Growth analysis of Asian seabass (*Lates calcarifer* Bloch 1790) based on morphometrics in BPBAP Situbondo, East Java

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Abstract. Asian seabass (*Lates calcarifer*) is an important food resource and has high economic value. This species has been farmed in aquaculture systems for the past several decades in many countries including Indonesia. In Indonesia, this species has been grown in numerous farms, one farm being the one belonging to the Association of Brackish Water Cultivated Fishery (BPBAP) of Situbondo. In this study, we examine the growth patterns of Asian seabass juveniles based on morphometrics using the truss morphometric method. Asian seabass juveniles are maintained at the following parameters: salinity 34 gr/L, dissolved oxygen 5.8 mg/L, temperature 31.2^{O}C and pH 8.1. Asian seabass juveniles at the age of 60 days have an average total length of 54 mm, at the age of 75 days they have an average total length of 73 mm and at 148 days they have an average total length of 117 mm. The growth pattern of each specimen is negative allometric, with the resulting b value of b<3. Thus, the growth rate of Asian seabass juveniles can be influenced by age and environmental factors in aquaculture.

Key Words: Asian seabass, *Lates calcarifer*, growth, morphometry.

Introduction. Kakap fish *Lates calcarifer* (Bloch 1790) known as seabass in Asia (Pethiyagoda & Gill 2012) or barramundi in Australia (Boonyaratpalin and Williams 2002; Ward et al 2008; Larson et al 2013; Pusey et al 2017) is an important fish for food production and has a high economic value on national and international markets (Mathew 2009; Pethiyagoda & Gill 2012; Vij et al 2014; Purba et al 2016; Nor et al 2019; Windarto et al 2019; Haque et al 2019). According to the Ministry of Marine Affairs and Fisheries of The Republic of Indonesia (2018), the total production of Asian seabass in 2016 amounted to 5.544 tons and in 2017 it increased by 25.051 tons.

Asian seabass (*Lates calcarifer*) is a catadromous species (fish that live most of their life in freshwater, but spawn in saltwater) (Moore and Reynold 1982; Vij et al 2014). This species distribution spreads from the tropical Australia (Hutchins 2001; Pusey et al 2010; Pethiyagoda & Gill 2012; Hammer et al 2012; Larson et al 2013; Pusey et al 2017) to the Asian countries (Randal and Lim 2000) bordering the Indian Ocean (Mishra et al 1999; Bijikumar & Sushama 2000; Manilo and Bogorodsky 2003). This species has also been utilized in aquaculture for the past several decades (Pethiyagoda & Gill 2012) in many countries such as Indonesia, Malaysia, Singapore, Taiwan, China, Hongkong, Brunei, Australia and Saudi Arabia (Chou and Lee 1997; Frost et al 2006; Zhu et al 2006; Rayes et al 2013; Windarto et al 2019). In Indonesia, this species has been cultivated in various regions, including Situbondo in which the Association of Brackish Water Cultivated Fishery (BPBAP) is located.

As a commercial and high-value fish (Ward et al 2008; Vij et al 2014), Asian seabass (*L. calcarifer*) needs attention during its development, although this species is quite easy to breed because of its high tolerance range for salinity (Moore 1979; Moore and Reynold 1982). In the early stages of growth, there are still problems such as low survival rates and relatively slow growth caused by external factors such as aquatic environmental conditions (Rayes et al 2013; Athauda & Anderson 2014). One effort to determine the quality of juveniles is to analyze the length-weight relationship of fish to determine the specific weight and length variations of individual fish or groups, as a guide to determine obesity, health condition, productivity and physiological conditions like gonadal development (Richter 2007; Blackweel 2000). This study aims to analyze morphometric characteristics and environmental conditions of Asian seabass raised at the BPBAP of Situbondo, to determine their growth patterns.

Material and Method

Description of the study sites. This research was carried out at the Association of Brackish Water Cultivated Fisheries (BPBAP) of Situbondo (S 7°41'04.9", E 113°52'14.7") from February to March 2020 (Figure 1). A total of 30 specimens were collected from three maintenance tanks, 10 specimens from each maintenance tank. The specimens were preserved in 96% alcohol solution for morphometric analysis.

