

UDC 574

**SIZE STRUCTURE, LENGTH-WEIGHT RELATIONSHIP, AND SEX RATIO  
OF SILKY SHARKS (*CARCHARHINUS FALCIFORMIS*, MÜLLER & HENLE, 1839)  
IN PRIGI WATERS, EAST JAVA, INDONESIA**

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**ABSTRACT**

Silky sharks (*Carcharhinus falciformis*) are one of the shark species found in Prigi waters, East Java. According to the International Union for Conservation of Nature (IUCN), silky sharks are included in the near threatened species. The purpose of this study was to determine the size structure, length-weight relationship, sex ratio, and level of gonadal maturity of silky sharks in Prigi waters, East Java. This research was conducted at Pelabuhan Perikanan Nusantara in Prigi, using descriptive methods. The data used were total length data and weight of *C. falciformis*. The study took samples of 30 individuals, consisting of 19 males and 21 females. The size of *C. falciformis* ranged from 61-189 cm. The longest male sharks were around 76-103 cm and the longest female sharks were 81-100 cm. The weight of *C. falciformis* ranged from 3.5 kg to 55 kg with an average of 8.5 kg. The length-weight relationship of *C. falciformis* resulted in an equation of  $y = 2.4087x - 9.0779$ . From this value, it can be concluded that the growth pattern has negative allometric where the growth of the body of the sharks is not balanced with their weight gain. The sex ratio between male and female is unbalanced, which is 0.45: 1.

**KEY WORDS**

*Carcharhinus falciformis*, length-weight, sex ratio, Prigi.

Sharks are members of the cartilaginous fish group in the *Chondrichthyes* class and *Elasmobranchii* subclass. Their biological characteristics include slow genital growth and maturity, low fecundity, long reproductive cycles, and long life spans (FAO, 2000; Castro *et al.*, 1999; Campagno, 1984; Last *et al.*, 1994). Some shark species of important economic value have nursery areas in shallow coastal waters. These factors cause shark resources to be very vulnerable to the pressure of over-exploitation.

Silky sharks (*Carcharhinus falciformis*) are members of the *Carcharhinidae* tribe, are abundant in number, and are spread in groups in tropical coastal waters (Campagno, 1984). Silky sharks or *C. falciformis* are commonly known as *lanjaman* or *hiu kejen* in Java, *hiu mungsing* in Bali, and *hiu kejen* or *hiu lonjor* in Lombok, West Nusa Tenggara (White *et al.*, 2006).

Input from several biological aspects is needed that the utilization of *C. falciformis* resources remains sustainable. This study aimed to analyze the size structure, the length-weight relationship, and the sex ratio of *C. falciformis* in Prigi waters, East Java. The results of this study are expected to be useful for the sustainable management of *C. falciformis*.

**METHODS OF RESEARCH**

The study took place at Pelabuhan Perikanan Nusantara Prigi, East Java (Figure 1) from July to October 2018. Measurements of the fork length were done using roll meters in centimeters, scales to measure the weight of sharks, stationary, and cameras. Visual observations were done to find out sex ratio. Sharks landed at Pelabuhan Perikanan Nusantara were identified and the enumerator officers assisted the process based on the characteristics found in the book "Economically Important Sharks and Rays Indonesia" (White *et al.*, 2006).

