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The Biological Aspect of Mackerel Scad (*Decapterus Macarellus* Cuvier, 1833) In Samudera Hindia (West Sumatera Block)

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ABSTRACT

Mackerel scad (*Decapterus macarellus*) is one of the important economical caught in the Indian Ocean West Sumatra waters captured using purse seine. Increased production of mackerel scad will lead to increased exploitation, causing population changes. Therefore, research was carried out to find out the biological aspects of the fish so that resource management can be done. The sampling was conducted in Lampulo, Sibolga, and Air Bangis from February to November 2016 with total samples of 716 fishes. This research was conduct to study some biological aspects which consist of size distribution, length-weight relationship, sex ratio, gonad maturity level, the length at first capture, and length of the first maturity in Indian ocean west Sumatera waters. The results showed that the size of the mackerel scad had ranged between 16 - 33.6 cm FL and the average was 24.5 cm. Growth patterns are allometric negative, sex ratio male and female in an unbalanced condition. The mackerel scad is most caught by purse seine in maturity condition. The average length at first captured was 25.08 cm FL and length at first mature was 20.47 cm FL. These were an ideal biological condition and must be maintained because it provides an opportunity for fish to increase the population. The mesh size purse must follow the Ministry of Maritime Affairs and Fisheries Regulation Number 71/2016 that adjusted for minimum at 1 inch.

Keywords: Mackerel scad, Indian Ocean, Purse seine

ABSTRAK

Ikan layang biru (*Decapterus macarellus*) adalah salah satu hasil tangkapan ekonomi penting di perairan Samudra Hindia Sumatera Barat yang ditangkap menggunakan purse seine. Peningkatan produksi ikan layang biru akan menyebabkan peningkatan eksploitasi dan menyebabkan perubahan populasi. Oleh karena itu, penelitian dilakukan untuk mengetahui aspek biologis ikan sehingga pengelolaan sumber daya dapat dilakukan. Pengambilan sampel dilakukan di Lampulo, Sibolga, dan Air Bangis dari Februari hingga November 2016 dengan total sampel 716 ikan. Penelitian ini dilakukan untuk mempelajari beberapa aspek biologis yang terdiri dari distribusi ukuran, hubungan panjang-berat, rasio jenis kelamin, tingkat kematangan gonad, panjang pada tangkapan pertama, dan panjang jatuh tempo pertama di Perairan Samudera Hindia Barat Sumatera. Hasil penelitian menunjukkan bahwa ukuran panjang ikan layang biru dalam kisaran panjang antara 16 - 33,6 cm FL dan modus ukuran adalah 24,5 cm. Pola pertumbuhan allometrik negatif, rasio jenis kelamin jantan dan betina dalam kondisi tidak seimbang. Ikan layang biru paling banyak ditangkap oleh purse seine dalam kondisi matang gonad. Panjang rata-rata pertama kali tertangkap (Lc) adalah 25,08 cm FL dan panjang pertama matang gonad (Lm) adalah 20,47 cm FL. Hal ini adalah kondisi biologis yang ideal dan harus dipelihara karena memberikan peluang bagi ikan untuk meningkatkan populasi. Ukuran mata jaring purse seine harus mengikuti Peraturan Menteri Kelautan dan Perikanan Nomor 71/2016 yaitu minimum 1 inci.

Kata kunci: Ikan layang biru, Samudra Hindia, Purse seine

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1. Introduction

The Indian Ocean is fertile water and has the potential of pelagic fish and enter into fisheries management area 572. The main fishing gear of pelagic fisheries in this area was purse seine. the fishing ground of purse seine covering the waters of South Aceh, North Sumatera to the border with the waters of West Sumatra to the Mentawai Islands (Hariati, 2015).

Habitat mackerel scad widely found in deep seawater, its spread influenced by high salinity. The distribution of mackerel scad is throughout Indonesia's waters. In general, these fish caught throughout the year in Ambon waters, but the distributions of scad mackerel fish in Indonesia include the Java Sea, Strain of Makassar, Ambon, Ternate (East Indonesia) (Tiews et al., (2001) in Silooy et al., 2019). Whereas in western Indonesia one of them is in the Indian Ocean Mackerel scad (*Decapterus macarellus*) is the dominant species caught by purse seine in The Indian Ocean West Sumatra waters.

