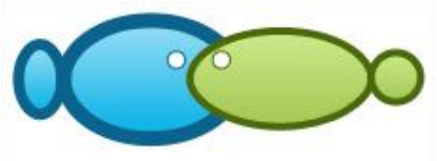

# Size distribution, length-weight relationship and age group of *Decapterus macrosoma* in eastern waters of Ambon Island, Indonesia

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**Abstract**. Research to study size distribution, length-weight relationship and age group of *Decapterus macrosoma* was conducted in the surrounding waters of Waai village, eastern Ambon Island, Indonesia. Fish samples were collected from purse seine fishers at the village and then brought to the laboratory for measurements. A total of 1,018 specimens were collected during the study period of May 2016 to February 2017. Fish length ranging from 13.3 to 31.5 cm (21.16±3.79 cm) whereas it weight ranging from 15 to 315 g (104.94±61.17 g). Growth pattern of *D. macrosoma* in the area showed positive allometric growth (b>3) for all sampling periods except for those sampled in July and November which showed isometric growth (b=3). It was also found that fish in the surrounding waters of Waai village consists of four age groups or cohorts.
**Key Words**: shortfin scad, scad mackerel, growth pattern, cohort, Maluku.

**Introduction**. Ambon is a small island in Eastern Indonesia that belongs to Maluku Province. This island is affected directly by Banda; the island has great potential of marine resources. Some of those marine resources are fishes which consist of demersal fish/reef fish, large pelagic and small pelagic fishes (Rijoly et al 2016; Limmon et al 2017a, 2017b). Large pelagic fish commonly caught in Ambon Island waters is skipjack tuna (*Katsuwonus pelamis*), while small pelagic fishes are garfishes (*Hemiramphus* spp), Indian mackerels (*Rastrelliger* spp), anchovies (*Stolephorus* spp), trevallies (C*aranx* spp) and scad mackerels (*Decapterus* spp) (BPS Maluku 2015). Among those small pelagic fishes, *Decapterus* spp can be found all year round and dominated the catch in term of number and volume.

According to Atmaja & Sadhotomo (2005), at least there are four species of scad mackerels that can be found in Indonesian waters i.e. *Decapterus kurroides, D. macarellus, D. russelli,* and *D. macrosoma.* Those fishes are captured mostly by purse seine or locally called "jaring bobo" by fishers in Ambon Island and the main purse seiner in the island belong to fishers in Waii Village.

Based on data of BPS Maluku (2015), purse seine armada in Ambon Island increased significantly, about 47% during the last five years i.e. 58 armada in 2010 became 85 armada in 2014. However, this increasing was not followed by significant increasing in volume of *Decapterus* spp landed i.e. 10,930 tonnes in 2010 and 12,330 tonnes in 2014 or only increased about 13%. This picture indicates that there is decreasing of catch per unit effort and it seems that optimum level of *Decapterus* spp exploitation in Ambon Island waters has been exceeded.

Even though has been exploited for long time, biological information of *Decapterus* spp is still lacking. Therefore, this research was conducted to study some biological

aspects namely size distribution, length-weight relationship and age group of *Decapterus macrosoma* in eastern waters of Ambon Island, Maluku, Indonesia.

**Material and Method**. This research was carried out for 10 months starting from May 2016 to February 2017 at the surrounding waters of Waai village, Ambon Island, eastern Indonesia (Figure 1).

