Growth Pattern and Relative Condition Factor of Shortfin Scad (Decapterus macrosoma) Landed in Banjarmasin Fishing Port, Indonesia

by Ahmadi .

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Abstract: The present study provides scientific information on growth pattern and relative condition of the Shorfin scad (*Decapterus macrosoma*) landed in Banjarmasin fishing port, Indonesia. A total of 313 individual scads comprising 178 males and 135 females, ranged from 152-225 mm total length and 37-110 g weight were investigated. The body shape of both male and female showed isometric growth pattern (b = 3.02-2.96). The regression coefficient was significantly different between the sexes. The total length, body weight, body depth, W/TL and BDD/TL ratios, and also condition factors of female were comparatively higher than those of male ($P < 0.001$). The highest percentage of catch falls between 180 and 189 mm TL (32.59-40.45%) and weighted between 50 and 59 g (20.65-21.79%). The relative condition factor values were ranged of 0.799-1.433 reflecting well-being of fish samples. The estimated length at first capture (L_{c50}) and selection factor values were 180 mm and 3.54 for male, and 185 mm and 3.64 for female. In the present work, the purse seine is considered male-biased gear, with the sex ratio of 1.3: 1. Outcomes of research could be useful for a sustainable pelagic fisheries management and the precautionary measures of over exploitation for this species.

Keywords: *Decapterus macrosoma*, Isometric, Masalama sea, Banjarmasin fishing port

Introduction

The Shortfin scad (*Decapterus macrosoma*) is one of commercially important pelagic fisheries resources that beneficially supports in food supply, fish processing industry and also fish bait for tuna longline fishing industry (Asni et al. 2019). It belongs to family Carangidae which has a high market demand locally due to its cheaper price relative to other pelagic fishes. At least there are four species of scad mackerels found in Indonesian waters i.e. *D. kurroides*, *D. macarellus*, *D. russelli*, and *D. macrosoma* (Atmaja and Sadhotomo 2005). Those fishes are mostly captured by purse seine, gill nets, ring net, mini-trawls, rod and line fishing (Ohshimo et al. 2014, Narido et al. 2016). The scad fishery is very important in Indonesia, employing large numbers of fishermen and taking a significant proportion of the total catch. However, high demand for those species resulted in the fish population tends to decline due to overfishing or over exploitation (Zamroni and Suwarso 2017, Kalhoro et al. 2017).

Several studies on *Decapterus* species have been well documented by the researchers including growth and reproduction (Ohshimo et al. 2014), growth and mortality (Mansor and Abdullah, 1995), food and feeding habits (Jaiswar et al. 1993), feeding behavior (Ory et al. 2017), length-weight relationship (Ashwini et al. 2016), biological aspect (Liestiana et al. 2015), population dynamic (Suwarni et al. 2015), optimization of enzymatic hydrolysis conditions (Rasli and Sarbon 2018), age determination (Shirishi et al. 2010), genetic diversity (Zamroni and Suwarso 2017), the major allergens identification (Misnan et al. 2008), species description (Kimura et al. 2013), stock assessment (Kalhoro et al. 2017), factors affecting the catches (Tsitsika and Maravelis 2006), bioeconomic analysis and resource management (Piliana et al. 2015), as well as market prices analysis for this species (Nababan et al. 2014). Each species of family Carangidae has own its characteristic and they may have different performance and behavior even in the same habitat (McBride et al. 2002, Ohshimo et al. 2006). To manage the shortfin scad fishery resource reasonably, it is therefore needed in-depth knowledge of its biology, feeding habit and ecology (Narido et al. 2016, Asni et al.

2019). The length-weight relationship is the most common scientific approach that used for analyzing growth and morphometric for an individual species of fish (Ongkers et al., 2016; Pattikawa et al. 2017), as well as for understanding survival, maturity and reproduction (Mehanna et al. 2015) of various species from different geographical regions. It is also useful in local and interregional, morphological and life historical comparisons in species and populations (Sani et al. 2010, Shirishi et al. 2010). In fish, the fish length is the best indicator of production efficiency (Ghorbani et al. 2012), while 14 the weight is considered to be a function of length (Weatherley and Gill 1987). In the present study we investigated the growth pattern and condition factor of shortfin scad from Masalama Sea that landed in Banjarmasin Fishing Port to provide some fundamental suggestions for better fisheries management.

Materials and Methods

The shortfin scads, locally called “Layang”, were caught by purse seines from Masalima Sea around Makassar Strait (WPP-713). Fishing season for this species was from September to February. The catch was transshipped from purse seiners (100-175 GT) to fish carrier vessels (25-30 GT) to be landed in Banjarmasin fishing port of South Kalimantan Province, Indonesia (Fig. 1), located on 03°18'03" S and 114°33'02" E. The scads fishery contributes about 25% of total catch landed. This fishing port is one of the regional technical Implementing Units (UPTD) under the Marine and Fisheries Service of South Kalimantan Province. The fishing port was built on 1975 and was the oldest fishing port in Kalimantan Island. It is very strategic area because it is accessible by fish carrier vessels from both Java and Sulawesi. Based on the daily report issued by fishing port authority, there are about 5-20 tons per day the scads landed by one vessel or equal to 50-100 tons given by 10 vessels (6-30 GT). A total of 1,808,700 L/year of fuel quota is provided by PT. AKR. Corporindo. Tbk and proportionally distributed to each vessel group (Shafari et al. 2019). Banjarmasin fishing port has no fish auction center. All transactions of the marketing channels are organized by a fish distributor agent (Rahman et al. 2019). The fish prices at fishermen and at the end of consumers were IDR 12,000 and IDR 35,000 respectively.

