# Aspects of reproductive biology of yellowtail fusilier fish (*Caesio cuning* Bloch, 1791) in Makassar water

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**Abstract**. The study aimed to investigate the reproductive biology aspects of Yellowtail Fusilier fish (*Caesio cuning* Bloch, 1791) in Makassar waters such as sex ratio, gonad maturity stages, Gonadosomatic Index and the size at first maturity. This research was conducted from February to June 2016. Sampling was carried out at Fish Landing Port at Beba, North Galesong Sub district, Takalar District. Analysis of sample was performed at the Laboratory of Fisheries Biology, Fishery Department, Hasanuddin University, Makassar. Gonad maturity stages and Gonadosomatic Index were analyzed descriptively. Sex ratio used square-test analysis, the size of first maturity used Spearmen-Karber method. The result showed that total samples obtained during the research were 709 individuals. The Sex ratio was 1.00:1.32. Gonad maturity stages of males and females were recorded from stages I to V. The smallest Gonadosomatic Index of male fish was at the stage I of 0.1413 and the highest was at the stage III by 0.8991%. The smallest Gonadosomatic Index of female fish was at the stage II of by0.0489% and the highest was at the stage III by 1.7723. The first gonad maturity of male fish was larger (273 mm) than female fish (257 mm).
**Key Words**: Fish landing port, gonad maturity, Makassar water, reproduction, sex ratio.

**Introduction**. Makassar waters have diverse fishery resources, thus it is known as the gate of export fishery trade in eastern Indonesia. Fishery resources are classified as renewable resources so that they can be managed any time as long as the management is conducted wisely, particularly for its preservation. One of the fishery resources that have bright prospects to increase income and welfare of the community and important economic value is the resources of reef fish (Dahlan et al 2015a,b).

Yellowtail fusilier fish are reef fish or locally known as "*Rappo-Rappo*". Based on data from Department of Marine and Fisheries of South Sulawesi (2015), the production of Yellow Tuna fish (*C. cuning*) fluctuated by year. In 2010, the production of Yellowtail fish caught reached 63.6 tons, in 2011 reached 187.8 tons, in 2012 reached 20.4 tons, in 2013 reached 98.3 tons and in 2014 decreased to 14.6 ton. Based on these data, it is necessary to conduct a study on reproductive biology in order to maintain the sustainability of yellowtail fish resources in Makassar waters. This study is expected to be used as a reference in the formulation of policies such as in determining the number of limits for shore caught fish and managing the potential of yellowtail fish resources.

## Material and Method

***Time and Place***. The study was conducted from February to June 2016 with random sampling at Fish Landing Port (FLP) of Beba, North Galesong Subdistrict, Takalar District (Figure 1). Meanwhile, the sample analysis was conducted at the Laboratory of Fisheries Biology, Faculty of Marine Science and Fisheries, Hasanuddin University. In order to

mantain the fish in fresh condition during the trip to the laboratory, the yellowtail fish were kept into a styrofoam box with ice. To measure the size and weight, the total length of the fish was measured using the ruler with the accuracy of 1 mm, while body weight and gonad weight were measured using a digital scale with a precision level of 0.01 g. To determine the sex ratio and Gonad Maturity Stage (GMS), fish were dissected using surgical scissors, scalpel, and tweezer. Gonad observation was performed by weighing the gonad using an electric scale with the accuracy of 0.01 g, while GMS observation was morphologically performed using a magnifyng glass and determined by a modification of the Caessie classification. Sampling and measurement of the sample were conducted 10 times for 5 months.

