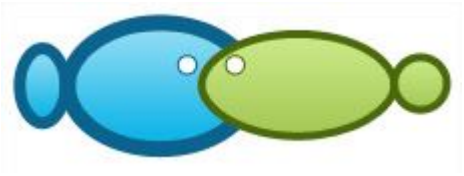

Length and weight relationship of squid (*Loligo* spp.) landed in Tegalsari coastal fisheries harbour, Tegal, Central Java

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Abstract. Fish catches landed at Tegalsari Fishing Port consist of demersal fish, a small number of pelagic fish and other species as squid (*Loligo* sp.). The catch of squid is landed in PPP. Tegalsasri in the last ten years (2009-2018) and it has achieved production of 38,074,434 kg, or an average of 3,807,443 kg every year. The results of measurements of length and weight from 300 squid samples, obtained a length between 11-21 cm with the largest frequency at 11 cm in length as much as 40 tails, and weighing between 48 and 150 grams with the largest ratio of the weight of 48 grams by 35 tails. While the results of the statistical calculation of the relationship of total length weight in the squid sample mentioned above obtained a linear regression equation Y = 1.7588x - 0.6715 so that $W = 0.6715L^{1.7588}$. Relationship between the length and weight of squid with a value (intercept) of 0.672; b (slope) of 1.759; and r (conversion coefficient) of 0.9695, indicates that squid landed in PPP. Tegalsari has a negative growth, which means that length growth is faster than its weight gain, thus the form of the body is elongated (binding). While the r-value of 0.9695 (only one), shows the high relationship with the height and height of the squid, that is, each length of the squid coat of 1 cm will affect the weight gain of 1.759 g.

Key Words: squid, growth, length-weight, correlation.

Introduction. Internationally, the annual capture production for the decade 2001-2010 for cephalopods (squid, octopus, and cuttlefish) in 2010 was 3.65 million. This was 15% less than the maximum for the 10 years up to 2010, which reached 4.31 million in 2007. In 2010, 2.98 million of the total cephalopods was squids, of which 48% was ommastrephids, 30% was loliginids and 2% was gonatids. The remaining 20% of squids were not identified (Arkhipkin et al 2015). Squids also has gained enormous splendor in recent years due to increasing demand in export trade. This is mainly due to abundance and high nutritional quality (Tehseen et al 2019).

Squid is one of the most important resources in Indonesian fisheries, with the level of global resource use considered still relatively low compared to other fish resource utilization. Most of the catch is dominated by species of squid in coastal waters with continental exposure. As Widodo et al (2012) stated, the level of utilization of the resources of oceanic squid located offshore is estimated relatively low. Squid is a distinguished commodity and has high economic value because of the delicious taste of meat and is in demand by many people. In Indonesia, which has a waters area of about 5.8 million km², squid catch is less than the total production of Indonesian fisheries which is 0.8% (Triharyuni et al 2012).

Fishery commodities landed at Tegalsari Fishing Port are dominated by types of demersal fish, including goldband goatfish (*Upeneus tragula*), peperek (*Leiognathus splendens*), tiga waja (*Pennahia argentata*), catfish (*Arius thalassinus*), grouper (*Cromyleptes altivelis*) and stingray (*Trigon sephen*). The pelagic species are dominated by the types of mackerel (*Scomberomorus* sp.), mackerel (*Auxis thazard*), and squid (*Loligo* sp). Production volume landed in Tegalsari fishing port in 2018 reached 21,196.64

tons with a production value of Rp. 408,952,180,000 (four hundred eight billion nine hundred fifty two million one hundred eighty thousand rupiahs) (as shown in Table 1). During the past 10 years, fish production has been landed in Tegalsari fishing port. Tegalsari shows an average increase of 17.19% for volume and 42.48% for the value of production each year. The distribution of fish landings every month in Tegalsari Fishing Port shows that the fishing season is almost evenly distributed throughout the year. From the results of interviews, the fishing ground of the fishermen who landed the fish caught in Tegalsari is mostly in the waters of the Java Sea, with the duration of fishing trip varying between 1 and 60 days. The productivity of fish capture activities tend to fluctuate by considering the annual production (Hendrayana & Hartanti 2018).