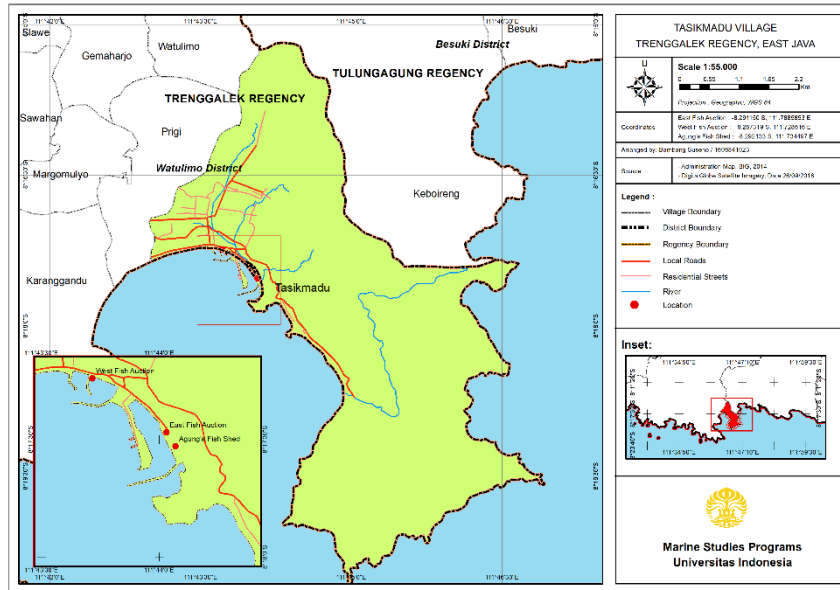


Figure 1 – Study Site

The length-weight relationship can be analyzed using the following formula:

$$W = aL^b \quad (1)$$

in which  $W$  represents weight (kg),  $L$  for length of fork (cm),  $a$  for intercept and  $b$  for slope. The linear form of the equation looks like the following:

$$\log W = \log a + b \log L \quad (2)$$

$b$  becomes an estimator on the relationship between length and weight with the following criteria:

- $b = 3$  shows an isometric growth pattern (weight gain is balanced by length increment);
- $b > 3$  shows a positive allometric growth pattern (weight gain is faster than length increment);
- $b < 3$  shows a negative allometric growth pattern (length increment is faster than weight gain).

The size structure of sharks was determined using the fork length data employing the following steps:

1. Determine the range of the class ( $J$ ) by the following formula:

$$\text{Range} = \text{the biggest data} - \text{the lowest data} \quad (3)$$

2. Calculate the number of class intervals ( $K$ ):

$$K = 1 + 3.3 \log n \quad (4)$$

3. Calculate the length of the class intervals ( $C$ ):

$$C = \frac{\text{Range}}{\text{The number of class intervals}} \dots\dots\dots (5)$$

4. Determine the median for each class interval;
5. Determine the frequency for each class interval;

- Sum the frequency and check whether the result is the same as the total length of the data.

Observation of the sex of sharks was carried out by observing the sexual differences in dimorphism, where there were visual differences between males and females. Sex determination was carried out based on the characteristics of a pair of claspers, i.e. the modification of the two pelvic of male sharks, which are used as copulation tools. Male sharks have a pair of clasper as a modification of the two shark pelvic fins and are located near the cloaca (Sentosa and Dimas, 2015). The sex ratio of sharks was analyzed using the formula:

$$P_j = \frac{A}{B} \times 100 \quad (6)$$

Where:  $P_j$  is the sex ratio (male and female), A is the number of sharks (male and female), B is the total number of individual fish samples. Next, by using the *Chi Square* test, a calculation on sex ratio is done:

$$X^2 = \sum_{i=1}^k \frac{(O_1 - E_i)^2}{E_i} \quad (7)$$

Where:  $X^2$  represents *Chi Square*,  $O_1$  represent the observed frequency, and  $E_1$  represents the expected frequency.

### RESULTS OF STUDY

The size of the captured silky sharks was in the interval of less than one meter to more than one meter. The shortest shark caught had a total length of 61 cm, while the longest had a total length of 189 cm. Female sharks had a total length of 61-162 cm (Figure 2) and for males was 76-189 cm (Figure 3).

From the results of the observations, the lowest length frequency of female silky sharks was between 61 cm to 80 cm and the highest was 161 cm to 180 cm. The number of sharks was dominated by young sharks with a size of 81-100 cm as many as 9 sharks, sharks with a size of 101-120 cm as many as 7 sharks, sharks with a size of 61-80 cm as many as 4 sharks, and sharks with a size of 161-180 cm as many as 1 shark. Dharmadi *et al.* (2007) write that the lowest length frequency female silky sharks are 51-60 cm and the highest is 241-250 cm.

