GONADAL DEVELOPMENT OF *CHANNA STRIATA* (BLOCH, 1793) FROM HMAWBI TOWNSHIP, YANGON ENVIRONS

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Abstract

Knowledge on reproductive biology of fish species is crucial important for the biodiversity conservation and for the sustainable development of the fishery. The biological information about *Channa striata* has been poorly documented in Myanmar. The present work has been conducted to investigate the gonadal development and fecundity of *C. striata* from their natural environment. Fish were sampled from rice fields of Hmawbi Township in Yangon Region. Gonadal development has been studied by macroscopic and microscopic observation of the different stages of gonad during the study period from November 2017 to October 2019. In the present study, macroscopic characteristics of the female gonads showed four maturation stages and histological observation indicated seven phases of oocyte development. Spawning period has been determined by observing the monthly Gonado-Somatic-Index and Condition factor of the females. Highest GSI value of female *C. striata* was found in June and length at first sexual maturity was estimated at 26.04 cm. The mean absolute fecundity was 33922.08 ± 9708.42 vitellogenic oocytes. The results from the present study clearly showed that the breeding season of *C. striata* was extended from May to July in Myanmar and their peak spawning season was in June.

Keywords: gonadal development, fecundity, length at first sexual maturity

Introduction

Channa striata, commonly known as snakehead, is a freshwater fish and native to Asia, Indonesia and tropical Africa (Herborg *et al*., 2007). It is locally known as Nga-yant in Myanmar. All species of snakeheads are piscivorous and feed on crustaceans and small vertebrates (Dasgupta, 2000). They breed in lakes, river, ponds and shallow water areas such as flooded paddy fields (Jayaram, 1999). Because of its high protein contents, snakeheads are important food fish in Southeast Asia. Snakehead is an economically important species and it is a popular dry fish in Myanmar. The natural population of this species is gradually declining because of over exploitation and habitat degradation.

Knowledge on reproductive biology of fish species provides important information for the rational management of a fishery resource (Greiner and Gregg, 2010; Reuter *et al*., 2010). Animals use various reproductive strategies to maximize their reproductive fitness and/or to ensure the survival of offspring. The reproductive tactics such as size at first sexual maturity, spawning period and fecundity are used by the individual organisms (Potts and Wootton, 1984) to increase their reproductive fitness. Many researchers has been doing research on reproductive biology of fishes in order to provide information for the sustainable development of the fishery and aquaculture.

A thorough understanding on the gonadal development of female *C. striata* provides important information to fish stock management. Due to over exploitation and habitat degradation, the population of *C. striata* is gradually decreasing and there is a growing concern over degradation of population of *C. striata* in their natural habitats. Hence, it is urgently needed to study the reproductive biology of *C. striata* and to monitor systematically in the purpose of fishery management. However, no detail work on reproductive biology of *C. striata* has been performed in Myanmar, thus, the present study was undertaken to study some aspects of reproductive biology of *C. striata*. The aims of the present study was to describe the different stages of gonadal development of female *C. striata* and to estimate their length at first sexual maturity.

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Materials and Methods

A total of 420 female *C. striata* were observed during the study period. The study area was located at Hmawbi township (17˚ 8′ 10″ N and 96˚ 0′ 34″ E) and all fish specimens were collected from the paddy fields with the help of fishermen from November 2017 to October 2019. Fish sample were kept in ice boxes and transported to the laboratory where total length (to the nearest 1mm) and body weight (to the nearest 0.01g) of fish were measured. The sex of fish were identified by observing gonads of the fish. Gonads of female (n = 15) were removed, weighed while wet (nearest 0.01g) and observed the development stages of the macroscopic gonad monthly. The gonadosomatic index (GSI) was calculated by using the formula described by Brook *et al*. (1997): GSI = total gonad weight (g)/ total body weight of fish (g) x 100. Hepatosomatic index (HSI) of females was calculated according to Cek and Yilmaz (2009): HSI = total liver weight (g)/ total body weight of fish (g) x 100. Female reproductive maturity was determined by macroscopic observation of different stages of the ovary. To determine the absolute fecundity of the female, the mean of three sub-samples, anterior, middle and posterior part of the ovary of twenty mature females, were used to calculate absolute fecundity by counting the number of oocytes per sub-samples of ovary to the total ovary weight. Total number of oocytes were calculated by using the formula described by Bagenal (1978): total number of oocyte = total weight of ovaries/subsample weight x number of counted oocytes in the subsample. Oocyte samples, taken from anterior, middle and posterior part of the ovary, were measured by using ocular micrometer and calculated the size of the oocyte by using the formula supported by De Vlaming *et al*. 1982: egg size = (length axis + wide axis)/2.

