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BIOLOGICAL INFORMATION AND SIZE AT MATURITY OF MALE CRENATE SWIMMING CRAB, *Thalamita crenata* FROM SETIU WETLANDS, TERENGGANU COASTAL WATERS

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Abstract: A study was conducted to determine the biological information (size at distribution, carapace width (CW) and body weight (BW)) and size at maturity of male crenate swimming crab, *Thalamita crenata* at Setiu Wetlands, Terengganu coastal water. Total of 121 samples of male *T. crenata* were collected from Setiu Wetlands, Terengganu in this study. The mean of CW and BW of males *T. crenata* was 6.69 ± 0.69 cm (range: 3.89 - 8.19 cm; n = 121). Only the healthy crabs reacted when being approached and having all of their appendages were chosen. Fifty crabs were randomly selected from the 121 samples and 40 crabs were classified as matured male (via morphological characteristics of vas deferens and spermatophore) with the most frequently size range was 7.0 - 7.9 cm CW (55%). This study concluded that the size at maturity (CW50) of male *T. crenata* occurred at 6.23 cm. Data obtained from this study could be used as the baseline data and useful in management and exploitation of this species for fisheries and aquaculture in Setiu Wetlands, Terengganu coastal water especially and Malaysia coastal water generally.

Keywords: Crenate swimming crab, *Thalamita crenata*, size at maturity, carapace width, body weight.

Introduction

Crenate swimming crab, *Thalamita crenata* is one of the most common and widespread swimming crabs of the mangrove creeks. Gut content analysis reveals that *T. crenata* is a generalistic predator, its diet being mainly composed of bivalves and slow-moving crustaceans (Cannicci *et al*., 1996). Then, *T. crenata* inhabits the rocky and muddy intertidal platforms in front of the *Sonneratia*-fringe and swims in the swamps during their activity periods (Vezzosi *et al*., 1995).

T. crenata can be recongnised by its olive to dark natural color and pale blue pincers. In addition, the front of the carapace has six equal-sized, rounded lobes between the eyes and on each area of the carapace are five teeth (Vezzosi *et al*., 1995). It is typically smaller than almost every other commercial crab species, with the carapace reaching an maximum width of approximately 8 cm, thus has a much lower market value. However, this species is preferable meals for the local community due to its flesh quality and can be classified as their daily diet due to abundance and easier to catch this species compared to the mud crab.

This information is often required to manage crab fisheries on sustainable basis. *T. crenata* is one of the predators in the food web of the mangrove forest and give an impact to the balance of the ecosystem in their habitat (Cannici *et al*., 1996). This shows that if this species is to be suffering from the exploitation, the food web in the ecosystem will become disrupted. One predator which are from the *Scylla* sp. are already suffering from overfishing activities in Setiu Wetlands. Predator role stand at the top of the food chain and without any reliable predator the food chain willl be in a total chaos (Ripple *et al.*, 2014). One of the predator roles is to make the other animals in the food chain to have fear by which will cause the other animals to eat less and this would avoid the overconsumption from occuring (Brown & Kotler, 2004).

As this species become demanded by the local people, nowadays they are still maintain in a high number, however we need to make some precautions as might be overexploitation occurs as such to the mud crabs in Setiu Wetlands. Biological information is important in understanding the behavior and characteristic of *T. crenata* and usefull in management of exploitation on *T. crenata* resources for capture fishery and aquaculture (Ikhwanuddin *et al*., 2009). More than that, the information about the size distribution, sex ratio, carapace width (CW) - body weight (BW) relationship and size at maturity can be used to investigate, study and understand those particular species mainly for their conservation purpose. Therefore, this study was designed to determine the carapace width and body weight relationship, to investigate the size distribution and to identify the size at maturity of crenate swimming crab, *Thalamita crenata* from Setiu Wetlands, Terengganu.

Methodology

Sampling Site

The study was done at Setiu Wetlands, Terengganu, Malaysia. Setiu Wetlands 5°31'23.1"N 102°55'56.1"E) is located along the coast facing the South China Sea in the state of Terengganu (Figure 1). It is situated about 60 km north from Kuala Terengganu. Setiu Wetlands is a unique place because in one interconnected area, there are nine types of ecosystems including sea, beach, mudflat, lagoon, estuary, river, mangrove forest, island and coastal forest can be found. The Setiu Wetlands is located in the lower reaches of the Setiu river basin within the Setiu district of Terengganu. The wetlands comprise primarily estuarine and coastal wetlands types and are included within a larger wetland complex known as the Setiu-Chalok-Bari-Merang basin wetlands.

