Some biology aspects of Indian Scad (*Decapterus russelli*, Rupell, 1928) in Pemangkat Fisheries Port, West Kalimantan

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Abstract. Indian Scad (*Decapterus russelli*, Rupell, 1928) is one of small pelagic fish that have important values in the south of China Sea. The objective of the study was to investigate some biology aspects of Indian scad caught by purse seine in the south of China Sea. The research was conducted from March to August 2014. This study used 395 fish samples with size between 14.1-21.9 cmFL (average 18.9 cmFL) and the sex ratio between female and male was 1:1.09. The growth patterns of Indian scad for male and female were positive allometric expressed by the following equation: \( W = 0.0093L^{3.1309} \) (R²=0.8719) for male and \( W = 0.0094L^{3.1359} \) (R²=0.8576) for female. The condition factors were about 0.25-6.22. Indian scads observed ranged between Maturity stage I and maturity stage V with GI for male and female were 0.056–6.36 % and 0.09 – 6.35 %, respectively. The Von Bertalanffy Growth Equation of Indian scad in the South of China Sea was \( L_t = 23.60 (1 - e^{-0.6(t+0.2789)}) \) with the length of infinity (\( L_{\infty} \)) =23.60 cmFL, coefficient of growth (K) = 0.6 year-1 and the theoretical age (\( t_0 \)) Indian scad that was equal to (\( t_0 \)) = -0.2789.

1. Introduction

The South China Sea is classified as shallow water with a depth of less than 200 m. The South China Sea is prominent in fisheries production in the world which reaches 10% -12%, and high diversity areas [1][2]. The results of an acoustic survey showed that the pelagic fish stocks in the Natuna and Anambas (the northern part of South China Sea) were 150 thousand tons and 183 thousand tons, respectively [3] Fisheries Resources in the South China Sea is a very substantial contribution for local, regional and international levels for food and income sources.

The exploitation of pelagic fish resources in the South China Sea Indonesia region has been continuously for a long time, especially by purse seine fleets based in Pemangkat, Palembang and the Riau Islands, and Java (Pekalongan, Juwana). Fishing activities by Java purse seine takes place between April and August. Dominant catches from purse seine were Indian Scad (*Decapterus russelli* and *Decapterus macrosoma*) was 67.3%, Indian Mackerel (*Rastrelliger kanagurta*) was 6.1, Spotted Sardinella (*Amblygaster sirm*) was 6.5%, Bigeye Scad (*Selar crumenophthalmus*) was 3.6% and Sardinella was 5.4% [4] The purse seine catches in Pemangkat were dominated by Indian Scad and Bigeye Scad. During a period of 4 years (2012-2015) the dominance species was caught by purse seine always the same as *Decapterus russelli*, *D. macrosoma* and, *Selar crumenophthalmus* [5].

Indian scad (*Decapterus russelli*, Rupell, 1928) is one of member from Carangidae family that have important economic values. Carangidae family are pelagic fishes that is widespread in Indo-Pacific area. About 32 genera and 140 species of carangids have been reported world over. Carangid resources stock assessment of from Mapur waters and Sunda strait were reported by [6] [7]. The biology of the species
was studied from Sibolga Bay waters [8], from Malacca strait[9], from North Moluccas waters [10] and from South China sea [11].

From several publications, it was found that study about *Decapterus russelli* is still lacking in Pemangkat Fisheries Port, especially study about biology aspects it species. That study is important for the management of *D. russelli* fisheries. The present study head to determine the biology aspect and growth parameter of *Decapterus russelli* in the Pemangkat Fishing Port.

2. Materials and methods

The data on length, weight, gonad and sex were collected during March to August 2014 from the purse seine landings at Pemangkat Fisheries Port (Figure 1). The number of sample was 395 fishes. Fork length of fish was measured by using measured board, then weight of fishes weight using a portable digital balance to the nearest gram.

![Figure 1. Map of fishing areas.](image)

2.1. Length - weight relationship

Relationship of Length and Weight are calculated by mathematical formula as follow [12]:

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

where W is weight (g), L is fish length (cm), a is body form coefficient and b is an exponent of growth pattern. In order to justify whether b values obtained from cubic relationship were different significantly from isometric (b=3) is evaluated by the student t-test. Where the t-test value is higher than t table then b ≠ 3 or allometric. Meanwhile when t-test value is smaller than t table then b = 3 or isometric.