A total of 313 individuals of the shortfin scads comprising 178 males and 135 females were directly purchased from Banjarmasin Fishing Port. Fish were measured for total length (TL), body depth (BDD) and weight (W). Total length was taken from the tip of the snout to the extended tip of the caudal fin. Body depth was measured from the dorsal fin origin vertically to the ventral midline of the body. The total length and body depth of each individual were measured with a ruler to the nearest mm, while whole body weight was determined with a digital scale to an accuracy of 0.01 g (CE, SF-400, China). The size distribution of fish sampled was set at 10-interval class for length and weight sizes.

The length-weight relationship of fish was expressed with the following equation (Froese 2006):

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

Where: W is the total weight (g), L is the total length (mm), *a* is the constant showing the initial growth index and *b* is the slope showing growth coefficient. The *b* exponent with a value between 2.5 and 3.5 is used to describe typical growth dimensions of relative wellbeing of fish population (Bagenal 1978). The analysis of covariance was applied for checking any difference between male and female in term of growth pattern.

The statistical significance of the isometric exponent (*b*) was analyzed by a function (Pauly 1984):

$$t = \left(\frac{\mathrm{SD\ (x)}}{\mathrm{SD\ (y)}}\right)\left(\frac{|\mathrm{b}-3|}{\sqrt{1-\mathrm{R}^2}}\right)\left(\sqrt{\mathrm{n}-2}\right) \qquad (2)$$

Where t is the t student statistics test value, SD (x) is standard deviation of log L, SD (y) is standard deviation of log W, b is the slope of curve, R^2 is coefficient determination and n is number of sample. The t-value was compared with t-table value (0.05) for degrees of freedom at 95% significant level. If the t-value was less than t-table value, fish grows isometrically ($b = 3$). If the t-value was greater than t-table value, fish grows allometrically ($b \neq 3$). The b value has an important biological meaning (Froese 2006): isometric growth indicates that the body increases in all dimensions in the same proportion of growth. When weight increases more than length, it shows positively allometric ($b > 3$). When the length increases more than weight, it indicates negatively allometric ($b < 3$). Determination coefficient (R^2) and regression coefficient (r) of morphological variables between male and female were also computed.

The condition factor of fish was estimated using the following formula (Weatherley and Gill 1987):

$$K = 100(W/L^3) \qquad (3)$$

Where K is the Fulton's condition factor, L is total length (cm) and W is weight (g). The factor of 100 is used to bring K close to a value of one. The K value is used in assessing the health condition of fish of different sex and in different seasons. Relative condition factor (Kn) was further estimated by following Le Cren (1951) formula:

$$Kn = W/\hat{}W \qquad (4)$$

Where Kn is relative condition factor reflecting 'condition', 'fatness' or well-being of fish, W is the observed weight and ^W is the calculated weight derived from length-weight relationship. The metric indicates that the higher the Kn value the better the condition of fish.

The length at first capture (L_{c50}) is the total length at which 50% of individuals are mature. It also represents the size at which 50% of the catches are retained by the gear or 50% of the recruits are under full exploitation (Udoh et al. 2017). The probability of capture was estimated by plotting the cumulative probability of capture with mid-length. Length at first capture (L_{c50}) was taken at 50% of the resultant cumulative curve.

The selection factor (SF) is the index related to escapement factor expressing relation between L_{c50} and the mesh size involved. The selection factor for the shortfin scad was simply estimated using the formula (Pauly 1984):

$$SF = \frac{\text{Lc50}}{\text{Mesh size}} \qquad (5)$$

The *t*-test was applied to compare the body sizes, the size ratios and condition factors between males and females. All tests were analyzed at the 0.05 level of significance using SPSS-18 software.

Results

All estimated length-weight relationship parameters, the body size ratios and condition factors including the length at first captured and selection factor of the shortfin scad were presented in Tables 1-3. The body size of male ranged of 155-223 mm TL (186.56 ± 12.60 mm) and 37-110 g weight (60.45 ± 13.94 g). While the body size of female ranged of 152-225 mm TL (191.19 ± 13.64 mm) and 42-108 g weight (67.10 ± 15.07 g), with the sex ratio of male to was 1.3 : 1.

The body shape of both male and female showed isometric growth pattern (Fig. 2A), indicating that the length and body weight of the fish increase in equal proportions.

