Biometrics of big eye scad, Selar crumenophthalmus and shrimp scad, Alepes djedaba from Semarang waters, Indonesia

by Ita W

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Biometrics of bigeye scad, *Selar crumenophthalmus* and shrimp scad, *Alepes djedaba* from Semarang waters, Indonesia

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Abstract. Fish species *Selar crumenophthalmus* (bigeye scad) and *Alepes djedaba* (shrimp scad) are some of the continuously exploited fish species by small-scale artisanal fishery in Semarang waters, Indonesia. The aim of this study was to determine the biological characteristics of their stocks through measuring of their lengths and weights, condition factors, sex-ratios and gonadosomatic index (GSI). Twice each month (fortnightly) 50 specimens each for both fish species were randomly collected from the fish lot at Tambak Lorok Auction Hall, Semarang, during the period from middle of April to middle of June the same year 2015. A total of 250 specimens each for each fish species were collected altogether and examined in the study. Length at first maturity (L_m) for *S. crumenophthalmus* and *A. djedaba* were 12.5 cm and 10.3 cm respectively, while their asymptotic lengths (L_∞) were 23.8 cm and 23.0 cm, respectively. Regression equation for *S. crumenophthalmus* was Log W = -1.470 + 2.857 * Log SL (r^2 = 0.955) while for *A. djedaba* was Log W = -1.565 + 2.939 * Log SL (r^2 = 0.961). The average condition factor of males of *S. crumenophthalmus* was 2.318, females 2.300, while for *A. djedaba* the males was 2.422 and females 2.432. The sex-ratios of both fish species did not significantly deviate from the normal Mendelian ratio of 1:1. The lowest and highest values for the gonadosomatic index of *S. crumenophthalmus* was 2.83 and 5.57, respectively while for *A. djedaba* was 2.92 and 5.70, respectively.

Key Words: biometrics, *Selar crumenophthalmus*, *Alepes djedaba*, fishery.

Introduction. Fish species *Selar crumenophthalmus* (bigeye scad) and *Alepes djedaba* (shrimp scad) are oceanic ray-finned fish known to be migratory species and belongs to the large group as family Carangidae (Blaber & Cyrus 1983) that are found in tropical regions around the world (Argente et al 2014). These species are of mainly nocturnal habit and disperse at night to feed on small shrimp, benthic invertebrates, pelagic fish eggs, pelagic fish larvae, forams and zooplankton (Froese & Pauly 2014). They travel in compact groups of hundreds of thousands of fish. Many species of the Carangidae are important for the commercial fisheries (Shuaib & Ayub 2011).

Small pelagic fisheries make up the main economic and social activities for coastal communities on the North Coast of Java Sea, however catches have been fluctuating considerably during the last thirty years (Fauzi & Anna 2012). The knowledge on quantitative aspects is an important tool for the adequate management of any fish species (King 2007). The purpose of the present study was to assess various features of the biology of *S. crumenophthalmus* and *A. djedaba* occurring in Semarang coastal waters, Indonesia. The results of this study will provide valuable information to all stakeholders.

Material and Method

Study site. Twice each month (fortnightly) 50 specimens each of fish species *S. crumenophthalmus* and *A. djedaba* were randomly collected from the fish lot at Tambak

Lorok Auction Hall during the period from middle of April to middle of June the same year 2015. A total of 5 times fortnightly samples each, and 250 specimens each for both fish species were collected altogether.

Species identification. During sampling the identification of *A. djedaba* was confirmed according to Sivakami (1990), while *S. crumenophthalmus* was confirmed according to Argente et al (2014).

Measurements. The following measurements were taken for each specimen to the nearest 0.1 cm: standard length (SL) - from the tip of the snout to the baseof the caudal fin; body weight (BW) of each fish was taken to the nearest 0.01 g with a digital balance (Sartorius). The fish were later dissected from the abdominal region and their sexes were determined by visual examination of the gonads. The gonads werethen removed carefully and their weights taken to the nearest 0.01 g with the help of a digital balance.