Table 1

Fishery commodities landed in Tegalsari fishing port during 2009-2018

No.	*Year*	*Volume (kg)*	*Percentage (%)*	*Production value (thousand)*	*Percentage (%)*
1	2009	12.001.633	0	48.617.327	0
2	2010	36.451.812	203.72	208.950.673	329.79
3	2011	44.414.927	21.85	264.724.622	26.69
4	2012	45.486.481	2.41	268.213.219	1.32
5	2013	50.870.625	11.84	316.971.667	18.18
6	2014	49.771.607	-2.16	490.693.093	54.81
7	2015	48.837.067	-1.88	621.889.982	26.74
8	2016	31.769.923	-34.95	649.943.640	4.51
9	2017	19.113.828	-39.84	410.643.799	-36.82
10	2018	21.196.637	10.90	408.952.180	-0.41
Amount		359.914.540	171.89	3.689.600.202	424.80
Average		35.991.954	17.19	368.960.020	42.48

Tegalsari Fishing Port (2019).

Squid fishing activities landed in Tegalsari Fishing Port are done using several types of fishing gear, such as purse seine nets, mini trawl, squid nets, hand line. Based on Tegalsari Fishing Port Statistics in 2019, in the last ten years (2009-2018) the production of squid fish reached 38,074,434 kg or an average of 3,807,443 kg per season. Thus the average rate of squid production in that period increased by 64.15% (Table 2).

Table 2

Squid production in Tegalsari fishing port during 2009-2018

No.	*Year*	*Volume (kg)*	*Percentage (%)*	*Production value (thousand)*	*Percentage (%)*
1	2009	379.628	0	7.267.485	0
2	2010	2.229.360	487.25	53.009.300	629.40
3	2011	3.926.990	76.15	97.862.587	84.61
4	2012	2.771.112	-29.43	69.098.950	-29.39
5	2013	3.372.772	21.71	84.290.575	21.99
6	2014	2.533.029	-24.90	126.577.190	50.17
7	2015	5.889.153	132.49	235.487.025	86.04
8	2016	7.996.819	35.79	374.318.856	58.96
9	2017	4.983.080	-37.69	249.154.000	-33.44
10	2018	3.992.491	-19.88	199.624.550	-19.88
Amount		38.074.434	641.49	1.496.690.518	848.46
Average		3.807.443	64.15	149.669.052	84.85

Tegalsari Fishing Port (2019).

This study aims to determine the level of relationship between the length and weight of squid (*Loligo* spp.) landed at the Fisheries Port of Tegalsasri Beach, Tegal City. A length analysis was carried out to see the condition of the mathematical relationship between the variable length of the coat and the weight of the squid which can be used as a tool to predict the growth of coat length through weight or vice versa (Karnik & Chakraborty 2001). Beside that the length-weight relationship and the condition factor are also important parameters in stock assessment studies, since it provides data about the growth of the squid (Granados-Amores et al 2019).

Material and Method

Description of the study sites. This study was conducted in Tegalsari Fishing Port Central Java, with the fishing ground in the north coast of Java. The research was conducted in 5 (five) months from October 2018 to February 2019. The fishing ground of squid caught and landed in Tegalsari Fishing Port mostly in the north Java Sea has the coordinates 05°21'00"–06°24'00" / 109°00'00"–116°00'00" (shown in Figure 1).

