REPRODUCTIVE BIOLOGY OF *GAZZA MINUTA* FROM MYEIK COASTAL WATERS*

Khin May Chit Maung[1]

Abstract

Reproductive biology of *Gazza minuta* 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 peak in June-January. The observed length at first maturity was 9.5 cm total length in males and 10.0 cm in females. The gonadosomatic index value was more prominent in females than in males. Sex ratio also indicates the general dominant of females over males. Fecundity varied from 10,002 to 69,421 eggs. Fecundity has positive relationship between fish length, fish weight and ovary weight of fish.

Keywords: Fecundity, gonadosomatic index, length at first maturity, spawning, *Gazza minuta*

Introduction

Species of *Gazza minuta* belonging to the Family Leiognathidae is a small sized (<300mm in standard length) bottom living fish and diagnosed by snout blunt, forward protracted mouth part, the presence of caniniform teeth on both jaws and body color silver with irregular marks or vertical wavy lines. The common name of this species is toothpony and also locally known as Ni-shaw or San-sat in Myeik and Nga-din-gar (or) Nga-waing in Myanmar. They are caught as by catch in variety of gears but the major contribution comes from the trawls fisheries. Large sized fishes are eaten as fresh and small sized ones are used as raw materials in the fish meal plants of Myeik.

The size at first maturity, spawning season, fecundity, sex ratio, histological examination of gonads and gonadosomatic index value are the essential parameters to determine the reproductive potential of individual fishes. These parameters are widely applied to formulate capture fisheries management strategies such as enforcement of minimum catch at size restriction and to close the fishing season during peak breeding period.

[1.] Dr. Assistant Lecturer, Department of Marine Science, Myeik University.

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Moreover the understanding of reproductive biology of species can provide scientific advice for fisheries management. Information on the maturation and spawning of *Gazza minuta* species is available from the seas around India (Jayabalan 1988, James and Badrudeen 1986). Although Thet Lyar Win (2012) stated the identification of *Gazza minuta* from Myeik, there is no information on the reproductive biology of this species. Thus, the present study aims to determine the size at first maturity and spawning period, to find out gonadosomatic index value and to get a better understanding of the fecundity in relation to fish length, fish weight and gonad weight of fish.

Materials and Methods

Samples were collected from the catches of trawl fisheries operated in Myeik coastal waters (Fig 1), from January to December 2014. A total of 422 specimens were examined during the study period. Total length and weight of each individual was measured to the nearest 0.1cm and 0.01 g respectively. Maturity stages were determined based on the external appearance like color, size, and the proportion of the gonad area occupied by them in the body cavity followed the system used by Rao *et al*. (2015). And then, the percentage occurrence of different maturity stages of fish in every month was recorded to estimate the spawning season of fish.

In histological analysis, the ovary was fixed in formalin, dehydrated in upgraded series of ethanol and cleared in xyline. After that, the fixed ovary was embedded in paraffin and cut section of 5μm thickness by rotary microtone. These sections were deparaffinised in xyline, hydrated in downgraded series of ethanol, subsequently double-stained with hematoxylin and eosin and examined under the microscope. The identification of oocytes is mainly based on the appearance of nucleus, nucleolus, vacuoles and yolk vesicle.

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 (χ^2) analysis according to the formula:

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

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. Fishes with stages IV and above maturation were considered as mature fishes. 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. Fecundity estimation based on the ripe ovaries was calculated according to the formula: Fecundity= total weight of ovary/sub-sample weight of ovary* no of ova in the sub-sample. Fecundity in relation to fish total length, fish weight and gonad weight were calculated by applying the method of least square based on the equation:

Log F= Log a+ b LogX

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

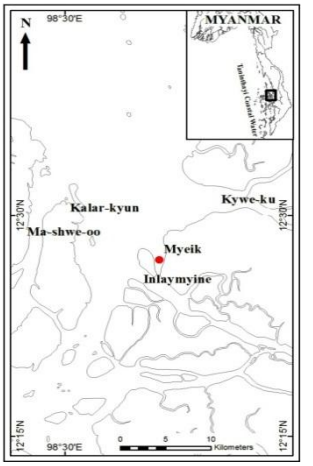


Figure 1. Map showing the Myeik coastal area

Result

Maturity stages

The gonad of *Gazza minuta* 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*. (2015) (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) (Figs. 2 and 3).