Histological analysis

The gonad samples of three mature females were preserved in 10 % buffered formalin monthly and they were kept at room temperature. They were dehydrated in graded alcohol series, exposed to Xylene and embedded in paraffin wax. Sections of 0.15cm-0.2cm thickness were prepared and stained with Haematoxylin and Eosin, then mounted with DPX. Finally, photographed with a ZEISS PRIMO STAR TRINOCULAR microscope which was equipped with the Axiocam ERc 5s camera. Gonad developmental stages were estimated observing sections under the microscope as immature, maturing, mature and spent phases (Navarao *et al*. 1989; Morton 1990).

Results

A total of 420 specimens were observed during the study period. The gonadal development of the female *C. striata* were observed through macroscopic and microscopic analysis. The female *C. striata* presented with total length varying from 27.3 cm to 50 cm (35.46 ± 5.61, n = 20) and weight varying from 737.1 to 162.39 g (364.86 ± 151.86, n = 20) (Table.1). The absolute fecundity of females ranged from 18148.68 to 56927.35 eggs (33922.08 ± 9708.42, n = 20). The oocyte diameter is varied from 1.1 to 0.55 mm (0.84 ± 0.13, n = 20) and egg diameter varied from 1.3 to 0.48 mm (0.99 ± 0.15, n = 20) (Table.1). The total length and ovary weight of females showed a positive correlation with a coefficient of determination (r^2) of 0.8756 (Fig. 1). There is a positive correlation between total length and number of eggs (r^2 = 0.8395, Fig. 2) and between ovary weight and number of eggs in the female ovary (r^2 = 0.8105, Fig. 3). The total length at first maturity of *C. striata* was 26.04 cm (Fig.4).

The GSI values of female *C. striata* (n = 360) varied from 0.08 to 2.49 and the highest value was found in May (Fig. 5). The HS

I values varied from 0.60 to 1.10 and the highest value was found in June (Fig. 5).

Through macroscopic observation, the immature stage was found throughout the year, except in July and August (Fig. 6). The developing stage was started to find in September and the mature stage in May to July (Fig. 6). The spent stage was found in June and August. (Fig. 6).

The ovary of *C. striata* is a paired hollow sac-like structures and more or less elongated, lying dorsal to the alimentary canal and ventral to the swim bladder. The two ovaries were united to form an oviduct which opened to the exterior via the oval shaped urogenital papilla. The size of the left ovary was usually larger than the right and the color of the ovary varied from reddish brown to light yellowish.

Macroscopic gonadal maturation stages of female *C. striata*

Macroscopic observation revealed four gonadal maturation stages in female *C. striata* as immature, developing, mature and spent (Plate. 1).

Stage (I) Immature

Ovaries are relatively small, thin, translucent and pale reddish in color.

Stage (II) Developing

In this stage, ovaries are increased in size and reddish in color. Small ova are visible through thick wall of gonad. Blood capillaries become conspicuous.

Stage (III) Mature

The ovaries occupy the whole of the body cavity and it is yellowish in color. The ripe eggs are apparently visible.

Stage (IV) Spent

The ovaries are small in size and dull white in color. The volume and weight of the ovary is decreased in this stge.

Microscopic gonadal maturation stages of female *C. striata*

The microscopic examination of the ovaries of *C. striata* showed seven phases of oocyte development (Plate. 2) constituting four different stages. The first or immature stage included the chromatin nucleolar stage (Phase I) and Perinucleolar stage (Phase II). The second or developing stage included early yolk vesicle stage (Phase III) and late yolk vesicle stage (Phase IV). The third or mature stage included early yolk granule stage (Phase V) and late yolk granule stage (Phase VI). The fourth or spent stage included artretic stage (Phase VII).

