Growth pattern, condition factor and reproductive aspects of three spot gourami *Trichopodus trichopterus* (Pallas, 1770) in mangrove waters of Muara Angke Jakarta and Ciperet Cilacap, Indonesia

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Abstract. Mangrove ecosystem is a unique and interesting ecosystem which inhabited by many fish species such as three spot gourami (*Trichopodus trichopterus*). This study aimed to determine length-weight relationship (LWR), growth pattern, condition factor, sex ratio and gonad maturity stage of three spot gourami from mangrove waters of Muara Angke Jakarta and the Ciperet Cilacap, Indonesia. Fish samples were collected by cast net and gill net at four research stations in Muara Angke and Ciperet Cilacap from January to March 2014 and September to October 2012, respectively. The total length and total wet weight were measured, subsequently, the sex and stage of gonad maturity were morphologically determined. The LWRs of three spot gourami in Muara Angke were $W = 6E-05L^{2.893}$ for male and $W = 0.0003L^{2.619}$ for female, whereas, the LWRs of male and female in Ciperet estuary were $W = 0.0007L^{2.371}$ and $W = 0.0006L^{2.444}$, respectively. Moreover, the growth pattern of the male one in Muara Angke was isometry, while the female was negative allometry. In Ciperet estuary, the growth patterns for male and female were negative allometric. The Fulton’s condition factors for males and females in the Muara Angke were ranged from 3.7118±0.7847 and 1.0014±0.0551, respectively. Whereas, in the Ciperet estuary, the condition factor values were ranged from 1.0011 ± 0.0485 and 1.0024 ± 0.0685 for males and females, respectively. The sex ratio for males and females on the Chi-square test with a confidence interval of 95% ($\alpha = 0.05$) was significantly different by 1:1.93 in Muara Angke and 1:1.69 in Ciperet estuary. In both areas, various maturity stages of gonad were found, with different dominant maturity stage. In Muara Angke, most of the fish were at higher gonadal maturity stages (III and IV), whereas in Ciperet estuary the lower gonadal maturity stages (I and II) was found.

Keywords: Ciperet estuary; Growth pattern; Muara Angke; *Trichopodus trichopterus*
1. Introduction

Indonesia as an archipelago with a total of 17,504 islands, has a wide mangrove ecosystem and is distributed in almost all of the islands. The area of mangroves in Indonesia is 3,112,989 ha and covered 22% of the total mangrove area in the world [1]. The existence of mangroves has been recorded along the east coast of Sumatra, the north coast of Java, the west and east coasts of Kalimantan, coasts in Sulawesi, small islands around Maluku, and Papua [1], [2].

As well known, mangrove is a unique and distinctive ecosystem, in which there is an association between flora and fauna and the surrounding environment. The surrounding areas of the mangroves is a high productivity area due to the additional energy such as food substances from the tidal process of sea water [3], [4]. In general, mangroves functioned as spawning, nursery, and foraging area for various species of fish, shrimp, birds, mammals, and reptiles. While it is known that molluscs, crustaceans, and fish play a significant role as a food chain in the mangrove ecosystem [5]. One of the economically important fish species inhabiting the mangrove ecosystem is Sepat (Trichopodus trichopterus).

Three spot gourami (Trichopodus trichopterus) with several local names are Siopet, Sompot, or Sepat rawa is one of the 1,258 freshwater fish species that inhabit Indonesian waters [6]. Three spot gourami belongs to Perciformes order, Osphronemidae family, and Trichopodus genera [7], [8]. This fish has a green to bluish body color, is decorated with several dark oblique ribbons, with two spots in the middle of the body and the base of the caudal fin. In general, the distribution in Indonesia includes Sumatra, Java, Kalimantan, and Bali [7]. Three spot gourami has a high economic value as an additional source of animal protein in rural areas [9]. This fish is caught and sold both for ornamental and consumption fish, fresh or salted. The selling price varies in several regions where dried Sepat in South Kalimantan is around Rp. 60,000 to Rp. 150,000/kg [9] while in Jakarta is around Rp. 65,000 to Rp. 90,000/kg (personal communication with Susanto, 2020), for instance.

Currently, a high rate of mangrove ecosystem conversion into ponds, agricultural land, tourism, and settlements become one of the major problems. It will have negative impacts on the inhabited fish population. Besides habitat destruction, fish communities in mangrove ecosystems are also under threat of overfishing with destructive gears, introduction fish, and global climate change [10], [11]. Fish is one of the many aquatic organisms that are vulnerable to environmental changes caused by anthropogenic factors [12]. According to available information that the extent of mangroves in several locations in Sumatra has decreased [13]. Certainly, this is very worrying due to most of the three spot gourami production still relies on catches from nature.

Therefore, this study aims to determine growth patterns, condition factors, and reproductive aspects of three spot gourami in two mangrove conservation areas, namely, Muara Angke Wildlife Reserve in Jakarta and Ciperet River in the Segara Anakan Cilacap. The results of this research are expected to be useful for fisheries resource management to ensure the three spot gourami sustainability.

