Reproduction aspect of tiger fish (*Datnioides polota* Hamilton) in musi river South Sumatera

Moh. Rasyid Ridho
Department of Biology, Faculty of Mathematics and Natural Sciences
Sriwijaya of University, Inderalaya

E-mail: moh.rasyidridho@mipa.unsri.ac.id

Abstract. The research about the aspect of Tiger fish reproduction (*Datnioides polota* Hamilton) in the Musi River South Sumatera has been carried out in March to May 2011. This research aims to determine the reproduction aspect of Tiger fish (*Datnioides polota* Hamilton) which covers the length-weight relationship, sex ratio, maturity level of the gonads, gonad maturity index, fecundity and egg diameter. The sampling was carried out by purposive sampling method using belat that is a net with 3 mm mesh size. Belat put in to cover the river bank along the 30-70 m with hight of nets ranging from 1.5-2 m, and the fish that catch by fisherman using another net. The sampling was conducted from March to May and obtained 86 fishes. The result of this research showed that the growth pattern of Tiger fish (*Datnioides polota* Hamilton) is positive allometric. Sex ratio of Tiger fish is a whole in a state that is not balanced is the number of male fish more than the female fish with a range of gonadal maturation index between 0.064 % to 9.954 %. Tiger fish fecundity ranged from 33.925 to 350.268 eggs and have gradually spawning patterns (partial spawning).

1. Introduction
The Musi River is a river located in the Province of South Sumatra, Indonesia with a river length of about 750 km and is the longest river on the island of Sumatra. The main water sources of the Musi River come from the Kepahiang, Bengkulu, and the end the river flow of 8 major tributaries, namely the Komering, Rawas, Batanghari Leko, Lakit, Kelingi, Lematang, Semangus, and Ogan rivers.

One of the potential resources in the Musi River is fish. Fish is one of the organisms that inhabit almost all layers of water. Fish are the organisms most consumed by humans. Therefore, fish is very important in the world of fisheries. There are many types of fish in the waters of the Musi River, one of which is the tiger fish.

The tiger fish (*Datnioidespolota* Hamilton) is one of the fish that has high potential as an ornamental fish found in the Musi River because it has unique features on its body. Many fishermen have caught this tiger fish. This fish is classified into the true bony fish group (*Osteichthyes*). This fish in the Musi River is found from the Mekarti Jaya area (Upang) to the direction of Sunggang.

According to Utomo and Krismono (2006) and Samuel et a., (2002), this fish is rarely found in waters [1,2]. Even in other large rivers such as the Batanghari River in Jambi, Kapuas in West Kalimantan, Barito in Central and South Kalimantan are also rarely found. Therefore, it is necessary to study the reproductive aspects of the tiger (*Datnioidespolota* Hamilton) so that it can be used as a reference in managing these fish resources in nature and can be developed as cultivated fish.

2. Materials and methods
This research was conducted from March to May 2011. The location of water and fish sampling was carried out at the Musi River, South Sumatra from Upang to Sungsang. Identification of fish samples was carried out at the Laboratory of the Department of Biology, Faculty of Mathematics and Natural Sciences, Sriwijaya University.

The tools used are dissecting set instruments, bottles, buckets, becker glass, separating needles, filter cloth, plastic bags, rubber bands, label paper, surgical boards, pencils, dropper pipettes, glove, rulers, and scales. The materials used were tiger fish samples from the waters of the Musi River, 10% formalin, Gilson's solution (60% alcohol, water, nitric acid, glacial acetic acid and mercury chloride).

2.1. Sampling of fish
Sampling of fish using purposive sampling method. Fishes were caught using a belat. Belat is a net with a mesh size a diameter of 3 mm. The belat is attached to cover the the river bank 30-70 m long with a net height ranging from 1.5-2 meters. In addition, fish are taken from the catch by fishermen using cast nets.

2.2. Sampling of water
The physical and chemical parameters observed included water temperature, brightness, pH, salinity, and dissolved oxygen. This measurement is carried out once at the beginning of sampling.