Gonadosomatic index. To determine the breeding season, gonadosomatic index (GSI) was assessed for both sexes of both fish species separately by the method described by White et al (2003).

$$GSI = GW/SW \times 100$$

where GW is gonad weight and SW is somatic weight. SW was calculated as total weight of fish minus gonad weight.

Length-weight relationship. The length-weight relationships were estimated according to the equation (Froese 2006):

$$W = a * SL^{\beta}$$

where *W* is the derived weight, *SL* is standard length, *a* is the intercept of regression curve and *b* is the regression coefficient. The values of *a* and *b* values were estimated from the $\log_{10}$ transformed values of length and weight equation:

$$\log W = a + b * \log_{10} L$$

The length weight relationship for both species were calculated separately. The Student's t-test was used to confirm whether *b* values (slopes) obtained for the length-weight relationships were significantly different from the isometric value ($b = 3$).

Sex-ratio. Based on gonad identification, adult individuals were listed into males (with milt) and females (with egg). Chi square (x^2) test was also used to confirm observed sex-ratios with the expected normal Mendelian sex ratio of 1:1 (Shuaib & Ayub 2011).

Condition factor. Fulton's condition factors (Froese 2006) were determined using Fulton's condition factor equation:

$$K = 100W/L^3$$

where *K* is the Fulton's condition factor, *W* is the whole body weight, and *L* is the body length (cm). Student's t-tests were used to confirm observed condition factors with the theoretical *K* of 3 ($K = 3$).

Results and Discussion

Length-weight relationship. Length at first maturity (L_m) for *S. crumenophthalmus* and *A. djedaba* were 12.5 cm and 10.3 cm respectively, while their asymptotic lengths (L_∞) were 23.8 cm and 23.0, respectively. For length-weight relationships the value of '*b*' for *S. crumenophthalmus* (Figure 1) was 2.857 and for *A. djedaba* (Figure 2) was 2.939.

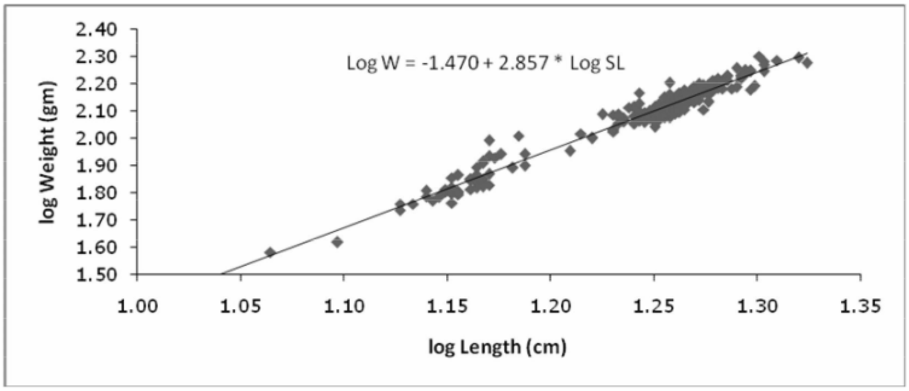

Figure 1. The regression equation for length-weight of *S. crumenophthalmus* is Log W = -1.470 + 2.857 Log SL, with n = 250, r = 0.977, r^2 = 0.995, 95% CL of a = -1.470 (-1.566 – -1.374), 95% CL of b = 2.857 (2.780 – 2.934); significant (t = 72.810; p = 0.000) regression.