The length-weight relationships for male and female were expressed as: $W = 0.000008TL^{3.0251}$ and $W = 0.00001TL^{2.9555}$ respectively. The estimated *b* values in the LWR equations were 3.02 for male and 2.96 for female. The *t*-test values for male and female obtained were less than *t*-table values confirming the fish grew isometrically. The R^2 values ranged of 0.881-0.893 indicating that more than 88% of variability of the weight is explained by the length. The regression correlation of male and female were 0.939 and 0.945, found to be higher than 0.5, showing the length-weight relationship is strongly correlated. Regardless the sex, we observed that individuals smaller than 180 mm TL grew negatively allometric with the exponent lower than the cubic value (b = 2.65, R^2 = 0.925), while individual larger than 209 mm TL grew positively allometric with the exponent comparatively higher than the cubic value (b = 3.37, R^2 = 0.932).

The *t*-test analysis showed that there were significant differences in total length, body weight and the mean W/TL ratio between male and female ($P < 0.001$). The mean W/TL ratios for male ranged from 0.238 to 0.493 (0.32 ± 0.05), while those for female varied from 0.237 to 0.482 (0.35 ± 0.05). The relationships were expressed as $W/TL = 0.8\times10^{-5}TL^{2.0251}$ (R^2 = 0.769) for male and $W/TL = 0.40\times10^{-4}TL^{1.7296}$ (R^2 = 0.623) for female (Fig. 2B). The regression correlation of male and female were 0.877 and 0.789, found to be higher than 0.5, showing the length-weight relationship is positively fitted. Female had body depth greater than male ($P < 0.05$). The mean body depths of male and female were 35.99 ± 5.17 mm and 38.44 ± 5.52 mm respectively. The increased of body depth was directly proportional to the total length. The relationships were presented in the following equations: $BDD = 0.0071TL^{1.6293}$ (R^2 = 0.6293) for male and $BDD = 0.0084TL^{1.6048}$ (R^2 = 0.6287) for female (Fig. 3A). The regression correlation (r = 0.793) obtained showing the relationship of body depth and total length is also positively correlated. The mean BDD/TL ratio of female was considerably higher than that of male ($P < 0.0001$). Those ratios ranged from 0.158 to 0.295 (0.19 ± 0.02) for male, and from 0.162 to 0.283 (0.20 ± 0.02) for female. The relationships given for male and female were $BDD/TL = 0.0071TL^{0.6293}$ and $BDD/TL = 0.0083TL^{0.6048}$ respectively (Fig. 3B).

The fish samples in the present study are mostly distributed in the middle size class (Fig. 4A). The highest percentage of catch was 40.45% for male and 32.59% for female, which falls between 180 and 189 mm TL, followed by 200 and 209 mm TL (25.19%) for female and between 170 and 179 mm TL (21.91%) for male. A low number of catch was observed for either smaller individual < 170 mm TL (< 2%) or larger individual > 219 mm TL (< 3%). The heaviest catch of male (47.75%) and female (36.30%) weighted between 50 and 59 g. The body weight of female appears greater than that of male weighted over 70 g (Fig. 4B). The t-test analysis showed that there were significant differences in individual class interval of length-weight size range between male and female ($P < 0.05$), particularly in the length size ranges of 160-169 mm, 190-199 mm, 200-209 mm and 220-229 mm, but no significant difference in the weight size range between male and female was observed (Table 4).

The Fulton's condition factor (K) value of female was significantly higher than that of male ($P < 0.05$). The K values obtained ranging from 0.729 to 1.009 (0.92 ± 0.07) for male and from 0.711 to 1.139 (0.95 ± 0.07) for female. The relationship of condition factor and the ratio of body weight to total length was expressed by $W/TL = 0.3478K^{1.0407}$ for male and $W/TL = 0.3654K^{0.9937}$ for female. The initial growth index of female was greater than that of male. The increased of the ratio of body weight to total length was corresponding to the condition factor. From available data, we also found the relative condition factor (Kn) value of female was significantly higher than that of male

(P < 0.0001). The Kn values obtained for male ranged from 0.799 to 1.209 (1.01 ± 0.07), while for female ranged from 0.897 to 1.433 (1.20 ± 0.09) reflecting well-being of fish samples. The K and Kn values obtained can be seen in Table 1.

The length at first capture (L_{c50}) was estimated at 180 mm for male and 185 mm for female, indicating individuals of the shortfin scad were mature. On the basis of L_{c50}, we also roughly estimated the proportion of smaller and larger individuals of scad male retained by the fishing gear was 24.16% (< 180 mm) and 75.84% (> 180 mm) respectively. While those of scad female estimated at 32.59% (< 185 mm) and 67.41% (> 185 mm), showing that the majority of catch was dominated by larger size and mature (Fig. 5).

The estimated selection factor (SF) for male and female was 3.54 and 3.64 respectively (Table 1). The mesh size used as the main input for calculating the SF value was 50.8 mm for both male and female. These SF values were derived from the corresponding Lc50 values (180-185 mm) and mesh size used.

