



Biology aspects and length-weight relationship of squid *Loligo chinensis* in the waters of Lamongan Regency, East Java Province, Indonesia

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Abstract. Lamongan Regency waters in East Java Province is one of the squid fishing ground. The dominant squid which is captured in this area is *Loligo chinensis*. This study was conducted to determine the relationship of length-weight and condition factor of squid *L. chinensis* in Lamongan Regency waters. During this research, measurement was conducted on 882 squids consisting of 450 females and 432 males. Mantle length of the females ranged from 46 to 380 mm and their weight ranged from 5 to 410 g. Mantle length of the male ranged from 45 to 290 mm and 6 to 360 g weight. They was negative allometric pattern, width weight relationship had equation (all samples) $W = 0.96932 L^{1.09444}$ and (males) $W = 0.77936 L^{1.75422}$ and (females) $W = 1.15228 L^{1.03104}$. Length at first mature was 124.74 mm (male) and 113.57 mm (females). The first mature size gonads (Lm), then the first long suspected mature gonads squid binoculars is 12.06 cm. The observation of reproductive biology, gonad maturity level (GML) squid binoculars didominasi by squid ripe gonads, ie GML IV 36.6%, GML III 31.2%, GML II 24.6% and GML I 5.4%.

Key Words: condition factor, gonad maturity level, negative allometric, reproductive biology.

Introduction. Squid is one of the main fishery commodities in the Province of East Java. In 2016, the squid production of this area reached 7,650 tons, or 5.43% of the national squid production (Ministry of Marine Affair and Fisheries, Indonesia 2013). The waters of Lamongan Regency are one of the squid fishing ground in the Province of East Java. The results of research conducted on squid in the waters of Bangka by Sari (2014) showed two types of squid namely *Loligo chinensis* and *Sephia* sp. with the dominant catch by fisherman of *L. chinensis*. Fishing gear used by local fishermen to catch squid is stationary lift net and squid jigging. According to Carpenter & Niem (1998) *L. chinensis* is found in the waters of the East China Sea, South China Sea, the Gulf of Thailand, the Arafura Sea, Timor Sea and the waters of northern Australia. These studies were about *Sepioteuthis lessoniana* types, while *L. chinensis* has not been studied in Indonesia. Therefore, the researchers were interested in studying the growth of *L. chinensis* in the waters of Lamongan Regency. This study aimed to determine the length-weight relationship and to estimate the relative condition factor of squid *L. chinensis* caught in the waters of Lamongan Regency.

Material and Method. This research was conducted from January to August 2014. Squid *L. chinensis* were caught by the fishermen using stationary lift net at fish landing sites in Brondong, Lamongan Regency, Indonesia. The estimation of the length-weight relationship used the formula $W = \alpha L^\beta$ (Ricker 1979), where W = weight of squid (g), L = mantle length of squid (mm), α = constant or intercept and β = regression coefficient. By using the least squares method, the equation was transformed into a linear form, $\log W = \alpha + \beta \log L$. β value was then tested to determine the type and pattern of growth of the squid. Testing was conducted to determine whether the β value is equal to three or not by using the t test (Walpole 1993). Condition factor or squid Ponderal Index was

calculated based on the length-weight relationship using the formula $K_n = W/\alpha L^b$ (Effendie 1979). The data used in this study consisted of primary and secondary data. Primary data were collected by observation and direct measurement of the catch fishermen. The taking process of sampling squids was performed by using stratified random sampling to represent the size of the squids. The relations width and weight of squid was estimated using the log form of the allometric growth equation: $W = a L^b$, Where: W = Weight, L = length of the mantle, a & b = Constant. Length-weight relationships allow the conversion of growth-in-length equations to growth-in-weight for use in a stock assessment model.

Results and Discussion. Squid *L. chinensis* caught during the study amounting 882 pieces, consisted of 432 males of squid and 450 females with average sex ratio 1:1.04. Number of females of *L. chinensis* is higher than the males, this condition can be seen from the sex ratio of more than one. The imbalance number of males and females of *L. chinensis* is predicted by the difference of behavior and the fishing factor. This is in accordance with the opinion of Nikolsky (1963), stating that the comparison of sexes can change towards and during the spawning period. To examine the balance of males and females, it shall be conducted the Chi Square test on 95% confidence interval, the result of test showing that there was no real difference between the proportion of males and females of *L. chinensis*. Mantle length of the females ranged from 46 to 380 mm and their weight ranged from 5 to 410 g. Mantle length of the male ranged from 45 to 290 mm and 6 to 360 g weight.

