Species composition and biology reproductions aspects of stingray (*Batoidea*) in south coast of Prigi waters, Trenggalek, East Java, Indonesia

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**Abstract.** Stingray (*Batoidea*) are often caught as bycatch in south coast of Prigi waters. The stingray resource has very limited in number and require a long time to reproduce. Attention must be paid to avoid the extinct of stingray resource. This research aimed to justify species composition and identify length weight relationship, sex ratio, and clasper maturity level of stingray (*Batoidea*) caught in south coast of Prigi waters. The research was carried out from December 2019 to April 2020 at Prigi archipelago fishing port as landing place. This study used a quantitative descriptive method with the number of samples that were successfully obtained as many as 97 stingray. During the study, 6 species of stingray (*Batoidea*) were identified, namely Taiwan guitarfish (*Rhinobatos schlegelii*), blotched fantail stingray (*Taeniura meyeni*), Japanese devilray (*Mobula japonica*), bluespotted maskray (*Neotrygon kuhlii*), shark ray (*Rhina aculeatissima*), dan bluespotted fantail ray (*Taeniura lyra*). Result indicated that Taiwan guitarfish (*R. schlegelii*) and bluespotted maskray (*N. kuhlii*) were two dominant stingray species in south coast of Prigi waters with proportion of 47.42% and 41.24% respectively. Disk width (*Dw*) and weight (*W*) of Taiwan guitarfish (*R. schlegelii*) ranged from 15.2 cm to 24.6 cm and from 268 gr to 1060 gr respectively and bluespotted maskray (*N. kuhlii*) ranged from 17.3 cm to 39.3 cm and from 140 gr to 2006 gr respectively. Another analysis showed that Taiwan guitarfish (*R. schlegelii*) and bluespotted maskray (*N. kuhlii*) had length weight relationship equations *W* = 0.0202 *Dw*^{3.4699} and *W*=0.0351* *Dw*^{2.9848} respectively. The sex ratio of Taiwan guitarfish Taiwan guitarfish (*R. schlegelii*) dan bluespotted maskray (*N. kuhlii*) was 1:1.4 and 1:1.2 respectively. In addition, clasper maturity level of the Taiwan guitarfish (*R. schlegelii*) and bluespotted maskray (*N. kuhlii*) species was dominated by *Non-Calcification* (NC). In conclusion, The stingray (*Batoidea*) caught in south coast of Prigi waters were dominated by Taiwan guitarfish (*R. schlegelii*) and bluespotted maskray (*N. kuhlii*). Length weight relationship of Taiwan guitarfish (*R. schlegelii*) and bluespotted maskray (*N. kuhlii*) was allometric positive and isometric respectively. Both of them was in balance condition sex ratio and was dominated by immature stage. Hence fishing activities in south coast of Prigi waters should avoid the stingray as bycatch in order to preserve the stock.

1. **Introduction**

Indonesia is divided into 11 Fisheries Management Area (FMA), and Prigi waters are included in the FMA 573 area which covers the Indian Ocean in the southern part of East Java. This waters is included in the area of Tasikmadu Village, Watulimo District, Trenggalek Regency at coordinates 111° 43’ 58” E dan 08° 17’ 22” S. This waters has a mud mixed with sand and little rocky reef, ranging in depth from...
6-45 meters [1]. Prigi archipelago fishing port is a place where various types of catch are landed, one of which is stingray (Batoidea).

Stingray (Batoidea) has become an important part of the catch fisheries are thriving today. This is due to the high demand for stingray meat for food and its skin as fashion raw materials (bags, wallets, and shoes).[2]. In addition, there are types of stingray gills that have high economic prices, which is manta ray gills. This is due to the myth of the efficacy of manta rays, which are believed to increase the stamina of adult men, overcome organ diseases in the human body, up to treat cancer, although this has not been scientifically proven [3]. Stingray (Batoidea) is a resource which is limited in number and distribution area, also has a long reproductive period. Indonesian waters have 101 types of rays (Batoidea), but currently several types of rays (Batoidea) have decreased in population until they are threatened with extinction [4].