Discussion

The most important result of the present study was that *D. Macrosoma* grew isometrically (b = 2.96-3.02), indicating that the length increased proportionally to body weight. Such growth pattern was also agreed with *D. Macrosoma* from Eastern Java Sea of Central Java (Prihartini et al. 2006), *D. russelli* from Mumbai waters and Mangaluru of India (Jaiswar et al. 2001, Ashwini et al. 2016), *D. tabl* from Camotes Sea of Philippines (Narido et al. 2016) or *D. maruadsi* from Gulf of Suez of Egypt (Mahenna et al. 2015). However, it was contrary to *D. Macrosoma* from Ambon Island of Maluku and Makassar waters of South Sulawesi (Pattikawa et al. 2017, Asni et al. 2019), *D.*

russelli from Mumbai waters of India (Panda et al. 2011), Latulahalat waters of Maluku (Ongkers et al. 2016) or *D. tabl* from Suruga Bay of Japan (Iwasaki and Aoki 2001) in which displayed positive allometric growth patterns. Meanwhile, *D. macarellus* from North Maluku sea (Iksan and Irham, 2009), *D. russelli* from Northern Arabian Sea of Pakistan (Kalhoro et al. 2017) or *D. Macrosoma* from PPI Sanggeng-Manokwari of West Papua (Randongkir et al 2018) were reported to have negative growth pattern or have a slower growth as compared to our finding (Table 5). Variation in slope may be attributed to sample size variation, life stages, growth difference, seasonal fluctuations, change in physiological condition during spawning periods, gonad development, sex and environmental factors such as food and space (Mehanna et al. 2015, Ashwini et al. 2016, Kalhoro et al. 2017).

In the present work, the purse seine is considered male-biased gear, indicated by the male ratio was 1.3 times higher than female. food availability and migration cycle The similar result was also documented for *D. macrosoma* from PPI Sadeng of Yogyakarta (Liestiana et al. 2015), *D. russelli* from Mangaluru of India (Ashwini et al. 2016) and *D. macrosoma* from Makassar waters of South Sulawesi (Asni et al. 2019). Meanwhile, the female-biased ratio was reported in *D. macrosoma* from Javanese waters (Prihatini et al. 2007) and *D. macarellus* from North Maluku (Iksan and Irham 2009). Variation in the sex ratio of the fish is closely related to food availability, water temperature, DO and migration cycle (Poojary et al. 2015, Awan et al. 2017, Asni et al. 2019).

In the present study, the mean K and Kn values obtained for *D. Macrosoma* female was comparatively higher than male (see Table 1), and the values close or equal to one indicating the scads were in good condition. Compared to other species, the current K values were relatively similar to *D. Macrosoma* from Banda Nera Island of Maluku and PPI Sadeng of Yogyakarta (Senen et al. 2011, Liestiana et al. 2015), *D. russelli* from Maharashtra and Mangaluru of India (Poojary et al. 2015, Ashwini et al. 2016), but it was lower than *D. russelli* from Eastern Java Sea of Central Java (Prihartini 2006) or *D. Macrosoma* landed in PPI Sanggeng of West Papua (Randongkir et al. 2018). Variation in the K value may be attributed to biological interaction involving intraspecific competition for food and space between species including sex, stages of maturity, and availability of food (Poojary et al. 2015, Ashwini et al. 2016). Information on condition factor of the scads is considerably needed for determining the gonad maturity and growth level (Shiraishi et al. 2010, Mehanna et al. 2015), as well as for monitoring of stock assessment and fishery resource management (Piliana et al. 2015, Kalhoro et al. 2017).

The estimated L_{c50} values for *D. macrosoma* (180-185 mm) landed in Banjarmasin fishing port were comparatively lower than *D. macrosoma* (255 mm) landed in PPI Sadeng of Yogyakarta (Liestiana et al. 2015), *D. macrosoma* (201 mm) landed in PPN Pekalongan (Prihatini et al. 2007) or *D. macarellus* (258 mm) collected from the waters off southern Kyushu (Shiraishi et al. 2010), but it was relatively higher than *D. macrosoma* female (172 mm) from Makassar waters of South Sulawesi (Asni et al. 2019), *D. russelli* (153 mm) from Maharashtra waters of India (Poojary et al. 2015) or *D. tabl* (175 mm) from Camotes Sea of Central Philippines (Narido et al. 2016). This variation can be affected by many factors such as time and duration of sampling, number and size of fish sampled, as well as the type and mesh size of fishing gear used. Due to the effect of fishing pressure or environmental changes (e.g. water temperature and food availability), the scads may change their behavior from a pelagic to a demersal mode of life as they increase in size, hence larger fishes may not be caught by the gears (Ronquillo 1974). Taking an example of purse seine fishery in the Pagasitikos Gulf of Greece, the catches were also restricted by the maximum height of purse seine (± 30 m), which implies that any species below this depth was out of reach (Tsitsika and Maravelis 2006).

On the basis of 50.8 mm (2-inch) mesh size of purse seine, the selection factor (3.54-3.64) for *D. macrosoma* in the present study were relatively lower than those landed in PPI Sadeng of Yogyakarta (5.02) (Liestiana et al. 2015). However, the current SF values obtained were comparatively higher than those for *Sardinella aurita* (1.63) and *S. maderensis* (1.83) corresponds to 83 mm mesh size (Ofori-danson et al. 2018). Seemingly the value of selection factor increased with mesh size and the corresponding L_{c50} value for this species. These SF values were large enough to show that purse seine can be considered a selective fishing gear for *D. macrosoma* since the two-third of total catch was larger individuals (67.41-75.84%). The selection factor of purse seine was not only determined by the mesh sizes, but also affected by gear construction, fish behavior and netting materials (Widjopriono and Mahiswara 2008).