Table 1: Maturity classification of *Gazza minuta*

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, semitransparent and occupy nearly 1/3 of body cavity.

Stage	Characteristics
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.
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.

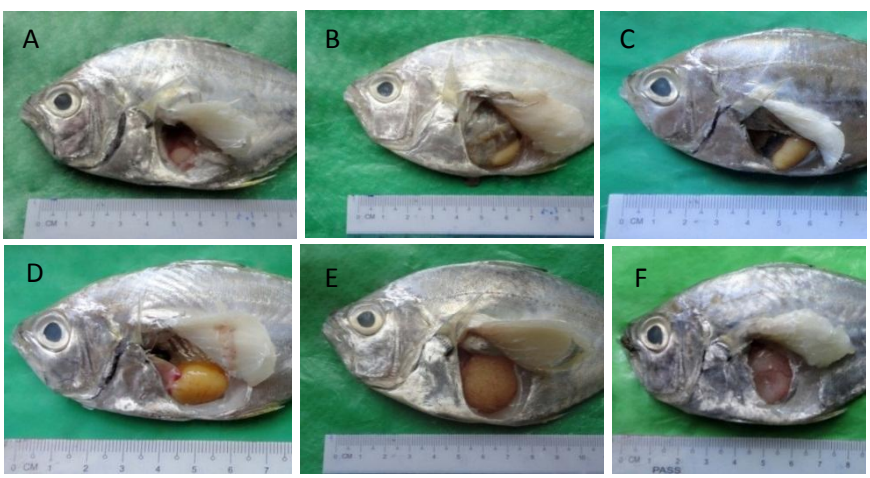


Figure 2. Different maturity stages of ovaries in *Gazza minuta* A) immature; B) early maturing; C) maturing; D) mature; E) ripe and F) spent.

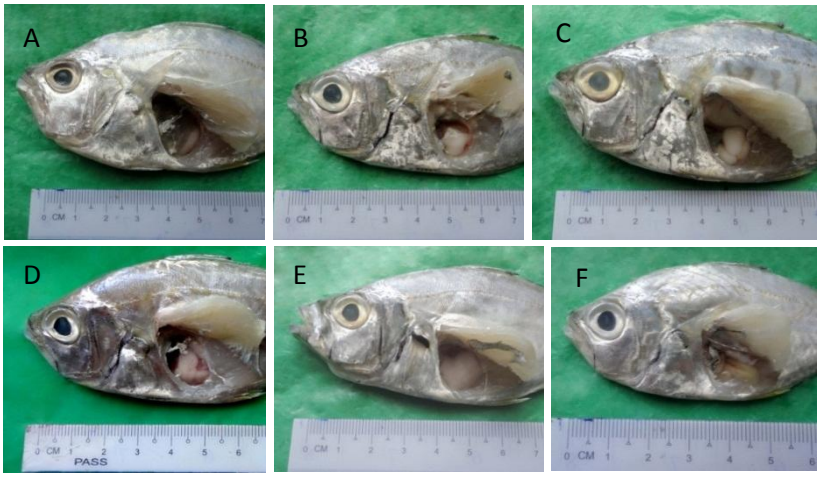


Figure 3. Different maturity stages of testes in *Gazza minuta* A) immature; B) early maturing; C) maturing; D) mature; E) ripe and F) spent.

Histological analysis of oocytes

In histological analysis, six stage of oocytes development (Fig. 4) were observed in the ovaries of silverbellies.