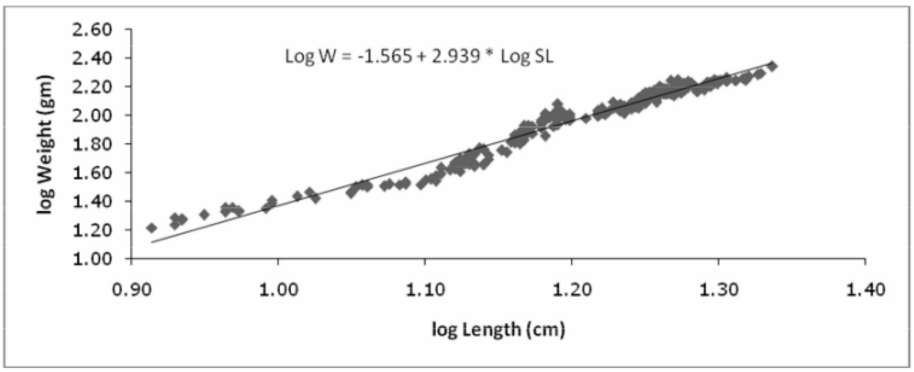

Figure 2. The regression equation for length-weight of *A. djedaba* is Log W = -1.565 + 2.939 Log SL, with n = 250, r = 0.980, r^2 = 0.961, 95% CL of a = -1.565 (-1.655 – -1.476), 95% CL of b = 2.939 (2.864 – 3.013); significant (t = 77.618; p = 0.000) regression.

The regression equation for length-weight of *S. crumenophthalmus*:

$$\text{Log W} = -1.470 + 2.857 * \text{Log SL } (r^2 = 0.955)$$

The regression equation for length-weight of *A. djedaba*:

$$\text{Log W} = -1.565 + 2.939 * \text{Log SL } (r^2 = 0.961)$$

Student's t-test revealed that regression slope of *S. crumenophthalmus* was significantly different (p = 0.046) (Table 1) from the theoretical slope of value 3. T-test for the regression slope of *A. djedaba* also revealed significantly different (p = 0.046) (Table 1) from theoretical slope of value 3.

Table 1

Values for t-test for the slopes of regression equations with theoretical b = 3 of *S. crumenophthalmus* and *A. djedaba* collected from landings at Tambak Lorok Auction Hall during the study

Species	*b (slope)*	*S.E. of b*	*Theoretical b*	*T-test*	*p*
S. crumenophthalmus	2.493	0.215	3.000	-2.360	0.046
A. djedaba	2.019	0.417	3.000	-2.354	0.046

Sex ratio. Sex composition for *S. crumenophthalmus* with N = 244 showed males dominated by 52.00% (n = 126) while females only 48.00% (n = 118). For *A.*

*djedaba*with N = 230 sex composition showed males dominated by 52.00% (n = 119) while females only 48.00% (n = 111). Chi square (x^2) test revealed that the sex ratio for both fish species did not significantly deviate from the normal Mendelian ratio 1:1 (Tables 2 and 3).

Table 2

Chi square test for sex ratios of *S. crumenophthalmus* collected from landings at Tambak Lorok Auction Hall during the study

Dates	*Total*	*Male*	*Female*	*x^2*	*Probability*
Middle of April	44	21	23	0.091	0.763
End of April	50	24	26	0.080	0.777
Middle of May	50	27	23	0.320	0.572
End of May	50	26	24	0.080	0.777
Middle of June	50	28	22	0.720	0.396
Total	244	126	118	0.262	0.609

Table 3

Chi square test for sex ratios of *A. djedaba* collected from landings at Tambak Lorok Auction Hall during the study

Dates	*Total*	*Male*	*Female*	*x^2*	*Probability*
Middle of April	36	17	19	0.111	0.739
End of April	44	20	24	0.364	0.546
Middle of May	50	27	23	0.320	0.572
End of May	50	26	24	0.080	0.777
Middle of June	50	29	21	1.280	0.258
Total	230	119	111	0.278	0.598

Breeding season based on gonadosomatic index. As shown in Figures 3 and 4, the GSI values for both males and females of both fish species *S. crumenophthalmus* and *A. djedaba* showed maturity was already attained by April, and further developed in the months that followed. This indicated that breeding periods of both *S. crumenophthalmus* and *A. djedaba* also passes through months April through to June.