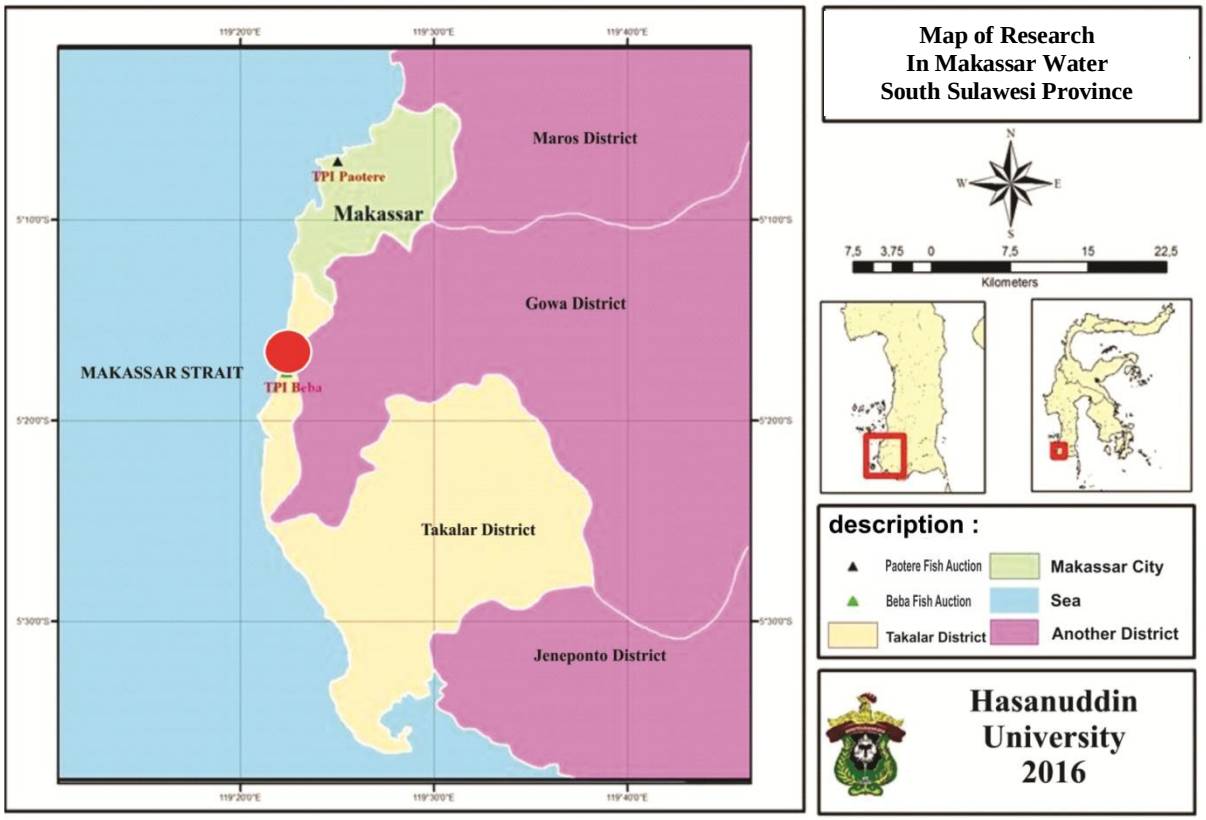


Figure 1. Sampling Map at Fish Landing Port (FLP) of Beba North Galesong Subdistrict, Takalar District.

***Data Analysis***. Sex ratio of Yellowtail fusilier fish was calculated using the formula:

$$NK = \frac{\sum J}{\sum B}$$

where: NK = sex ratio, ΣJ = number of male fish (tail), ΣB = number of female fish (tail).

To determine the sex ratio between male and female fish, Gonad Maturity Stage (GMS) was calculated by using the formula (Zar 2010):

$$E_{ij} = \frac{\left(n_{io} \times n_{oj}\right)}{n}$$

where: $E_{ij}$ = expected theoretical frequency,
$n_{io}$ = number of i rows,
$n_{oj}$ = number of j columns,
n = number of observed value frequency.

Gonadosomatic Index (GI) is calculated by the formula (Johnson 1971):

$$IKG = \frac{Bg}{W} \times 100$$

where: Bg = gonad weight (gram) and W = total body weight (grams).

***Size at First Sexual Maturity***. The average size at first sexual maturity was estimated by the Spearman-Karber method (Udupe 1986) using the formula:

$$m = x_k + \frac{X}{2} - \left\{X \Sigma p_i\right\}$$

with 95% confidence interval, it is calculated as:

$$\text{Antilog } m = \left[ m \pm 1{,}96 \sqrt{X^2 \Sigma \left( \frac{p_i - q_i}{n_i - 1} \right)} \right]$$

where: m = Log of fish length at first mature gonad; Xk = Log of mean length value at first mature gonad; X = Log of median of last length at first mature gonad; X = Log of increased length of the fish at the median; Pi = The proportion of mature gonad at the interval of $i^{th}$ with the number of fish at the interval of $i^{th}$; ni = Number of mature gonad at the interval of $i^{th}$; qi = 1 - pi; M = Antilog m of the length of first matured gonad (Facilitated by Excel 2013).