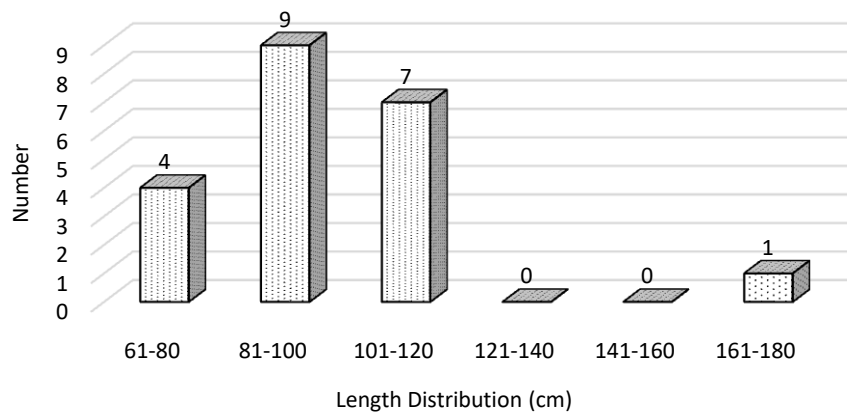


Figure 2 – The size frequency distribution of the female silky sharks

In male silky sharks, the lowest length frequency is 76 cm to 103 cm and the highest is 188 cm to 215 cm. The number of sharks with a size of 76-103 cm was 5 (the highest), sharks with a size of 104-131 cm was 3, and only 1 shark with a size of 188-215 cm.

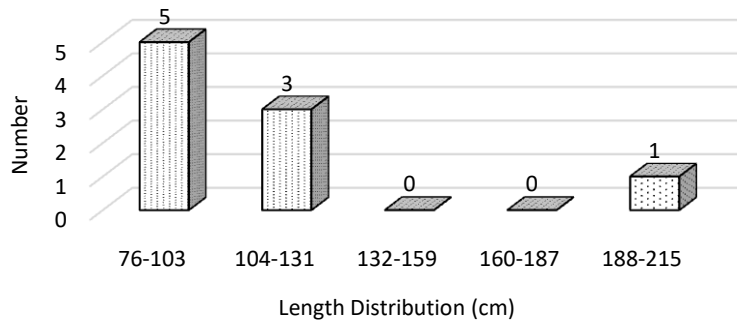


Figure 3 – The size frequency distribution of the male silky sharks

The observed silky sharks had a weight ranging from 3.5 kg to 55 kg (average 8.5 kg). The calculation of the growth pattern (length-weight) of silky sharks at the study site showed a slope value (b) of 2.4087. Thus, it can be concluded that the growth pattern is a negative allometric where the growth of the body is not balanced with weight gain. The regression results showed  $y = 2.4087x - 9.0779$  with a coefficient of determination ( $R^2$ ) of 89.88% (Figure 4).

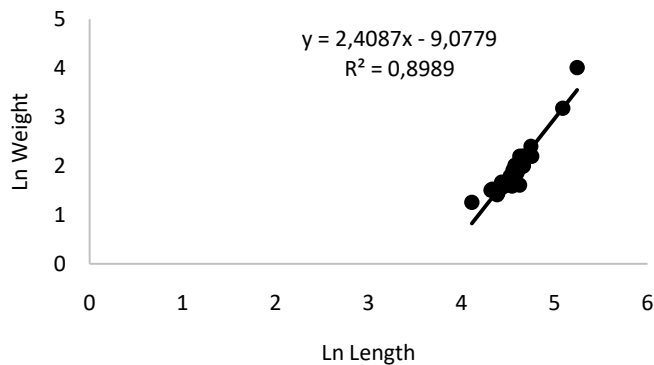


Figure 4 – The length-weight relationship of silky sharks

It is important to observe the balance of male and female fish populations in waters. The ideal ratio between the number of male and female fish is 1: 1, a situation that describes the number of male and female fish caught as relatively similar (Kune *et al.*, 2011). Purwanto *et al.* (1986) state that to maintain the population, the ratio between male and female fish is expected to be in a balanced condition.