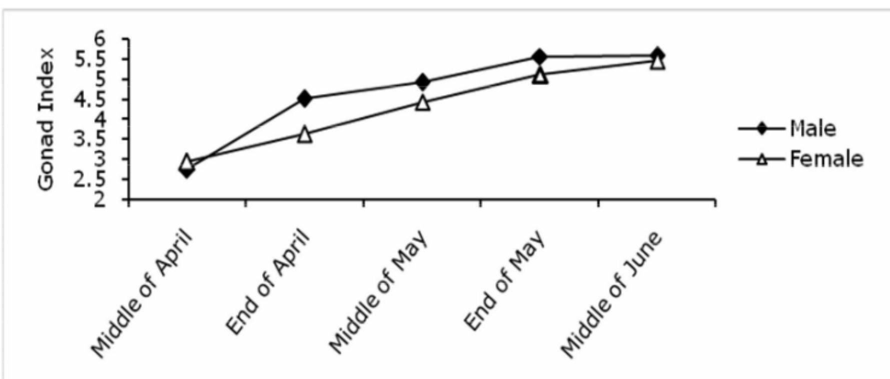

Figure 3. Fortnightly average Gonadosomatic index (GSI) for male and female of *S. crumenophthalmus* collected from landings at Tambak Lorok Auction Hall during the study.

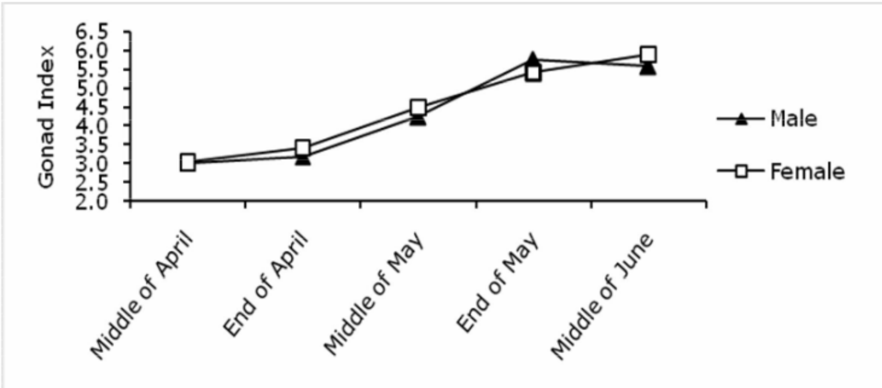

Figure 4. Fortnightly average Gonadosomatic (GSI) for male and female of *A. djedaba* collected from landings at Tambak Lorok Auction Hall during the study.

Condition factor. Average condition factors (*K*) of males and females of *S. crumenophthalmus* were 2.318 and 2.300, for *A. djedaba* 2.422 and 2.432, respectively. T-tests (Tables 4 and 5) for *K* showed both males and females for both species all significantly lower (p = 0.001) than theoretical *K* of 3.

Table 4

Values for t-tests for the condition factor (*K*) of males and females of *S. crumenophthalmus* with the theoretical *K*

Sex	*Observed K*	*S.E. of observed K*	*Theoretical K*	*t-test*	*p*
Male	2.318	0.092	3.000	-7.413	< 0.001
Female	2.300	0.052	3.000	-13.373	< 0.001

Table 5

Values for t-tests for the condition factor (*K*) of males and females of *A. djedaba* with the theoretical *K*

Sex	*Observed K*	*S.E. of observed K*	*Theoretical K*	*t-test*	*p*
Male	2.422	0.074	3.000	-7.812	< 0.001
Female	2.432	0.082	3.000	-6.932	< 0.001

Stock assessment is vital for sustainable resource management (Pranoto et al 2005; Yusuf et al 2009; Redjeki 2013). The overall length-weight relationship of both fish species *S. crumenophthalmus* and *A. djedaba* showed the predictability of weights given their lengths data were all statistically significant. This conveys that there is strong relationship between their lengths and weights increment and that the models developed from these lengths and weights data are reliable and can be used in the conversion between fish length and weight to provide some measure of biomass. The *b* values (slopes) of males and females of *S. crumenophthalmus* showed 'non-significant' deviations away from the theoretical *b* with males slightly higher and females lower while the species' overall *b* was significantly lower than the theoretical *b*. The overall *b* of the species also included juveniles while the males and females were merely adults alone. Overall *b* for *S. crumenophthalmus* was lower than the theoretical *b* which indicated that majority of the large specimens have changed their body shape to become more elongated or small specimens were in better nutritional condition at the time of sampling (Froese 2006).

The *b* values (slopes) of males and females of *A. djedaba* were both lower than the theoretical *b* with females significantly lower and males non-significantly lower while the species' overall *b* was significantly lower than the theoretical *b*. The overall *b* of the species also included juveniles while the males and females were merely adults alone.