2.2. Sex ratio

Sex ratio between female and male was analyses using the Chi-Square test \(X^2\) to find out whether there was any dominance of either sex using following formula:

\[
X^2 = \frac{(O_M - E)^2}{E} + \frac{(O_F - E)^2}{E}
\]

where: \(O_M\) and \(O_F\) = observed number of male and female ; and \(E = \) Expected value, \(E = n/2\)
2.3. Maturity stage
Maturity stages were detected through a morphological investigation of the gonads by visual. Gonadosomatic index (GSI) was analysed using formula:

\[
GSI = \frac{Wg}{W} \times 100 \%
\]

Where:
GSI = Gonadosomatic Index; 
Wg = Gonado weight (g) 
W = Fish Weight (g) [13]

2.4. Growth parameters
Length of infinity (\(L_\infty\)) and growth constant (K) were obtained from length frequency distribution data and that was analyzed using ELEFAN-I. The growth coefficient of \(D.\) russelli was approximated by Von Bertalanffy growth function (VBGF). The growth equation was designed by [14] as:

\[
L_t = L_\infty (1 - e^{-K(t - t_0)})
\]

Wherein
\(L_t\) = length at the predicted time \(t\) (year) 
\(L_\infty\) = length of infinity (cm) 
K = growth coefficient 
\(t_0\) = the hypothetical age or time where length =0 
\(t_0\) value is predicted by the empirical formula by [15] as:

\[
\log_{10}(-t_0) = -0.3922 - 0.275 \log_{10}L_\infty - 1.038 \log_{10}K
\]

3. Results and discussion
3.1. Length frequency
Based on analyze, length frequency of Indian scad was caught by purse seine in the South China sea was distributed between 14.5-22.5 cmFL. Length of Indian scad for male was distributed between 14.1-21.6 cmFL (modus 18.5 cmFL) and between 14.4-21.9 cmFL with modus of 19.2 cmFL for female (Figure 2). This size is smaller than indian scad in Latuhalat, Ambon waters where Indian scad male was between 7.5-23.5 cm and 7.5-28.6 cm for female [16].

![Figure 2. Length frequency of Indian scads female in the Pemangkat Fishing Port.](image-url)
3.2. Length -weight relationship

Total number of 395 fishes in the range size between 14.1-21.9 cm FL and 33.4-170.8 g weight were used for establishing the relationship of length-weight. The relationship assigned equations were:

- Female: \( W = -0.0094 \times L^{3.1359}, R^2 = 0.8576 \) (Figure 3).
- Male: \( W = -0.0093 \times L^{3.1309}, R^2 = 0.8719 \) (Figure 4)
- Combined sex: \( W = -0.0084 \times L^{3.1675}, R^2 = 0.8694 \) (Figure 5)

Based on the regression equation, the b values of *D. russelli* obtained ranged from 3.1309 to 3.1675 and \( R^2 \) was about 85.76% to 87.19%. Overall, the b values shows > 3 or positive allometric growth pattern, it means that weight increase is faster than length increase. This pattern was similar with Indian scad in the Sunda strait [7], in Malar waters [17], in Kakinada waters [18]. However, the growth pattern in this study was different from Indian scad in the north south of Sumenep waters [19] and in the Sunda strait [20] that was negative allometric growth pattern. According to [21] prey behaviour, food availability and waters condition were various factors influenced shape of body fish.

**Figure 3.** Relationship of Length and Weight of Indian scads female in Pemangkat Fishing Port.

**Figure 4.** Relationship of Length and Weight of Indian scads male in Pemangkat Fishing Port.
3.3. Condition factor
The monthly factor of condition of Indian scad during the study ranged between 1.31 to 1.82 (Figure 6). Figure 1 shows that the highest value of the condition factor was in August of 1.82 and the lowest was in July of 1.31. According to [22], factor of condition was a quantitative parameter that represents condition of fish (fitness, maturity and spawning gonadal development and general welfare of the fish) and determines present and future population success by influencing growth, reproduction, and survival. Beside of that, condition factor represents the population’s condition through the various levels of the life cycle. The condition factor was decreases normally when early of spawning season due to metabolic rates was very high [23]. Because of that, the highest of condition factor in August is supposed that some fishes have reached gonad maturity.