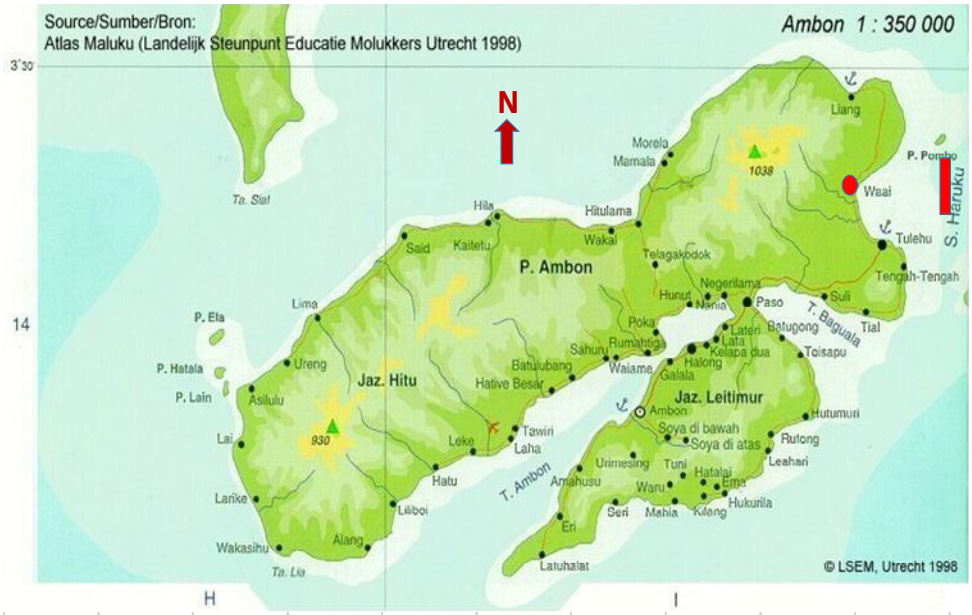


Figure 1. The map showing sampling site (red square) (LSEM 1998).

Fish samples were collected from purse seine fishers at Waai village and brought to the laboratory for measurement. Total length of fish was measured from tip of the mouth to tip of the tail by using plastic ruler to the nearest mm, whereas weight was weighted using a 5.0 kg blue LCD blacklight portable digital balance to the nearest gram. Data was processed with Microsoft Excel 2010 and FiSAT II ver. 1.1.2 program.

Analysis of length-weight relationship was done by using power function of Pauly (1984):

$$W = a \times L^b$$

where: W = weight (g);
L = total length (cm);
a = intercept;
b = slope.

The confidence interval of slope (b) at p=0.05 was calculated following formula of King (1995):

$$b = t \times sb$$

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

Age group was determined by using the method proposed by Bhattacharya (1967) and processed with FiSAT II ver. 1.1.2 program.

## Results and Discussion

***Size distribution of Decapterus macrosoma***. Totally, 1,018 individuals of *D. macrosoma* were collected during the period of research May 2016 to February 2017. Fish length ranged from 13.3 cm to 31.5 cm while its weight ranged from 15 g to 315 g (Table 1).

Table 1

Size of *Decapterus macrosoma* during the period of May 2016 – February 2017

| Period | n | Length (cm) | | | | Weight (g) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | (ind.) | Min | Max | Mean | SD | Min | Max | Mean | SD |
| May | 100 | 15.6 | 31.5 | 23.73 | 4.20 | 39 | 315 | 154.33 | 77.65 |
| June | 107 | 15.7 | 30.5 | 22.96 | 3.59 | 39 | 314 | 138.4 | 64.97 |
| July | 105 | 18.0 | 24.7 | 20.65 | 1.63 | 65 | 149 | 94.93 | 23.63 |
| August | 92 | 20.3 | 31.0 | 23.71 | 2.30 | 78 | 300 | 147.82 | 46.43 |
| September | 107 | 13.3 | 19.7 | 16.25 | 1.55 | 15 | 60 | 33.54 | 11.76 |
| October | 104 | 18.4 | 24.4 | 20.92 | 1.61 | 50 | 157 | 93.22 | 31.22 |
| November | 76 | 23.0 | 26.4 | 24.56 | 0.84 | 129 | 184 | 152.36 | 16.39 |
| December | 104 | 13.4 | 29.2 | 19.5 | 4.53 | 15 | 215 | 71.99 | 59.90 |
| January | 114 | 14.7 | 26.6 | 20.72 | 2.76 | 37 | 189 | 93.1 | 41.78 |
| February | 109 | 14.0 | 26.9 | 20.48 | 3.86 | 20 | 193 | 91.85 | 59.31 |
| Total | 1018 | 13.3 | 31.5 | 21.16 | 3.79 | 15 | 315 | 104.94 | 61.17 |

n - number of individuals; Min - minimum; max - maximum; SD - standard deviation.