Thomson and Ben-Yami (1984) classified purse seine into the less selective fishing gear because species of fish caught by purse seine showed a wider range of size or age than those caught by a gill net. In point of fact, Javanese fishermen still operated purse seine with a smaller mesh size (1.5 inch) to catch the mackerel scads resulted in fish population tends to decline (Prihartini et al. 2007). It is acknowledged that purse seine has a higher productivity as compared to other fishing gears such as beach seine, drift gillnets and mini trawls (Yonvitner et al. 2020). Besides using the larger mesh size (2.5-3 inch), the selectivity of purse seine can be improved by installing rigid metal sorting grids on the pocket sections (Beltestad and Misund 1995) or using a panel of diamond-shaped mesh in the posterior part (Goncalves et al. 2004) to reduce and minimize the fisheries bycatches. Moreover, the sinking performance of purse seine with the larger meshed-panels and heavier material was also numerically simulated (Hosseini et al. 2011). Although the existing scads fishery is sustainable, however, the precautionary measures of control should be taken into consideration. Therefore, further improvement of real-time monitoring of catch per unit effort (CPUE) in the investigated area should be done to ensure fish arriving in good marketable condition and not being fully exploited. Fishing intensity should be rationalized to effectively prevent over exploitation of the scads population.

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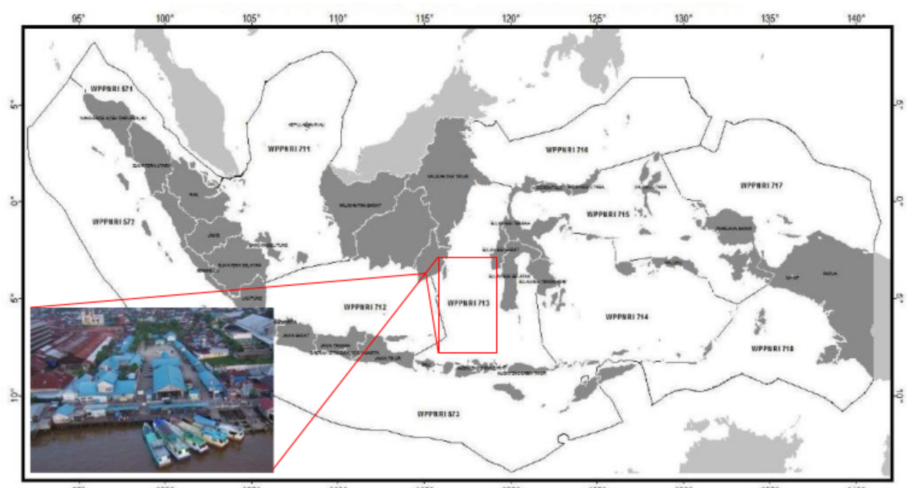

Figure 1. The picture shows the location of Masalima Sea and Banjarmasin fishing port

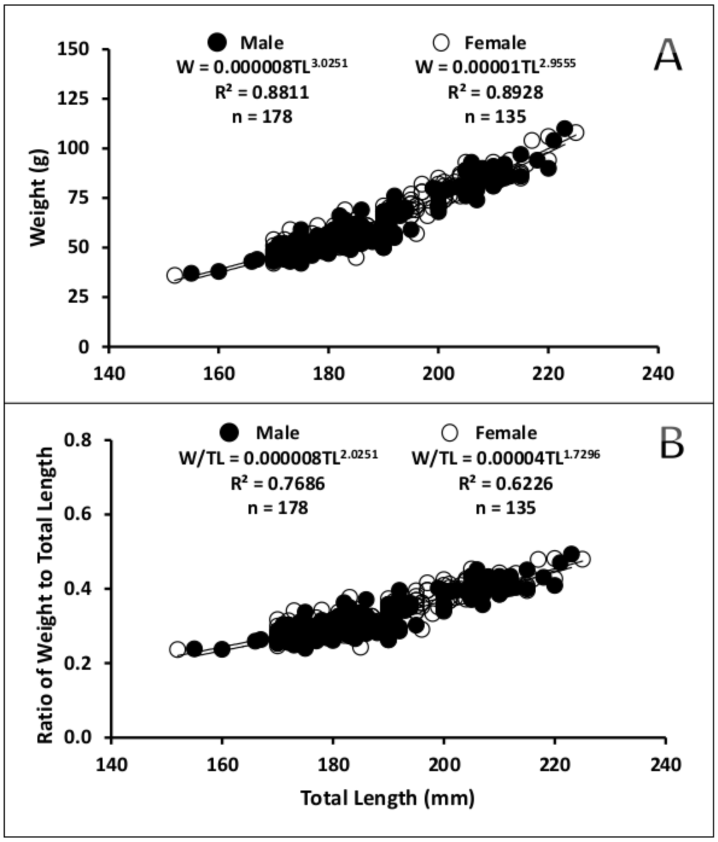

Figure 2. **[A]**. The relationship between body weight and total length of the shortfin scad landed in Banjarmasin fishing port. Both male and female showed isometric growth pattern. **[B]**. The relationship between the mean ratios of body weight to total length of the fish. Females had the ratio values greater than males.