2.3. Data analysis
Data analysis included length-weight relationship, sex ratio, gonad maturity level, gonad maturity index, fecundity, and egg diameter using the Excel software.

2.3.1. Long relationship with fish weight
To determine the relationship between length and weight of tiger fish, measurements were made. The total length of the fish is measured from the leading edge of the head to the tip of the rear tail fin using a ruler to an accuracy of 1 mm. The total weight of fish was measured using digital scales with an accuracy level of 0.01 g.

The long-weight relationship was analyzed according to Ridho et al., (2009) with formula [3]:

\[ W = aL^b \]

Information:
- \( W \): body weight of fish (g)
- \( L \): total length of fish (mm)
- \( A \): intercept (the intersection of the length-weight relationship curve with the y-axis)
- \( b \): slope (slope)

2.3.2. Sex ratio
To determine the relationship between length and weight of tiger fish, measurements were made. The total length of the fish is measured from the leading edge of the head to the tip of the rear tail fin using a ruler to an accuracy of 1 mm. The total weight of fish was measured using digital scales with an accuracy level of 0.01 g.

To analyze the sex comparison of sample fish, the Chi-square (\( \chi^2 \)) test was performed [4] as follows:

\[ \chi^2 = \sum \frac{O_i - E_i}{E_i} \]

Information:
- \( O_i \): frequency of i-th male and female fish observed
- \( E_i \): the expected frequency, namely the frequency of male fish + the frequency of female fish divided by two
- \( x^2 \): the value of the random variable \( x^2 \), which the distribution of draws for example is close to
the Chi-squared distribution.

2.3.3. Gonad Maturity Level (GML). Observation of the maturity level of the gonads was done by dissecting the fish and looking at the gonads, then determining the sex and maturity level of the gonads. GML is determined morphologically based on analysis of size, shape, color, oil droplets and filling in the abdominal cavity [5].

According to Effendie (1995), the level of fish gonad maturity can generally be divided into [6):

1. Immature, the gonads are very small like threads and transparent, the cross section of the gonads in male fish is flat with gray color, the cross section of the female fish is round with a reddish color.
2. Develop, the gonads fill 1/4 of the body cavity, the color of the male fish is gray or white, the shape is flat, while the female fish is reddish in color and round in shape, and the eggs are not visible.
3. Mature, the gonads fill 1/2 the body cavity, the gonads in male fish are white, in female fish are yellow. The shape of the egg is visible through the ovary wall.
4. Ripe, gonads fill 3/4 of the body cavity, male fish gonads are white filled with white liquid, female gonads are yellow, almost clear or clear, eggs can be seen, sometimes with gentle pressure on the stomach there is a protruding hole in the discharge.
5. Spent, almost the same as the second stage and difficult to distinguish, male gonads are white, sometimes with brown spots, female gonads are red, mushy and eggs are not visible.

2.3.4. Gonad Maturity Index (IKG). According to Effendie (1979), the measurement of the gonad maturity index is calculated by comparing the gonad weight to the body weight of the fish with the formula [7]:

\[ IKG = \frac{BG}{BT} \times 100\% \]

Information:
- IKG: gonad maturity index
- BG: Weight of the gonads (g)
- BT: Body weight (g)

2.3.5. Fish Fecundity. According to Yustina and Arnentis (2009), fecundity can be calculated as follows [8]:

\[ F = \frac{G \cdot V \cdot X}{Q} \]

Information:
- F = fecundity (Number of egg grain)
- G = gonad weight (g)
- V = dilution content (100 ml)
- Q = sample egg (1 g)
- X = number of eggs per ml

2.3.6. Egg diameter
Observation of egg diameter was carried out on three parts of the gonad to see the difference in size distribution, namely the posterior, anterior, and median layers as sample gonads. Each part of the sample gonad eggs with a total number of 150 eggs, then observed using a microscope equipped with a whiple grade ocular micrometer [9].