3.4. The growth parameter
The results of growth parameters for Indian scads using the ELEFAN I method shown in Figure 7. The length asymptotic parameter (L∞) =23.60 cm, values of growth coefficient (K) =0.6 year-1 and t0 = -0.2789, therefore Von Bertalanffy equation was Lt = 23.60 (1 - e ^ (0.6(t + 0.2789))). From [19] estimated L∞ as 25 cm, K as 0.58, and t0 as -0.29 year^-1 for D. russelli from Sumenep waters. [24] L∞ as 23.18 cm, K as 0.6, and t0 as -0.16 year^-1 for D. russelli from Karnataka waters [18] determined the L∞, K and t0 values as 232.3 mm, 1.08 year^-1 and -0.08 year^-1 for D. russelli in Kakinada. [25] Estimated varying L∞
The present study is similar with parameters of growth from Sumenep and Karnataka waters. According to [26], the difference in the \( L_{\infty} \) values for the species from different regions may be due to differences in size structure at different localities caused by differences in the environmental parameters, the type of fishing gears used and methodology adopted for the study of growth parameters.

![Growth curve of Indian Scad in the South China Sea.](image)

**Figure 7.** Growth curve of Indian Scad in the South China Sea.

3.5. Sex ratio

According to [27], basic information to estimate reproductive and size potential in fish populations are sex ratio and size structure. The sex ratio between male and female in this study was 1.09:1.00 or 52%: 48% (Figure 8). The Chi-square values at 5% probability level during the study period showed that there was not remarkable difference which indicates that the sex ratio was balance.

The similar sex ratio of 1:1 for Indian scad was also found by several other studies such as [16] in Ambon Island, [28] in Ambon Bay and [29] in Tegal Waters and in the Makassar Strait. Sex ratio male to female from D. ruselli in the Mangaluru coast was 1:0.51 [30]. [31] added that sex ratio of D. ruselli varied from 1:0.43 in 140-149 mm length group to 1:1 in 110-119 mm length group. [32], stated that sex ratio 1:1 was an ideal condition because both sexes are equally active so they have the same chance to be caught. In addition, the same sex ratio is ideal for reproduction because it allows one male to fertilize one female fish. According to [33] sexual ratio deviations from the 1:1 pattern can arise from a variety of factors including differences in fish distribution, activity and movement.

![Sex Ratio of Indian Saed in the South of China Sea.](image)

**Figure 8.** Sex Ratio of Indian Scad in the South of China Sea.
3.6. Maturity stage
The Indian Scads Maturity Stage I for male was mostly found in May. Maturity stage II was mostly found in April, Maturity stage III was mostly found in May and stage IV was mostly found in March (Figure 9). For female, the maturity stage IV was mostly found in June, maturity stage V mostly found in May, stage III in April, stage II in August and stage I in July. Maturity stage IV was mostly found in June suggest that Indian Scads starts to spawn (Figure 10).

3.7. Gonadosomatic index
The monthly gonadal somatic index (GSI) of Indian scads are represented in Figure 11. The lowest GSI of Indian scads occurred in July and the highest was in June. That means, the spawning season for Indian scads probably occur in June. This season similar with the spawning season for Indian scads in Maharashtra waters was occur between December to March and June to October. Gonadal Somatic index is needed as a measure of activity that occurs in the gonad. The female fish have GSI value relatively higher than male [32].

Figure 9. Monthly maturity stage of Indian scad male in the South China Sea.

Figure 10. Monthly maturity stage of Indian scads female in the South China Sea.

Figure 11. Monthly gonadal somatic index (GSI) of Indian scads.
Figure 11. Monthly gonadal somatic index of Indian scads in the Pemangkat Fishing Port.

4. Conclusion
This research supplied fundamental information on the biological aspect and population parameter of *D. russelli* that could be useful for sustainable fishery management in the Pemangkat Fishing Port. In this study, the growth pattern of Indian scad was negative allometric. The parameters of growth for Indian scad were $L_\infty = 23.60$ cm, $K = 0.6$, and $t_0 = -0.2789$ year$^{-1}$ with Von Bertalanffy equation was $L_t = 23.60 \left(1 - e^{0.6(t+0.2789)}\right)$. The highest condition factor was in August and the spawning season of Indian scad in the South of China scad probably occurred in June.

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