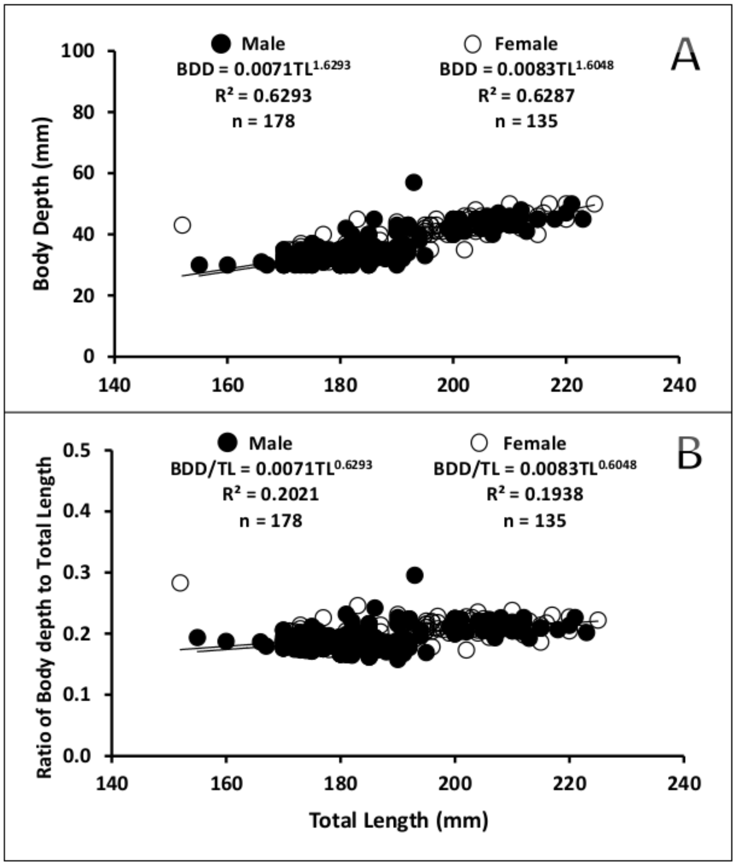

Figure 3. **[A]**. The relationship between body depth and total length of the shortfin scad. The body depth increases proportionally to the total length. [**B**]. The relationship between the mean ratios of body depth to total length of the fish. Females had the ratio values comparatively greater than males.

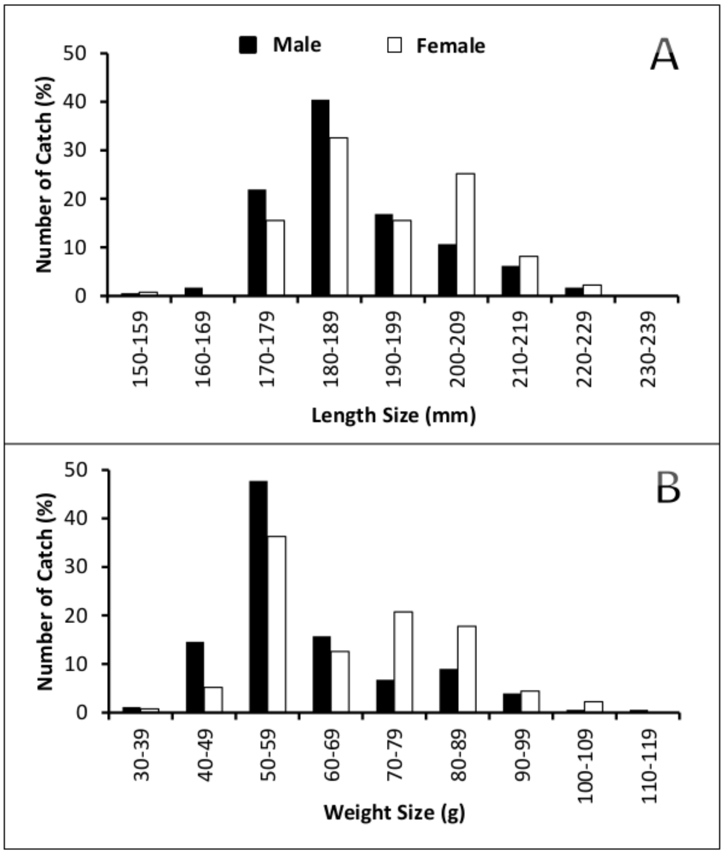

Figure 4. The percentages of length size [A] and weight size [B] distribution between males and females of the shortfin scad obtained from Banjarmasin fishing port.