1. Chromatin nucleolus stage: Oocyte is transparent and rounded or more or less polygonal shape with the large nucleus visible at the centre.

2. Perinucleolar stage: A large number of nucleoli of different sizes are arranged along the periphery of the nucleus. Oocyte is surrounded with single layer of follicle cells.

3. Yolk vesicle formation stage (or) cortical alveoli formation: Yolk vesicles started to appear at the periphery of the oocyte, nucleus irregular in shape. They increased in size and number to form several peripheral rows and give rise to cortical alveoli.

4. Vitellogenic stage (or) yolk stage: The development of yolk globules is observed in this stage. The nucleus migrates toward the periphery. The unique oil droplet was clearly seen at central part of the oocyte. The cortical alveoli are further pushed toward the periphery and become arranged in two to three successive layers.

5. Ripe stage: Oocyte is transparent and completely packed with yolk mass. Oocyte increased in size by hydration. The layers of cortical alveoli are clearly observed. The nucleus disappeared due to the condense yolk accumulation.

6. Spent stage or atretic stage: Oocytes are irregular in shape. Various types of postovulatory follicles present. The yolk contents were completely disappeared.

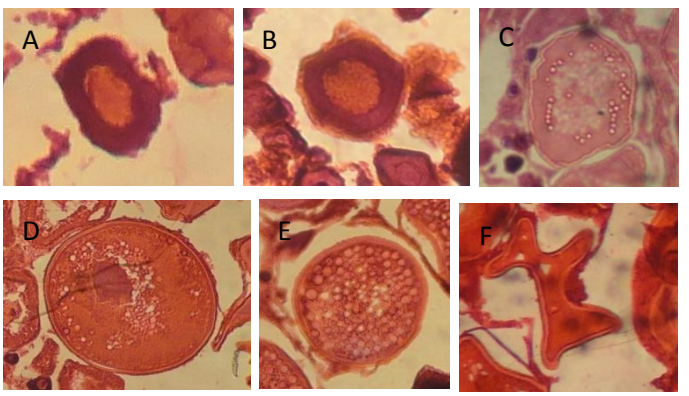


Figure 4. Different stages of oocytes A) Chromatin nucleolus stage; B) Perinucleolar stage; C) Yolk vesicle formation stage (or) cortical alveoli formation; D) Vitellogenic stage (or) yolk stage; E) Ripe stage and F) Spent stage or atretic stage.

Occurrence of different maturity stages

The occurrence of mature males and females was recorded to determine the spawning season of fish. *Gazza minuta* in stage I and II

(immature and early maturing males) occurred in almost all months except November (Fig 5). Maturing males (stage III) were encountered in almost all months except January and February, comprising with the maximum percentage of 38.7% (May) and minimum percentage of 13.4% (June). The percentage of males was found to be highest in the month of June until January in mature stage IV. Ripe males in stage V was not found in June, October, November and December. Fish with spent stage was only observed in April, June, July, November and December with small percentage.

Females in stage I (immature) was recorded in almost all months except January, September and October (Fig 6). Monthly percentage occurrence of female ranged from 3.3% (October) to 43.3% (April) in early maturing stage. Fish with maturing ovary occurred in almost all months except April and May. Mature females were observed in all months and its percentage reached to minimum in February and March (20%) and maximum in January (75%). Except March and April, ripe females were observed in all months. For spent stage, it was only recorded in January, August, September, November and December respectively.