Zamroni and Suwarso (2017) state that the catch and index of abundance of this fish have increased from 2012 to 2013 by 1.3% or around 444 tons. Increased production is an indication of an increase in resource exploitation, if it occurs continuously will cause population decline. The occurrence of population changes can be seen from changes in fish biological characteristics such as changes in structure, sex ratio, gonad maturation level, and the relationship of body weight with body length. Ansyari & Herlan (2013) state research into changes in these biological aspects will form the basis of rational management.

The research of mackerel scad has been done the waters of in the eastern part of Indonesia (Zamroni, & Suwarso, 2011; Rahmadi, & Puspasari, 2015; Fadilal, et al., 2016; Widiyastuti & Zamroni, 2017; Pattikawa, et al., 2018; Widiyastuti, et al., 2020; Widiyastuti & Herlisman, to be published), while the research on biological mackerel scad, especially in the Indian Ocean West Sumatera waters has not been much performed (Hariati, 2005; Zamroni & Suwarso, 2018; Rumpa & Isman, 2018) especially about aspect biological. For this reason, this research is important and was conducted to study some biological aspects which consist of size distribution, growth pattern, sex ratio, gonad maturity, and the length at first capture (Lc) and the length at first maturity (Lm) mackerel scad (D. *macarellus*) in Indian ocean west Sumatera waters. This research was conducted to understand the biological aspect of mackerel scad as a consideration on arranging a proper management.

2. Materials and methods

2.1. Sampling site and data collections

Mackerel scad samples collected from the purse seine at Lampulo, Sibolga, and Air Bangis (Figure 1). The study was conducted from February to November 2016. The total sample of the mackerel scad collected 716 samples with the random sampling method (Figure 2). Mackerel scad samples carried out fork length (FL) measurements using measuring paper and body weight measured with a digital scale.

Then fish that have been measured fork length and weight will be dissected to observe the sex and maturity of the gonads. The observation of the gonads was conducted morphologically and was determined based on the modification of the Cassie classification (Effendie, 2002).

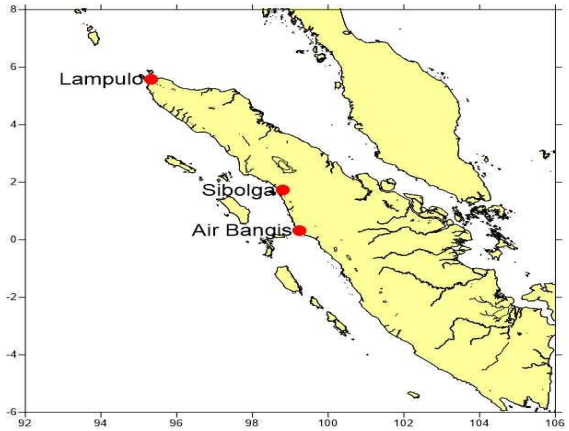

Figure 1. Map of study area

Figure 2. Mackerel Scad (*Decapterus macarellus*)

2.2. Data Analysis

The length structure of the fish fork tabulated by the frequency of fish numbers analyzed at each interval of the length class. Then analysis length-weight relationship using (Pauly, 1984) :

$W = a L^b$ .....(1)

Where:

W = weight (g);
L = Total length (cm);
a = intercept;
b = slope.

The interval value of slope (b) at p=0.05 was calculated according to (King, 2007):

b ± t x sb

Where: t = t table (p=0.05; df=n-2); sb = standard deviation of b

The sex ratio is analyzed by comparing the number of male and female fishes (Effendie, 2002).

X = M/F .....(2)

Where :

X = sex ratio,
M = number of males,
F = number of female.

Then the sex ratio was analyzed by the Chi-square test (Walpole, 1993) to find out the balance of male and female compositions.

The analysis of biological data includes distribution fork-length, the average length captured (L50% = Lc) and length at first mature (Lm), sex-ratio, length-weight relationships. The average length at first captured (Lc) was analyzed using the Kerstan equation (Kerstan, 1985):

$$Y\ (\%) = \left[\frac{100}{(1+a*e^{-b*x})}\right] \quad \text{.....(3)}$$

Where:

Y(%) = proportion held at each point of long class
a = intercept
b = Slope
e = exponential
x = length captured (L-50%)

The gonad maturity stage determined visually according to five point maturity scale for partial spawners refers to Holden & Raitt (1974). Stage I: virgin, immature; Stage II: development (maturing); Stage III: ripening; Stage IV: mature or ripe; and Stage V: spent.