2. Materials and Methods

Three spot gourami samples were captured in the mangrove waters of Muara Angke Wildlife Reserve, Jakarta from January to March 2014, and from the Ciperet River (Segara Anakan waters) Ciperet Village, Kutawaru District, Cilacap, Central Java from September to October 2012. The fish samples from Ciperet River was taken from the specimen collections of the LIPI Zoology Museum. All fish specimens were caught by cast nets with meshes size of 1-2 cm, gill nets with mesh size of ¾, 1, 1.5 and 2 inches. Furthermore, the fish samples were fixed with 4% formalin and 70% alcohol as a permanent preservative.

In laboratory, three spot gourami samples were measured with a digital calliper with an accuracy of 0.1 millimeter. The total length of the fish (total length) is measured from the tip of the mouth to the tip of the caudal fin; while the total weight of the fish was weighed using a digital scale meter with an accuracy of 1 g.

Length and weight fish were analyzed using Length (L)-weight (W) relationships, with the formula (1) [14]:

\[ W = aL^b \]  

(1)
where, \( W \) is a fish weight (g); \( L \) is a fish length (mm); \( a \) and \( b \) are constants.

Fulton’s condition factors with the formula (2) [14]:

\[
K = \frac{10^5 W}{L^3}
\]  

(2)

where, \( K \) is Fulton’s condition factors; \( W \) is weight of fish (g); \( L \) is length of fish (mm).

Furthermore, the fish were separated by sex by performing dissected to observe the gonads. In dissected using scissors, starting from the rectum to the head without damaging the organs to be observed and analyzed. Then the gonads are added to 70% alcohol. To observe sex ratio using the formula (3) [15]:

\[
SR = \frac{\sum M}{\sum F}
\]  

(3)

where, \( SR \) is sex ratio; \( \sum M \) is number of male fish; \( \sum F \) is number of female fish.

Gonad observation by observing the shape, size and color of the gonads. These characteristics refer to the modification of Cassie’s gonad observations [16].

3. Results and discussion

3.1. Length frequency

A total of 123 three spot gourami was collected in Muara Angke, consists of 42 males and 81 females, with a total length ranged from 35.64 mm to 108.88 mm and 35.43 mm to 103.32 mm for males and females, respectively (figure 1). As much as 121 individuals of three spot gourami were captured from Ciperet estuary consists of 45 males and 76 females with a total length ranged from 34.21 mm to 85.64 mm and 35.54 to 107.54 mm for males and females, respectively (figure 2). The results were similar with three spot gourami from Banjar, South Kalimantan with total length ranged from 41.0 mm to 108 mm [17]. Total length of this species in the Lake Bangkau swamp pond, South Kalimantan was range from 73.0 mm to 125 mm [18].

Overall the results showed that three spot gourami in Muara Angke and Cilacap were categorized as juvenile (34.21-69.43 mm) to adult (71.71-110.53 mm) size. Three spot gourami was recorded as having a total length of 120 mm [7]. The male is commonly caught with a total length of 100 mm [19].

Figure 1. Length frequency of three spot gourami from Muara Angke [A.Male; B.Female].
**Figure 2.** Length frequency of three spot gourami from Ciperet River [A.Male; B.Female].

**Figure 3.** Length and weight relationship of three spot gourami from Muara Angke.

**Figure 4.** Length and weight relationship of three spot gourami from Ciperet River.
3.2. Length-weight relationship
The results of the length weight relationship were obtained for the correlation coefficient (r) of 0.955 for males and 0.993 in females at Muara Angke. These results indicated that for male fish there is a proximity between length and weight of 95.5% and 99.3% for females (figure 3). The correlation coefficient (r) for male fish in the Ciperet River is 0.994 and 0.991. This showed that there is a proximity of length and weight of male fish of 99.4% and 99.1% for females (figure 4).

As a whole that the value (r) which is almost close to one indicates that the variance that is influenced by other factors at the two locations is likely to be quite small [20]. Both male and female fish are thought to be sufficient in obtaining food. As for that in a length and weight relationship, it shows relative growth, which is still very possible to change based on time [14]. While other opinions stated that weight changes in fish are thought to result from changes in feed and energy allocation for growth and reproduction, which result in different weight of fish with the same length [21].

The results of the growth pattern analysis showed that male fish had an isometric growth pattern, the results were obtained after the b value was equal to 3 with LWR equation was $W = 6E-05L^{2.89}$; whereas females had a negative allometric growth pattern, where the value of b was smaller than 3 (b < 3) and LWR was $W = 5.0003L^{2.62}$. Then in the Ciperet River, both male and female fish had negative allometric growth patterns. The value of b was less than 3 with LWR equation were $W=0.0007L^{2.37}$ and $W=0.0006L^{2.44}$ for male and female, respectively. The male of T. pectoralis in the Benanga reservoir had growth isometrically, while the female had positive allometric growth pattern [12].

