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ARTICLE

Reproductive Biology of Splendid Ponyfish *Leiognathus Splendens* (Cuvier, 1829) in Myeik Coastal Waters, Myanmar

Khin May Chit Maung[1*] Phan Minh Thu[2,3] Nyo Nyo Tun[1]

1.Myeik University, 1 Saparshwewar St., Kalwin Ward, Myeik City, Tanintharyi Region, Myanmar
2.Institute of Oceanography, Vietnam Academy of Science and Technology (VAST), 01 Cau Da St., Nha Trang, Vietnam
3.Graduate University of Science and Technology, VAST, 18 Hoang Quoc Viet St., Cau Giay, Ha Noi, Vietnam

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ABSTRACT

Reproductive biology of *Leiognathus splendens* was studied by using the samples collected from the catches of trawl fisheries in Myeik coastal waters during January to December 2014. Spawning takes place throughout the year, with a peak during April-May and September-December. The observed length at first maturity was 9.0 cm total length in males and 8.4 cm in females. The mean gonadosomatic index was more prominently in females (2.5) than males (1.5). Sex ratio (1 male: 1.1 females) also indicates the general dominant of females over males Fecundity varied from 6120 to 58412 eggs. Relationship of fecundity to fish length, fish weight and ovary weight showed that fecundity is more related to the gonad weight (r=0.9) than length (r=0.8) and weight of fish (r=0.7).

1. Introduction

Leiognathus splendens belonging to the Family Leiognathidae is a small sized bottom living fish and diagnosed by snout blunt, downward protracted mouth part and body color silver with short wavy grey-brow vertical lines [1]. They are commonly known as silverbellies, slipmouths, dollarfish, coinfish and ponyfish and also locally known as Ni-shaw or San-sat in Myeik and Nga-din-gar (or) Nga-waing in Myanmar [2].

Several studies on the maturation and spawning of the silverbellies from the Indian waters were done [3-8]. Although, species of *L. splendens* is also widely distributed along Myeik coastal waters and one of the major contributors to the trawler bycatch in Myeik, no detailed information on reproductive biology is available from Myeik coastal waters. Thus, the present study attempted to determine length at first maturity and spawning period, to find out gonadosomatic index and to get a better understanding of the fecundity in relation to fish length, fish weight and gonad weight of fish.

2. Material and Methods

Fish samples were collected from the catches of trawl fisheries (5.08 cm in cod end) in Myeik coastal waters, from January to December 2014. A total of 805 specimens were examined during the study period. Total length and

**Corresponding Author:*
Khin May Chit Maung,
Myeik University, 1 Saparshwewar St., Kalwin Ward, Myeik City, Tanintharyi Region, Myanmar;
Email: khinmaychitmaung1@gmail.com

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weight of each individual was measured to the nearest 0.1 cm and 0.01 g respectively. Maturity stages of fish were determined based on the external appearance like color, size, and the proportion of the gonad area occupied by them in the body cavity [9]. And then, the percentage occurrence of different maturity stages of fish in every month was recorded to estimate the spawning season of fish.

Sex was recorded by careful examination of the gonad. Sex ratio was calculated and tested for the expected ratio of 1:1 by chi-square (x^2) analysis according to the formula:

$$x^2 = \frac{\sum(O-E)^2}{E}$$

where *O*: observed frequency of males or females, E: expected frequency of males or females.

For estimation on the size at first maturity, the lengths of fish were grouped into 0.5 cm interval size groups [4]. The length at which 50% of the individuals attain sexual maturity L50 was estimated by fitting the point where the total length of fish (X-axis) and 50% level of maturity (Y-axis) are met.

Gonadosomatic index (GSI = gonad weight / fish weight * 100) was calculated separately for males and females [10]. Fecundity estimation based on the ripe ovaries was calculated [4]. Fecundity in relation to fish total length, fish weight and gonad weight were calculated by applying the method of least square [11,12] based on the equation:

$$\text{Log } F = \text{Log a} + \text{b Log } X$$

where *F*: Fecundity, a: constant, b: exponent and *X*: fish length (or) fish weight (or) gonad weight.