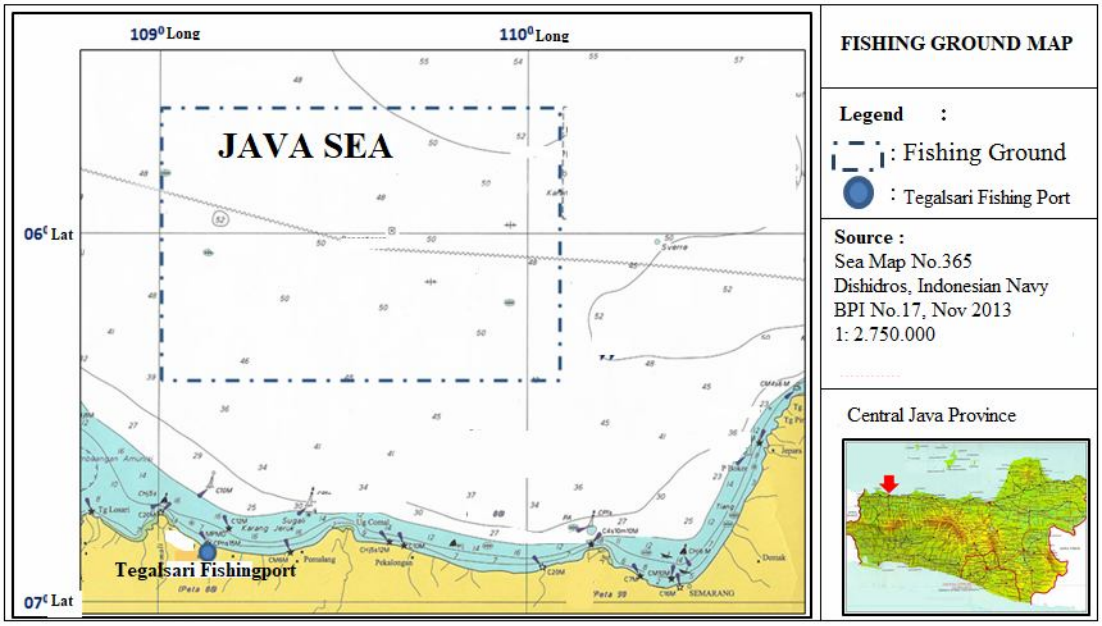

Figure 1. The fishing ground of squid.

Method. The sampling method was carried out by direct survey and measurement of the the length and weight of the squid landed at Tegalsari Fishing Port. Sampling was done randomly to the squid catches on every observation day.

Sparre & Venema (1992) state that in order to obtain an unbiased average estimate, the sample drawn must be a random sample, i.e each fish from the stock must have the same chance to be sampled assuming a random sample can be obtained. Length measurement is done by measuring the length of the mantle, the distance between the most prominent lateral and the posterior part using scientific ruler, and weighing the weight using a digital sitting scale CAMRY brand EK3650 model (Figure 2).

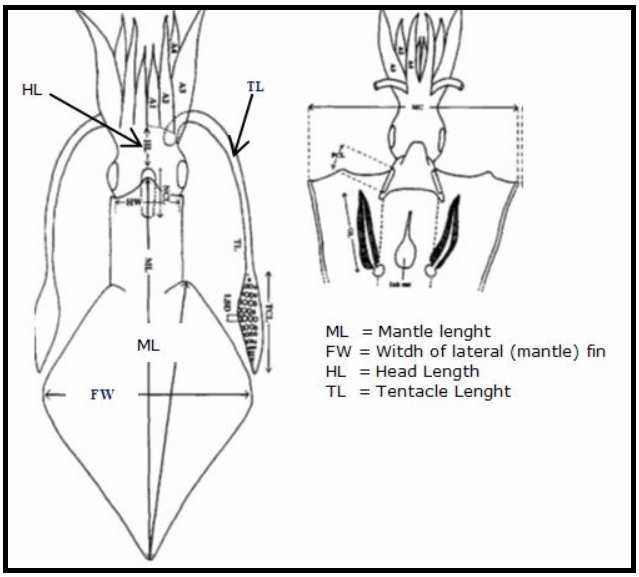

Figure 2. Morphometric measurement method for squid (Pierce et al 1994).

Data analysis. The relation of length and weight of squid (*Loligo* spp.) was analysed by using the equation (Effendie 2002):

$$W = aL^b$$

where: W = squid weight (gram);
L = squid width (cm);
a = intercept;
b = regression.

The value "a" and "b" gathered by using algorithm:

$$\text{Log } W = \text{Log } a + b \text{ Log } L$$

Whereas the growth criteria were analysed according to Ricker (1979):

1. if b < 3, the growth of squid is negative allometric (growth in length is faster than weight gain);
2. if b > 3, the growth of squid is positive allometric (weight gain is faster than length growth);
3. if b = 3, the growth of squid is isometric (length growth with added weight balance).

Results. The results of measurements of length and weight from 300 squid samples, obtained long data ranging from 11 to 21 cm with the largest frequency at 11 cm in length by 40, and the weight size ranged from 48 to 150 grams with the greatest frequency at a weight of 48 grams as much 35 tails. While the results of the statistical calculation of the relationship of total length and weight in the squid, it obtained a linear regression equation Y = 1.7588x - 0.6715 thus $W = 0.6715L^{1.788}$ (Figure 3).

Based on the calculation above, the value of the length and weight of the squid is obtained with the value of a (intercept) of 0.672; b (slope) of 1.759; and r (correlation coefficient) of 0.9695. Furthermore according to Fauziyah et al (2020) based on the "b" value the squid landed in Tegalsari Fishing Port has negative allometric growth, which means that long growth is faster than weight gain and the body shape tends to be elongated (thin). While the r value obtained is equal to 0.9695 (close to one), so it can be said that there is a close and positive relationship between the growth of the length and weight of the squid. Thus it can be said that every growth of the squid mantle length of 1 cm will result in a weight gain of 1.759 g.