Stage (1) Immature

(I) Chromatin nucleolar stage (CN)

In this stage, oocytes were small cells surrounded with a thin peripheral zone. They contained a spherical and large nucleus, which occupies the greater part of the cell with one nucleolus.

(II) Perinucleolar stage (PN)

In perinucleolar stage, the size of the oocyte became larger and the shape vary from polygonal to oval according to the oocyte development. The nucleus became enlarged.

Stage (2) Developing

(III) Early yolk vesicle stage (EYV)

Small yolk vesicles can be seen in the cytoplasm. These yolk vesicles first appeared at the periphery of the oocyte.

(IV) Late yolk vesicle stage (LYV)

In this stage, the yolk vesicles gradually spread towards the central nucleus and the nucleoli were present at the periphery of the nucleus.

Stage (3) Mature

(V) Early yolk granule stage (EYG)

Small yolk protein granules stained in light pink can be seen in the outer cortex. They were gradually increased in size and number and then moved towards the inner cortex.

(VI) Late yolk granule stage (LYG)

The oocytes were greatly increased in diameter and yolk granules and lipid droplets were fused in this stage.

Stage (4) Spent

(VII) Atretic stage (AT)

The nucleus became degenerate followed by the dilution of the yolk and fragmentation of the zona radiata.

Through microscopic observation, the immature stages (chromatin nucleolar stage and perinucleolar stage) were found in October and November and developing stages (early yolk vesicle stage and late yolk vesicle stage) were found between December and April (Plate. 3). The mature stages (early yolk granule stage and late yolk granule stage) were highly found in June. The spent stage (atretic stage) was commonly found in August (Plate. 3).

Table 1 Absolute fecundity, oocyte and egg diameter of mature *C. striata*

	Weight (g) (n=20)	**Length (cm) (n=20)**	**Absolute fecundity (n=20)**	**Oocyte diameter (mm) (n=20)**	**Egg diameter (mm) (n=20)**
Mean±SD	364.86 ± 151.86	35.46 ± 5.61	33922.08 ± 9708.42	0.84 ± 0.13	0.99 ± 0.15
Range	737.1 – 162.39	27.3 – 50.0	18148.68 – 56927.35	1.1 – 0.55	1.3 – 0.48

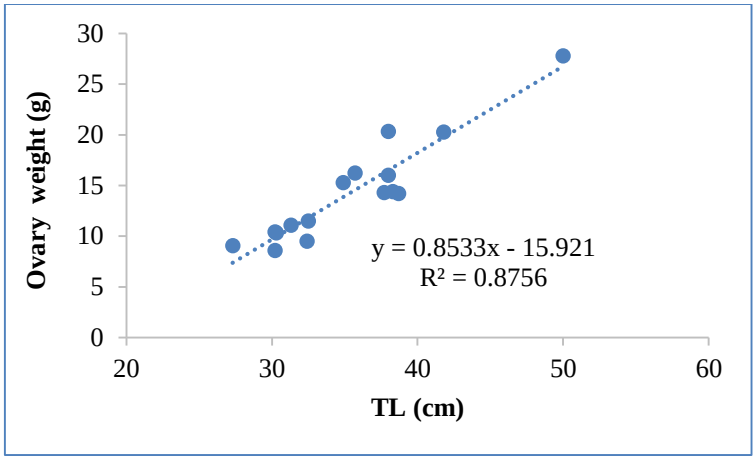


Figure 1 Relationship between total length (TL) and ovary weight of female (n=20)

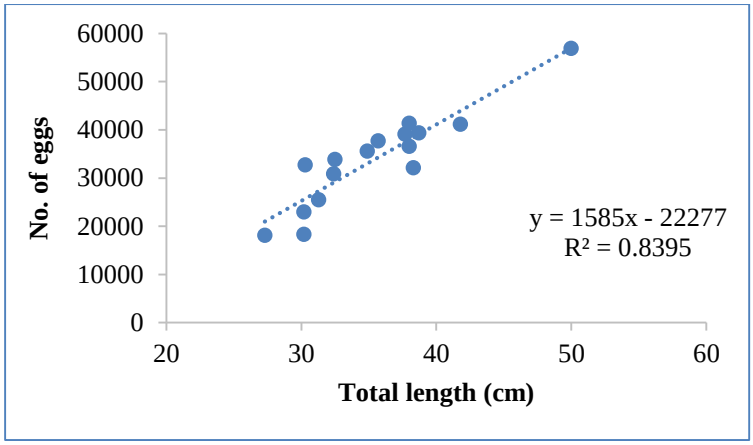


Figure 2 Relationship between total length (TL) and number of eggs of female (n=20)