3. Results

Total of 805 specimens (380 males and 425 females) with the ranges of 4.5- 14.9 cm in length and 14- 45.7 g in weight were used to determine the reproductive biology of this species.

3.1 Maturity Stages

The gonad of *L. splendens* is rounded, unpaired structure lying in the middle of the body cavity attached to its dorsal wall. The maturity classification followed the system used by Rao *et al.* [9] (Table 1). Six maturity stages were recognized as immature (stage I), early maturing (stage II), maturing (stage III), mature (stage IV), ripe (stage V) and spent (stage VI) (Figures 1 and 2).

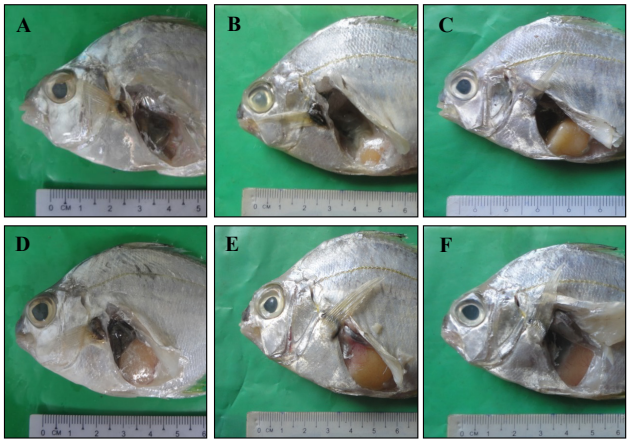

Figure 1. Different maturity stages of ovaries in Leiognathus splendens

Note: 1 (A) Immature; 1 (B) Early maturing; 1 (C) Maturing; 1 (D) Mature; 1 (E) Ripe and 1 (F) Spent.

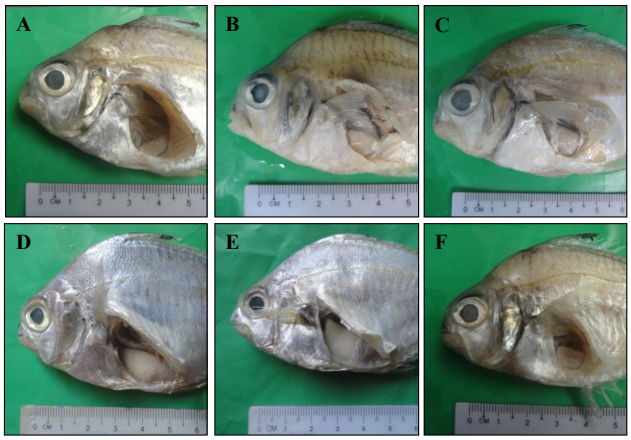

Figure 2. Different maturity stages of testes in Leiognathus splendens

Note: 2 (A) Immature; 2 (B) Early maturing; 2 (C) Maturing; 2 (D) Mature; 2 (E) Ripe and 2 (F) Spent.

Table 1. Maturity classification of *Leiognathus splendens*

Stage	Characteristics
Stage I - Immature	The immature ovaries are characteristically small, transparent, pale in color and occupy a very portion of body cavity. Ova are invisible to naked eye.
	The immature testes are small, transparent, pale in color and occupy the posterior part of body cavity.
Stage II - Early maturing	The early maturing ovary is pale-yellow in color, translucent in appearance and occupies less than 1/3rd of the body cavity. Ova are invisible to naked eye.
	The early maturing testes are pale whitish in color, semi-transparent and occupy nearly 1/3 of body cavity.
Stage III - Maturing	The maturing ovary is yellow in color and occupies ½ of the body cavity. Blood capillaries visible. Granular ova are clearly visible with naked eye.
	The maturing testes are creamy white in color, translucent in appearance and occupy nearly ½ of the body cavity.

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Stage IV - Mature	The mature ovary compact and occupy more than half of the body cavity. They are yellow in color with numerous blood capillaries over the entire ovary. Granular ova are clearly visible with the naked eye.
	The mature testes are creamy white, soft and occupy about ¾ of the body cavity.
Stage V - Ripe	The ripe ovaries are bright yellow in color with numerous blood capillaries and occupy about ¾ to nearly entire length of body cavity. Translucent eggs clearly visible in the ovary.
	Ripe testes are soft, creamy white in color, occupy entire length of body cavity and exude milt under slight pressure.
Stage VI - Spent	The ovaries are flabby and loose, pale yellow in color and occupy not more than half of the body cavity. Spent testes are flabby and occupy nearly ½ of body cavity.