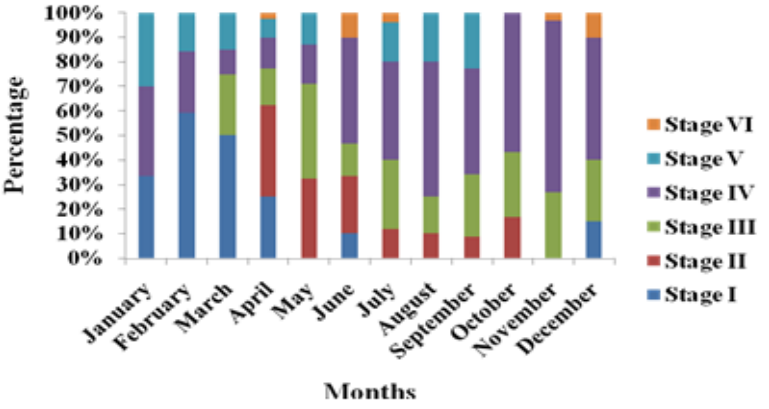


Figure 5. Monthly percentage occurrence of maturity stages of *Gazza minuta* (Males).

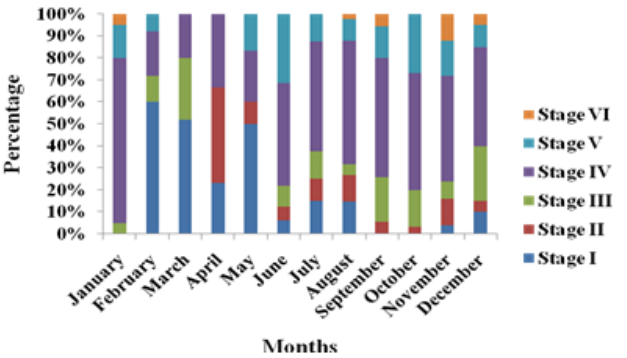


Figure 6. Monthly percentage occurrence of maturity stages of *Gazza minuta* (Females).

Length at first maturity

The percentage occurrence of mature fish in different length group of males and females of *Gazza minuta* was illustrated in Fig. 7. No mature male occurred in 7.3-7.7 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 9.5 cm in males and 10.0 cm in females.

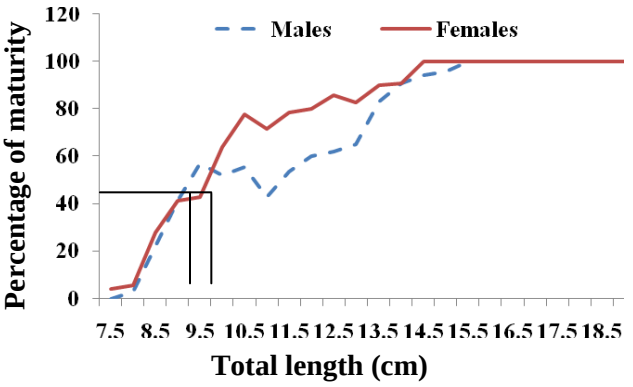


Figure 7. Length at first sexual maturity of males and females

Sex ratio

The monthly sex ratios of *Gazza minuta* were estimated and tested for the expected ratio of 1:1 by chi-square ($\chi 2$) analysis. The resulted average ratio was 1 male: 1.1 females ($\chi 2$=1.9). Females were more abundant in almost all months except February and April (Table 2). The range of chi-square values (0.02 to 1.6) showed that there was no significant difference in number of males and females in all months from the expected 1: 1 ratio.

Table 2. Monthly sex ratio of *Gazza minuta*

Months	M:F	$\chi 2$	Months	M:F	$\chi 2$
Jan	1:1.2	0.4	July	1:1.1	0.1
Feb	1:0.9	0.03	Aug	1:1.3	0.5
March	1:1.1	0.1	Sept	1:1.1	0.03
April	1:0.9	0.1	Oct	1:1.2	0.3
May	1:1.3	0.4	Nov	1:1.1	0.02
June	1:1.2	0.3	Dec	1:1.5	1.6

Gonadosomatic index (GSI)

The monthly GSI values ranged from 1.2 to 2.9 for males and from 3.0 to 6.5 for females. The average GSI values of females were always higher than those of males in all months (Fig. 8). The average GSI values obtained for males and females were 2.1 and 4.6 respectively.