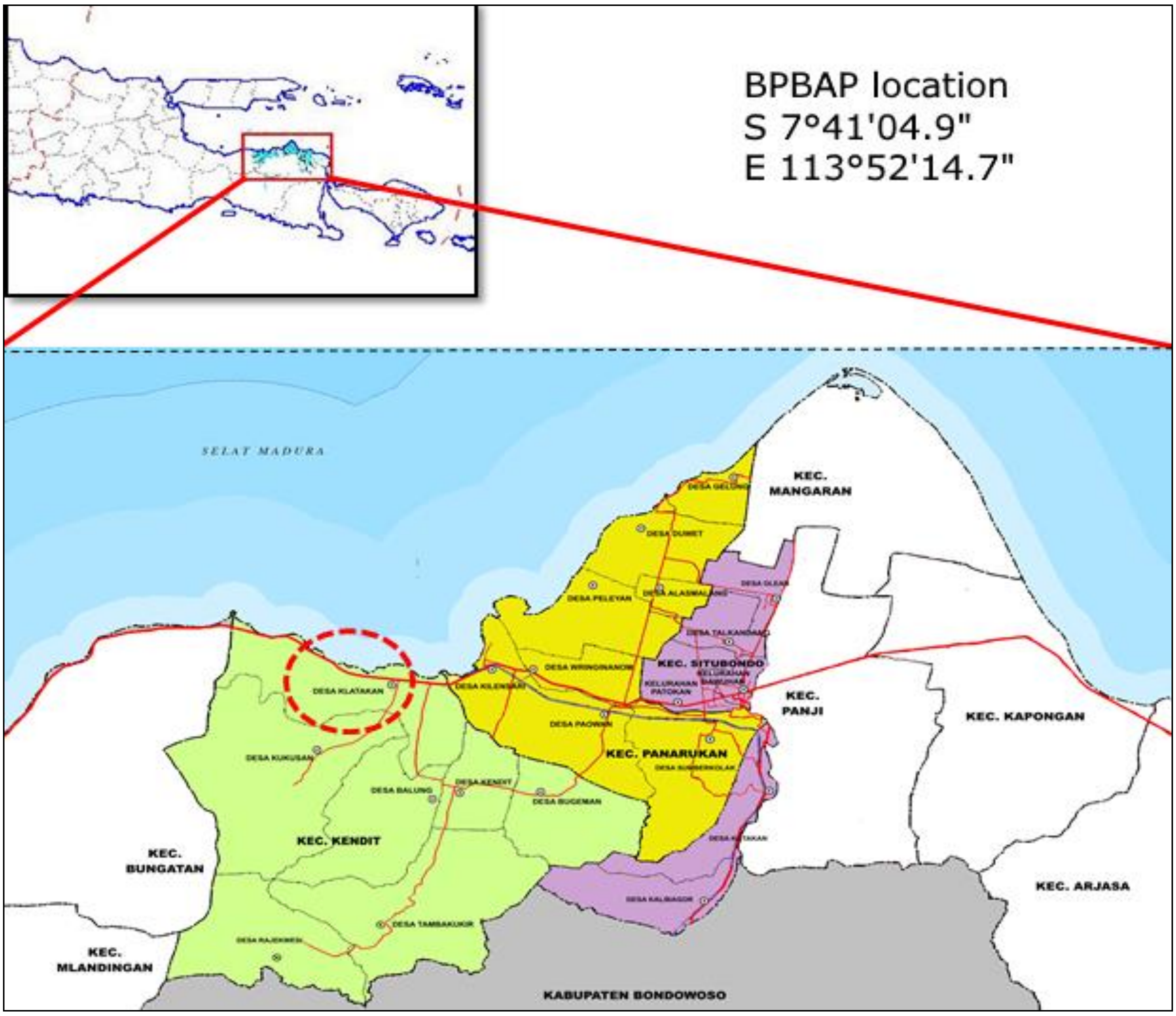

Figure 1. Map of BPBAP Situbondo, East Java.

Methods for measuring morphological characters. Morphometric measurements of the Asian seabass (*Lates calcarifer*) specimens were carried out through the morphometric truss method described by Gopikrishna et al (2006), that has been adapted to fit our experiment. This method places marking points on the fish body and determines distances between marking points. A total of 30 specimens were measured from 3 maintenance tanks, 10 specimens from each maintenance tank. Eleven morphometric characters were measured: total length (TL), standard length (SL), predorsal length (PredL), head length (HL), eye diameter (EL), preorbital length (PreoL), prepelvic length (PrepelL), prepectoral length (PrepecL), preanal length (PreaL), maximum body depth (MB), caudal height (CH), using calipers with 0.01 mm accuracy, while the total weight measurements of fish were determined using a digital scale with an accuracy of 0.1 gram (Figure 2).