Sampling was done twice a month from July to September 2015 (on high tide) by using traps known as 'bubu' or 'bento' by local peoples. Chicken heads were selected as baits in this study as their smell make it easier to attract the crabs into the traps (Amin-Safwan *et al*., 2016). All the obtained samples were transferred to the Institute of Tropical Aquaculture (AKUATROP)'s hatchery, Universiti Malaysia Terengganu for further study.

Figure 1: Sampling site, Setiu Wetlands, Terengganu, Malaysia (5°31'23.1"N 102°55'56.1"E)

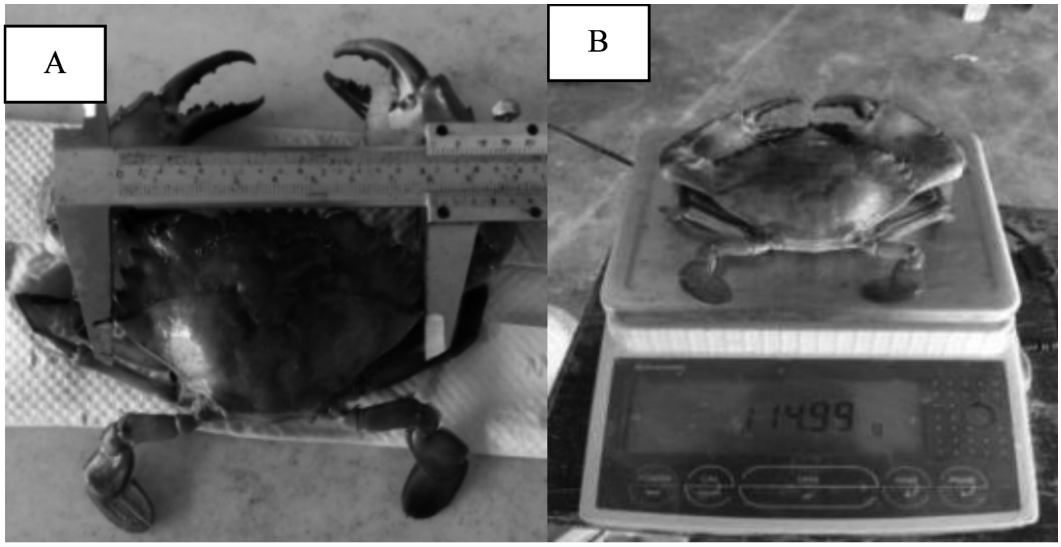

Figure 2: A) Measuring carapace width using vernier callipers. B) Measuring crab weight using electronic balance

Carapace Width (CW)-body Weight (BW) Relationship

The crab sizes were measured as the external carapace width (CW), which was the distance between 5th antero-lateral spines of the carapace using Vernier calipers while the crab body weight (BW) were then measured using electronic balance (Figure 2). Then, the relationship between CW-BW relationships were determined using regression analysis.

Size Distribution

All the samples were counted and categorized based on its carapace width size and these were used to determine the size distribution. The size was divide in the range of 1.0 cm from each group size.

Size at Maturity

50 male crabs (consist of varied CW and BW size) were randomly selected from a total of 121 samples obtained at the end of the sampling activities and observed to determine the size at maturity. The male crabs were dissected to determine their maturity and their appearance of the vas deferentia identification (Figure 3). Mature males have enlarged and the vas deferens is white in colour (Calogeras & Knuckey, 1995) (Figure 4). The maturity of the gonad was determined from the external morphology of the vas deferens (VD) and seminal vesicle (SV). Mature male crustacean such as crabs and lobster had their VD and SV appeared to be swollen and whitish in colour (Ikhwanuddin *et al.*, 2014).

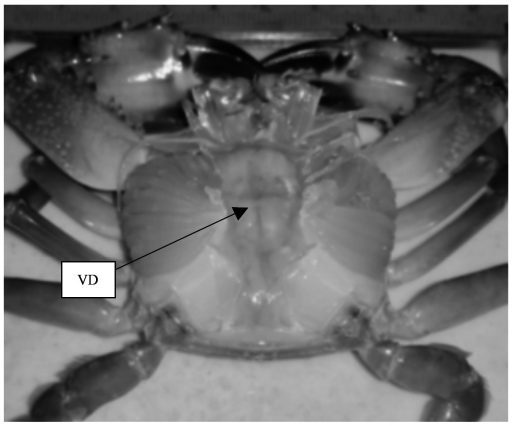

Figure 3: External morphology of immature male *T. crenata* with transparent colour of vas deferens (VD) and absent of seminal vesical (SV) which suppose to contain spermatopohores