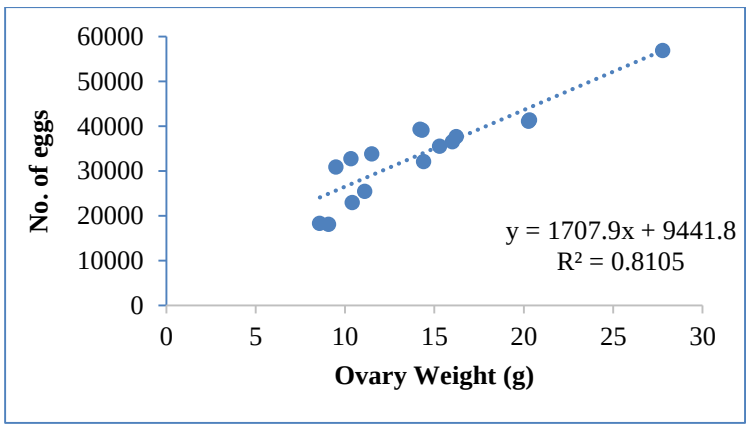


Figure 3 Relationship between ovary weight and number of eggs of female (n=20)

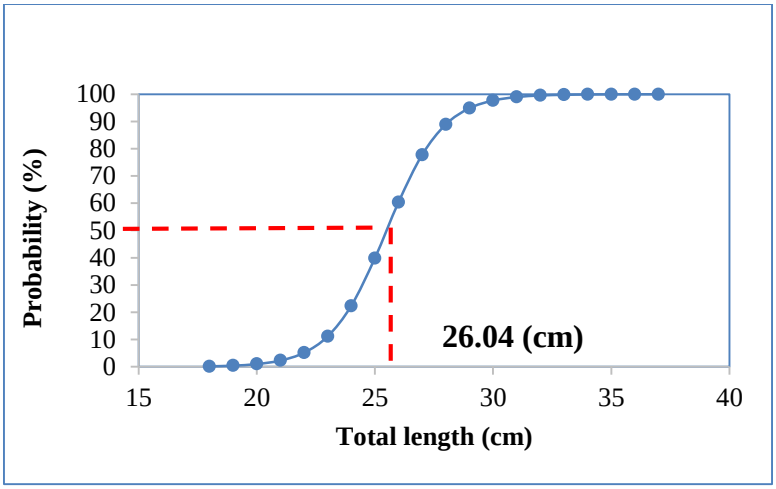


Figure 4 Length at first maturity (L_m50) of female *C. striata* (n=145)