## Results and Discussion

***Sex Ratio***. Sex ratio and size are basic information in estimating reproductive and size potential in fish populations (Vicentini & Araujo 2003). Biologically, the growth determines the sex of species (Tahya 2016; Tahya et al 2016; Karim et al 2016). The number of yellowtail fish caught in Makassar water during this study fluctuated during the month range from 14 to 75 with the total 174 tails of male fish and 15 to 52 with the total 151 tails of female fish respectively (Table 1). Thus, the total sex ratio of the male and female fish was 1.10:1.00. The results of chi-square test obtained $X^2_{calculate}$ of 18.92, while $X^2_{table(0.04)}$ of 9.58. This shows that the sex ratio of each fish was not significantly different at each period of sampling which indicates that the sex ratio in the fish tends to be balanced.

Table 1

The sex ratio of the yellowtail fish (*C. cuning*) at each period of sampling in Makassar water

| *Period of sampling* | *Number of observed fish* | | | *Sex Ratio (M:F)* |
|---|---|---|---|---|
| | *Male* | *Female* | *N (Number)* | |
| February | 26 | 32 | 58 | 1.00 : 1.23 |
| March | 14 | 52 | 66 | 1.00 : 3.71 |
| April | 35 | 36 | 71 | 1.00 : 1.00 |
| May | 24 | 16 | 40 | 1.50 : 1.00 |
| June | 75 | 15 | 90 | 3.80 : 1.00 |
| Total | 174 | 151 | 325 | 1.10 : 1.00 |

Based on the results, the total sex ratio of yellowtail fish obtained in Makassar water was 1.10:1.00 (male : female), that was similar with ideal ratio of 1:1 (Dahlan et al 2015b). Similar results are found in many other species such as in African mud catfish (*Clarias gariepinus*) in which a 1:1.02 ratio was found (Olalusi 2014), and to *Micropogonias furnieri* in which a 1.3:1 ratio was found (Vicentini & Araujo 2003). One of the factors affecting sex ratio is food, if food availability is abundant, female fish will be dominant. Otherwise, if food availability is reduced, male fish will be dominant (Nikolsky 1963).

***Gonad Maturity Stage (GMS)***. Gonad maturity stage obtained in this study was at the stages I to V, both for male and female fish. The frequency (%) of the yellowtail fish (*C. cuning*) based on the gonad maturity stage obtained (a) fish that have mature and (b) immature gonads at the period of sampling as can be seen in Table 2.

Table 2

Frequency (%) of yellowtail fish (*C. cuning*) based on gonad maturity stage at each period of sampling

**Male Fish**

| *Period of sampling* | *Gonad maturity stage* | | | | | | *Frequency (%)* | |
|---|---|---|---|---|---|---|---|---|
| | *I* | *II* | *III* | *IV* | *V* | *VI* | *Feb - March* | *April - June* |
| February | 4 | 19 | 7 | 3 | 0 | 33 | 69.69 | 30.31 |
| March | 18 | 17 | 15 | 2 | 2 | 54 | 64.81 | 35.19 |
| April | 4 | 19 | 5 | 5 | 2 | 35 | 65.71 | 34.29 |
| May | 8 | 10 | 2 | 3 | 1 | 24 | 75.00 | 25.00 |
| June | 14 | 19 | 14 | 8 | 2 | 57 | 57.89 | 42.11 |
| Total | 48 | 84 | 43 | 21 | 7 | 203 | Immature gonad > mature gonad | |

**Female Fish**

| *Period of sampling* | *Gonad maturity stage* | | | | | | *Frequency (%)* | |
|---|---|---|---|---|---|---|---|---|
| | *I* | *II* | *III* | *IV* | *V* | *VI* | *Feb - March* | *April - June* |
| February | 0 | 4 | 28 | 25 | 3 | 60 | 07.67 | 92.33 |
| March | 5 | 9 | 24 | 14 | 3 | 55 | 25.45 | 74.55 |
| April | 2 | 14 | 4 | 6 | 0 | 26 | 61.52 | 38.48 |
| May | 0 | 3 | 5 | 8 | 0 | 16 | 18.75 | 81.25 |
| June | 0 | 5 | 11 | 8 | 0 | 24 | 20.83 | 79.17 |
| Total | 7 | 35 | 72 | 61 | 6 | 181 | Immature gonad < mature gonad | |

