Biological characteristics of silver sillago (*Sillago sihama* Forsskal) in Bombana Water, South East Sulawesi

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**Abstract.** Silver Sillago is a demersal fish belong to family Sillaginidae. Sampling site held in district Bombana and conducted since April-November 2018. This research aimed to analyse some aspects regarding of its species. Some aspects are concerned in this observation, e.g., length-weight, sex composition, fecundity rate, length at first capture and length at first maturity, growth, mortality rate and utility rate. These sample were obtained from fisher using trawl. Number sample were observed 5242 specimens with fork length (FL) between 6.16-28.9 cm and average of fork length around 18.13 cm. Growth pattern this species in this area is isometric, while growth of length equal with its weight. Length at first captured is 17.96 cm in fork length measurement. Also, length at first maturity is 22.66 cm. This condition show that this species cannot sustain and maintain stock equilibrium in this area due to they were captured in immature. Peak Season for spawning period of Silver sillago in this area being predicted in August. Natural Mortality (M) is 1.35, Mortality by capture is 1.45, total mortality is 2.80 while utility rate is 0.52.

1. Introduction

Silver sillago is demersal fish and belong to family sillaginidae, mostly captured by trawl. Species were capture by trawl mainly demersal fish i.e, ponyfish, goatfish, grouper, shark, ray, octopus, lizardfish and various shrimp [1]. Although this species has an economic value, since year 2000, utilization of this species usually in fresh, fillet and raw material for snacks.

Silver sillago in Indonesia distribute almost in the region of sumatera, Java, Borneo, Bali, Nusa Tenggara, Celebes, Mollucas and Papua. In Indonesia well known seven species of Sillago i.e. *S. sihama*, *S. macrolepis*, *S. maculate*, *S. chondropus*, *S. nierstraszi*, *S. burrus*, and *S. Aelous*. *Sillago sihama* live in habitat and wide spread distribution. Silver silago spread in area Africa, Asia, Australia and Micronesia [2]. Sillaginidae are commonly known as lady fish and/ or sand whitings. Eight species of lady fish/ whitings are reported from India, viz *Sillago sihama*, *S. vincenti*, *S. parvisquamis*, *S. macroolepis*, *S. argentifasciata*, *S. maculate*, *S. chandropus* and *S. panijus* [1, 2]. Of these, the Indian sand whiting, *S. sihama* occurs commonly in the coastal waters of Ratnagiri. It is one of the highly priced fishes in coastal region of Maharashtra [3]. Family sillaginidae is small to moderate-sized fishes and primarily inhabit inshore waters with the sandy substrate or estuarine areas of rivers [4]. Geographically the family in widely distributed throughout the Indian and pacific ocean [5]. Family Sillaginidae currently comprises in 34 spesies [6] in the genera [7-9] and three sub genera [7] of the genus sillago [8, 10]

Previously, study regarding of biological of silver sillago had been done by some scientist, but this paper aim to cover the recent data and information i.e length frequency distribution, length-weight, sex
determination, fecundity rate, length at first capture and length at first maturity, growth, mortality rate and utility rate and spawning season in bombana waters.

2. Methodology

2.1. Data Collection
Specimens of sample from trawl were obtain in landing place of Bombana by enumerator within period April-November 2018. Length measurement by accuracy 0.1 cm and weight of specimens by accuracy 1.0 gram. Sample of gonad were visualized and observed to find out maturity rate which is refer to Holden and Raitt [11].

Figure 1. Silver sillago (Sillago sihama) (Source of personal documents)

2.2. Length Distribution
Tabulation of length distribution were solved by calculate length average and percentage of frequency from each length average during one-year observation.

2.3. Length Weight Relationship
Length weight relationship is refer to Effendie [12] with equation:

\[ W = aL^b \]

While : \( W \) = Weight; \( L \) = Length; \( a \) = Intercept (the point where curve length weight crosses y-axis); \( b \) = Slope; To examine \( b=3 \) or \( b\neq3 \) with t-test (partial test); \( H_0 : b=3 \), length weight relationship is isometric; \( H_1 : b \neq 3 \), length weight relationship is allometric; Length weight relationship is allometric positive if \( b>3 \) (weight gain growth is faster than length growth) and allometric negative if \( b<3 \) (length gain growth is faster than weight growth).