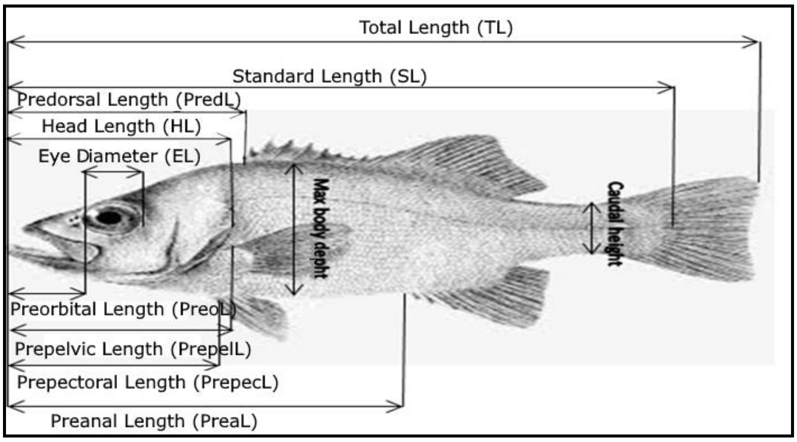

Figure 2. Measured morphological characters of *Lates calcarifer* (Gopikrishna et al 2006).

***Length-weight analysis**.* The analysis of the length-weight relationship is conducted through linear regression analysis (De Robert & William 2008) and by using the formula $W=aL^b$, where W is the body weight (g), L is the total length (cm), a is a coefficient related to body form and b is an exponent indicating the growth type according to its value. Length-weight analysis is used to calculate parameters a and b by measuring changes in weight and length. Weight can be considered a function of length. Measurement of length and weight gain of fish will bring up the value of b which can determine the type of fish growth. According to Effendie (2002), three types of values appear in the length and weight measurements of fish, $b<3$ shows a negative allometric growth type, $b=3$ indicates a balanced allometric growth type or isometric growth and $b>3$ indicates a positive allometric growth type.

Results and Discussion

***Morphometry of the body**.* Based on observations of Asian seabass morphometric characters at BPBAP in Situbondo, we determined the differences in size based on fish age (Table 1). Asian seabass which is raised in tank 3 is 148 days old and has an average total length of 119 mm. Fish that are raised in tank 1 are 60 days old with a mean total length of 46 mm. Fish that are raised in tank 2 is are 75 days old with an average total length of 76 mm. The difference in Asian seabass sizes from the three locations can be caused by age, sex, the nature of the fish itself and its environment (Chahyani et al 2016).

Table 1

Average morphometric measurement (mm) of Lates calcarifer from BPBAP in Situbondo

Tank	*TL*	*SL*	*PredL*	*HL*	*EL*	*PreoL*	*PrepelL*	*PrepecLL*	*PreaL*	*MB*	*CH*
1	46	39	26	11	4.0	5.0	0.20	0.13	21	22	9.0
2	76	62	33	16	5.0	6.0	0.29	0.20	24	30	12
3	119	102	41	20	6.0	6.0	0.36	0.35	68	43	15

Observation of the length-weight relationship of Asian seabass was carried out on each specimen. The results showed that the specimens taken at the three locations had average b values as follows: 0.9806 for tank 1, 0.9326 for tank 2 and 2.1669 for tank 3. The average values for a, also named R^2, were: 0.9481 for tank 1, 0.8725 for tank 2 and 0.8328 for tank 3. The results of the calculation of the length and body weight of fish (Table 2), indicate that there are variations in fish growth patterns, where the type of growth of each fish sample is negative allometric, with the resulting b value is smaller than 3 which means that the length increase is faster than the fish body weight gain. The value of b depends on physiological and environmental conditions such as temperature, pH, salinity, geographical location, sampling techniques (Jennings et al 2001) and biological conditions such as gonadal development and food availability (Froese 2006) and internal factors such as heredity, sex, age and parasitic factors or diseases (Fujaya 1999).

