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RESEARCH NOTE

POPULATION GROWTH OF GREEN MUSSEL, *Perna viridis* Linnaeus FROM SOUTHERN PART OF THE MALACCA STRAITS

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Perna viridis Linnaeus, or locally known as green mussel or green-lipped mussel, has been cultivated in Malaysia since the early 1970s. Despite the advanced research and development for green mussels in Malaysia, the mass production had been limited to some areas such as Teluk Danga Johor and Kesang area, Sebatu in Melaka which could be due to the environmental factors (Manoj & Appukuttan, 2003; Kripa *et al*., 2009). The projects in Sebatu which is in Malacca Straits, abandoned in 2009 and left the production site in Kg. Kong Kong and Danga in the Straits of Johor to support the local demand for fresh mussels.

There were reports on the accumulation of heavy metal in the mussel collected from the coastal area of Johor (Yap *et al*., 2004). Kamaruzzaman *et al.* (2008) indicated the metal accumulation in tissues of green mussel collected from their study area in Muar river estuary. Mercury was also found to accumulate in the mussel (Rahman *et al*., 2009). The condition could be related to the intensive of urbanization activities. Such pollution status obviously affects the preference on green mussel as cheap protein supply for the nation. It further hindered the interest to improve the green mussel industry in Malaysia.

There is little progress in the research of green mussel in Malaysia since then (Azman *et al.,* 2012; Soon & Ransangan, 2014; Abdullah *et al*., 2014; Soon & Ransangan, 2016). Sufficient knowledge on the natural stock, population and exploitation level would be very essential as to start to manage the production activity (Nurul Amin *et al*., 2005). Background knowledge on the ecology and growth would contribute to the success of any management plan for the sustainable production. This study aimed to evaluate the growth and exploitation level of green mussel in one of the most popular place for green mussel production in Malaysia, the Kesang coastal area in the Straits of Malacca. It will become significant model for the growth and could be used as the benchmark for status of this natural resource.

Southern part of the Peninsular Malaysia receives the influence of the Straits of Malacca which is known as the busiest straits in the world. Kesang coastal area was chosen as the study area because of the natural availability of mussel seeds in the area. The *P. viridis* platforms were located at 1º 19.164' N, 103º 35.924' E (Figure 1). The mean sea depth in this area was about 7m. Field samplings were carried out monthly starting from August 2007 to July 2008.

Water parameters, the temperature, salinity, pH and dissolved oxygen, were measured *in-situ* using a hydro lab multi-probe meter. Samples of *P. viridis* were collected from those attached to rope collectors firstly deployed during the early months of the study period. 400 nylon rope collectors with 2m long and attached with weighted brick on each bottom were set up. Spats of *P. viridis* used the rope collector as their substrates to grow. Each collector was placed on the bamboo with 1 meter interval and three rope collectors were taken randomly and preserved with 10% formalin. Samples were then brought back to the laboratory for further analysis.