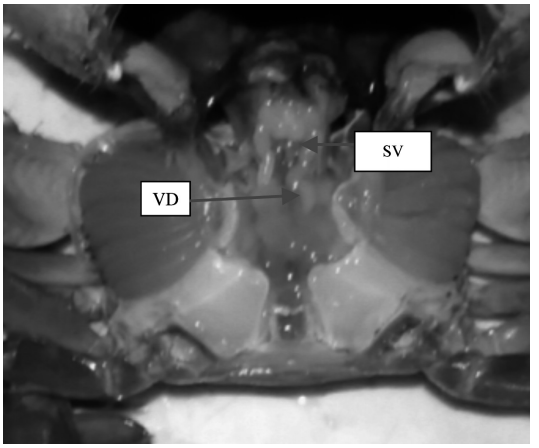

Figure 4: External morphology of mature male *T. crenata* with white colour of vas deferens (VD) and seminal vesicel (SV). SV is the part of the reproductive system of mature male crab inside the seminal vesicle are the spermatophores

Data Collection Analysis

CW-BW relationship

Data for carapace width and body weight relationship were determined by expression $W=aL^b$**,** where W is the derived weight (g), L is the carapace width (cm), a, is the intercept of the regression curve and b is the regression coefficient. The parameters a (intercept) and b (slope) were determined by linear regression based on logarithms **log (W) = log (a) + b log (L)** (Lagler, 1968).

Data were presented as mean and standard deviation. Microsoft Excel 2013 was used to plot the graph. The mean, minimum, maximum and standard deviations for body weight and carapace width were also determined.

Size Distribution

Data were presented on graph bar according to percentage number and size range. The size range is 1.0 cm in range. The calculation for percentage number is as follow:

$$\% = \frac{\text{No. of crabs in the same size range}}{\text{Total no. crabs}} \text{ X } 100$$

Size at Maturity

Data were presented as mean ± standard deviation. The size when 50% of the crab was sexually matured was chosen as appropriate measure of the size at maturity (CW50). The CW50 was determined by using the carapace width ranges that shows percentage of maturity (through sigmoid curve obtained).

Results and Discussion

Carapace Width (CW) and Body Weight (BW) Relationship

Table 1 shows that the mean of CW and BW of *T. crenata* males are 6.69 ± 0.69 cm CW (range: 3.89 - 8.19 cm; n=121) and 65.23 ± 19.63 g BW (range: 10.66-115.08 g; n=121) respectively.

Table 1: The mean body weight and carapace width of male *T. crenata* sampled from Setiu Wetlands,Terengganu

	Male	
	CW (cm)	**BW (g)**
Mean	6.69	65.23
Max	8.19	115.08
Min	3.89	10.66
SD	0.69	19.63
N	121	

The CW-BW relationship for males *T. crenata* was estimated at $BW = 2.9121e^{0.456CW}$ ($R^2 = 0.8078$) (Figure 5). The CW-BW linear regression of morphometric relationship showed that it is significant ($\rho=0.001$; $\rho<0.05$). This showed that as CW increased, BW also increased or vice versa.

Measuring the carapace width (CW) of the crab is essential method frequently used in the study of crustaceans. The CW-BW relationship for males *T. crenata* was attained as $BW = 2.9121e^{0.456CW}$ (R2=0.8078) mate the CW from the BW. Based on the obtained equation, we may estimate the CW and BW for *T. crenata* from Setiu Wetlands in the future by in-situ or by only knowing CW or BW. The value of coefficient of

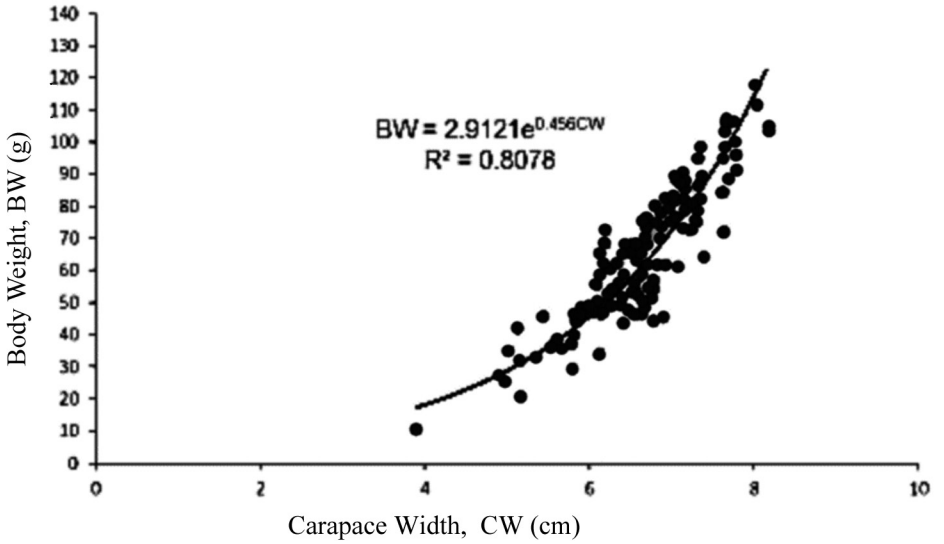

Figure 5: Morphometric relationship between body weight and carapace width of male *T. crenata* (n=121) sampled from Setiu Wetlands, Terengganu