Table 2

Average measurements for length (mm) and weight (mg) of Asian seabass *Lates calcarifer* in BPBAP Situbondo, East Java

Tank	*n*	*Lr (mm)*	*La (mm)*	*Wa (mg)*	*R²*	*b*	*Wr*	*K*
1	10	41-52	46.8	51.1	0.9481	0.9806	105.67	2.86
2	10	72-83	76.7	64.6	0.8725	0.9326	124.96	2.28
3	10	117-122	119.9	115.4	0.8328	2.1669	126.34	2.22

Table 2 presents the tank, number of specimens (n), length range (Lr), average length (La), average weight (Wa), R^2 coefficient, b coefficient, average relative weight (Wr) and the condition factor (K). The correlation coefficient (R^2) of the results of the study ranged from 0.8328 to 0.9481. High correlation coefficient values indicate a close relationship between weight gain and length increase. The coefficient value (R^2) of the total weight gain variance can be explained by the graph of the length-weight relationship (Figure 3). Table 2 shows the average relative weight (Wr) value of Asian seabass obtained from the three maintenance sites with an average value of 118.99, this indicates that the waters in Situbondo BPBAP are still in a balanced state, meaning they provide sufficient food to sustain the Asian seabass growth. This is consistent with the statement of Muchlisin et al (2009), that relative weight values above 100 are said to show a state of balance. In addition, the value of the condition factor (K) obtained from the calculation results averages at 2.45.

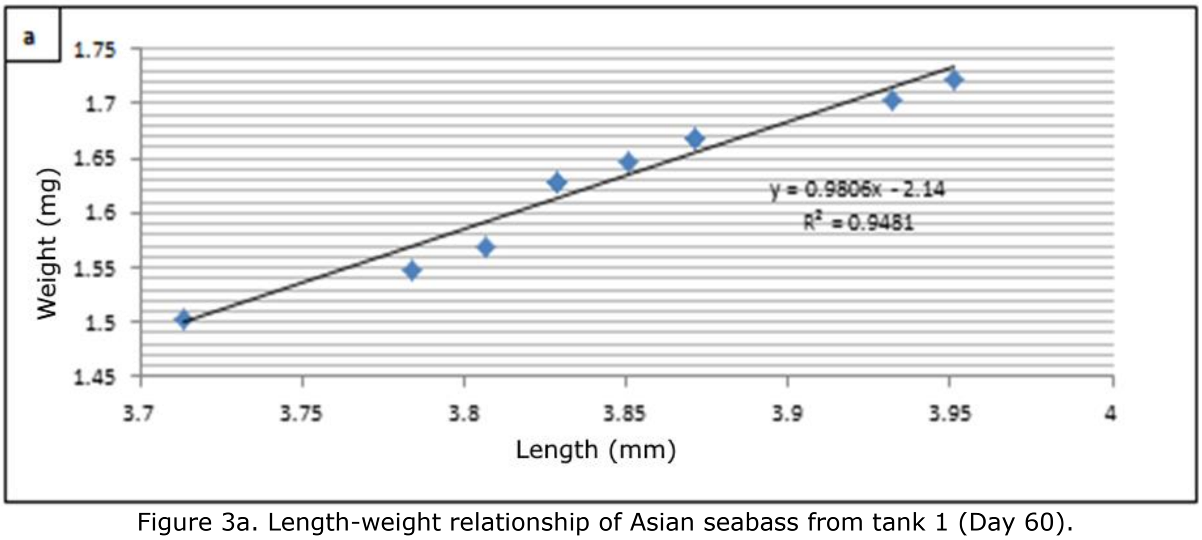

Figure 3a. Length-weight relationship of Asian seabass from tank 1 (Day 60).