On February, the immature gonads (GMS I and II) of male fish were 69.69%, while the mature gonads (GMS III, IV, and V) were 30.31%. In March, the immature gonads of male fish were 64.81%, while the mature gonads were 35.19%. On April, the immature gonads of male fish were 65.71%, while the mature gonads were 34.29%. On May, the immature gonads of male fish were 75.00%, while the mature gonads were 25.00%. On June, the immature gonads of male fish were 57.89%, while the mature gonads were 42.11%. Meanwhile for female fish, immature gonads (GMS I and II) on February were 7.67%, while mature gonads (GMS III, IV, and V) were 92.33%. In March, immature gonads (GMS I and II) were 25.45% while mature gonads (GMS III, IV and V) were 74.55%. In April, the immature gonads were 61.52% while the mature gonads were 38.48%. In May, the immature gonads were 18.75%, while the mature gonads were 81.25%. In June, immature gonads were 20.83%, while mature gonads were 79.17%. Based on the above data, it shows that the female yellowtail fish caught at the GMS III, IV and V are more than that at the GMS I and II.

***Gonadosomatic Index (GI)***. Changes occured in fish gonad can be quantitatively known from GI. This is in line with the development of gonadal maturity and the increase of gonad weight. Distribution of Gonadosomatic Index on each GMS for both male and female fish can be seen in Table 3.

The average GI of male Yellowtail fish in this study ranged from 0.2135 to 1.9281%, while the female fish ranged from 0.9072 to 2.5975%. The smallest GMS in the Yellowtail fish was at GMS I (0.2135%) and the largest was at GMS IV (1.9281%), furthermore, there was a decrease in GMS V with the average value of 0.6573% as can be seen in Table 3. This is due to male fish at GMS V has performed spawning. In general, male yellowtail fish spawn at GMS III. The smallest average GI on female yellowtail fish was at GMS II (0.9072%) in which the largest was at GMS IV (2.5975%) and then decreased at GMS V with the average of 1.5325%. The decrease GMS is due to the occurrence of spawning.

Table 3
Distribution of gonadosomatic index (%) of males and females yellowtail fish (*C. cuning*) based on gonad maturity stage (GMS)

| *GMS* | *Male Fish* | | *Female Fish* | |
|---|---|---|---|---|
| | *Interval* | *Average* | *Interval* | *Average* |
| I | 0.0177 - 0.8209 | 0.2135 ± 0.2317 | 0.1162 - 3.7072 | 1.4705 ± 1.0578 |
| II | 0.0319 - 1.0567 | 0.7503 ± 0.0199 | 0.2357 - 1.5944 | 0.9072 ± 0.3699 |
| III | 0.0961 - 1.5912 | 0.9825 ± 0.4197 | 0.6965 - 2.9881 | 1.6552 ± 0.5198 |
| IV | 0.5650 - 5.1961 | 1.9281 ± 0.8546 | 1.4273 - 4.9027 | 2.5475 ± 0.8157 |
| V | 0.3579 - 1.1074 | 0.6573 ± 0.2839 | 0.2621 - 3.4427 | 1.5325 ± 0.7740 |

Based on the results, gonadosomatic index (GI) of female fish was larger than male fish. The larger GI value in female fish is due to greater gonad weight of female fish. Meanwhile, male and female yellowtail fish had GI value that was smaller than 20%, thus yellowtail fish are categorized as fish that can spawn more than once every year.

***Size at First Sexual Maturity***. Estimation of the size at the first sexual maturity is one way to find out the development of fish population, such as estimation when the best time of spawning or have finished spawning (Dahlan et al 2015a,b). The analysis of Spearman-Karber method showed that the average size at the first sexual maturity in male fish was 273 mm with body length ranged from 260-286 mm. Meanwhile, the average size at the first sexual maturity in female fish was 257 mm with body length ranges from 245-264 mm. This indicated that first sexual maturity in male fish was smaller than that of female fish. Farley et al (2014) also found that male fish experiences earlier sexual maturity than that of female fish.

**Conclusion**. Based on the results of this study, it can be concluded that the sex ratio of males and females yellowtail fish is balanced based on the period of sampling, male yellowtail fish have less mature gonad than female fish, male yellowtail fish reach first sexual maturity with a size of 273 mm which is larger than that of female fish by 257 mm, and gonadosomatic index in male fish is smaller than that of female fish.

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