These results showed that the male fish in Muara Angke has the same length growth rate as their weight. Whereas for female, the length growth rate is faster than weight as for both males and females from Ciperet River. In the field, it can be seen that three spot gourami have movements that tend to be active, so that the energy used is quite large and it is suspected that it will affect its growth pattern. As it is known that the value of b is very dependent on the movement of the fish, where fish with active movements generally have a lower b value compared to the passive fish [22]. In addition, this condition is thought to be from the morphology of the three spot gourami itself, where three spot gourami is flat upright, tends to be elongated and has a small and tapered mouth [7]. It has been confirmed that the length-weight relationship between fish species depends on hereditary body shape [23].

3.3. Condition factor
The condition factor of male and female in Muara Angke were 3.7118 ± 0.7847 and 1.0014 ± 0.0551, respectively, as in the Ciperet River, male fish have average condition factor of 1.0011 ± 0.0485 and female 1.0024 ± 0.0685. The value of the condition factor which tends to be high is presumably that the food availability for these species of fish is very sufficient. Food, space, and physical activity greatly affect fish growth [24].

Three spot gourami in nature feeds on zooplankton, crustaceans and insect larvae [7]. In line with this, the two locations from several studies are known to be inhabited by types of food from three spot gourami [25][27]. According to information it is known that mangrove waters have a system to maintain fisheries productivity [28]. Mangrove roots and stems are also thought to be able to anticipate several types of fish that inhabit the area from the threat of predators. In general, that a high condition factor value indicates the suitability of fish with their habitat in obtaining food, and it is able to determine fish health and productivity of fish populations [14], [29].

3.4. Sex ratio
Based on the results of observations on the sex of three spot gourami in Muara Angke, as many as 123 individuals consisting of 42 males and 81 females. In the Chi-square test with a 95% confidence interval on the sex ratio of the fish, the results were significantly different so that it could be stated that the sex ratio was 1:1.93, which means 1 male to 1.93 female. Whereas in Ciperet River the ratio between male and female is 1:1.69. The sex ratio of three spot gourami T. pectoralis in Tangkeran Barat and Delima Canal, Riau showed of 1:2 sex ratio pattern [30].
Overall, it can be seen that the results of the sex ratio for three spot gourami at two different locations were not 1:1. Sex ratio is the ratio of males and females in a population where the ideal condition is a ratio of 1:1 [31]. There is a 1:1 pattern deviation, due to several factors including differences in behavior such as swarming between males and females, environmental conditions, gonad maturity and fishing activity [12], [32].

3.5. Gonad maturity stage
In the observation of the gonadal maturity stage (GMS) in Muara Angke, it was seen that GMS IV of male was dominant of 40.48%, followed by GMS II of 28.57%, GMS III 19.05% and GMS I 11.90%. Whereas for female GMS III dominating of 28.40%, then GMS IV 27.16%, GMS II 25.93% and GMS I 18.52% (figure 5). As for the male and female Ciperet River dominated by GMS II of 53.33% and 34.21%, then GMS IV 22.22% and 32.89%, GMS III 13.33% and 22.37%, finally GMS I 11.11% and 10.53% (figure 6).

![Figure 5](image1.png)
**Figure 5.** Gonadal maturity stage of three spot gourami in Muara Angke.

![Figure 6](image2.png)
**Figure 6.** Gonadal maturity stage of three spot gourami fish in Ciperet River.
Based on the above results, it is assumed that both males and females tend to be closer to spawning time in Muara Angke, as evidenced by the number of GMS IV and GMS III that were caught. Inversely, the lower gonadal maturity stage (GMS II) was dominant in Ciperet River. The first size of gonad maturation of the same species at different locations can produce different gonad ripens [14]. Besides that, the possibility of different seasons, habitat, and the number of fish samples collected could be influencing. In line with this, a study in the Lake Bangkau swamp pond in October 2012 found that three spot gourami were more frequently observed at GMS III [18]. Observations on T. pectoralis in Tangkerang Barat and Delima canals were dominated by GMS IV in February, while the increase in GMS III and IV in Taliwang Lake occurred in July [30], [33].

4. Conclusion

The growth pattern for three spot gourami in Muara Angke was isometric for males and negative allometric for females. However, both males and females have negative allometric growth in the Ciperet River. The relatively high condition factors indicate that Muara Angke and Ciperet River are adequate in supporting the growth of three spot gourami. The reproductive aspect showed an unbalanced sex ratio pattern at Muara Angke as at Ciperet River. A higher percentage of the mature individual was found in Muara Angke. Presumably, the period of January-March has been the spawning season of the three spot gourami in Muara Angke. On the other hand, the fish in the Ciperet River has been in a maturing stage during the period September-October with a lower gonadal maturity stage.

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