Most people are still not aware toward the decline stingray (Batoidea) resource availability at this time. Therefore, it is necessary to carry out the identification of the stingray (Batoidea) catch as the first step for a sustainable stingray management in the future. The identification activity aims to identify various problems with something which is then used to plan the program to be implemented [5]. This study aims to determine about stingray (Batoidea) starting from the species, dominant species, sex, length-weight relationship, and clasper maturity level of stingray (Batoidea) caught in Prigi waters.

2. Materials and methods

This research used a quantitative descriptive method which was conducted from December 2019 to March 2020 at Prigi waters, Trenggalek Regency, East Java. Primary data obtained from the catch of stingray (Batoidea) landed at Prigi archipelago fishing ports (AFP). Meanwhile, secondary data consist of information obtained from port offices and fisheries journals to support primary data. In this study, the biological aspects of stingray (Batoidea) were analyzed regarding the relationship between length and weight, sex ratio, and clasper maturity level.

2.1. Species composition

The activity of species composition determination of the stingray (Batoidea) catch is very necessary in order to know what types of stingray were caught and in what proportion. The formulation in determining the composition of fish species can be analyzed using the equation [6]:

\[ K = \frac{N_i}{N} \times 100\% \]  

Where:
- \( K \) = Percentage of fish species - i (i = 1,2,3,… n)
- \( N_i \) = Number of individual fish species - i (i = 1,2,3,… n)
- \( N \) = Number of individuals of all types of fish (total number of individuals per sampling).

2.2. Length weight relationship

Analysis of length-weight relationship can be assessed based on [7]. The length used to perform growth pattern in stingray is represented by disk width (Dw). Therefore, the length-weight relationship equation become:

\[ W = a \times D^b \]  

Where:
- \( W \) = Stingray weight (gr)
- \( Dw \) = Disk width (cm)
- \( a \) = Intercept (intersection between imaginary line of length and weight plotted with y-axis)
- \( b \) = slope

This equation is then converted into a linear equation. Due to length used as growth pattern in rays is represented by disk width (Dw), so that the form of length weight relationship in linear equation becomes: \( \ln W = \ln a + \ln D + b \ln W \). Justification whether the length-weight relationship is isometric or allometric is analyzed by using the T-test. If the value of \( T_{count} \) is higher than \( T_{table} \), the growth pattern is
allometric (positive allometric if the value of b > 3 and is negative allometric if the value of b < 3), whereas if the value of T\text{count} is less than T\text{table}, the growth pattern is isometric.

2.3. Sex ratio (GML)
Analysis of the sex ratio is obtained by using the formula [8] as follows:

\[ NK = \frac{Nb}{Nj} \]  \hspace{1cm} (3)

Where:
\[ NK \] = Sex ratio
\[ Nb \] = The number of female fish
\[ Nj \] = The number of male fish

To determine the balance of sex, calculations must be made using the chi-square test \( (X^2) \) [9] with the following formula:

\[ X^2 = \sum \frac{(o_i - e_i)^2}{e_i} \]  \hspace{1cm} (4)

Where:
\[ o_i \] = The observed frequency of male and female fish
\[ e_i \] = The expected frequency of fish is in balance

If the calculation results show that the value of \( X^2\text{cnt} < X^2\text{tab} \) (0.005) then accept H\text{0}, which means that there is no significant difference between female and male sex ratios. However, if \( X^2\text{cnt} > X^2\text{tab} \) (0.005) then accept H\text{1}, which means that there is a significant difference between the female and male sex ratios.