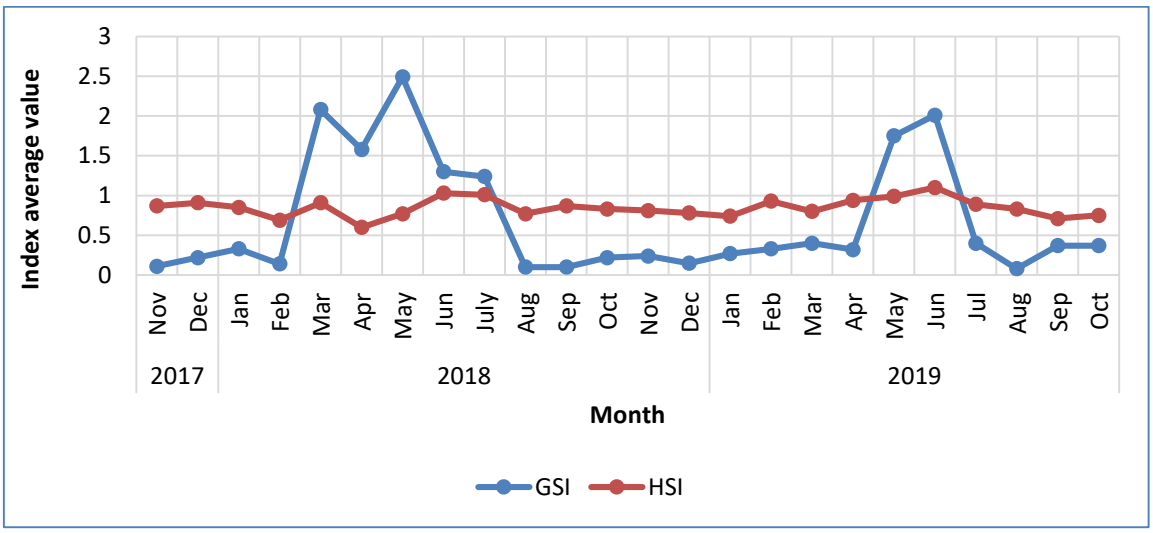


Figure 5 Monthly variation of GSI and HSI of female *C. striata* (n=360)

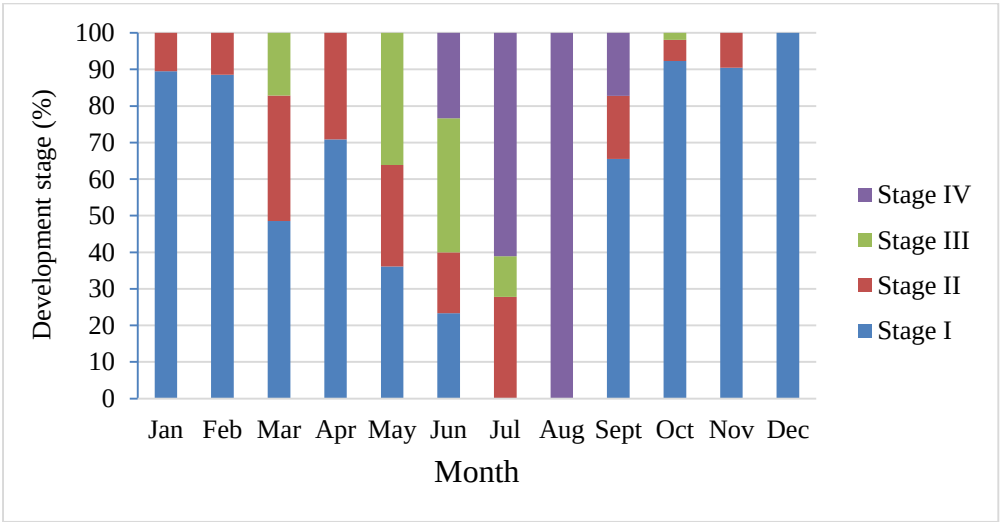


Figure 6 Monthly developmental stages of ovary of *C. striata* (n=180)


Stage I (Immature)


Stage II (Developing)


Stage III (Mature)

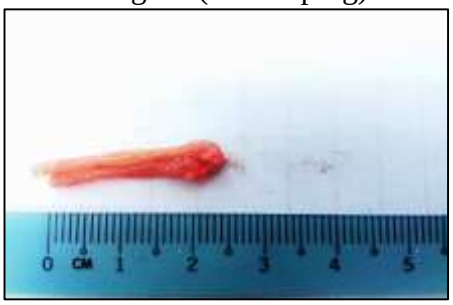
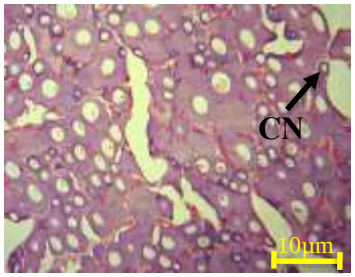
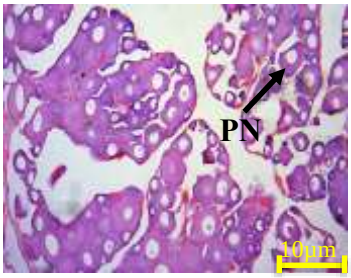

Stage IV (Spent)

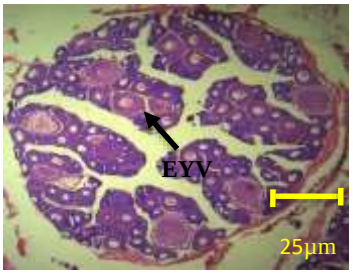
Plate 1 Developmental stages of the female ovary (Macroscopic features)