3. Materials and methods
3.1. Long distribution
Based on the results of this research that has been carried out, the number of fish obtained for 3 months, from March to May amounted to 86 fish. The fish obtained have varying lengths (Figure 1), including 69 male and 17 female fish. After the analysis was carried out, it was obtained 14 classes of total length measurements. The frequency of male fish was spread in the middle of class 109.5-369.5 mm, while female fish were spread in the middle of class 109.5-289.5 mm. The number of male fish is more than female fish, one of which is because the tiger fish is in its spawning space. According to Yustina and Armentis (2002) that the fish in conducting the ruaya to the spawning area between male and female fish each make their own groups [8]. The sex ratio in spawning for each fish species is different, but the ratio is generally close to one to one.

In Figure 1, it can be seen that the modus of fish length obtained ranges from 109.5 mm to 369.5 mm and the highest number of fish is at a length of about 149.5 mm. The longest tiger fish obtained is 350 mm in size. This is different from Kottelat and Whitten (1996), that tiger fish (Datnioides polota Hamilton) has a maximum length of 300 mm [10]. This difference indicates that the size of the tiger fish (Datnioides polota Hamilton) in the Musi River has a larger size. This indicates that the environmental conditions (availability of natural food) in the Musi River are still very supportive of the growth of these fish. According to Effendie (1995), in the tropics, food is a more important factor than water temperature. When the other factors are normal, fish with excess food will grow more rapidly [5].

3.2. Long-weight relationship
The results of the analysis of the length-weight relationship showed that the growth of the tiger fish is allometric positive which is depicted in Figure 2 below:

Figure 2. Relation of length and weight of tiger fish (Datnioides polota Hamilton)
In Figure 2 it can be seen that the value of b is 3.098. This shows that the tiger fish has a positive allometric length relationship pattern, that is, the weight gain is faster than the length of the fish. In accordance with Effendie (1995), if the value of b is greater than 3, the growth is allometrically positive [5]. The value of R$^2$ is 0.91, this means that the length and weight of the tiger fish has a high correlation because the R value is close to 1. According to Effendie (1995), the correlation coefficient value shows the relationship between the two variables [5]. R values close to 0 indicate a low relationship between the two variables. Conversely, if the R value approaches 1, it means that there is a strong relationship between the two variables.

By knowing the relationship between length and weight, it can be seen the growth pattern of a fish. According to Ernawati et al., (2009) [9], the growth pattern of fish can be used to determine the condition of these fish. This situation is an indication of the fish spawning season, especially female fish.

### 3.3. Sex ratio

The sex ratio between male and female fish was obtained with a ratio of 1: 0.24. Statistically with the $X^2$ test, the result is $X^2$ count $>$ $X^2$ table. This shows that the distribution between male and female tiger fish during the study is not balanced. The number of male fish obtained is more than the female fish. The sex ratio of tiger fish (Datnioides polota Hamilton) during the study is presented in Table 1.

| Sex         | Amount |
|-------------|--------|
| Male        | 69     |
| Female      | 17     |
| Total       | 86     |

The frequency of hopefulness 43

**Hypothesis**

H$_0$ : balanced sex ratio
H$_1$ : Sex ratio is not balanced

\[
X^2 \text{count} = \frac{(69-43)^2}{43} + \frac{(17-43)^2}{43} = 31.44
\]

\[
X^2 \text{table} = X_{0.05} (V=2-1) = 3.841
\]

Decision: bruss off-H$_0$ because $X^2$ count $>$ $X^2$ table.
Conclusion: sex ratio is not balanced.

One of the imbalances in the number of male and female fish caught is due to differences in behavior and several factors during fishing. In nature there is often a deviation from the sex ratio from ideal conditions. This is due to the swarming behavior patterns between male and female fish, environmental conditions and fishing) [9]. According to Ridho and Patriono (2016) this condition showed that the tiger fish it is possible that the tiger fish has the same pattern as white snapper fish (L. calcarifer Block), there is a change in sex from male to female (hermaphrodite protandri) [11].