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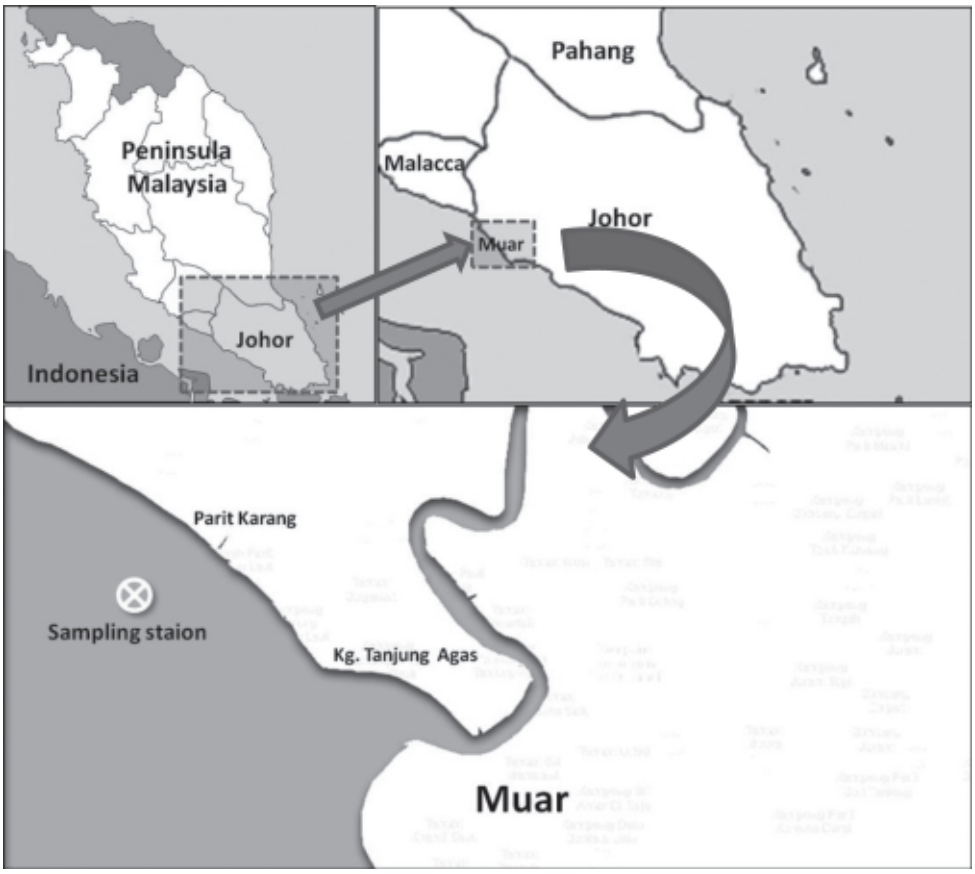

Fig. 1. Sampling Station map in Kesang coastal water, the Straits of Malacca.

Three rope collectors were brought back to laboratory each month for analysis. In the laboratory, about 150-200 green mussel samples from the ropes were washed to remove mud and other organisms. Length and height of the shell were measured using a vernier caliper. Samples were sorted on the oven tray and dried for 48 hours at 60ºC before recording the flesh dry weight. A total of 1848 samples were collected throughout the study period. All data for 12 months study were compiled for further analysis.

The fitting of the best growth curve was based on the ELEFAN I program (Pauly & David, 1981), which allow the fitted curve through the maximum number of peaks of the length-frequency distribution. With the aid of the best growth curve, the growth constant (K) and asymptotic length (L_∞) were estimated. The Von Bertalanffy growth function (VBGF) equation as defined by this equation, $L_t = L_\infty [1 - e^{-k(t-t_0)}]$ which was fitted to estimate the length at age curve using non-linear squares estimation procedures. L_t is the mean length at age t, L_∞ for asymptotic length, K for growth constant, t the age of *P. viridis* and t_o is the hypothetical age at which the length is zero. With L_∞ and K value, the growth performance index (φ') was calculated based from this equation, $\varphi' = 2\log_{10}L_\infty + \log_{10}K$ with L_∞ is asymptotic length and *K* is growth constant.

Temperature, salinity and dissolved oxygen values fluctuated in the study period from 2007 to 2008 but still in the range of good water condition. Salinity showed the biggest range compared to other parameters (Table 1). The values reached the condition of brackish water indicating potential effect of wet season. The water condition at Kesang coast during the study period was comparable to the report of Kamaruzzaman *et al.* (2008). Muar river estuary connected to the study area was also reported to have fluctuation in the water parameters as well (Rahman *et al.*, 2009).

Table 1. Environmental condition of the study area in Kesang, the Straits of Malacca in 2007-2008

Water parameter	Range value
Temperature (ºC)	27.3 – 29.9
Salinity (ppt)	24.53 – 30.19
pH	7.21 – 8.11
Dissolved oxygen (mg/L)	5.47 – 6.9