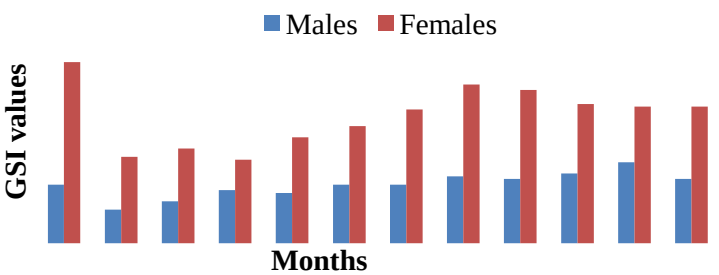


Figure 8. Monthly average GSI values of males and females

Fecundity

Fecundity estimation was based on 18 ripe females ranging in fish size between 8.5 cm and 16.5 cm TL and weight between 15.2 g and 50.1 g. The number of ova varied from 10,002 to 69,421 with average fecundity of 28,281 ova. The regression analysis of fecundity on fish length, fish weight and gonad weight can be expressed as

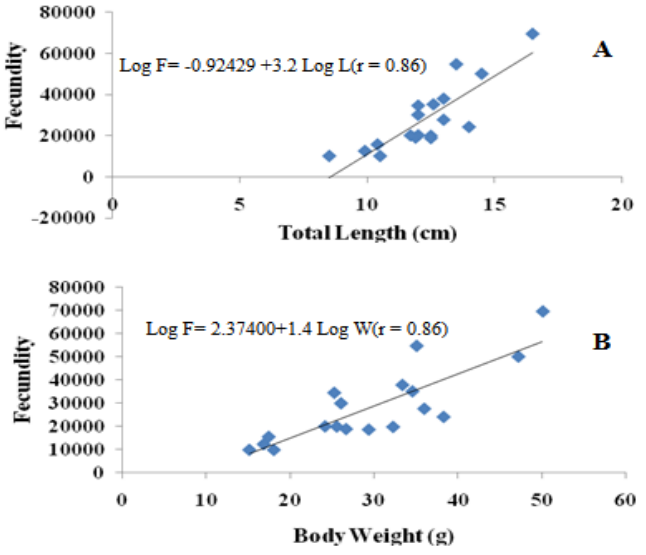
Log F= 0.92429 + 3.2 Log L (r = 0.86) (Fig. 9A)

Log F = 2.37400+ 1.4 Log W (r = 0.86) (Fig. 9B)

Log F = 3.55889 + 1.8 Log Wg (r = 0.94) (Fig. 9C)

where F= fecundity, L= total length of fish, W= weight of fish and Wg= weight of gonad

The resultant correlation coefficient r values indicated that the correlation was significant.



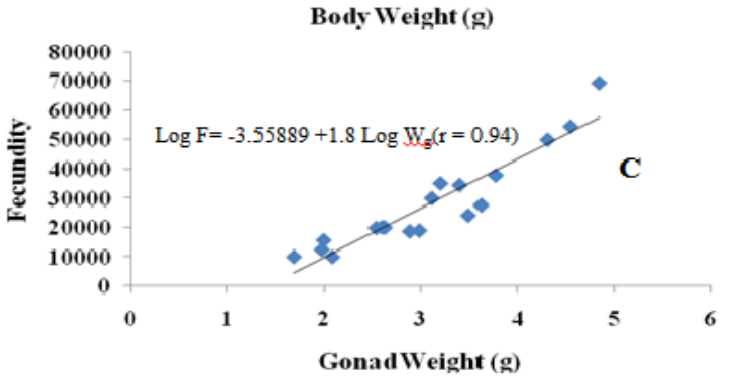


Figure 9. Fecundity in relation to A) total length; B) body weight and C) gonad weight of *Gazza minuta.*

Discussion

Species of *Gazza minuta* regularly contributes to the catches of trawl fisheries of Myeik coastal waters. Maturity stages of silverbellies were classified as three stages based on ova characteristics (Arora, 1952), five stages in female and three stages in male based on the external appearance of ovaries (Abraham *et al*. 2011) and six stages (Rao *et al*. 2015). The scale of maturation stages is different in different groups of species and in different regions (Abraham *et al*. 2011). In the present study, six stages of maturity (Immature, Early maturing, Maturing, Mature, Ripe and Spent) were classified in the gonads of *Gazza minuta* (Figs. 2 and 3).