### 3.4. Gonad maturity level and gonad maturity index

The gonad maturity level of male and female tiger fish is determined by morphological observations. Observation of the GML morphology of male fish was different from that of female fish. According to Effendie (1979), observed female fish are shape, size, color, smoothness, filling of the ovaries in the body cavity and size, clarity of shape and color of eggs in the ovaries [7]. Whereas for male fish that were observed were the shape, size, color and filling of the testes in the body cavity as well as the
The gonad maturity level of the tiger fish based on the sample can be grouped into the maturity level of the gonads I, II, III and IV (Table 2).

In Table 2, it can be seen that as many as 69 individual male tiger fish can be grouped into gonad maturity levels I, II, III and IV. GML I amounted to 4 individuals with a body weight range of 21–52 g and a total length range of 100–130 mm. GML II contained 54 individuals with a body weight range of 17–261 g and a total length range of 91–223 mm. At GML III, there were 10 individuals with a body weight range of 50.14–229 g and a total length range of 130–218 mm. GML IV contained only 1 individual with a body weight of 964 g and a total length of 350 mm.

Table 2. Number of tiger fish at each level of gonad maturity obtained during the study along with the range of body weight and total length

| Sex   | GML | Number (individual) | Range of Body Weight (g) | Range of Total Length (mm) |
|-------|-----|---------------------|--------------------------|---------------------------|
| Male  | I   | 4                   | 21 – 52                  | 100 – 130                 |
|       | II  | 54                  | 17 – 261                 | 91 – 223                  |
|       | III | 10                  | 50.14 – 229              | 130 – 218                 |
|       | IV  | 1                   | 964                     | 350                       |
| Amount|     | 69                  |                          |                           |

| Female | I   | 2                   | 18.15 – 28.18            | 92 – 103                  |
|        | II  | 3                   | 78 – 158                 | 154 – 184                 |
|        | III | 5                   | 41 – 257                 | 166 – 215                 |
|        | IV  | 7                   | 119 – 543                | 173 – 274                 |
| Amount |     | 17                  |                          |                           |

A total of 17 individual female tiger fish were grouped into gonad maturity levels I, II, III and IV. At GML I there were 2 individuals with a body weight range of 18.15–28.18 g and a total length range of 92–103 mm. GML II amounted to 3 individuals with a body weight range of 78–158 g and a total length range of 154–184 mm. GML III was found as many as 5 individuals with a body weight range of 41–257 mm and a total length range of 166-215 mm. GML IV contained 7 individuals with a body weight range of 119-543 g and a total length range of 173-274 mm.

There is a tendency that the longer and heavier the tiger fish, the higher the GML. According to Yustina and Arnentis (2002), this can be caused by environmental conditions in which the fish live, especially the availability of food [8]. The difference in the beginning of an individual fish experiencing gonadal maturity is also caused by age, size and physiological factors of the fish itself.

The level of gonad maturity (GML) V was not found in this study, this is because during the observation of captured tiger fish, it is generally still at levels I, II, III and IV. This means that the tiger fish has a year-round spawning pattern. This is the same as the spawning pattern of palau fish (*Osteochilus vittatus*) in Batanghari River [12]. According to Effendie (1995), for fish that have a year-round spawning season, the composition of the gonad maturity level will be obtained at any time [5].

The gonad maturity index (GMI) consists of various levels with different percentages. Quantitative changes that occur in the gonads can be seen from the GMI. In line with the development of gonad maturity, the weight of the gonads also increases. GMI will reach its maximum just before spawning occurs.

Table 3. The gonad maturity index of the tiger fish during the study
In Table 3, it can be seen that the GMI value of tiger fish in this study ranges from 0.008% to 9.954%. According to Yustina and Arnentis (2002), fish that have GMI values smaller than 20% are fish groups that can spawn more than once per year [8]. This indicates that the tiger fish obtained during the study are of a small GMI value. This is consistent with Pulungan et al., (1987) that generally fish that live in tropical waters can spawn throughout the year with a smaller GMI value when the fish matures gonads [13].