2.4. Assessment for length at the first capture (Lc) and first sexual maturity (Lm)
Assessment for length at first capture was solved by making relationship graph between length (axis) and number of specimen (ordinate) to generate sigmoid curve. Lc value is 50% was expressed:

\[
\frac{S}{L est} = \frac{1}{1 + \exp\left(\frac{S1 - S2 + L}{S1 - S2}\right)}
\]

\[ L_{50\%} = \frac{S1}{S2} \]

Where: SL = logistic curve; \( S1 = a \); \( S2 = b \); S1 and S2 = Constant value
Assessment length at first maturity was solved by following procedure from Udupa [13] using formula :

\[ m = Xk + X/2 - (X\sum Pi) \]

Where : \( m \) = log at first maturity; \( Xk \) = log at 100% maturity; \( X \) = log size increment; \( Pi \) = distribution fish maturity at group 1; Average length at first ovary maturity was obtain from antilog (m)

2.5. Sex Determination
Sex determination was examined by comparing number of male and female using chi-square test [14]. This can be expressed as :

\[ X^2 = \sum_{i=1}^{k} \frac{(Oi - ei)^2}{ei} \]

Where : \( Oi \) = frequency both male and female; \( ei \) = number of male and female expectation 1; \( k \) = Group on observation for male and female
2.6. Maturity Stage
Maturity stage were visually observed to ensure gonad morphology change. Maturity stage was referred by Holden and Raitt [11] and consists of 5 scale i.e, I (immature), II (Developing), III (imminent spawning), IV (spawning and post-spawning) and V (spent).

2.7. Population Dynamics
Group of age determination was conduct by length frequency analysis using FISAT II to determine its normal distribution.

3. Results and Discussions

3.1. Length Weight Relationship
Analysys of length weight measurement as a key to discover relationship in fisheries resources management [15,16], measurement of length weight aims to know variability of weight and length individually and in a group, so as can be used as a clue related rate of fat, healthy, productivity, physiological and gonad development. In Bombana water, by t-test on parameter b with confidential interval 95% (α=0,05), were obtained t_value < t_table.

![Figure 2. Length weight relationship in bombana water, 2018](image)

3.2. Length Distribution
Length distribution in Bombana on April to November 2018 about 5,242 specimens. Length distribution showed normal distribution and mode of length were fluctuated each month. On the particular month were obtain only one peak mode, whereas on the others month occurred two or three peak modes. Length distribution of silver sillago about 10.5 and 29.5 cm fork length and average length is 18.5 cm (figure 3). Size of silver sillago in Bombana water is larger than sulistiono [17] research in mayangan, subang where about 6.5 – 23.4 cm fork length.

![Figure 3. Length distribution of silver sillago in Bombana, 2018](image)
| No | Location                                      | FL (cm) | References                          |
|----|----------------------------------------------|---------|-------------------------------------|
| 1  | Northern Arabian Sea Coast                   | 11-22   | S. K. Panhwar et al. 2016           |
| 2  | Indian Waters/Indian sand whiting            | 15.5 - 16.4 | Ebtisam FS and Zakir A A, 2009    |
| 3  | Perairan Mayangan, Subang Jawa Barat         | 6.5 - 23.4 | Sulistiono 2011                    |
| 4  | Karwar waters                                | 11-34   | C. R. Reddy and B. Neelakantan, 1992|
| 5  | Perairan Bombana, Sulawesi Tenggara         | 10.5 - 29.5 | Nurainun et al. 2020              |

### 3.3. Sex Determination

Sex determination is the variable of life history and milestones to measure population healthiness in the water [18]. This variable was used to compare population of female and male in the water. By knowing sex determination can be assessed population equilibrium, the assumption, number male and female in the water is 1 : 1. Effendi [19] noticed that comparison between male and female in equilibrium will generate a big chance for spawning. Statistic test and assumption that one male to one female in balance, but not all fishes has comparison 1 : 1 in equilibrium. In fact, sex ration is not absolute in nature life, as its happen in Bombana. This situation is influenced by food availability, population density, and food chain steadiness.