The length at first mature (Lm) was allegedly by the Spearmean-Karber way as proposed by Udupa (Udupa, 1986) as follows:

$$m = xk + \frac{X}{2} - (X \sum pi) \quad \text{.....(4)}$$

Where:

m = Log length at first mature
xk = Log mid-class value where all fish (100%) Already ripe gonad
pi = Proportion of ripe fish in the first class where Pi = ri/ni when ni = ni + L
RI = the number of ripe fish in the length class to-I then the length of the fish at the time reaches the first maturity (M) is M = Antilog (M).

If the confidence level of 95% (A = 0.05) of (m) is used, then the range is an antilog (m ± 1.96 ∑ (x2 (Pi-qi/ni-1)).

3. Results and discussion

3.1. Distribution length

The length distribution of the study ranged from 16.0-33.6 cm FL (Figure 3). The highest mode is located at the mid-length value of 24.5 cm FL. The longest fish structure was found in October, while the fish size was shorter in August (Table 1). Even the size structure of this water tends to be longer than other waters (Table 2).

This difference in size structure can be caused by differences in the mesh size used and the fertility of the waters (Pane et al., 2020). These waters have high chlorophyll levels and phytoplankton as primary productivity (Merina et al., 2016). Sufficient food will support the growth of fish body length.

3.2. Length-weight relationship

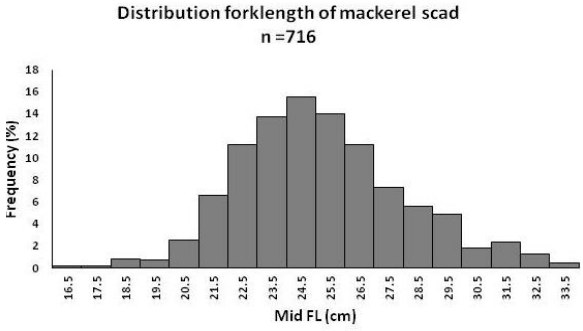

Figure 3. Distribution fork-length of mackarel scad

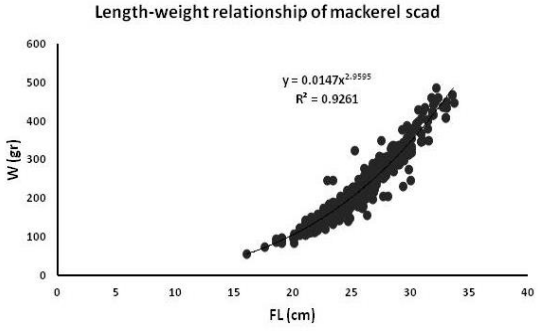

Figure 4. Length-weight relationship of mackerel scad

Table 1. Monthly length distribution of mackerel scad

Month		Fork Length (cmFL)			
	N	Min	Max	Average	Standard Deviation
Feb	63	21.0	30.0	25.51	1.69
Mar	92	16.0	29.0	22.29	1.90
Jun	111	20.0	29.0	24.29	1.54
Aug	42	20.8	29.8	25.58	2.38
Oct	238	18.5	33.6	26.72	3.24
Nov	170	21.2	32.1	25.70	2.01

Table 2. Prevoius research results

Reference	Waters	FL (cm)
Fadilal et al., 2016	Banda Sea	11.4 – 29.5
Widiyastuti & Zamroni, 2017	Tomini Bay	17.25 – 30.25
Pattikawa et al., 2017	Ambon	11 - 24.5
Widiyastuti et al., 2020	Ambon	10.5 – 29.5
Widiyastuti & Herlisman, to be published	Kendari	17.5 – 30.5
This study	Indian ocean of Western Sumatera	16 – 33.6

The length-weight relationship of the mackerel scad resulted in the value of b was 2.959, this indicates a negative allometric growth pattern where a regression coefficient value (b) is less than 3 (b < 3) (Figures 4). It is meanings that fish grow faster in length than the bodyweight gain.

