductive aspects of *Microchirus azevia* (Risso, 1810) (Pisces: Soleidae) from the south coast of Portugal. Sci Mar. 2005;69(2):275-83.
2. Ahamed A. Reproductive biology of the tub gurnard *Trigla lucerna* (Linnaeus, 1758), in the Libyan eastern coast of Mediterranean Sea. Egypt J Aquat Biol Fish. 2012;16(1):95-104.
3. Ahmed ZF, Rahman MS, Hossain MY, Wahab MA. An investigation into the diet of a freshwater small fish Chhep chela *Chela cachius* (Hamilton-Buchanan, 1822) in a large perennial pond in Mymensingh, Bangladesh. Prog Agric. 2004;15(2):135-40.
4. Ali N, Paul SK, Ahmed ZF, Saha D, Fatema K, Majumdar PR. Reproductive biology of the silver hatchet *Chela cachius* (Hamilton, 1822) in a perennial water body in Bangladesh. Egypt J Aquat Biol Fish. 2021;25(4):313-27.
5. Amin M, Elhalfawy MM, Khouraiba MM, Ali AM. Some biological aspects and gonads histology of *Sepia savignyi* (Blainville, 1827), in the Gulf of Suez, Egypt. Egypt J Aquat Biol Fish. 2019;23(2):43-54.
6. Butt JA, Khan K. Food of freshwater fishes of North West Frontier Province, Pakistan. Proc 7th Pak Congr Zool. 1987:217-33.
7. Chakraborty A, Sarkar I, Lal J, Bej A, Mondal M, Bhuiya K, *et al*. Study of hepatosomatic index, gonadosomatic index and fecundity of Tengra fish (*Mystus gulio*). J Sci Res Rep. 2024;30(10):12-21.
8. Craig JF, Halls AS, Barr JJF, Bean WC. The Bangladesh floodplain fisheries. Fish Res. 2004;66(2-3):271-86.
9. Cerda JB, Calman G, Lafleur GJ Jr, Limesand S. Pattern of vitellogenesis and follicle maturational competence during the ovarian follicular cycle of *Fundulus heteroclitus*. Gen Comp Endocrinol. 1996;103(1):24-35.
10. Dursun D, Eronat EGT, Akalin M, Salman MA. Reproductive biology of pink cuttlefish *Sepia orbignyana* in the Aegean Sea (eastern Mediterranean). Turk J Zool. 2013;37(5):576-81.
11. Froese R. FishBase. [Internet]. 2010 [cited 2025 Apr 25]. Available from: http://www.fishbase.org
12. Hamilton F. An account of the fishes found in the river Ganges and its branches. 1st ed. Edinburgh: Edinburgh & London; 1822. p. 1-39.
13. Horwood JW, Bannister RC, Howlett GJ. Comparative fecundity of North Sea plaice (*Pleuronectes platessa* L.). Proc R Soc Lond B Biol Sci. 1986;228(1253):401-31.
14. Herawati T, Akhodiah S, Yustiati A, Dhahiyat Y, Lili W. Histological analysis of ovarium development of *Hampala macrolepidota* Kuhl & Van Haselt, 1823 from Jatigede Reservoir, West Java. IOP Conf Ser Earth Environ Sci. 2020;535(1):012058.
15. Islam MA, Begum M, Pal HK, Alam MJ. Studies on the gonadosomatic index and fecundity of *Mystus gulio* (Ham.). Prog Agric. 2008;19(2):161-6.
16. Kibria MG, Ahmed KKU. Diversity of selective and non-selective fishing gear and their impact on inland fisheries in Bangladesh. WorldFish Cent. 2005;28(2):43-8.
17. Menon AGK. Checklist - freshwater fishes of India. Rec Zool Surv India Misc Publ Occas Pap. 1999;(175):366.
18. Mishra S, Saksena DN. Gonadosomatic index and fecundity of an Indian major carp *Labeo calbasu* in Gohad reservoir. Bioscan. 2012;7(1):43-60.
19. Pollino CA, Holdway DA. Reproduction of a laboratory-based population of the Australian crimsonspotted rainbowfish (*Melanotaenia fluviatilis*). Aust J Ecotoxicol. 2003;9(2):8-13.
20. Rahimibashar MR, Alipour VP, Hamidi, Hakimi B. Biometric characteristics, diet and gonad index of lizardfish (*Saurida tumbil*, Bloch 1795) in north of the Persian Gulf. World J Fish Mar Sci. 2012;4(1):1-6.
21. Rajaguru A. Biology of two co-occurring tonguefishes, *Cynoglossus arel* and *C. lida* (Pleuronectiformes: Cynoglossidae), from Indian waters. Fish Bull. 1992;90(2):328-67.
22. Roos N, Islam MM, Thilsted SH. Small indigenous fish species in Bangladesh: contribution to vitamin A, calcium and iron intakes. J Nutr. 2003;133(11):4021S-6S.
23. Shafi M, Quddus MMA. Bangladesher Matsho Shampad (Fisheries of Bangladesh). Dhaka: Kabir Publications; 2001. p. 186-7.
24. Talwar PK, Jhingran AN. Inland fisheries of India and adjacent countries. Vol. II. New Delhi: Oxford-IBH Publishing Co. Pvt. Ltd.; 1991. p. 1-1158.
25. Thilsted SH, Roos N, Hasan N. The role of small indigenous fish species in food and nutrition security in Bangladesh. NAGA Newsl. 1997;13.
26. West G. Methods of assessing ovarian development in fishes: a review. Mar Freshw Res. 1990;41(2):199-222.
27. Vitale F, Svedäng H, Cardinale M. Histological analysis invalidates macroscopically determined maturity ogives of the Kattegat cod (*Gadus morhua*) and suggests new proxies for estimating maturity status of individual fish. ICES J Mar Sci. 2006;63(3):485-92.
28. Yeldan H, Avşar D. A preliminary study on the

reproduction of the rabbitfish (*Siganus rivulatus* (Forsskål, 1775)) in the northeastern Mediterranean. Turk J Zool. 2000;24(2):173-82.
29. Zin T, Than AA, Naing TT. Gonadosomatic index (GSI), hepatosomatic index (HSI), condition factor (K) and length-weight relationship (LWR) in *Channa orientalis* Bloch and Schneider, 1801. Univ Res J. 2011;4(2):47-61.