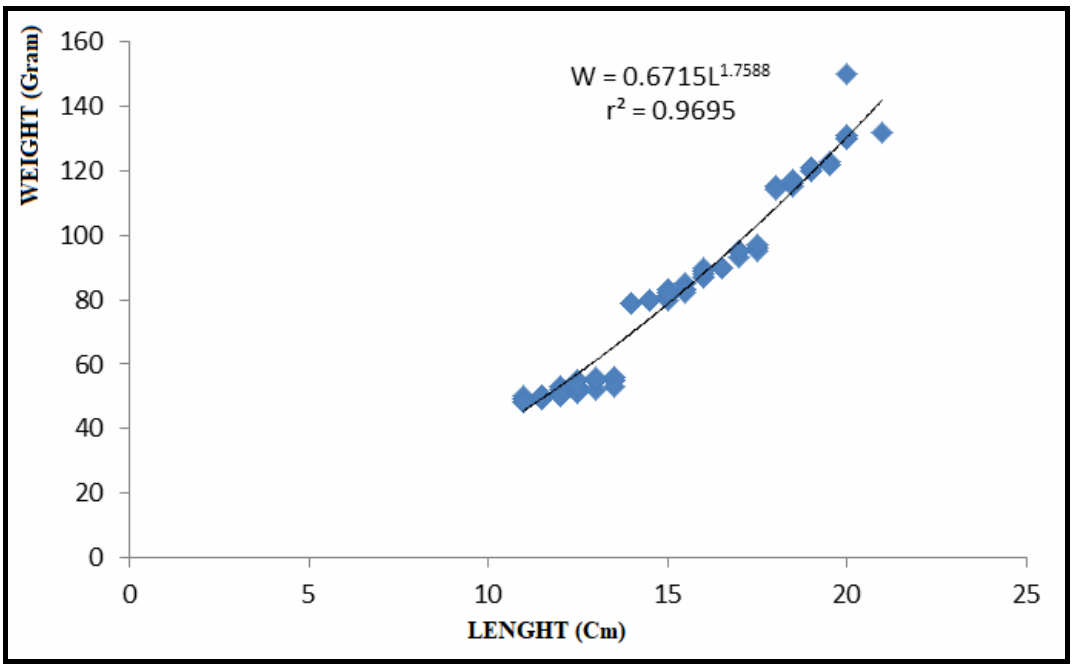

Figure 3. Graphic relationship of length and weight of squid (*Loligo* spp.).

Discussion. The data analysis of the relationship of length and weight of squid that landed in Tegalsari Fishing Port is shown on Table 3.

Table 3

Results of analysis of the length and weight of squid

Sample (n)	*Intercept (a)*	*Slope (b)*	*The correlation coefficient (r)*	*Length and weight relationship (W)*
300	0.672	1.759	0.9695	$W = 0.06715L^{1.7588}$

The growth of squid which landed in Tegalsasri Fishing Port during February to June has a negative allometric growth (tends to be thin). This could be occurred because of the fertility and less nutrient of the waters and also the pollutants of the waters that brought by several rivers into the Sea. As Sukimin et al (2002) stated, fish growth is influenced by several factors such as the quality of the environment and condition of the fish (age, offspring, and genetics). Furthermore, Yudha (2011) stated that nutrient availability is one of the factors that support the abundance of squid resources. Similarly, according to Nyunja et al (2002), the nutrients represent one of the main factors that influence the growth and reproduction of an organism, besides nutrient is also known as a factor that regulates patterns of abundance, migration, and distribution. Also regarding to Nomura & Yamazaki (1977), animals will approach light not only due to reactions to light sources but also due to feeding factors and one of the external factors that affect phototaxis in fish is the availability of nutrient around the light source.

According to Okgerman (2005), the study of long-term relationships is important to know because, with this information, we can know the pattern of squid growth in information about the environment in which the species lives and the level of squid health in general. The factor that seems to be influential is the positive phototaxis nature of the squid's own biology.

Conclusions. The length and weight relationship of the squid that landed at the Tegalsari Fishing Port during October 2018 to February 2019 tends to be allometric negative with an intercept value (b) 1.759 (< 3) and the length and weight relationship closely related to the value "r" by approaching to one (0.9695). This means that:

- the length of squid is growing faster than weight gain (b < 3);
- a close and positive relationship between length and weight growth (r = 0.9596);
- every 1 cm growth of the squid mantle will increase the weight by 1.759 g (b = 1.759).

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