The results of Yunrong et al (2013), in Beibu Bay - China emphasized that the length of *L. chinensis* male and female coats in general was 49 to 438 mm weighing 7.3733 g. Similar values with slight differences has been reported by Sukramongkol et al (2006) in Andaman Bay, Thailand with *L. chinensis* length between 50 to 286 mm for male and 46 to 235 mm for female.

Oktariza et al (2015) captured *L. chinensis* males of 144-176 mm (20.11%) and female with length of 144-176 mm (43.50%).

Observation on the study location showed that male *L. chinensis* can reach a larger size than females. The growth of female *L. chinensis* is entirely completed before the maturation of the gonads. Meanwhile, the male growth keeps occurring even when the gonads are already mature. The value β of female *L. chinensis* is higher than that of the male. This shows that the growth of the females is faster than that of the males, and that the females reached the maximum size more quickly than males. First Mature size gonads (L_m), the results of observations made on the level of maturity of the gonads and size distribution of the 882 long-tail squid caught binoculars, then the first long suspected mature gonads squid binoculars is 12.06 cm. By using a 95% confidence level obtained long-range first ripe gonad is 10.7 cm to 13.6 cm. So the squid which already exceeds the size of the first ripe gonads totaling 644 tails squid (73.01%).

The observation of reproductive biology, gonad maturity level (GML) squid binoculars dominated by squid ripe gonads, ie GML IV 323 tail or 36.6%. While being mature gonads, namely the GML III 275 head, or 31.2%. Squid immature gonads are GML II as many as 217 head, or 24.6% and GML I as much as 48 animals or 5.4%. As well as squid that are or have that GML V spawn as many as 19 head or about 2.2%. First Caught size (L_c), L_c calculation used in accordance with the calculation L_c that is in use by Pope et al (1975) and Jones (1976) in Sparre & Venema (1999). Based on the results of size analysis was first caught on squid binoculars is 9.4 cm. The average value of male *L. chinensis* condition factor ranges from 0.69 to 1.13 and that of the females is from 0.57 to 1.04. These values indicate that the *L. chinensis* is less flattened in shape because the values are between 1 and 3. Values which are smaller than one indicate that the weight based on the observation is smaller than the weight based on the presumption of mantle length and vice versa. This condition, which is called 'sexual dimorphism', was also observed in the studies of *L. chinensis* and *L. duvaucell* in the Andaman Sea (Sukramongkol et al 2006), *L. chinensis* in the Gulf of Thailand (Chotiyaputta 1994) and North Queensland, Australia (Jackson 1993).

Table 1
 Calculation results of *Loligo chinensis* length-weight analysis

Squid samples	A	B	R ₂	R	N	W = aL ^b	Growth characteristics
Male	0.77936	1.75421	0.801	1.7542	432	W = 0.77936 L ^{1.75421}	Negative allometric
Female	1.15228	1.63184	0.785	1.6318	450	W = 1.15228 L ^{1.63184}	Negative allometric
All samples	0.96932	1.68444	0.801	1.6844	882	W = 0.96932 L ^{1.68444}	Negative allometric

A - Intercept; B - slope; R - correlation; N - number of samples; W - linear equations.

The value of K is a quantitative parameter of the condition of eating and food habits (Le Cren 1951). Relatively good feed conditions are showed by higher K score. The results of this study on *L. chinensis*, indicated a higher K value. This shows that larger is the squid, higher is the consumption of qualitative food (Effendie 1997). Squid food is related by size: feeds small squid on planktonic organisms and feeds more squid on crustaceans and small fish. The condition of squid feeding is also influenced by seasonal changes and by the habitat. Concerning the influence of seasonality on statolith growth of *L. chinensis* was studied by Jackson (1995). Thereby in the summer, in a short period of 60-100 days a rapid increase was observed in the statolith length, against a slower, gradually statolith length increase in the winter in 80-170 days. Male *L. chinensis* squids in the waters of Lamongan Regency have bigger length and weight than the females.

Conclusions. Mantle length of the female *L. chinensis* ranged from 46 to 380 mm and their weight ranged from 5 to 410 g. Mantle length of the males ranged from 45 to 290 mm and 6 to 360 g weight. Relationship of mantle length and body weight of male and female *L. chinensis* is different. Coefficient value of the females is higher than that of the males. This shows that the growth of female *L. chinensis* is faster than that of males. In other words, female *L. chinensis* reaches the maximum size faster than males does. The growth of *L. chinensis* is negative allometric.

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