#### Table 1. Range of length silver sillago in various area

| No | Location                                      | FL (cm) | References                          |
|----|----------------------------------------------|---------|-------------------------------------|
| 1  | Northern Arabian Sea Coast                   | 11-22   | S. K. Panhwar et al. 2016           |
| 2  | Indian Waters/Indian sand whiting            | 15.5 - 16.4 | Ebtisam FS and Zakir A A, 2009    |
| 3  | Perairan Mayangan, Subang Jawa Barat         | 6.5 - 23.4 | Sulistiono 2011                    |
| 4  | Karwar waters                                | 11-34   | C. R. Reddy and B. Neelakantan, 1992|
| 5  | Perairan Bombana, Sulawesi Tenggara         | 10.5 - 29.5 | Nurainun et al. 2020              |

### 3.4. Maturity Stages

Maturity stage composition of silver sillago is stage IV (spawning & post spawning) occurred in September and November 2018 about 25,0% and 32,30% respectively. Based on the observation, gonad indices of female about 0.73 and 3.48. The lowest gonad indices occurred in April and the highest on August. The more mature of gonad, the closer to spawning and gonad indices will be increase. Generally, female indices bigger than male indices even though have same maturity stages (figure 4). Observation in Mayangan Central java water show the spawning season take place in December [17].

### 3.5. Average first length at capture (Lc) and average length at first maturity (Lm)
Average first length at capture (Lc) of silver sillago is 17.96 cm fork length shorter from average length at first maturity (Lm) of 22.66 cm fork length. If value $Lc < Lm$ show that, silver sillago unable to recruit due to smaller fish were captured. Sustainability of fish stock will be disturbed if this situation take place continuously. Saputra et al. [20] and Widodo and Suadi [21] describe regarding biologically overfishing can be divided into growth overfishing and recruitment overfishing. Growth overfishing occurred where harvesting were dominated small fish in growth size. On the other hand, recruitment overfishing happened while harvesting were dominated by spawning stock or adult fish in maturity stage. Allen et al [22] noticed that recruitment overfishing more severe situation than growth overfishing.

3.6. Growth Parameter

Based on Von Bertalanffy growth model were obtained growth coefficient ($K$) amount 0.64 year$^{-1}$. Asymptotic ($L_\infty$), 30.8 while maximum samples were observed is 28.99 show that the maximum measurement length of fish were not captured. Theoretical age while length equal to zero ($t_0$) is 0.0993 years, consequently mathematical term for growth of silver sillago from Banda sea and landed in Bombana $L_t = 30.8 \left(1 - e^{0.64(t-0.0993)}\right)$. This is in accordance with a statement [23] that fish having the coefficients growth low will need a long time to reaches a length of asymptotnya and fish in that it has value growth high took quick to reaches a length of asymptot. Every waters have traits that different in structure geographical, season, and cycle water, hence an organism that lives in it will have the shape and size of different fishes (figure 6).

![Figure 4](image4.png)

**Figure 4.** Maturity Stage and Gonad Maturity Index Siver sillago (S. sihama) in Bombana, 2018.

![Figure 5](image5.png)

**Figure 5.** Average First length at at capture (Lc) and average length at first maturity (Lm) silver silago in Bombana, 2018

![Figure 6](image6.png)

**Figure 6.** Von Bertalanffy growth curve of silver sillago in Bombana 2018
3.7. Mortality Rate and Utility Rate

Natural mortality (M) of Silver Sillago in temperature 29°C from Banda sea is 1.35 year⁻¹, fishing mortality (F) 1.45 year⁻¹ and total mortality (Z) 2.80 year⁻¹, exploitation rate (E) is 0.52. Based on this result, silver sillago has exploitation rate more than 0.5 (figure 7). It shows that silver sillago have over exploitation and if this sustain for a long time would interfere stock availability. It is need further management for sustainable resources in the future.

Figure 7. Mortality graph of silver sillago

4. Conclusions

Length of silver sillago in Bombana water varied from 10.5 – 29.5 cm fork length. Sex determination in the observation between male and female is 0.69:1. Spawning peak period occurred in August, first capture on 17.96 cm fork length and first maturity in 22.66 cm FL. Actually, some measurement show that fish harvested are immature with consequences of stock depletion in the habitat. By exercising regarding silver sillago growth, note that there were specimen with longer measurement not caught yet. Utility level in Bombana is over exploitation and for caring its sustainability, management this species begins with restriction or displacement of fishing ground at peak spawning season on August.

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