I. Chromatin nucleolar stage



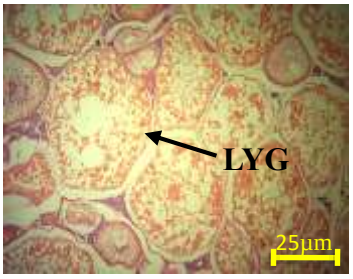
II. Perinucleolar stage



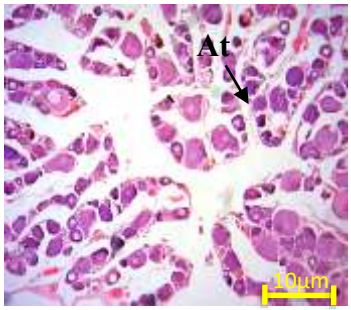
III. Early yolk vesicle stage

IV. Late yolk vesicle stage

V. Early yolk granule stage



VI. Late yolk granule stage



VII. Atretic stage

Plate 2 Developmental stages of ovary of *C. striata* (Microscopic features)

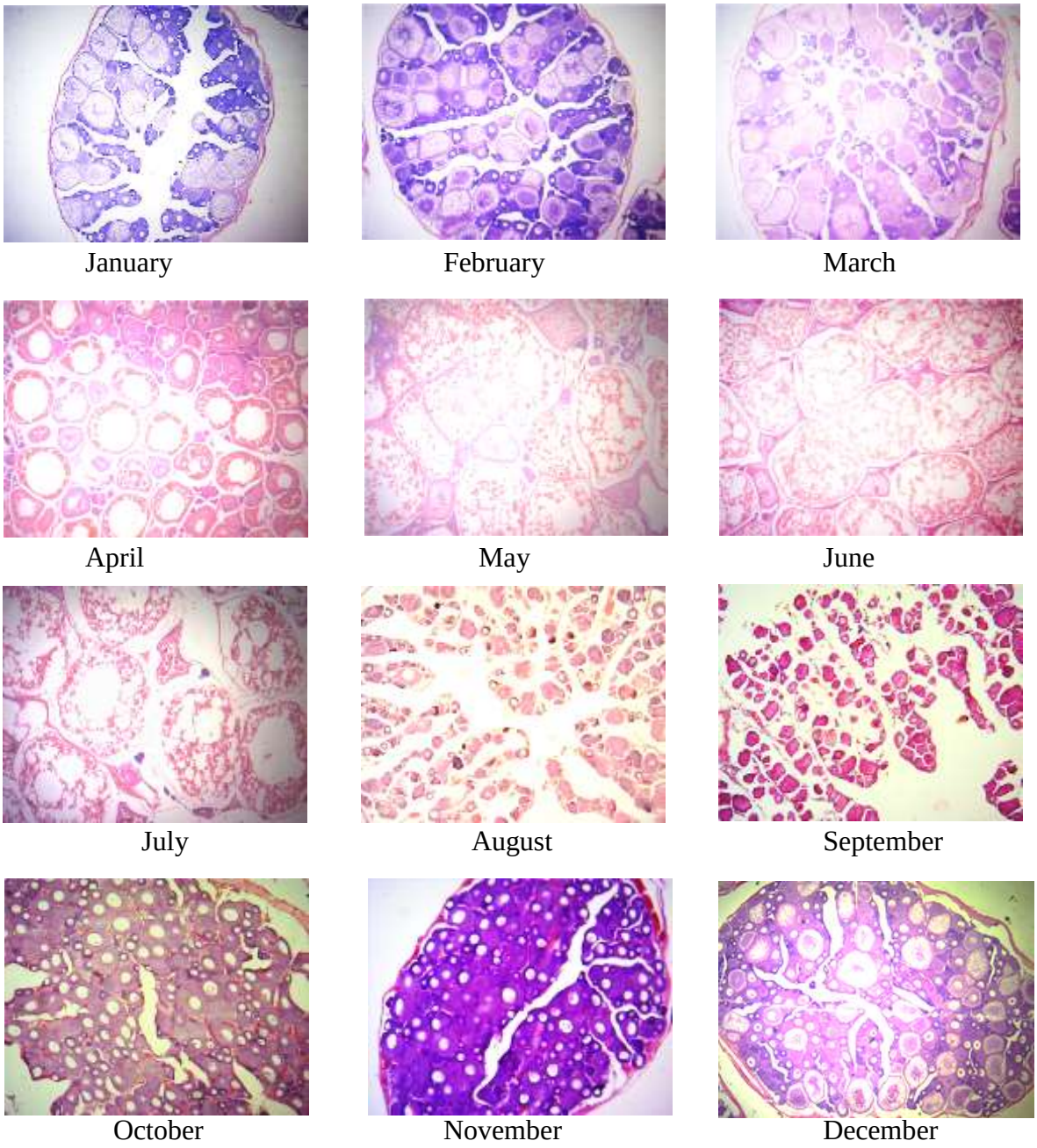


Plate 3 Monthly development of oocyte of *C. striata*

Discussion

In the present study, the macroscopic characteristic of gonads indicated four maturation stages of ovary in *C. striata*. Histological studies of gonads of *C. striata* showed seven phases of oocyte development. The macroscopic features of gonads stated that immature stages was found throughout the year except in July and August. Developing stage was started to find in September and mature stage was found in May, June and July indicating that spawning occurred during the month of May to July. In addition, the occurrence of mature stage of gonads was highest in June. Spent stage was found in June and August. These results indicated that the breeding season of *C. striata* might be the period between May and July in Myanmar.

Meanwhile, the GSI value was highest in May and abruptly decreased in June. The microscopic observation also gave the same result as the mature stage (late yolk granule) was found

in May, June and July and Spent stage (atrectic) was found in August. The result from this study clearly indicates that the breeding season of *C. striata* might started in May and proceed until July in Myanmar. The breeding season of *C. striata* was June-July in Malaysia and has only one breeding season (Ghaedi *et al.* 2013). Hence, our result strongly supports to the result of former researcher. The result from this study clearly showed the breeding season of *C. striata* coincided with the onset of rainy season (May to July) in Myanmar.

The absolute fecundity of the female ranged from 18148.68 to 56927.35 with a mean absolute fecundity of (33922.08 ± 9708.42). Jhingran (1984) cited fecundity of *C. striata* in India as 3000 to 30000 per ovary. Ghaedi *et al.* (2013) reported that the absolute fecundity of 33949 ± 3388 in Malaysia. However, Li (2016) recorded an absolute fecundity of *C. striata* in Taiwan ranging from 4484 to 96498. One possible reason for different value of absolute fecundity of *C. striata* is that fecundity of female depends on their life history traits (size at first maturity, life span etc.) and the environmental factors (availability of food etc.). Our result is consistent with the range of estimate value of the absolute fecundity of *C. striata.*

