Length-Weight Relationship of the Three-Spot Swimming Crab (*Portunus sanguinolentus* Herbst, 1783) in Trang Province, Thailand

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Abstract

The length-weight relationship of Three-spot swimming crab (*Portunus sanguinolentus* Herbst, 1783) in the coastal area of Trang, southern Thailand was estimated from 1,553 crabs (male=956, female=597) collected by two fishing gear types, i.e. crab gill net and crab trap. The sampling was conducted between January to December 2016. The range of the inner carapace width (ICW), the outer carapace width (OCW) and the carapace length (CL) were 5.21-10.76, 6.34-13.34 and 2.82-6.56 cm, respectively. The range of body weight (BW) was 18-130 g The length-weight relationships between inner carapace width, outer carapace width and carapace length with body weight of the crabs were $BW=0.208*ICW^{2.710}$, $BW=0.134*OCW^{2.627}$ and $BW=2.121*CL^{2.248}$, respectively. The values of the exponent "b" in the length–weight relationship ($W=aL^{b}$) of males and females varied between 2.242 to 2.742. The slope of the linear equation, the number indicating growth pattern, were significantly different from "b=3" ($p < 0.05$) for all measured length of crabs. It can be concluded the growth patterns of Three-spot swimming crab was allometric.

Keywords: Three-spot swimming crab, Length-weight relationship, Trang Province

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Introduction

Portunus sanguinolentus (Herbst, 1783) also known as the Three-spot swimming crab or the blood-spotted swimming crab or red-spotted swimming crab, (Carpenter and Niem, 1998), in Pakistan, small-scale fishermen call it 'takari', while those in Thailand call it "Poo Dao" in Thai. The common name derives from a distinct characteristic, namely the three prominent red to maroon spots on the posterior part of the carapace (Rasheed and Mustaquim, 2010). *P. sanguinolentus* is widely distributed in the Indo-Pacific region from the east coast of South Africa to Hawaii (Apel and Spiridonov, 1998). It is an important fishery stock in Hakodate, Japan, through Korea to China and Taiwan (Miyake, 1983; Secor *et al*., 2002). Its habitats include sandy, muddy and seagrass areas, from the intertidal zone to at least 30-50 m depths (Sumpton *et al*., 1989; Carpenter *et al*., 1997; De Lestang *et al*., 2003; Hamasaki *et al*., 2006).

In Thailand, *P. sanguinolentus* is mostly caught along with *P. pelagicus* using crab traps. *P. sanguinolentus* fisheries are a minor source of income for small-scale fishers in many parts of the coastal areas of the Andaman sea. In the future, the *P. sanguinolentus* fisheries in Trang Province will be an important source of income for small-scale fishers (Sawusdee and Songrak, 2009; Songrak *et al*., 2013; Songrak *et al*., 2014).

Knowledge of the fishery biology of a species is one of the most important benefits in fishery management and harvesting strategies (Johnson *et al*, 2010; Sawusdee and Songrak, 2009). The reproductive biology of *P. sanguinolentus* to reported differences in many aspects such as age, size, timing and range of spawning season, fecundity, and size at first maturity (Quinn and Kojis, 1987; Hamasaki *et al*., 2006; Rasheed and Mustaquim, 2010).

The stock status of *P. sanguinolentus* in the coastal areas of Trang and the Andaman Sea remain unknown due to lower knowledge of the biological parameters and the statistics used for analysis. Accordingly, this study uses various aspects of the length-weight relationships, including data on carapace width, carapace length, and weight and size frequency distributions from samples taken from the Trang coast. The results of this study can support one of the most important sources of information needed to study the fishery biology of *P. sanguinolentus* in the future.

Materials and Methods

1. Study area

This study was conducted in Trang Province, southern Thailand, along 136 km of the coast between longitude 99° 10′ to 99° 35′ E and latitude 7° 5′ to 7° 27′ N (Fig. 1). This area supports a large part of the crab landings (around 25%) from the Andaman Sea and covers an area of 650 km^2, including the intertidal zone down to 5-25 m in depth (Songrak *et al*., 2014).