determination (R^2) shown a high percentage with 80.78%. This result was similar to the previous study by Ikhwanuddin *et al*. (2009) where all the male mud crab from genus *Scylla* (*S. olivacea, S. paramamosain* and *S. tranquebarica*) had the CW-BW relationship with the value of R^2 = 0.8206, 0.8385 and 0.8564 respectively. *Scylla* sp. and *Thalamita* sp. is the the predators in the Setiu Wetlands food chain, so their CW-BW relationship would be similar to each other. Since the use of R^2 value is adopted from the method from the *Scylla* sp., a comparison of these two species is needed. As the value of R^2 of the relationship of crabs approaching 1.0, this showed that the strong relationship.

Table 2: Size distribution for male *T. crenata* sampled from Setiu Wetlands, Terengganu

Size range (cm)	No. of male crabs
3.0-3.9	1
4.0-4.9	1
5.0-5.9	13
6.0-6.9	66
7.0-7.9	37
8.0-8.9	3
Total	121

Size Distribution

From the result obtained, it showed that male size ranged from the smallest 3.0 cm up to as large as 8.9 cm of CW. Overall, male *T. crenata* caught from Setiu Wetlands had the dominant size in the range of 6.0 - 6.9 cm and their percentage were 54.54% from all the male caught. Size range of 3.0 – 3.9 cm and 4.0 – 4.9 cm were the uncommonly size range found with only 0.83% (Table 2).

Most fishers target to catch larger males which had the dominant size in the range of 6.0 - 6.9 cm and avoid smaller crabs including females due to quality and quantity of flesh. However, the smaller crabs would be discarded did not survive which reflected the smaller number of immmature crab in this study. Males crabs is known to grow faster (Xiao & Kumar, 2004), thus yielding a more broadly size of male.

Size at Maturity

Table 3 showed from the total of 50 male samples taken for the observation for size at maturity, only 40 crabs were classified as matured. Mature male crabs were most frequently found (55%) in size range of 7.0 - 7.9 cm CW (Table 4).

The immature males were the most frequently found (50%) in the size range of 5.0 - 5.9 cm CW (Table 5). Based on the CW, the largest immature male encountered was 6.32 cm and the smallest mature male was 6.13 cm. The mean size of maturity of male crab was 7.09 ± 0.51 cm.

Size at maturity (CW50) in males is based on the presence of vas deferens and its sperm. The percentage of mature male was calculated for each 1.0 cm CW interval from CW size range of 6.0 cm (the smallest size range of the crab sampled) to CW range of 8.9 cm (the largest

Table 3: Mean size (cm) of mature and immature male *T. crenata* sampled from Setiu Wetlands

	Mean Size (cm)	
	Mature	**Immature**
Mean	7.09	5.65
Max	8.19	6.32
Min	6.13	3.89
SD	0.51	0.73
N	40	10
Total sample	50	

Table 4: Size range distribution for matured male of *T. crenata*, sampled from Setiu Wetlands, Terengganu

Size range (cm)	**Frequency**	**%**
6.0-6.5	5	12.5
6.5-7.0	11	27.5
7.0-7.5	15	37.5
7.5-8.0	7	17.5
8.0-8.5	2	5.0
Total	40	100

Table 5: Size range distribution for immature male of *T. crenata*, sampled from Setiu Wetlands, Terengganu

Size range (cm)	**Frequency**	**%**
3.0-3.9	1	10
4.0-4.9	0	0
5.0-5.9	5	50
6.0-6.9	4	40
Total	10	100

size range of crab sampled). Using sigmoid curve, size at maturity (CW_{50}) of *T. crenata* male occurred at 6.23 cm CW with the curve equation: $y = 0.29x - 1.283$ and $R^2 = 0.8235$ (Figure 6).