3.2 Occurrence of Different Maturity Stages

The occurrence of mature males and females were recorded to determine the spawning season of fish. Immature and early maturing males (stage I & II) occurred almost all months except October and November. Their percentages were lowest in May and highest in February. Males with maturing testes (stage III) were found in almost all months except February, April, September and October (Figure 3). Fish with mature testes (stage IV) occurred in all months with a peak in September and October. The above 50% proportion of mature males occurred in almost all months except March, June and July. Ripe testes in stage V were recorded from January to July and November. Males in stage VI (spent) were only found in August, September and October.

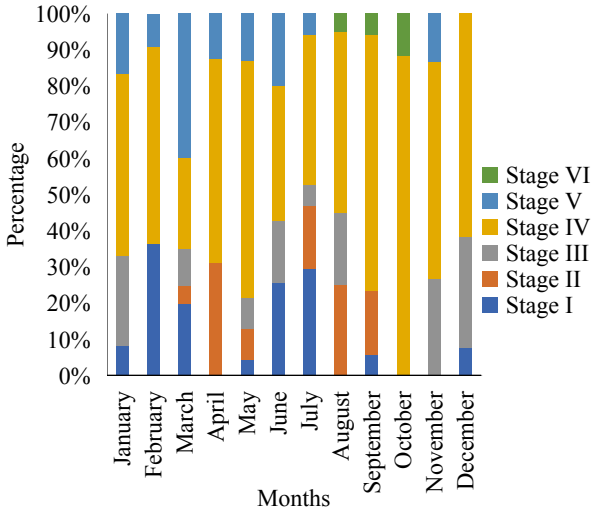

Figure 3. Monthly percentage occurrence of maturity stages of L. splendens (Males)

Females with immature and early maturing ovaries (stage I & II) were found in all months except June (Figure 4). These quantities were high in July, August and December. Except April, July and October, the female with maturing ovaries (stage III) was recorded in all months. Mature female (stage IV) occurred in considerable quantities in all months. Higher percentages were observed in April, May, September, October, November and December and lower percentage occurred in the months of March, July and August. The ripe females (stage V) were not observed in the month of December. Females in stage VI (spent) were observed in January (4.3%), April (12.5%), June (4.8%), July (8.7%), September (5.9%), October (5.6%) and November (11.1%).

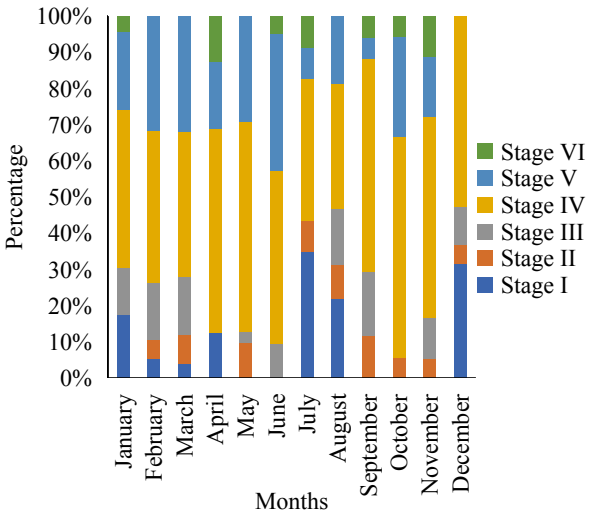

Figure 4. Monthly percentage occurrence of maturity stages of L. splendens (Females)

3.3 Length at First Maturity

No mature male occurred in 5.8-6.2 cm and 6.3-6.7 cm length group. Percentage of mature fish increased with the increase of length for both male and females. The mean size at first maturity (50%) was about total length of 9.0 cm in males and 8.4 cm in females (Figure 5).