The average length for all samples was 21.16±3.78 cm with the smallest mean was 16.25±1.55 cm that was found in September and largest mean was 24.56±0.84 cm, occurred in November (Figure 2).

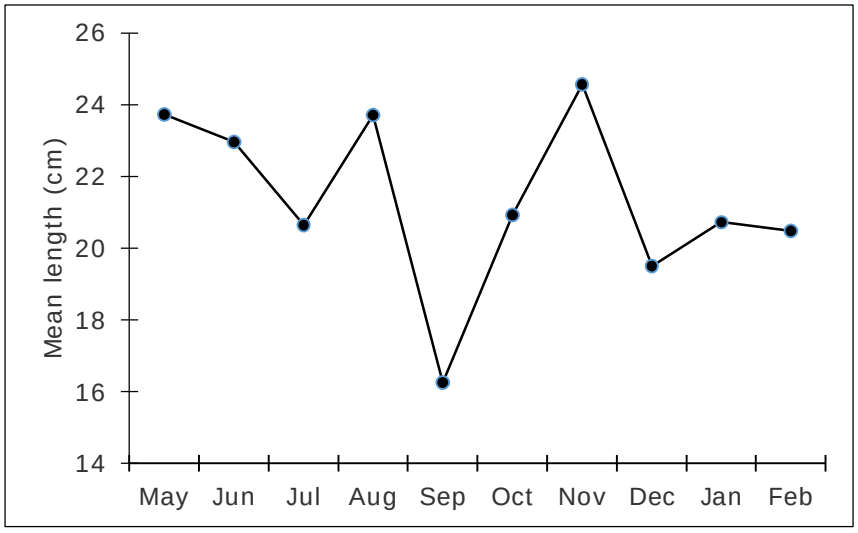


Figure 2. Monthly distribution of mean length of *Decapterus macrosoma.*

Based on Table 1 and Figure 2, peak of recruitment of *D. macrosoma* in the area occurred in September as shown by relatively smaller size of fish caught compared to fish found in other periods. Syahailatua & Sumadhiharga (1991) reported peak of recruitment of *D. macrosoma* in Ambon Bay waters occurred in July to August. Minor difference of recruitment pattern might be due to time and sampling period in which Syahailatua & Sumadhiharga (1991) carried their study for longer period i.e. from the year of 1989 to 1991.

Monthly distribution of average weight of *D. macrosoma* is presented in Table 1 and Figure 3. It can be seen in Figure 3 that distribution of monthly average weight shows the same trend as monthly mean length shown in Figure 2 in which the lowest mean weight occurred in September i.e. 33.54±11.76 g (Table 1). However, the highest weight is not found in November but in May i.e. 154.33±77.65 g (Table 1). This, indicated that for a given length, fishes caught in May tend to be heavier than those caught in November.