Figure 1 Map of Trang seacoast showing study sites

2. Sample collection

P. sanguinolentus was sampled on a monthly basis from January to December 2016 from small-scale fishers in four villages, which using crab trap for Blue swimming crab fisheries including Ban Changlang in Sikao District, Ban Namrab, Ban Pramung in Kantang District, and Ban Tungpeaw in Haad Sum Ran District, all of which are in Trang Province.

The samples were collected by sampling 3 kilograms per village per month. All samples were measured and recorded for inner carapace width (ICW; nearest cm), outer carapace width (OCW; nearest cm), carapace length (CL; nearest cm), body weight (BW; nearest g) and sex.

3. Analytical Methods

The length-weight relationship of *P. sanguinolentus* was calculated by curvilinear regression analysis using data for inner carapace width, outer carapace width and carapace length distribution, which were constructed for analyzing growth with body weight (King, 2007):

$$BW = aICW^{b} \text{.....} \text{.....} \text{.....} (1)$$
$$BW = aOCW^{b} \text{.....} \text{.....} \text{.....} (2)$$
$$BW = aCL^{b} \text{.....} \text{.....} \text{.....} \text{..} (3)$$

Exponent ‘b’ usually varies at around three. When the exponent is statistically significant at around three, the pattern of growth is termed ‘isometric’. On the other hand, the growth pattern can also be ‘allometric’. The coefficients describe the relationship of body weight and carapace width, which can vary based on biological and environmental factors (King, 2007).

Results

A total of 1,553 crabs were included in the sampling from small-scale fishermen (956 males and 597 females). The distribution of the inner carapace width (ICW) ranged from 5.21-10.76 cm, while the outer carapace width (OCW) ranged from 6.34-13.34 cm The carapace length (CL) ranged from 2.82-6.56 cm, while the body weight (BW) ranged from 18.00-130.00 g (Fig. 2 and Table 1). The OCW that ranged between 9.00 and 14.00 cm accounted for 66.90%, while only 33.10% were smaller than 8 cm (Fig.2).

Table 1 Carapace width, carapace length and body weight characteristics of *P. sanguinolentus* on the Trang coast

Sex	N	Inner carapace width (cm)			Outer carapace width (cm)			Carapace length (cm)		
		Mean	Min.	Max.	Mean	Min.	Max.	Mean	Min.	Max.
Male	956	7.52	5.21	10.76	9.46	6.87	13.34	4.04	3.00	6.56
Female	597	7.48	5.22	10.05	9.48	6.34	12.47	4.04	2.82	5.78
Both	1,553	7.50	5.21	10.76	9.47	6.34	13.34	4.04	2.82	6.56

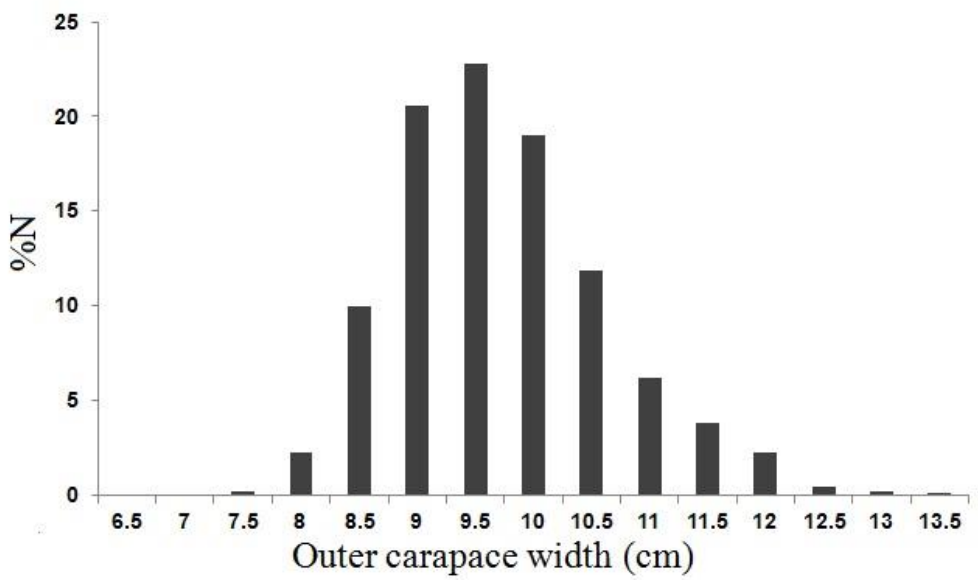

Figure 2 Carapace width frequency distribution of *P. sanguinolentus* on the Trang coast

The parameters for the relationship between inner carapace width, outer carapace width and carapace length were estimated from the carapace width and carapace length data for male, female and overall crabs, as presented in Table 2.