2.4. Clasper maturity level (CML)
The method to identify clasper maturity in rays (Batoidea) is only performed in the male gender by measuring the clasper without dissecting the body of the rays. There are three classification of clasper maturity [10] namely non calcification (NC), none full calcification (NFC), and full calcification (FC) (Table 1).

| Table 1. Classifications of clasper maturity level (CML). |
|----------------------------------------------------------|
| Condition | Remarks |
|-----------|---------|
| Immature / Non-Calcification (NC) | The clasper has not been calcified and is not ready to fertilize. This condition can also be seen from the shorter length of the clasper than the pelvic fins |
| Maturing / None-Full Calcification (NFC) | The clasper is only partly calcified and is still not ready to fertilize. This condition can also be seen from the length of the clasper which is parallel to the pelvic fin. |
| Mature / Full-Calcification (FC) | The clasper is hard and stiff textured, fully contains calcium and is ready to fertilize. This condition can also be seen from the longer clasper length of the pelvic fins. |

3. Results
Samples of rays (Batoidea) were obtained from purse seiners, gill netters, and long liners which landed their catch at Prigi AFP during December 2019-March 2020. There were total of 97 rays. The samples were used for measuring length and weight, observing the maturity level of the clasper and identifying species and gender. During the research it was known that the highest catch of stingray (Batoidea) was obtained in January 2020 with 64 fish, while the lowest was obtained in March 2020 with 2 fish (Figure 1).
3.1. Stingray (Batoidea) composition
Species composition of stingray (Batoidea) consists of several different species. In the study, the proportion for each species were obtained; Taiwan guitarfish (R. schlegelii) by 47.42%, blotched fantail stingray (T. meyeni) by 1.03%, japanese devilray (M. japanica) by 5.15 %, bluespotted maskray (N. kuhlii) by 41.24%, shark ray (R. ancylostoma) by 1.03%, and bluespotted fantail ray (T. lymma) by 4.12% (Figure 2).

3.2. Length weight relationship
The equation obtained for the analysis of the length-weight relationship of Taiwan guitarfish is $W=0.0202*DW^{3.4699}$ with an $R^2$ value of 0.904 (Figure 3), which means that length affects fish body weight by 90%. The result of the T-test shows the value of $t$ count is 18.6948 and $t$ table is 2.0141. That means $t$ count $> t$ table 0.05 where $b \neq 3$ obtained a positive allometric growth pattern, which means that body weight growth is more dominant than length growth. While the equation obtained for the analysis of the length-weight relationship of bluespotted maskray is $W = 0.0351 * DW^{2.9848}$ with an $R^2$ value of 0.942 (Figure 4), which means that length affects fish body weight by 94%. The result of the T-test shows that the $t$ count is 0.8011 and the $t$ table is 2.0227. It means that $t$ count $< t$ table 0.05, the growth pattern is isometric, which means the length increase is in line with the weight gain.
Figure 3. Length-weight relationship of Taiwan guitarfish (*R. schlegelii*).

Figure 4. Length-weight relationship of bluespotted maskray (*N. kuhlii*).

3.3. Sex ratio of dominant stingray (Batoidea)

The sex ratio is used to determine the ratio of the number of male and female fish in a population (Figure 5). The sample of Taiwan guitarfish (*R. schlegelii*) obtained during the study consisted of 19 males and 27 females (1:1.4) with proportion between male and female was 41%: 59%. The sample of bluespotted maskray (*N. kuhlii*) obtained during the study consisted of 18 males and 22 females (1:1.2) with a proportion between male and female fish was 45%: 55%.

Figure 5. Sex ratio proportion of taiwan guitarfish (*R. schlegelii*) and bluespotted maskray (*N. kuhlii*).

Based on the Chi-square analysis on the Taiwan guitarfish (*R. schlegelii*), the calculated $X^2$ count is 0.038 < $X^2$ table of 3.841. The results of the Chi-square analysis on the bluespotted maskray (*N. kuhlii*) obtained $X^2$ count is 0.015 < $X^2$ table of 3.841. From the results of the two species (Table 2), it can be concluded that there is no significant difference between the male and female sex ratio.