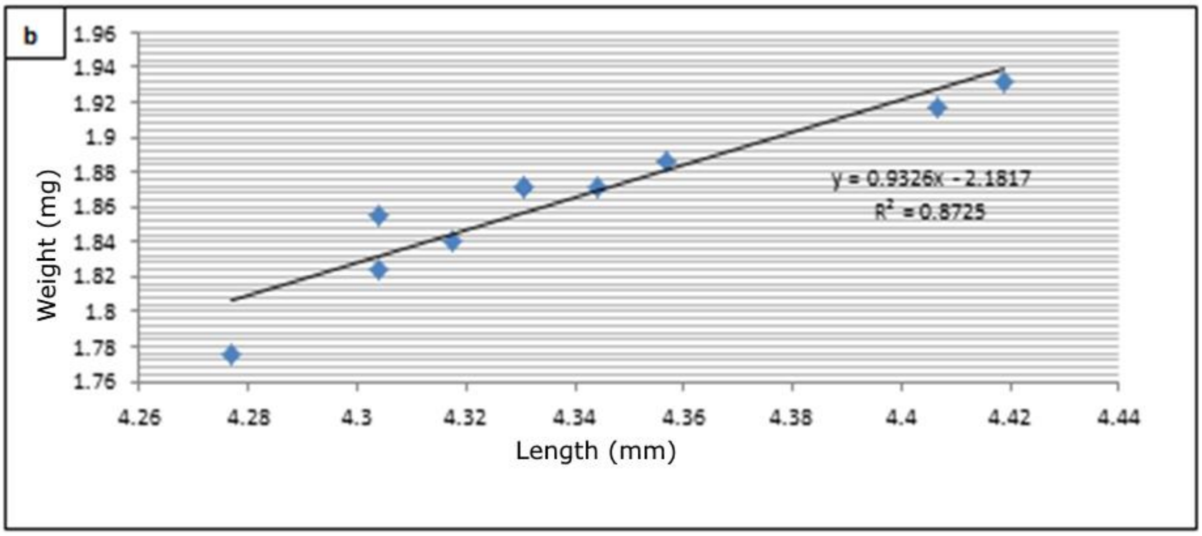

Figure 3b. Length-weight relationship of Asian seabass from tank 2 (Day 75).

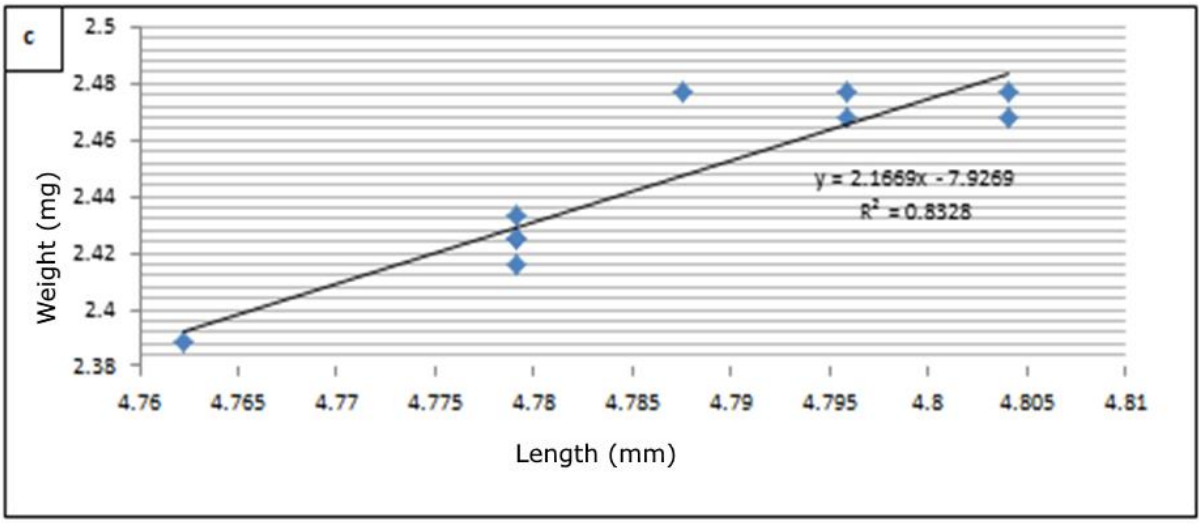

Figure 3c. Length-weight relationship of Asian seabass from tank 3 (Day 148).

Water quality. Asian seabass at BPBAP Situbondo lives at a high salinity of about 34 gr/L, dissolved oxygen of about 5-6 mg/l (normal), temperature of 29.5-31.5 ^{O}C (normal) and pH around 7.9-8.1 (normal). High levels of water salinity can affect Asian seabass life. According to the Indonesian National Standard (2014), Asian seabass juveniles (*Lates calcarifer*) can increase in body length by 2-3 cm within 8-10 days and can increase in weight with up to 0.5 g/day if the salinity levels are in the interval of 28-32 gr/L. The average relative weight (Wr) value of Asian seabass obtained from the three locations is 118.99 (Table 2), this indicates that the waters in BPBAP Situbondo are still in a balanced state for the life and growth of Asian seabass. Wr values above 100 indicate a balanced state (Muchlisin et al 2009).

Conclusions. Asian seabass from BPBAP Situbondo East Java, Indonesia has a growth pattern that varies in each specimen. The difference in morphological variations is influenced by age and water environment factors. In addition, Asian seabass growth patterns are allometric negative (b<3), so that the specimens grow in length faster than they gain body weight.

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