Gonad maturity index tends to increase with increasing gonad maturity level. This can be seen in Table 3, female fish have a range of GMI values at GML I, namely 0.165-0.213 and increasing up to GML IV, namely 1.992-9.954. This is in accordance with Effendie (1995) statement that there is a relationship between the gonad maturity index and the gonad maturity level, the gonad maturity index will increase with the increasing level of gonad maturity and will decrease after the fish have finished spawning [5].

3.5. Fecundity
The results of the fecundity calculation of the 8 individual fish obtained can be seen in Table 4.

| Fecundity (grain of eggs) | GML | Total Length (mm) | Body Weight (g) | Gonad Weight (g) |
|---------------------------|-----|-------------------|-----------------|-----------------|
| 33.925                    | IV  | 173               | 146             | 5.75            |
| 33.976                    | III | 215               | 257             | 2.74            |
| 39.380                    | III | 170               | 137             | 3.58            |
| 72.624                    | IV  | 185               | 152             | 15.13           |
| 77.448                    | IV  | 238               | 287             | 9.22            |
| 150.040                   | IV  | 227               | 268             | 12.11           |
| 150.423                   | IV  | 192               | 174             | 11.31           |
| 350.268                   | IV  | 274               | 543             | 34.34           |

In Table 4, it can be seen that the fecundity of the tiger fish ranges from 33,925 to 350,268 eggs. The smallest fecundity was in fish with gonad weight of 5.75 g, while the highest fecundity was in fish with gonad weight of 34.34 g. This value shows the potential of the eggs produced for one spawning. There were 2 eggs with GML III whose fecundity was calculated, this is because when the gonads have been added to the Gilson solution, the eggs in them have separated and the fecundity can be calculated.
The size of the fecundity is influenced by several factors. According to Yustina and Armentis (2002) [8], the fecundity of a species is strongly influenced by food, fish size, and environmental conditions. Fecundity can also be affected by egg diameter. Fish that have a large body size generally have a low fecundity value because their egg diameter tends to be large. According to Soekiswo (2014) there is a relationship between fish length and weight on fecundity, this is based on research on mendo fish, where the highest fecundity is 8250 grains with a body length of 28 mm and a body weight of 0.7 grams [14].

![Graph of relationship between total length and frequency](image1)

![Graph of relationship between body weight and frequency](image2)

**Figure 3.** Relationship of fecundity with (a) total length, (b) body weight

The results of fecundity regression with total length and body weight (Figure 3) obtained relationship coefficient ($R^2$) values of 0.490 and 0.470. This value is low, so it can be concluded that there is a non-close relationship between fecundity and length and body weight of fish. Effendi (2003) states that the fecundity of a type of fish is closely related to its environment, in this case the fecundity of a fish species will change when environmental conditions change, this is related to the abundance of food available in that environment [15]. So that fecundity is more often related to length than weight, because the length of shrinkage is smaller than the weight which can be easily reduced if there are changes in the environment and physiological conditions of the fish.

### 3.6. Egg diameter

The distribution of egg diameter was observed based on the eggs of the eight ovaries. From each ovary, 50 eggs were taken in the posterior, median and anterior parts. Egg diameter ranges from 0.27 to 1.35 mm, and the largest number is eggs with a diameter of 0.54 mm, amounting to 488 eggs (43.96%). Meanwhile, the lowest number was eggs with a diameter of 1.35 mm (0.12%) (Figure 4).

![Histogram of egg diameter](image3)

**Figure 4.** Size of tiger fish egg diameter at GML III and IV in April and May 2011
From the egg diameter chart above, there are two peaks that are clearly visible. This shows that the tiger fish spawn little by little and spawn gradually. According to Yustina and Arnentis (2002) [8], the heterogeneous distribution pattern of egg diameter is an indication that these fish are not spawning all at once (partial spawning). This shows that the developing process in the ovaries of the tiger fish is not the same or that the miosis event takes place simultaneously.