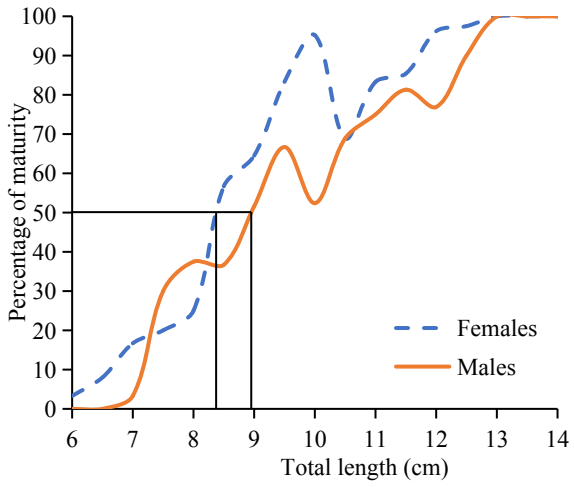

Figure 5. Length at first sexual maturity of males and females L. splendens

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3.4 Sex Ratio

The monthly sex ratios of *L. splendens* were estimated and tested for the expected ratio of 1:1 by chi-square (χ^2) analysis. The resulted average ratio was 1 male: 1.1 females (χ^2=2.6). Females were more abundant in almost all months except May and August (Table 2). The monthly chi-square values range from 0.1 to 2.77. The resulted chi-square value (χ^2=2.6) showed that there was no significant difference at 5% probability level.

Table 2. Monthly sex ratio of *L. splendens*

Month	M:F	χ2	Month	M:F	χ2
Jan	1:1.2	0.42	July	1:1.5	2.32
Feb	1:1.5	2.06	Aug	1:0.6	2.77
March	1:1.2	0.50	Sept	1:1.1	0.10
April	1:1.1	0.30	Oct	1:1.3	1.44
May	1:0.7	1.66	Nov	1:1.2	0.52
June	1:1.4	1.14	Dec	1:1.1	0.10

Note: no significant difference at 5% probability level.

3.5 Gonadosomatic Index (GSI)

The ranges of GSI values were 0.9-1.9 for males and 1.7-3.2 for females. The mean GSI values obtained for males and females were 1.6 ±0.4 and 2.5 ±0.5 respectively. The values of both males and females were found to be lower in the months of March and higher in October. The monthly average GSI values of females were always higher than those of males in all months (Figure 6). The average GSI values obtained for males and females were 1.6 and 2.5 respectively.

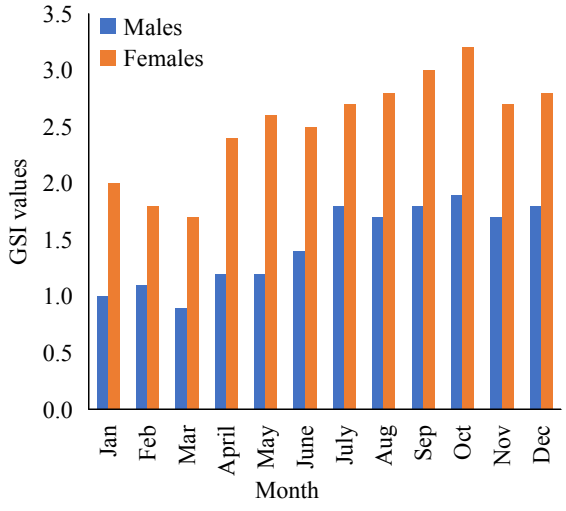


Figure 6. Monthly average GSI values of males and females L. splendens

3.6 Fecundity

Fecundity estimation was based on 16 ripe females ranging in fish total length between 9.5 cm and 14.2 cm and weight between 15.16 g and 45.91 g. The number of ova varied from 6,120 to 58,412 with average fecundity of 22,338±17842 ova. The regression analysis of fecundity on fish length, fish weight and gonad weight can be expressed as:

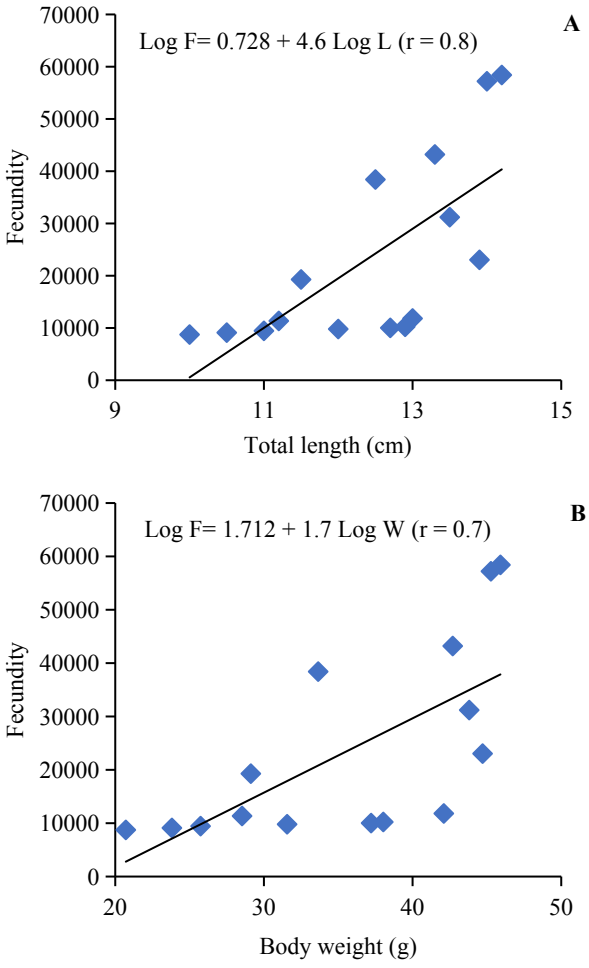
$$\text{Log } F = -0.728 + 4.6 \text{ Log } L \text{ (r = 0.8)} \quad \text{(Figure 7A)}$$

$$\text{Log } F = 1.712 + 1.7 \text{ Log } W \text{ (r = 0.7)} \quad \text{(Figure 7B)}$$

$$\text{Log } F = 3.587 + 2.3 \text{ Log } W_g \text{ (r = 0.9)} \quad \text{(Figure 7C)}$$

where F: fecundity, L: total length of fish, W: weight of fish and W_g: weight of gonad.

The resultant correlation coefficient r values (>0.5) indicated that the correlation was significant. It was found that the fecundity generally increases with increase in total length of fish, weight of fish and gonad weight.



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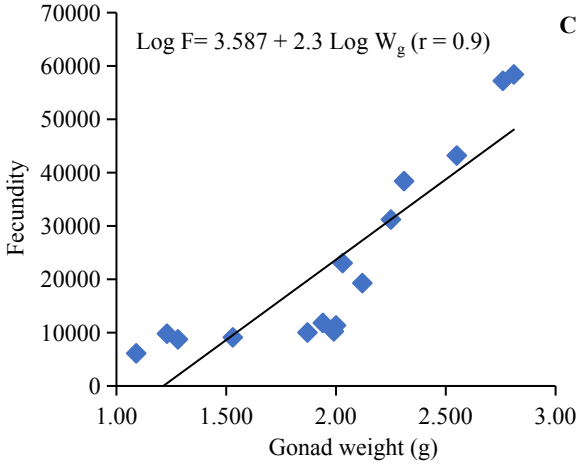

Figure 7. Fecundity in relation to total length (A); body weight (B) and gonad weight (C) of L. splendens.

4. Discussion

Species of *Leiognathus splendens* regularly contributed to the catches of trawl fisheries in Myeik coastal waters were analyzed to estimate fish maturation. The scale of maturation stages is different in different groups of species and in different regions [4]. These variations may also be due to variations in gonad development and spawning periodicity [9]. Maturity stages of silverbellies were classified as three stages based on ova characteristics [5], five stages in female and three stages in male based on the external appearance of ovaries, ova diameter frequency distribution, microscopic structure of ova and color and size of testes [4], six stages [9] and seven stages [6,11,13]. Six maturity stages were recognized in the gonads of Leiognathus splendens of the present study based on the coloration of gonads and proportion of the area occupied by gonad in the body cavity.