Table 2 Parameters of the relationships between carapace width and carapace length of *P. sanguinolentus* on the Trang coast

Sex	ICW-OCW relationship			ICW-CL relationship			OCW-CL relationship		
	a	b	r^2	a	b	r^2	a	b	r^2
Male	0.889	1.141	0.862	0.635	0.453	0.655	0.682	0.355	0.607
Female	0.728	1.690	0.873	0.474	0.477	0.705	0.511	0.373	0.675
Both	0.841	1.150	0.865	0.585	0.461	0.671	0.627	0.361	0.627

The formula for the carapace width and carapace length derived as,

Male OCW = 0.889+1.141*ICW
Male CL = 0.635+0.453*ICW
Male CL = 0.682+0.355*OCW
Female OCW = 0.728+1.690*ICW
Female CL = 0.474+0.477*ICW
Female CL = 0.511+0.373*OCW

The results showed that the linear regressions between carapace width and carapace length were significant ($P<0.05$).

The parameters of the relationship between inner carapace width, outer carapace width and carapace length with body weight for male, female and overall crabs are presented in Table 3.

Table 3 Parameters of the relationship ($BW=aL^b$) between carapace width and carapace length with the body weight of *P. sanguinolentus* on the Trang coast

Sex	ICW-BW relationship			OCW-BW relationship			CL-BW relationship		
	a	b	r^2	a	b	r^2	a	b	r^2
Male	0.196	2.742	0.850	0.122	2.670	0.779	2.117	2.254	0.614
Female	0.237	2.644	0.813	0.157	2.549	0.741	2.119	2.242	0.652
Both	0.208	2.710	0.838	0.134	2.627	0.765	2.121	2.248	0.626

The formula for the relationship between inner carapace width, outer carapace width and carapace length with body weight derived as,

Male $BW = 0.196*ICW^{2.742}$

Male $BW = 0.122*OCW^{2.670}$

Male $BW = 2.117*CL^{2.254}$

Female $BW = 0.237*ICW^{2.644}$

Female $BW = 0.157*OCW^{2.549}$

Female $BW = 2.119*CL^{2.242}$

The results showed that the linear regressions between carapace width and carapace length with body weight were significant ($P<0.05$).

The inner carapace width, outer carapace width and carapace length with body weight relationships were allometric for both sexes. However, exponential values (b) for the inner carapace width with body weight relationships of males and females were 2.742 and 2.644, respectively, indicating a nearly isometric pattern of growth.

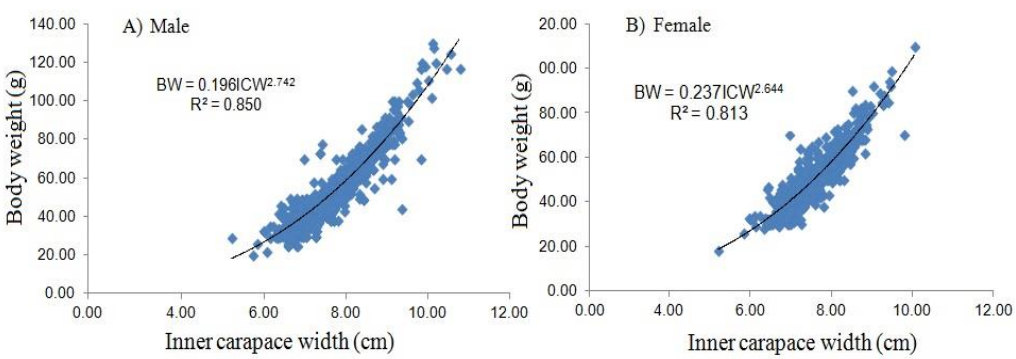

Figure 3 Relationships between inner carapace width and body weight of *P. sanguinolentus* on the Trang coast (A=Male and B=Female)