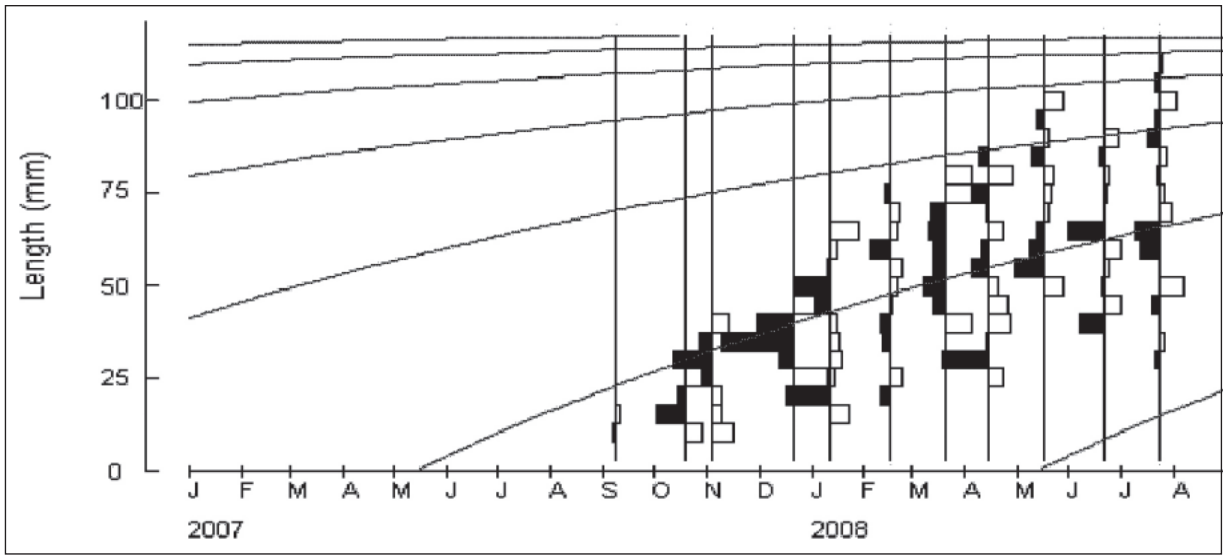

Fig. 2. Von Bertalanffy growth curves (L_∞ = 120.75 mm and K = 0.66 year^{-1}) for *P. viridis* superimposed on restructured length-frequency histograms. Black and white bars = positive and negative deviation from 'weighted' moving average of length classes. Number of sample = 1848 individuals.

Frequency data were obtained from the measurement of 168 samples each month. The growth for the first three months was seen between September and December 2007 with high percentage of spat in the size range of 10-15mm and 25-35mm respectively. The frequency of the size ranged between 60-80%. This indicated the fast growing month for the spats. The growth rate slowed down as they increase their age. Starting from February to May 2008, the frequency decreased between 20-55% when their size ranged mostly between 35-65mm. Between June and July 2008 the frequency for 60mm was as high as 30-40% only. L_∞ on the other hand is interpreted as the mean length of very old (infinitely old) mussel. It is called as the asymptotic length and in this case, was 120.75mm (Figure 2). Based on the reconstructed curve, the growth performance index (φ') was 3.983, as quantified by the ELEFAN-1of FiSAT software. The growth constant K= 0.66 year^{-1}, which is a curvature parameter determined how fast is the mussel approaches its L_∞.

The growth constant from this study showed lower value with 0.66^{-} year^{-1} compared to other similar studies in Malaysia especially from Choo and Specier (1979) and Al-Barwani *et al.* (2006). When the growth constant is compared to asymptotic length, the value was inversely proportional. In other word, the slow growing *P. viridis* usually has potential to grow big. *P. viridis* could grow bigger than the previous study but need more time. This condition could give better quality of brood stock to sustain the population in the coastal area. Nonetheless, the performance would be influenced by the availability of their food, the chlorophyll-a in the area (Soon *et al*., 2016). This could become the reason why the growth performance was lower than those found in Marudu Bay, Sabah. In contrast, the growth was higher than the species found in the Bangladesh water (Nurul Amin *et al.,* 2005).

Further study is required to determine the growth response of *P. viridis* towards fluctuation of sea water quality in the sea farming area. The ecological carrying capacity of the area could be the limiting factor for the population growth. With the unexpected environmental changes experienced in the Straits of Malacca and the southern part of Peninsular Malaysia, high quality of brood stocks is badly needed to sustain the industry in the country. Control on harvesting wild stock in the area is suggested as to sustain the source of wild seed in future.

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