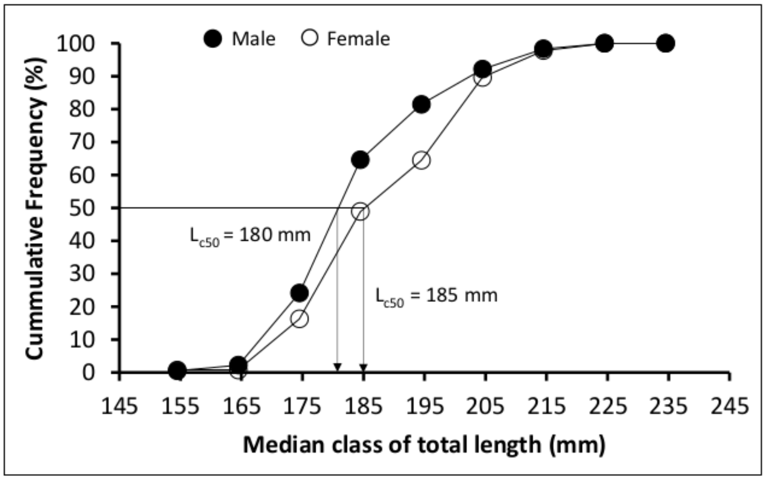

Figure 5. The length at first capture (L_{c50}) of the shortfin scad estimated at 180 mm for male and 185 mm for female caught by 50.8 mm mesh size of purse seine

Table 1. Total length, weight, condition factor and selection factor of the Shortfin scad male and female landed in Banjarmasin fishing port

Sex	n	Total length (mm)			Weight (g)			a	b	R^2	r	Growth pattern	K	Kn	L_{c50} (mm)	SF
		Min	Max	Mean ± SD	Min	Max	Mean ± SD									
Male	178	155	223	186.56±12.60	37	110	60.45±13.94	0.000008	3.02	0.881	0.939	I	0.92±0.07	1.01±0.07	180	3.54
Female	135	152	225	191.19±13.64	42	108	67.10±15.07	0.00001	2.96	0.893	0.945	I	0.95±0.07	1.20±0.09	185	3.64
Significance t-test				P<0.001			P<0.0001						P<0.001	P<0.0001		

n = Number of fish samples, SD = standard deviation, a = constant, b = exponent, R^2 = determination coefficient, r = regression coefficient, I = isometric, K = Fulton's condition factor, Kn = relative condition factor, SF = selection factor

Table 2. The ratio of body sizes of the Shortfin scad landed in Banjarmasin fishing port.

Sex	n	W/TL	a	b	R^2	r	BD/TL	a	b	R^2	r
Male	178	0.32±0.05	0.80×10^{-5}	2.0251	0.7686	0.8767	0.19±0.02	0.70×10^{-2}	0.6293	0.2021	0.4496
Female	135	0.35±0.05	0.40×10^{-4}	1.7296	0.6226	0.7891	0.20±0.02	0.80×10^{-2}	0.6048	0.1938	0.4402
Significance t-test		P<0.0001					P<0.0001				

n = Number of fish samples, a = constant, b = exponent, R^2 = determination coefficient, r = regression coefficient, TL = total length, W = body weight, and BDD = body depth.

Table 3. The descriptive statistics of the parameters observed for the Shortfin scad taken from Banjarmasin fishing port.

Parameters Observed	Mean ± SD of Body sizes		t-test for Equality of Means						
	Male (n = 178)	Female (n = 135)	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
TL (mm)	186.56 ± 12.60	191.19 ± 13.64	-3.107	311	0.002	-4.6308	1.4906	-7.5637	-1.6980
W (g)	60.45 ± 13.94	67.10 ± 15.07	-4.228	311	0.000	-6.9135	1.6354	-10.1317	-3.6958
BD (mm)	35.99 ± 5.17	38.44 ± 5.52	-4.032	311	0.000	-2.4483	0.6072	-3.6430	-1.2535
W/TL	0.32 ± 0.05	0.35 ± 0.05	-4.392	311	0.000	-0.0266	0.0061	-0.0387	-0.0147
BD/TL	0.19 ± 0.02	0.20 ± 0.02	-3.715	311	0.000	-0.0081	0.0022	-0.0124	-0.0038
K	0.92 ± 0.07	0.95 ± 0.07	-3.480	311	0.001	-0.0361	0.0104	-0.0565	-0.0157
Kn	1.01 ± 0.07	1.20 ± 0.09	-20.944	311	0.000	-0.1894	0.0090	-0.2072	-0.1716

TL = total length, W = body weight, BDD = body depth, K = Fultons' condition factor, Kn = relative condition factor

Table 4. The significant test for the Shortfin scad based on the range of length-weight size distribution.

Range of length size	Number of Catch		t-test for Equality of Means						
	Male	Female	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
150-159	1	1	.	0	.	3.0000	.	.	.
160-169	3	0	37.591	2	0.001	164.3333	4.3716	145.5238	183.1429
170-179	39	21	0.518	58	0.606	0.3956	0.7636	-1.1329	1.9241
180-189	72	44	0.636	114	0.526	0.3068	0.4824	-0.6488	1.2624
190-199	30	21	-5.346	49	0.000	-3.4762	0.6502	-4.7828	-2.1695
200-209	19	34	2.092	51	0.041	1.5232	0.7280	0.0618	2.9847
210-219	11	11	-0.735	20	0.471	-0.8182	1.1127	-3.1392	1.5028
220-229	3	3	125.484	2	0.000	221.3333	1.7638	213.7442	228.9225
230-239	0	0	.	0	.	.00000	.	.	.