3.7. Physical and chemical properties of water
Based on the fish sampling locations in Musi (Upang) and Musi (Sungsang), the physical and chemical properties of water were obtained such as temperature, brightness, pH, DO, and salinity (Table 5). The water temperature does not differ between the two locations, which is 30°C. The brightness of Musi (Upang) is around 41 cm while that of the Musi (Sungsang) is about 44 cm. The pH and salinity values at the sampling site were not different, namely pH 6.5 and salinity 0. Then the dissolved oxygen (DO) value was 5.50 mg/L in Muara Upang and 6.42 mg/L in the Upang River.

The tiger fish at the time of sampling were at a water temperature of 30°C. According to Alfiansyah (2011), the range of water temperature that is needed for fish growth in tropical waters can take place between 25°C - 32°C [16]. Water temperature is very influential on chemical, physical and biological processes in the waters, so that a change in temperature in a water will change all processes in the water. This can be seen from the increase in water temperature, the solubility of oxygen will decrease. From the research results, it was known that an increase of 10°C in water temperature resulted in an increase in oxygen consumption by aquatic organisms by around 2-3 times, so that the oxygen demand by the aquatic organism was reduced.

| Parameters                  | Location                        |
|-----------------------------|---------------------------------|
|                             | Musi (Muara Upang) (02°58'29.4") | Musi (Sungang) (02°40'47.4") |
| Water Temperature (°C)      | 30                              | 30                              |
| brightness (cm)             | 41                              | 44                              |
| pH                          | 6.5                             | 6.5                             |
| Dissolved Oxygen (mg/L)     | 5.50                            | 6.42                            |
| Salinity (ppt)              | 0                               | 0                               |

In Table 5, it can be seen that the pH of the water at the two sampling stations is 6.5. According to [17], the ideal pH value for aquatic organisms ranges from 6.7 to 8.6. But fish can live between a pH of 5 to 9. Water that comes from the mountains usually has a higher pH. The longer the pH of the water will decrease towards an acidic atmosphere. This is due to the addition of organic materials which then liberates CO₂ from the decomposition process.

The dissolved oxygen values at the two sampling stations were 5.50 mg/L and 6.42 mg/L. According to Sastrawijaya and Tresna (2009), the normal value of dissolved oxygen at a water temperature of 30°C is 7.5 mg/L [17]. Fish can live in the range of dissolved oxygen values between 5 to 7 mg/L. If the dissolved oxygen level is always low, then aerobic organisms will die and anaerobic organisms will break down organic matter and produce materials such as methane and hydrogen sulfide. These are the substances that make water smell bad.

Water quality is a determinant of the state of life. This is because the aquatic ecosystem is absolutely dependent on water conditions. According to Effendi (2003), temperature has a great influence on oxygen solubility [15]. Each species has its optimum temperature. There are fish that have an optimum temperature of 15°C, some are 24°C, and some are 32°C. According to Effendie (1995), the environment is very influential on fish growth [5]. The main external factors affecting growth are food and water.
temperature. Fish growth will be optimum if it is supported by good environmental conditions. Water quality is one of the most important things to know in aquatic ecosystems.

4. Conclusion
Based on the research that has been carried out, the following conclusions are obtained:
1. The growth pattern of the tiger fish (*Datnioides polota* Hamilton) is positive allometric.
2. The sex ratio of tiger fish (*Datnioides polota* Hamilton) is not balanced, there are more male fish than female fish.
3. The gonad maturity level (GML) of tiger fish based on the sample is grouped into GML I, II, III, and IV with a range of gonad maturity index (GMI) between 0.064% to 9.954%. tiger fish including fish that spawn more than once per year.
4. The fecundity of tiger fish ranges from 33,925 to 350,268 eggs. The fecundity of the tiger fish is not closely related to the total length and body weight of the fish.
5. Based on the distribution of egg diameter, the tiger fish has a gradual spawning pattern (partial spawning).

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