Table 2. Comparison of the calculated $X^2$ count and the $X^2$ table.

| Species                  | Male | Female | Total | Expectation | $X^2$ Count | $X^2$ Table |
|--------------------------|------|--------|-------|-------------|-------------|-------------|
| Taiwan Guitarfish (*R. schlegelii*) | 19   | 27     | 46    | 23          | 0.038       | 3.841       |
| Bluespotted Maskray (*N. kuhlii*)   | 18   | 22     | 40    | 20          | 0.015       | 3.841       |
3.4. Clasper maturity level (CML) of dominant stingray (Batoidae)

Male stingray (Batoidae) has 3 levels of clasper maturity, namely Non-Calcification (NC), None-Full Calcification (NFC), and Full-Calcification (FC). Proportion results are obtained from calculating the total amount divided by the number of certain clasper maturity level phases. There were 19 male Taiwan guitarfish (R. schlegelii) (Figure 7.B) recorded with a percentage of NC by 79% (15 fish), NFC by 5% (1 fish), and FC by 16% (3 fish) (Figure 6). There were 18 males Bluespotted maskray (N. kuhlii) (Figure 7.A) with a percentage of NC by 72% (13 fish), NFC by 0% (0 fish), and FC by 28% (5 fish).

![Figure 6. Clasper maturity level (CML) of taiwan guitarfish (R. schlegelii) and bluespotted maskray (N. kuhlii) male during the study.](image)

![Figure 7. Clasper of bluespotted maskray (A) and Taiwan guitarfish (B).](image)

4. Discussion

The results of the analysis showed that the dominant species of stingray (Batoidea) landed at Prigi Archipelago fishing port during the study were Taiwan guitarfish (R. schlegelii) by 47.42% and bluespotted maskray (N. kuhlii) by 41.24%.

The results of the analysis of length-weight relationship obtained in this study showed a positive allometric growth pattern in taiwan guitarfish (R. schlegelii) with a b value of 3.469. This result means that the growth in body weight is more dominant than the growth in length. The isometric growth pattern is shown on the bluespotted maskray (N. kuhlii) with a b value of 2.984. This result means the increase in length corresponds to the increase in weight.

Analysis of the length-weight relationship can describe the adaptability of a species to its waters. A positive allometric growth pattern indicates that the species has been able to adapt to its ideal waters [11]. The positive allometric pattern is shown by the fish that are found in fairly calm waters, muddy substrate, and nutrition is well available so that the food eaten is well utilized [12]. The isometric growth pattern means the increase in length is proportional to the increase in weight. The isometric growth pattern is influenced by the characteristics of the water in supporting the availability of suitable food and habitat, thus affecting the growth, maturity of each individual and the success of his life.[13]. Fish growth is influenced by internal and external factors. Internal factors that influence fish growth include
heredity, sex, age, parasites, and disease. Meanwhile, the main external factors that influence fish growth are the availability of food and water temperature [14].

The sex ratio obtained in the results of taiwan guitarfish (R. schlegelii) and bluespotted maskray (N. kuhlii) was dominated by females. The sex ratio is known to see the condition of the fish population so that its sustainability is maintained. If the number of male and female fish is balanced, it is hoped that it can prevent extinction.

Sex ratio is closely related to fish habitat. The ideal habitat for spawning generally has a balanced number of male and female fish. If it is not balanced, at least the female fish is more dominant. If the number of males is more dominant, there is a risk of competition with other male fish to get a partner [15].

The maturity level of the clasper can show information about the condition of the fish which are in which clasper phase (immature, ripening, or ripe). In this study, it was found that the catch (dominant species) of rays (Batoidea) landed in the Prigi AFP was dominated by the level of immature/non-calcification (NC). For the purpose of resource sustainability, fish should be caught when the gonads are ripe so that the reproduction process continues. If most of the catch is still immature it can result in poor fish resource conditions in that area [16].

5. Conclusion
The dominant species of rays (Batoidea) landed at Prigi Archipelago fishing ports during the study were Taiwan guitarfish (R. schlegelii) and bluespotted maskray (N. kuhlii). The growth pattern during the study on the Taiwan guitarfish (R. schlegelii) was positive allometric, while the growth pattern in the bluespotted maskray (N. kuhlii) was isometric. The sex ratio during the study in Taiwan guitarfish (R. schlegelii) and bluespotted maskray (N. kuhlii) species was dominated by females. The clasper maturity level during the study on Taiwan guitarfish (R. schlegelii) and bluespotted maskray (.kuhlii) was dominated by immature/Non-Calcification (NC).

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