Range of weight size	Number of Catch		t-test for Equality of Means						
	Male	Female	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
30-39	2	1	1.732	1	0.333	1.5000	0.8660	-9.5039	12.5039
40-49	26	7	0.149	31	0.882	0.1429	0.9578	-1.8107	2.0964
50-59	85	49	-0.135	132	0.893	-0.0668	0.4935	-1.0430	.9095
60-69	28	17	0.873	43	0.388	0.8740	1.0011	-1.1449	2.8928
70-79	12	28	-0.283	38	0.779	-0.3214	1.1349	-2.6189	1.9760
80-89	16	24	0.269	38	0.789	0.2500	.9285	-1.6297	2.1297
90-99	7	6	-0.362	11	0.725	-0.4048	1.1196	-2.8690	2.0595
100-109	1	3	-0.866	2	0.478	-2.0000	2.3094	-11.9366	7.9366
110-119	1	0	.	0	.	110.0000	.	.	.

Table 5. Comparative length-weight relationship, condition factor and growth pattern of the shortfin scad from different geographical areas.

Area of Studies	Province	Species	Sex	n	Body size (mm)		Growth pattern	*b*	Kn	References
					Min	Max				
Banjarmasin Fishing Port	South Kalimantan	*D. Macrosoma*	M	178	155	223	I	3.025	1.01	Present study
Banjarmasin Fishing Port	South Kalimantan	*D. Macrosoma*	F	135	152	225	I	2.956	1.20	Present study
Western Java Sea	Central Java	*D. Macrosoma*	P	610	96	216	I	2,978	2,075-2.966	Prihartini, 2006
Makassar waters	South Sulawesi	*D. Macrosoma*	M	201	128	340	A+	3.37	-	Asni et al., 2019
Makassar waters	South Sulawesi	*D. Macrosoma*	F	169	120	330	A+	3.73	-	Asni et al., 2019
PPI Sadeng, Gunung Kidul	Yogyakarta	*D. Macrosoma*	P	1,324	145	380	A-	2.88	1.05	Liestiana et al., 2015
Bone Bay	South Sulawesi	*D. Macrosoma*	P	849	121	295	-	-	-	Suwarni et al., 2015
PPI Sanggeng, Manokwari	West Papua	*D. Macrosoma*	M	222	109	303	A-	1.84	0.67-1.86	Randongkir et al., 2018
PPI Sanggeng, Manokwari	West Papua	*D. Macrosoma*	P	278	125	299	A-	2.03	0.72-1.80	Randongkir et al., 2018
Banda Nera Island	Maluku	*D. Macrosoma*	P	1,134	75	315	A+	3.19	1.11	Senen et al., 2011
Ambon Island	Maluku	*D. Macrosoma*	P	1,018	133	315	A+	3.59	-	Pattikawa et al., 2017
North Maluku	Maluku	*D. macarellus*	M	645	211	311	A-	2.28	-	Iksan and Irham, 2009
North Maluku	Maluku	*D. macarellus*	F	1,355	215	315	A-	2.98	-	Iksan and Irham, 2009
Eastern Java Sea	Central Java	*D. russelli*	P	756	86	214	I	3.027	1,659- 2,230	Prihartini, 2006
Northwest coast	India	*D. russelli*	P	1,831	80	218	I	3.00	-	Jaiswar et al., 2013
Latulahalat, Ambon Island	Maluku	*D. russelli*	M	220	75	235	A+	3.63	-	Ongkers et al., 2016
Latulahalat, Ambon Island	Maluku	*D. russelli*	F	223	94	286	A+	3.89	-	Ongkers et al., 2016
Mangaluru	India	*D. russelli*	M	667	110	230	I	3.02	1.023	Ashwini et al., 2016
Mangaluru	India	*D. russelli*	F	339	130	220	I	3.09	1.051	Ashwini et al., 2016
Northern Arabian Sea	Pakistan	*D. russelli*	P	997	10	310	A-	2.66	-	Kalhoro et al., 2017
Maharashtra	India	*D. russelli*	P	812	110	229	-	-	0.93-1.08	Poojary et al., 2015
Mumbai waters	India	*D. russelli*	P	235	142	230	A+	3.17	-	Panda et al., 2011
Malabar	India	*D. russelli*	M	193	65	242	A-	2.32	-	Manojkumar, 2007
Malabar	India	*D. russelli*	F	179	65	242	I	2.98	-	Manojkumar, 2007
Gulf of Suez	Egypt	*D. maruadsi*	P	1,864	73	251	I	2.90	-	Mahenna et al., 2015
Camotes Sea	Philippines	*D. tabl*	P	317	125	314	I	2.99	-	Narido et al., 2016
Suruga Bay	Japan	*D. tabl*	P	…	180	430	A+	3.18	-	Iwasaki and Aoki, 2001

A+ = positive allometric, A- = negative allometric, I = isometric, W = weight, TL = total length, Kn = relative condition factor, M = male, F = female, P = pooled

Growth Pattern and Relative Condition Factor of Shortfin Scad (Decapterus macrosoma) Landed in Banjarmasin Fishing Port, Indonesia

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