Similar to that of *S. crumenophthalmus*, the overall *b* for *A. djedaba* was less than the theoretical *b* which indicated that majority of the large specimens have changed their body shape to become more elongated or small specimens were in better nutritional condition at the time of sampling (Froese 2006).

The overall sex-ratio of fish species *S. crumenophthalmus* did not deviate further from the normal Mendelian ratio of 1:1, that is males and females were near even in number in the population. The fortnightly distribution of sexes for *S. crumenophthalmus* in all of the dates also showed 'non-significant' deviation from the normal Mendelian ratio. However females were observed to be dominant in the earlier dates of the study while males dominated the later dates.

For fish species *A. djedaba* the overall sex-ratio also did not deviate further from the normal Mendelian ratio of 1:1; males and females were near even in number in the population. Fortnightly distribution of sexes for *A. djedaba* in all of the dates also showed non-significant deviation from the normal Mendelian ratio. However, in a similar scenario to that of *S. crumenophthalmus*, females of *A. djedaba* were observed to be dominant in the earlier dates of the study while males dominated the later dates. A similar study elsewhere (Shuaib & Ayub 2011) on sex-ratios of *A. djedaba* with a total of 390 (n = 390) adult specimens of which males with a total of 188 (n = 188) while females a total of 202 (n = 202) showed 'non-significant' ($p > 0.05$) Chi square test result, indicating a not significant deviation from the normal Mendelian ration of 1:1.

Any deviation in the sex ratio could be due to partial segregation of mature forms through habitat preferences (Reynolds 1974), due to migration (Collignon 1960) or behavioral differences between sexes (Polonsky & Tormosova 1969), thus rendering one sex to be more easily caught than another.

Fortnightly gonadosomatic index (GSI) analysis (Hartati et al 2005) for males and females of *S. crumenophthalmus* showed the lowest values in the beginning (middle of April) and progressively increased towards the end with the highest GSI recorded in middle of June. This indicated that the breeding period of *S. crumenophthalmus* falls through months April through to June. Several studies have shown that *S. crumenophthalmus* reproduction extends over a period of 6 to 7 months: between March and September (Tobias 1987) or April and September (Kawamoto 1973; Clarke & Privitera 1995).

Fortnightly gonadosomatic index (GSI) for males and females of *A. djedaba* showed the lowest values in the beginning (middle of April) and steadily increased towards the end with the highest GSI recorded in middle of June. This also indicated that the breeding period of *A. djedaba* also falls through months April through to June. A study of *A. djedaba* from Cochin waters India noted the peak breeding period for this species to be during May to November (Sivakami 1990). The current study also confirmed that a larger proportion of the population already attained maturity by May and the gonads progressively increased in the months that followed.

When compared to the theoretical value of the condition factor (b = 3), the average condition factors (K) for both sexes of fish species *S. crumenophthalmus* were significantly lower. This indicates that both sexes of *S. crumenophthalmus* experienced negative allometric growth (decrease in relative body thickness or plumpness), which is decrease in condition or form with increase in length (Froese 2006). The average condition factors for males and females of *A. djedaba* as compared to the theoretical condition factor (b = 3) were also significantly lower. Both sexes of *A. djedaba* also experienced negative allometric growth (decrease in relative body thickness or plumpness) (Froese 2006). The K value was greatly influenced by the stage of development of the reproductive organs. Besides, there are also other factors that are known to influence the K value and this include, age of fish, sex, season of maturation, fullness of gut, type of food consumed, amount of fat reserved and degree of muscular development (Abowei 2010).

Conclusions. There were strong relationships between the lengths and weights of *S. crumenophthalmus* and *A. djedaba* where there is high dependency of weight on length. Both fish species were experiencing negative allometry growth. Breeding periods for both fish species also falls through months April through to June. Gonad development during spawning season is one factor that affects condition factors of fish which is also evident in this study. Sex ratios for both *S. crumenophthalmus* and *A. djedaba* from Semarang waters were near even according to normal Mendelian ratio of sexes.

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