Biological and environmental aspects of tilapia (*Oreochromis niloticus*) in the Jatibarang Reservoir, Central Java

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Abstract. Tilapia (*Oreochromis niloticus*) is an invasive fish species in Indonesia. A study on biological aspects is expected to be used as an assessment to implement fisheries mitigation, restoration, and enhancement. This study aimed to analyze the environmental conditions, biological aspects of the sex ratio, total length-weight relationship, maturity stages, and tilapia fecundity in the Jatibarang Reservoir. Fish samples were collected four times in July-October 2020 using gill nets (mesh size of 3 inches). The sampling sites were 2 stations located in Jatibarang Reservoir. Environmental parameters were measured, including water temperature, pH, and dissolved oxygen. Fish were measured for total length, weighed for gonads, and total weight. Water temperature, pH, and dissolved oxygen ranged from 28.0-31.9 °C, 6.41-6.70, and 6.04-7.39 mg/l, respectively. The sex ratio of tilapia was 1:1.9 (females: males). Total length ranged from 95 to 349 mm, and total weight ranged from 13 to 798 g. The growth pattern of tilapia was positive allometric. The condition factor of male and female fish was 0.94-1.16 and 0.95-1.21, respectively. 36.8% of the female fishes were ripe stage (IV), and 65.8% of the male fishes were immature stage (I). The fecundity ranged from 28 to 7,852 eggs.

1. Introduction

Jatibarang Reservoir was built to control flooding and develop Semarang’s water resources [1]. Jatibarang Reservoir is used for several activities such as fishing activities and tourism [2]. Jatibarang Reservoir is located in the Kreo watershed by damming the Kreo River as the primary water source. The area of water in the Jatibarang Reservoir is 189 ha, a volume of 20.4 million m³, the average discharge is 2.9 m³/s [3], the average depth of 16.9 m [4].

There are six fish species in the Kreo River. They are *Channa striata*, *Rasbora caudimaculata*, *Clarias batracus*, *Macrobachium pilimanus*, *Oreochromis mossambicus*, and *Oreochromis niloticus* [5]. In addition to the native fish population of the Kreo River, the Jatibarang Reservoir is also fish stocked with relatively high intensity. Fish stocked is carried out by the community or the government [4].

Tilapia (*O. niloticus*) is an invasive fish species in Indonesia. *O. niloticus* entered Indonesia in 1969 and pests in various rivers and lakes [6]. Tilapia tolerant in various water conditions. That is the reason why they can dominate the habitat. Besides, it can reproduce rapidly and eat everything, so that it can compete with endemic fish in their habitat [7].

Based on the description, it is necessary to study the biological aspects of tilapia (*O. niloticus*) in the Jatibarang Reservoir. A study on biological aspects is expected to be used as an assessment in the implementation of fisheries mitigation, restoration, and enhancement [8]. Various biological aspects are generally observed: length frequency distribution, length and weight relationship, reproductive biology including sex ratio, maturity stages, gonadosomatic index, and fecundity [9]. This study aimed
to analyze the environmental conditions, biological aspects of the sex ratio, total length-weight relationship, maturity stages, and tilapia fecundity in the Jatibarang Reservoir.

2. Materials and methods

2.1. Materials

Materials and tools used in this study for observed water quality (environmental conditions), collected fish in the waters, and observed fish in the laboratory. The material used was tilapia while the tools used were a boat, GPS, Water Quality Checker AMTAST EC910, gill net, and microscope.

2.2. Sampling methods

Fish samples were collected four times in July-October 2020 using gill nets (mesh size of 3 inches) in Jatibarang Reservoir, Semarang City, Central Java (07°02’20.3 S, 110°21’04.4 E). The sampling sites were 2 stations located in Jatibarang Reservoir (figure 1). Environmental parameters such as water temperature, pH, and dissolved oxygen were measured with Water Quality Checker AMTAST EC910.

![Figure 1. The sampling sites in Jatibarang Reservoir](image)

The sample of tilapia used in this study was identified as *Oreochromis niloticus*. A total of 56 fish were caught and analyzed. The total length of fish was measured with an accuracy of 1 mm and the total weight was weighed with an accuracy of 0.1 g. Fish were dissected to determine sex. The gonads were weighed to the nearest 0.01 g.

2.3. Data analysis

The maturity stages of the gonad were identified and distinguished according to Cassie [10]. The determination of the sex ratio is calculated based on Effendie [11]. The gonadosomatic index (GSI) was calculated as the gonad weight relative to the total weight [12]. Ripe female fish were used to estimated fecundity.

3. Result and Discussion

3.1. Dissolved oxygen, water temperature, and pH

Water temperature ranged from 28.0 to 31.9 °C and it was indicated good conditions. Water temperature is important because it affects certain chemical and biological reactions that occur in
water and aquatic organisms [13]. The pH value of water ranged from 6.41 to 6.70. This pH value is still in good condition because it ranged from 6 to 9 [14]. Dissolved oxygen in Jatibarang Reservoir ranged from 6.04 to 7.39 mg/l. Dissolved oxygen is one of the important parameters and a limiting factor for fish life. A minimum dissolved oxygen concentration of 5 mg/l is required to satisfactorily support activities at most life stages [15].