The same results were obtained by mackerel scad growth patterns in the North Maluku waters. The males and females of mackerel scad each have a value of b = 2.285 and b = 2.981 (Iksan & Irham, 2009). Unlike the growth patterns of mackerel scad in the waters of Ambon, isometric, and positive allometric (Pattikawa et al., 2018). The difference in the value of b obtained will certainly cause the difference of length-weight relationship pattern. Differences are suspected due to the influence of food availability, spawning time, as well as fishing pressure. In line with Zahid % Simanjuntak (2009) that differences in growth patterns influenced by season, Habitat, gonad maturity, sex, food, gastric fullness, health, preservation techniques, and annual variation on environmental conditions.

3.3. Sex ratio and Gonad maturity level

Based on observations from dissected fish, it found the fish grows faster in length than the body-weight gain sex composition obtained consisted of 388 males and 322 females (Figure 5). The results of the sex ratio of male and female mackerel scad have obtained 1.2:1. The results of the chi-square test obtained that the mackerel scad was no significant difference between males and females of the population in unbalanced conditions.

The sex ratio of mackerel scad that dominant males more than females were also found in the Banda Sea with a ratio of 1.06:1 and at the Flores Sea 1.06:1 (Siby et al., 2019) at Tomini Bay 1.06:1 (Widiyastuti & Zamroni, 2017) and in the Kendari waters 1.3:1 (Fadilal et al., 2016), in Majene 0.98:1 (Nur et al., 2017). This unbalanced condition between males and females is an indication that the balance of the

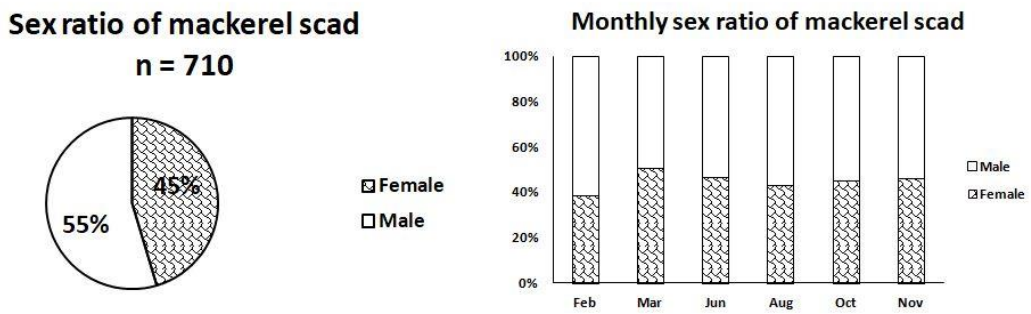

Figure 5. Sex ratio of mackerel scad

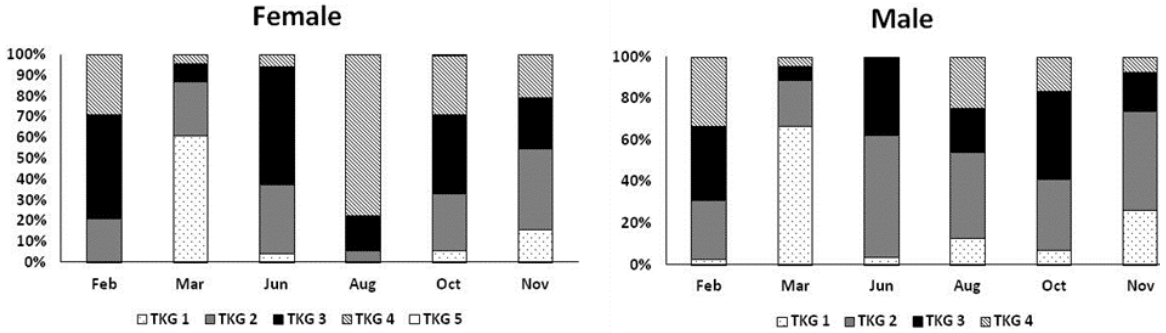

Figure 6. The gonad maturity stage of mackerel scad female and male

population can be disturbed. Ball & Rao (1984) states that the balance of male and female fish is needed to maintain survival in a population or dominant female fish.