The balanced condition is expected to prevent population extinction. The results of sex ratio calculation of male and female silky sharks obtained during the study were 0.45: 1. The  $X^2$  test obtained a value of 0.3201 ( $p > 0.05$ ), which means that the ratio of male and male is significantly different.

## DISCUSSION OF RESULTS

The type and grouping of sharks varies, seen from body shape and size. The body shape is elongated and it consists of three body parts, namely the head, body, and tail. The size of the body varies, ranging from the smallest (15 cm) such as pygmy sharks (*Squaliolus laticaudus*) to the largest size with the body reaching a dozen meters long like the whale

shark (*Rhyncodon typus*). In general, the morphological characteristics of silky sharks (*Carcharhinus falciformis*) are as follows: (1) the base of the first dorsal fin is behind the back end of the pectoral fin, (2) the inner side of the second dorsal fin is very long between 1.6 to 3.0 times the height of the fin, (3) a line exists between the dorsal fin, (4) the snout is rather long, round, and narrow (visible from the bottom), (4) the small upper teeth have curves on one side, and (5) the teeth are small, slender, and erect (White *et al.*, 2006, Fahmi and Dharmadi, 2013b).

The size of *C. falciformis* obtained ranged from 61-189 cm. The length class of 81-100 was the class with the highest number of catch of female *C. falciformis*, while the 161-180 cm size class was the lowest female catch class. The class of 76-103 cm was the class with the highest number of male catch, while 188-215 cm was the lowest male catch class.

Sanchez-de Ita *et al.* (2011) confirm that the length range of silky sharks caught on the west coast of Baja California Sur, Mexico is 88-260 cm. Ronquillo-Benitez (1999) and Chong-Robles (2006) have found that in southern Pacific waters of Mexico, the length range of silky sharks captured is 50-368.5 cm, with birth length between 70-87 cm (Compagno, 1984; Cadena-Cardenas, 2001). Chodriyah *et al.* (2017) reveal that the total length of silky sharks is between 65-300 cm (female) and 74-315 cm (male) in the southern waters of West Nusa Tenggara.

Many factors may cause the variety in length, such as water conditions (food availability, temperature, as well as physical and chemical factors) and biological factors (physiological factors, genetics, age, and sex) (Effendie, 1997; Fry and Milton, 2009; Restianingsih *et al.*, 2016). According to Sanchez-de *et al.* (2011), differences in the size range of sharks indicate the different fishing gear used by fishermen.

The results of the analysis on the length-weight relationship of *C. falciformis* showed an allometric negative growth pattern, meaning that length increment is faster than weight gain. Effendie (2002) states that if the value of *b* is less than three (3), then allometric growth is negative, which indicates that the fish is flat, or length increment is faster than weight gain.

Sexually dimorphic sharks have visual differences between males and females. The Ministry of Maritime Affairs and Fisheries (2014) reveals the testicular and clasper pelvic fins in male sharks are used for sperm delivery as a modification of the pelvis. The internal testis is located at the anterior end of the body in the epigonal organ cavity. The bladder and reproductive tract join together to form the urogenital sinus. Female sharks have internal ovaries located anteriorly in the body cavity and are paired. The left ovary is often in a lysis condition or has no eggs. Once the egg is released and is fertilized, a membrane or horny shell is released around the membrane when the egg passes through the gland.

## CONCLUSION

The catch of silky sharks has a total length range of 61-162 cm for female sharks and 76-189 cm for male sharks. The pattern of shark growth is negative allometric, where length increment is faster than weight gain is. The ratio of catch between male and female sharks is 0.45:1, indicating more female sharks than male sharks.

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