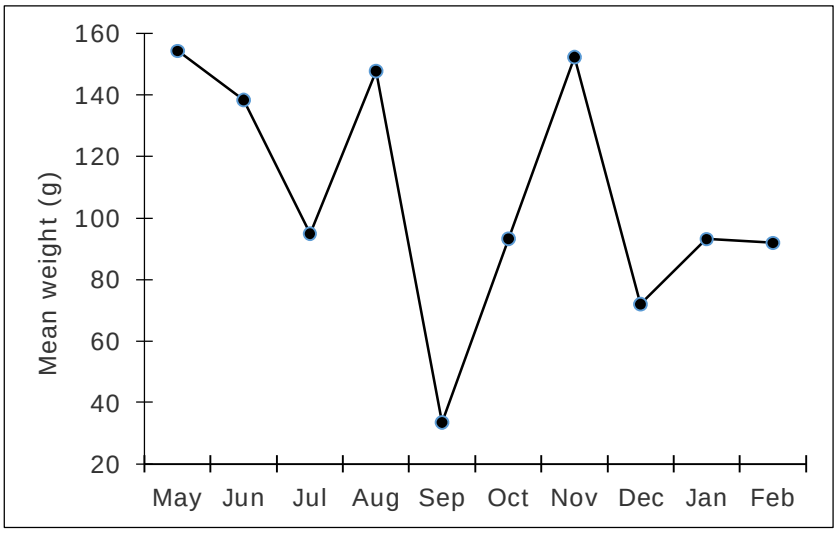


Figure 3. Monthly distribution of mean weight of *Decapterus macrosoma.*

Maximum total length reported so far for *D. macrosoma* was 35.0 cm with the common length was 25.0 cm (Froese & Pauly 2017). Senen et al (2011) found the total length ranged from 7.5 to 31.5 cm of *D. macrosoma* in Banda Neira waters, Maluku Province, while Suwarni et al (2015) reported the range of 12.1-29.5 cm for the same species in Bone Bay waters, South Sulawesi. Meanwhile, Widodo (1988) reported the ranged of 13.0–25.3 cm with the mean of total length was 17.51±1.27 cm for *D. macrosoma* in Java Sea.

Widodo (1988) and Syahailatua (2004) reported that first maturity of *D. macrosoma* in Java Sea and Ambon Bay occurred at total length of 16.28 cm and 16.30 cm, respectively. Based on those statements, it can be stated that most of *D. macrosoma* found in this study are adult fishes in which as many as 85.1% had length >16.5 cm while only 14.9% of the total fishes collected had length ≤16.5 cm (Figure 4).

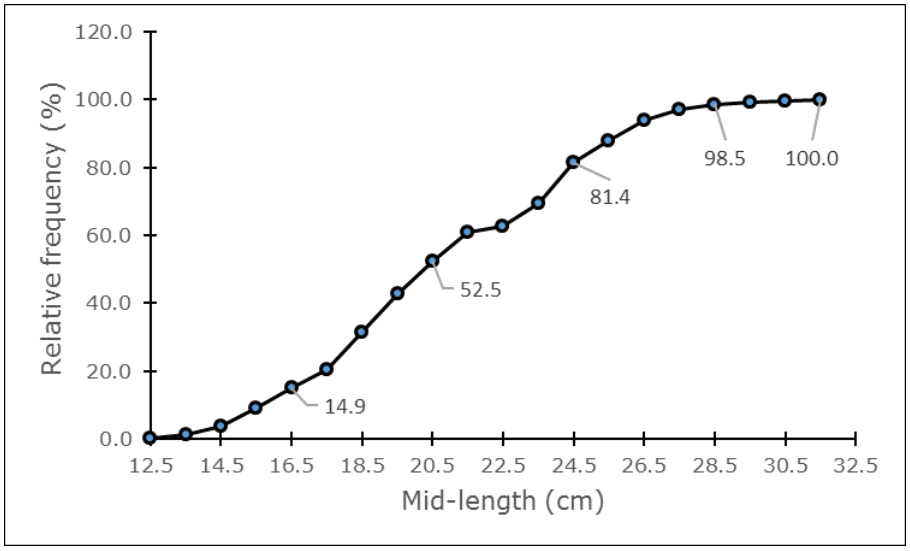


Figure 4. Relative cumulative frequency of length of *Decapterus macrosoma.*

***Length-weight relationship***. Length-weight relationship of *D. Macrosoma* during the study periods of study is presented in Table 2. It can be seen in Table 2 that the values of correlation coefficient (r) ranged from 0.956 to 0.997. These figure are higher than the value of r table (critical value of r) at p = 0.01. These results indicated that there are

highly significant correlation between length and weight and the contribution of length to weight as shown by determination coefficient ($R^2$) ranged from 91.4% to 99.4%. Those values also indicated that these relationships can be used for further analysis.