The length at first maturity of *C. striata* in Myanmar was 26.04 cm which is close to the value (25.5cm) recorded in the irrigated rice field of Malaysia (Ali, 1999). Alikunhi (1953) reported that the smallest mature female specimen was 23.4 cm in length with ovaries in the 4th stage of development. In Sri Lanka, the TL for the smallest mature *C. striata* female was 23.2cm (Kilambi 1986). However, Li (2016) reported that the minimum body length of sexually mature females in Taiwan was 28cm. Hence, the result from this study is consistent with the result of former researchers from Southeast Asian countries and was different from Taiwan because Taiwan is located at a higher lattitude and with a greater minimum body length of the mature females. In addition these differences in female length at first maturity are expected and likely to be associated with different environmental conditions and/or availability of the food. This study provides clear and update information on the gonadal development of female *C. striata* and its length at first maturity.

Conclusion

The knowledge on reproductive biology of any fish species is crucial important for fishery management. In this study, gonadal development of female *C. striata* was investigated. In general, it was concluded that the breeding season of *C. striata* coincides with the rainy season (May to July) of Myanmar and ends in August. The length at first sexual maturity of female is 26.04 cm and their absolute fecundity is 33922.08 ± 9708.42. More empirical research on reproductive biology of *C. striata* should be encouraged for the sustainable development of fish species and its culture.

Acknowledgements

I would like to acknowledge Professor Dr. Aye Mi San, Head of the Department of Zoology, University of Yangon, for giving me a permission to perform this research and her valuable advice on this research work. My heartfelt thanks are due to my teachers, colleagues and personnel who helped me a lot to accomplish this work within a limited time frame.

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