3.2. Sex ratio
A total of 56 fishes were measured with 19 females (34%) and 37 males (66%). The sex ratio of tilapia in the Jatibarang Reservoir was 1:1.9 (females: males) and shows no difference significantly (p>0.05). The results of the sex ratio in this study were almost the same as in other studies. The sex ratio of female and male tilapia in several studies was 1:1.3 [16], 1:1 [17] [18], 1:1.2 [19]. The sex ratio varies between fish species, but in most cases, approaches one [20].

3.3. Total length and weight relationship
The total lengths of tilapia (O. niloticus) measured ranged from 95 to 349 mm, while the total weight ranged from 13 to 798 g. The total length of males ranged from 95 to 348 mm and females from 152 to 349 mm. The total weight of males ranged from 13 to 785 g and females from 55 to 798 g. Tilapia in this study ranged from small to large. This means that environmental parameters such as pH support the growth of tilapia. The optimum pH for tilapia growth is 6–9 [21].

![Figure 2. Length frequency of tilapia in Jatibarang Reservoir](image)

The length interval of tilapia which has the highest relative frequency is 195-244 mm, both males (36.8%) and females (52.6%). Meanwhile, the length interval of tilapia which has the lowest relative frequency is 295-344 mm and 345-394 mm of 2.6% for males, while the length interval of 95-144 mm of 0% for females (figure 2). The difference in frequency is caused by several factors, such as sex, age, disease, food, temperature, and water quality [22].

The results of the length-weight relationship analysis showed that there is a close correlation between the total length and the total weight of the fish as indicated by the correlation coefficient (r) of 0.9752. These results also indicate that tilapia has a value of b = 3.2688 (figure 3). The t-test on b showed that the growth pattern of tilapia was positive allometric. This means that weight growth is faster than length growth. This result was different from other studies which reported that the growth pattern of tilapia (O. niloticus) was negative allometric [16] [17]. In most fish, growth and body size showed a positive allometric pattern [23]. This may be correlated with environmental conditions such as water temperature [24] [25] and habitat [26].
Figure 3. Total length-weight relationship of tilapia in Jatibarang Reservoir

3.4. **Condition factor**

The value of the condition factor in male and female fish was 0.94-1.16 and 0.95-1.21, respectively. The condition factors in this study were almost the same at each fish length interval, both male and female. However, the condition factor for female fish at a length of 95-144 mm didn’t exist because there were no female fish that were mature gonads (figure 4).

![Condition factor graph](image)

**Figure 4.** Condition factor of males and females tilapia in Jatibarang Reservoir

The condition factors in this study were almost the same as other studies, such as the condition factor of tilapia in Lake Rawa Pening ranging from 1.03 to 1.09 [16]. The high condition factor indicates good environmental conditions for fish life. Differences in condition factor values can be influenced by differences in environmental conditions, age, and fish size fish [27]. An increase in the value of the condition factor can occur with the increase in gonad maturity and will reach a peak before spawning [22].
3.5. Maturity stages
Based on the maturity stages of female gonads, 10.5% of the total fishes were immature (I), 26.3% were maturing (II), 26.3% were mature (III), and 36.8% were ripe (IV) (figure 5). These results indicate that 63.1% of the female fishes were in the process of reproduction. Meanwhile at the maturity stages of male gonads: 65.8% of the total fishes were immature (I), 28.9% were maturing (II), 2.6% were mature (III), and 2.6% were ripe (IV) (figure 6). These results indicate that 5.2% of the male fishes were in the process of reproduction.

The smallest sizes in mature female and male fish had a total length of 190 mm and 173 mm, respectively. Another study reported that the reproductive maturity length of male and female fish were 222 and 208 mm, respectively [28]. These differences may be due to differences in food abundance and availability, temperature, and other environmental factors in different places [20]. At all lengths, the GSI in males was lower than that in females. This is because female gonads were relatively heavier than male gonads.
3.6. Fecundity

The fecundity of tilapia caught in this study ranged from 28 to 7,852 eggs. Another study reported that the fecundity of tilapia (*O. niloticus*) ranged from 123-587 eggs [16], 255-6,930 eggs [28], 399-2,129 eggs [29]. This difference in fecundity may be correlated with food abundance within the population [30]. Fish species can show differences in fecundity between fish of the same species, size, and age [31].

4. Conclusion

Water temperature, pH, and dissolved oxygen ranged from 28.0-31.9 °C, 6.41-6.70, and 6.04-7.39 mg/l, respectively. The sex ratio of tilapia was 1:1.9 (females: males). Total length ranged from 95 to 349 mm, and total weight ranged from 13 to 798 g. The growth pattern of tilapia was positive allometric. The condition factor in male and female fish was 0.94-1.16, and 0.95-1.21, respectively. 36.8% of the female fishes were ripe stage (IV) and 65.8% of the male fishes were immature stage (I). The fecundity ranged from 28 to 7,852 eggs.

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