The values of b which are used to determine growth pattern of *D. macosoma* ranged from 2.976 to 4.108. King (1995) stated that confidence interval of b at p = 0.05 can be used to test the value of b whether it is the cubic or not. The author also stated that if the value of confidence interval of b includes 3.00, then the relationship between length and weight is cubic which shows isometric growth. It can be seen in Table 2 that the range of b at p = 0.05 that include 3.00 only found in July and November samples. These figures indicated that only fishes in those month show isometric growth i.e. length increment is proportional to weight increment while samples in other months or total sample (Table 2, Figure 5) show b>3 or positive allometric growth pattern which mean weight increment is larger or faster than length increment.

Table 2

Length-weight relationship and growth pattern of *Decapterus macrosoma* during the period of May 2016 – February 2017

| *Period* | *W = a L $^b$* | *r* | *$R^2$* | *Range of b at P = 0.05* | *Growth pattern* |
|---|---|---|---|---|---|
| May | W = 0.0074 L $^{3.112}$ | 0.994 | 0.988 | 3.04–3.18 | Positive allometric |
| June | W = 0.0080 L $^{3.104}$ | 0.989 | 0.979 | 3.02–3.19 | Positive allometric |
| July | W = 0.0100 L $^{3.008}$ | 0.976 | 0.954 | 2.88–3.14 | Isometric |
| August | W = 0.0068 L $^{3.147}$ | 0.987 | 0.974 | 3.04–3.25 | Positive allometric |
| September | W = 0.0010 L $^{3.644}$ | 0.982 | 0.965 | 3.51–3.78 | Positive allometric |
| October | W = 0.0003 L $^{4.108}$ | 0.966 | 0.933 | 3.89–4.33 | Positive allometric |
| November | W = 0.0090 L $^{2.976}$ | 0.956 | 0.914 | 2.77–3.18 | Isometric |
| December | W = 0.0020 L $^{3.510}$ | 0.987 | 0.975 | 3.40–3.62 | Positive allometric |
| January | W = 0.0030 L $^{3.345}$ | 0.996 | 0.992 | 3.29–3.40 | Positive allometric |
| February | W = 0.0020 L $^{3.476}$ | 0.997 | 0.994 | 3.43–3.53 | Positive allometric |
| Total | W = 0.0020 L $^{3.592}$ | 0.988 | 0.976 | 3.56–3.63 | Positive allometric |

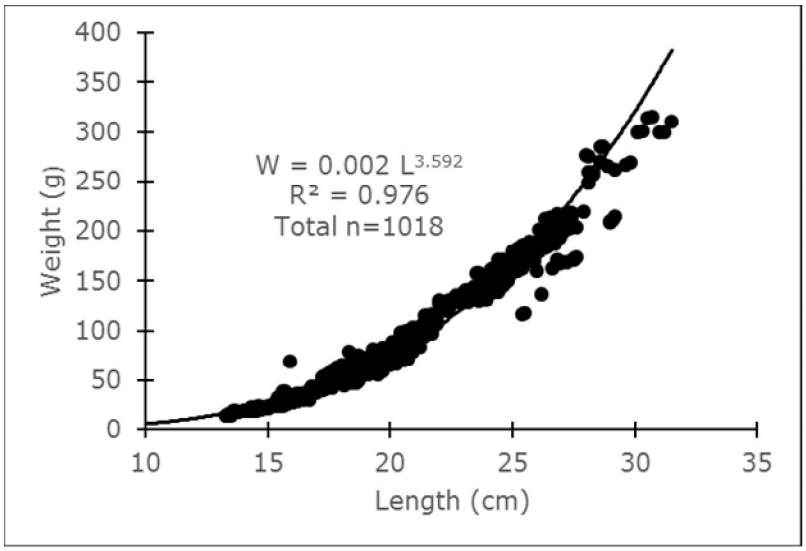


Figure 5. Length-weight relationship of *Decapterus macrosoma.*

Length-weight relationship of *D. macrosoma* also has been studied by some researchers' in Indonesian waters. Widodo (1988) found isometric growth pattern for male, female and combined sex of *D. macrosoma* in Java Sea. Subsequently, Prihartini et al (2007) also found isometric growth for combined sex of *D. macrosoma* in Java Sea. Meanwhile,