The gonad maturity level is the specific stages of the development of gonads before and after the fish spawned (Effendie, 2002). Immature fish identified had levels 1 and 2, while mature fish have levels 3, 4, and 5. Mackerel scad in the Indian Ocean West Sumatera waters caught by purse seine was found mostly in the maturity conditions of male and female.

The gonad maturity level varies every month (Figure 6). The female mackerel scad began to be found in the mature level in June and reached its peak in October, the same condition found in the male fish. The maturity condition of gonads mackerel scad in Tomini Bay is widely found in August of males and females (Widiyastuti & Zamroni, 2017), in the Banda Sea in October and December (Siloy et al., 2019). The difference in results of the maturity of mackerel scad gonads obtained from research in North Maluku waters. Mackerel scad found in mature gonads in March (Iksan & Irham, 2009) and the waters of Kendari found in April - May (Widiyastuti & Herlisman, to be published). This condition shows the alleged spawning of mackerel scad as the result of the research Suwarso & Hariati (1988) mentions the spawn of long-lasting and partial spawn based on a variation of gonad somatic index according to the size and gonad maturity level.

3.4. The length at first capture (Lc) and length at first mature (Lm)

The relationship between the average length at first capture and the first time ripe gonads can indicate the condition of sustainable or not a resource, by knowing whether the average length of the fish has been spawning or not yet (Saputra et al., 2009). The importance of the first-time measurement of mature gonads can periodically become an indicator of pressure on the population (Siby et al., 2009).

The length at first capture (Lc) mackerel scad is 25.08 cm (Figure 7), while the length at first mature (Lm) is 20.47 cm. This condition indicates that the fish has experienced gonad maturity before being capture (Lc> Lm). It means that fish have reached adult size and have contributed to the increase in population. Saranga et al., (2019) states that the condition of one indicator is that the exploitation of fisheries is in ideal condition if the value of Lc> Lm because if otherwise, it becomes an indicator if the fishing pressure has affected the growth of fish stocks.

The length at first mature (Lm) of mackerel scad was found in different conditions with the results of this study (Asyari & Herlan, 2013; Pattikawa et al., 2018; Widiyastuti et al., 2020). The variation of Lm value is also found in some

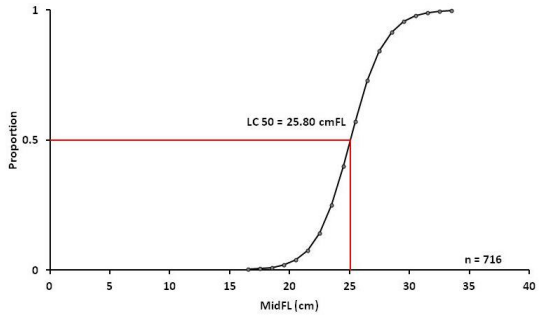

Figure 7. Length at first capture of mackarel scad

waters as in Makassar Strait Lm = 25.12 cm FL, in Banda Sea Lm = 25.45 cm FL, and Flores sea Lm = 25.86 cm FL (Fauzi et al., 2012). Previous research indicates that there is a different habitat environment that will affect the difference of (Lm). Added by Agustina et al., (2015) these differences are also influenced by sex, food, hormones, and the environment. The length at first mature (Lm) not always the same size although the size structure of the fish is the same length class (Udupa, 1986).

Analysis of the length of the caught fish and the size of the mature gonad fish are the basis that the condition of mackerel scad fish resources in these waters is still kind because as many fish have contributed to the environment. However, management must be needed to maintain the preservation of resources by applying the rules of using mesh size purse seine by 1 inch by Minister of Maritime Affairs and Fisheries Regulation 71 of 2016. The socialization and supervision on the size of these nets must be by involving various stakeholders including fishermen organizations to jointly maintain the sustainability of mackerel scad fish resources in the waters of the Western Indian Ocean in Sumatra.

4. Conclusion

The length distribution of the study ranged from 16.0-33.6 cmFL. Most Mackerel scads are caught by purse seine in mature size. The length at first capture is greater than the length at first mature which is an ideal biological condition for the availability of mackerel scad stock. The Mesh size of purse seine suggests being adjust following the rule 1 inch.

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