The spawning season of fish has been determined by the percentage of mature fishes present in the catch and by changes in gonadosomatic index. The present study showed that *L. splendens* spawn twice a year during April- May and September- December. The spawning season of *L. splendens* was from March till August or September with a peak in April and August in Rameswaram [5], almost throughout the year with two peaks in April-May and October-January in Porto Novo coast [6] and during October to December and February to April in Ratnagiri coast [14]. In general, spawning activity varied according to geography. Variation in spawning time in different regions are due to differing environmental parameters such as temperature, light and salinity which cause changes in physiological activities and subsequently spawning time [15].

Studies on the size at first maturity are essential to ensure a sustained yield by regulating the mesh size of the net, to make sure that the smaller fish also gets an opportunity to spawn at least once in their life time. *L. splendens* mature first at an average total length of 9.0 cm in males and 8.4 cm in females in the present study (Figure 5). The minimum size at first maturity of female at smaller size than that of male in the present study is consistent with the report [6]. All the females of *L. splendens* above 6.8 cm in standard length were found to be mature along the Thangachimadam coast [5]. The length at first maturity of *L. splendens* was estimated at total length of 75 mm in south-west coast of Indian [4] and 10.5 cm in Ratnagiri coast [14]. Kacem *et al*. [16] pointed out difference at size at first maturity due to biological factor and ecological environment. Moreover, the size at maturity can be reduced due to fishing pressure [17].

Sex ratio studies provide information on the proportion of male to female fish in a population and are expected to be 1: 1 in nature. Any deviation from this ratio may indicate the dominance of one sex over the other [10]. It is stated that dominance of one sex relative to the other can be due to different behaviors in the two sexes leading to an easier catch of one sex, differences in fishing methods and equipment, different fishing factors related to season and schooling in feeding and spawning ground and spatial-temporal segregation of the sexes [15,16,18]. Females were more dominant in the catches than the males in the present study. Earlier authors [9,13] also indicated the predominance of females in the silverbellies catches. However, males were dominant in the trawl catches of Porto Novo coast with the ratio of 1 male: 0.86 female [6].

Gonadosomatic index (ratio of gonad weight to body weight) is an indirect method for estimating spawning season of species. High GSI values observed during the spawning periods are because of the occurrence of higher percentage number of mature gonads. Low values were coincided with the occurrence of more number of immature gonads. The index values of *L. splendens* in the present study were observed to be higher than those reported in previous studies [4], [6] but lower than the value of *L. splendens* from Ratnagiri coast [14]. The difference of GSI values may be related to genetic potential variations and also to food resources variability [16]. The monthly average GSI values of females were always higher than those of males in all months of present study period. Similarly, GSI value of silverbellies was higher in females than in males [6], [14]. On the basis of occurrence of mature fishes and monthly GSI values, the spawning season of *L. splendens* in Myeik coastal waters was almost throughout the year, with two peaks during April- May and September-

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December.

Fecundity (total number of eggs per fish) is the most common measure of reproductive potential in fish. The observed fecundity range of *L. splendens* of present study was 6120 - 58412 eggs in fish of total length 9.5 - 14.2 cm with average fecundity of 22338 eggs. Compared to fecundity estimates of silverbellies from Indian waters [4], [5], [6], [14], fecundity estimate of *L. splendens* of present study was high because the previous authors used the small length range of fish.

The observed correlation coefficient 'r' values of present study indicated that fecundity was positively correlated with the fish length, body weight and gonad weight of fish. However, fecundity is more related to the gonad weight than total length and body weight of *L. splendens* according to the result of coefficient 'r' values. In the present study, the weight of ovary of a fish is mainly influenced by the number of ova contained in them. Thus, it is indicated that the weight of gonad is more suitable indices for estimating the fecundity than length and weight of fish.

5. Conclusion

According to the observation, it would be concluded that *L. splendens* spawn throughout the year, with two peaks during April-May and September-December. Thus, prohibition on fishing should be put during these months. Although species of *L. splendens* are caught as by catch in various fishing gears, they are mainly contributors of trawl and bagnet that are multispecies fisheries. The optimum mesh size for each species may affect the other species taken in this gear. Therefore, the best ways are needed much more research on stock structure for fisheries management and to decrease fishing effort for sustainable utilization on this species.

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