Senen et al (2011) found negative and postive alllometric growth in Banda Neira waters, Maluku Province while Syahailatua (2004) only found negative allometric growth of *D. macrosoma* in Ambon Bay. LeCren (1951) and Froese (1998, 2006) stated that variation of growth pattern could be due to variation in sexes as well as maturity of the fish sampled, location, season and food availability.

***Age groups***. Results of age groups or cohort analysis are presented in Figure 5 and Table 3. Population of *D. macrosoma* in southern waters of Ambon Island during the study periods had four age groups or cohorts. The result in present study is in accordance with the result of similar study conducted by Suwarni et al (2015) for *D. macrosoma* in Bone bay waters.

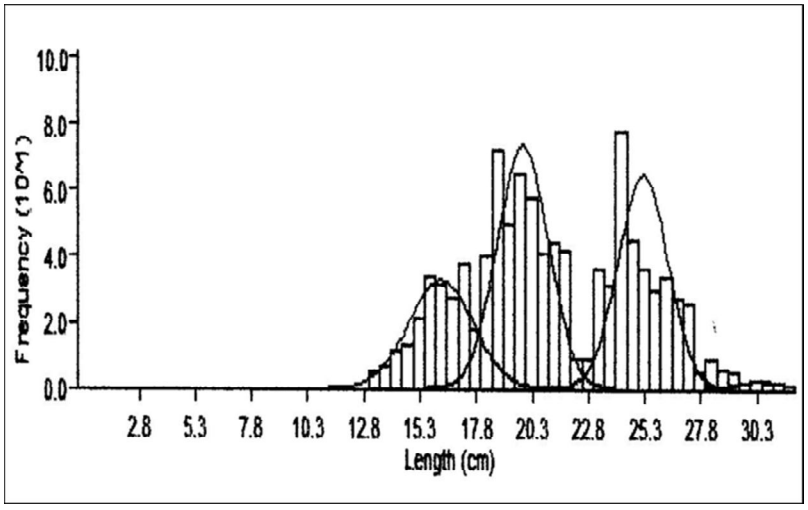


Figure 6. Normal curve of age group of *Decapterus macrosoma.*

Age groups of *D. macrosoma* is determined by using length frequency data for the whole periods of sampling and processed with FiSAT Program. Bhattacharya (1967) stated that length frequency data of a given population actually can be separated into a series of normal distributions or pseudo cohorts which represented the number of age groups in that population. Furthermore, Sparre & Venema (1992) stated that those normal distribution can be separated if separation index (SI) between two consecutive pseudo cohorts or age groups is equal or larger than two (SI≥2.00). It can be seen in Table 2 that all SI values are >2.00. This indicated that pseudo cohorts or age groups of *D. macrosoma* population are well separated and it consists four age groups or four cohorts.

Table 3

Output of FiSAT program in cohort analysis of *Decapterus macrosoma*

| *Group* | *Mean (cm)* | *SD* | *Population (ind.)* | *Separation index* |
|---|---|---|---|---|
| 1 | 16.18 | 1.43 | 236 | - |
| 2 | 19.83 | 1.14 | 420 | 2.12 |
| 3 | 25.17 | 1.10 | 359 | 2.30 |
| 4 | 30.41 | 0.93 | 12 | 2.24 |

**Conclusions**. Totally, there were 1018 samples of *D. macrosoma* collected during the study period with the length ranging from 13.3 to 31.5 cm (mean 21.16±3.79 cm) and the weight ranging from 15 to 315 g (mean 104.94±61.17g). All samples showed positive allometric growth pattern except for those collected in July and November which had isometric growth pattern. *D. macrosoma* in the area consists of four age groups or cohorts.

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