Reproduction also involves changes in growth and development of oocytes during the process of gonad maturation (Priyadharsini *et al*. 2013). Histological examination is accurate method to determine the oocyte development. The general pattern of histological development of the oocytes of the present study is similar to that of the most teleosts. The six oocyte stages were identified in the ovaries of silverbellies in the present study according to the scales modified by Priyadharsini *et al.* (2013) and Agarwal (1996).

The spawning season of fish has been determined by the percentage of mature fishes present in the catch. In the present study, mature gonads of

males and females occurred in all months and its percentage was high from the months of June till January (Figs. 5 and 6). So *Gazza minuta* spawns throughout the year, with peak during June to January. Similarly, the population of *Gazza minuta* from Porto Novo coast of India spawns during July to January (Jayabalan, 1988). James and Badrudeen (1986) also stated species of *Gazza minuta* from the seas around India spawn over a prolonged period. In general, spawning activity varied according to geography.

Studies on the size at first maturity is 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. *Gazza minuta* mature first at an average total length of 9.5 cm in males and 10.0 cm in females in the present study (Fig. 7). This size at first maturity of present study was slightly smaller than that of Jayabalan (1988) in which he estimated the length at first maturity of *G. minuta* from Porto Novo coast as 99 mm in males and 102 mm in females.

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. Table 2 showed that the number of females were more dominant in the catches than the males. However, the analysis of chi-square method showed that there was no significant difference at 5% probability level. Jayabalan (1988) also indicated the predominance of females in the silverbellies catches of Porto Novo coast.

Gonadosomatic index (ratio of gonad weight to body weight) is an indirect method for estimating spawning season of species. The monthly GSI value of the present study ranged from 1.2 to 2.9 in males and from 3.0 to 6.5 in females. The average values obtained for males and females were 2.1 and 4.6. Seah *et al.* (2009) reported that the mean value of GSI for *Gazza minuta* from the coastal waters of South China Sea was 0.382 in females and 0.093 in males. The resultant values of present study were observed to be higher than

the mean value of GSI for of South China Sea that was reported by Seah *et al*. (2009). 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 (Jayabalan 1988).

Fecundity (total number of eggs per fish) is the most common measure of reproductive potential in fish. Pillai (1972) stated the fecundity of *Gazza minuta* as ranging from about 7950 to 28430 eggs in the Gulf of Mannar. From Porto Novo, Jayabalan (1988) estimated that the number of eggs in *G. minuta* varied from 11650 to 26750. Thus, the estimation of fecundity on *G. minuta* (10,002 - 69,421 eggs) of the present study was higher than those of Pillai (1972) and Jayabalan (1988).

The observed correlation coefficient 'r' values of the present study indicated that fecundity is more related to the gonad weight than total length and body weight of *Gazza minuta*. Thus, it is indicated that the weight of gonad is more suitable indices for estimating the fecundity than length and weight of fish.

Conclusion

According to the observation, it could be concluded that *Gazza minuta* spawn throughout the year, with peak in June-January. Thus, prohibition on fishing should be put during these months. Although species of *G. minuta* are caught as by catch in various fishing gears, they are mainly contributors of trawl that is multispecies fisheries. The optimum mesh size for each species may affect the other species taken in this gear. Therefore, many more researches on stock structure for fisheries management should be carried out to decrease fishing effort for sustainable utilization on this species.

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