Sexual maturity is defined as the ability to successfully mate and results in the extrusion of fertilized eggs (Robertson & Kruger, 1994). The study of maturity size on *T. crenata* is very limited than other species of crab such as *Scylla* spp. and *Portunus* spp. The studies of reproductive biology of *T. crenata* have been conducted in Gazi Bay, Kenya by Sigana (2002). Then, studies on species *Scylla* sp. have been conducted by Robertson & Kruger (1994) in South Africa, Tongdae (2001) in Thailand, Ikhwanuddin (2001) for Sarawak coastal water and Ikhwanuddin *et al*. (2010a, b) for Terengganu coastal water. There are no recent study on size at maturity of *T. crenata* in Setiu Wetlands, Terengganu. During the present studies, it was observed that functional and physiological maturity occur almost at the same time (Rasheed & Mustaqim, 2010).

Robertson & Kruger (1994) stated that the size at which 50% of the population is mature commonly used to measure the maturity for crustaceans. Therefore, results of this research shows that male attained CW50 maturity at 6.23 cm. However, size at maturity is may differ at different water regions and depended on the geographical differences (Ikhwanuddin *et al*., 2009). Then, Quinn & Kojis (1987) used the colour and size as an indicator of gonad maturity similar to the identification done by Ikhwanuddin *et al*. (2014). However, those study were done on female crab, where ovary develops different colour during different maturation stages. However, based on study by Islam & Kurokura (2012) on male mud crab S. *olivacea*, there were three stages of testes maturation and it can be differentiate through colouration. However, histological assessment is needed for accurate determination of testes maturation stages.

Based on Islam & Kurokura (2012), testes was not visible to the naked eye (Stage 1 – Immature stage), testis was formed and thin vas deferentia (Stage 2 – Early maturing) and colour of testes become opaque and white (Stage 3 – Matured). This colouration was observed in the present study too. As suggestion for future study on size at maturity, other parameter such as gonad somatic index (GSI) can be a good parameter chosen for use to compare gonad maturity. Rasheed & Mustaqim (2010) used both the relative growth and the condition of gonad in their study and Robertson & Kruger (1994) used

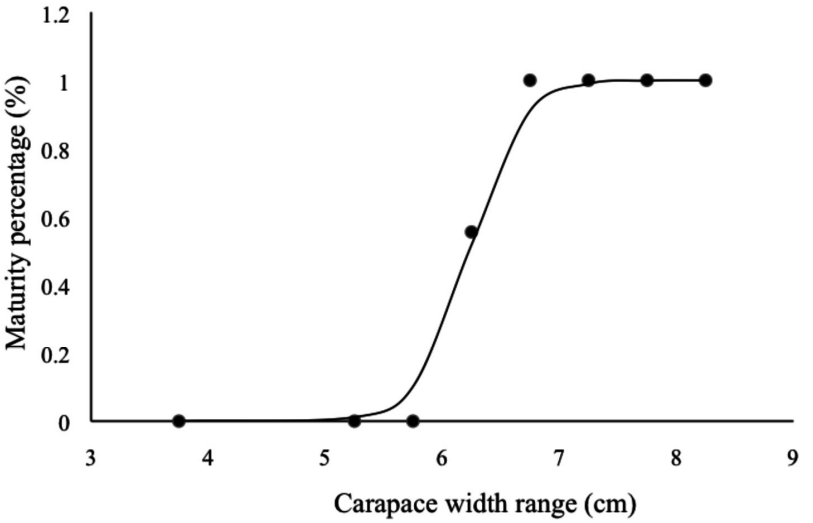

Figure 6: Sigmoid curve of male crab of *T. crenata* size at maturity. Size at maturity (CW_{50}) for male *T. crenata* was 6.23 cm

the attainment of the mature abdomen from the same method as this study.

From the result obtained, the number of immature crabs is less compared to mature crabs. Exploitation of immature crabs may affect the sustainable yield in one particular area. Ikhwanuddin *et al*. (2009) suggested the crab fishing should be prohibited during spawning peak seasons of crabs. One of the suggestions is to enforce the Legal Minimum Carapace Width (LMCW) in this area, where only mature size crabs was allowed to be caught and harvesting the undersize crab is prohibited for both recreational and commercial fishery purposes (Ikhwanuddin *et al*., 2009).

Conclusion

For size distribution, the dominant size of male *T. crenata* in Setiu Wetlands, Terengganu was in the range of 6.0 – 6.9 cm CW while the size at maturity (CW_{50}) was at 6.23 cm in male *T. crenata.* This biological information of male *T. crenata* is useful in management and exploitation of *T. crenata* resources for capture fishery and aquaculture sector in Terengganu coastal water especially by determining the minimum legal size for capture. By applying this information, the population of *T. crenata* will be maintained, thus making sure all the population of other aquatic animals in the food chain of Setiu Wetlands is in order.

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