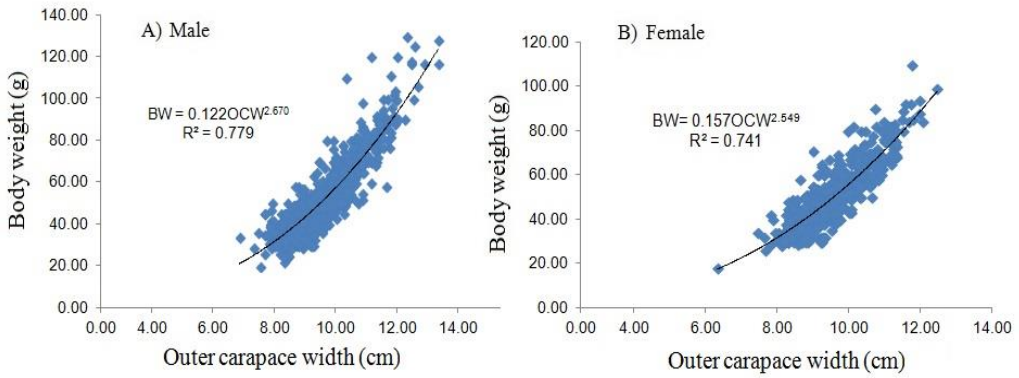

Figure 4 Relationships between outer carapace width and body weight of *P. sanguinolentus* on the Trang coast (A=Male and B=Female)

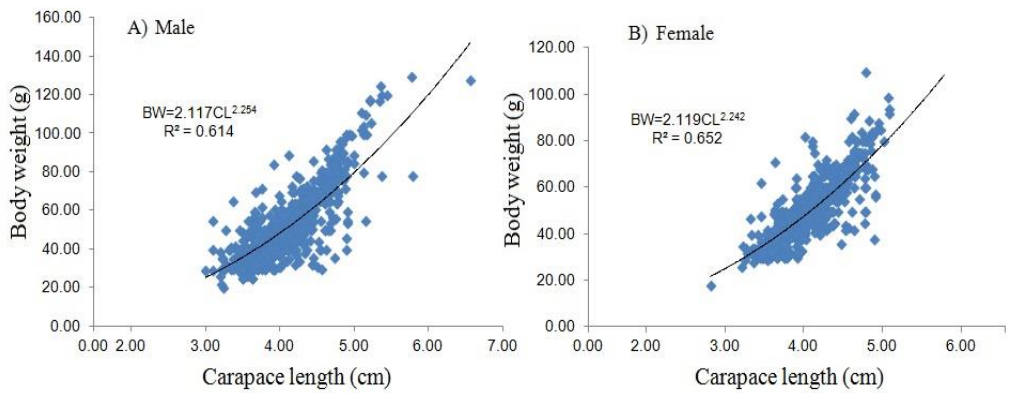

Figure 5 Relationships between carapace length and body weight of *P. sanguinolentus* on the Trang coast (A=Male and B=Female)

Discussion

The length and weight relationship of *P. sanguinolentus* on the Trang seacoast was different than that of crabs from other parts of tropical regions and supports other reports concerning regional differences in the fishery biology of crabs. For example, the values for exponent 'b' were found to be 2.198, 2.612 and 2.936 (width-weight relationship) and 2.771, 2.844 and 2.566 (carapace length-weight relationship) in male, female and both sexes of *Callinectes sapidus,* respectively (Atar and Secer, 2003).

In general, exponent 'b' often lies between 2.5 and 3.5 and is usually close to 3 for carapace width and carapace length with weight regression equations

(Stickney, 1972; Sukumaran and Neelakantan, 1997; Atar and Secer, 2003; Rasheed and Mustaquim, 2010; Trirunavukkarasu and Shanmugam, 2011). Pauly (1984) reported that an extraordinarily large amount of length and weight data was taken from a wide variety of fishes. Values of b < 2.5 or b > 3.5 are generally based on a very small range of sizes, with such values of b most likely erroneous. An exponent 'b' value of 3 indicates symmetrical or isometric growth, while values other than 3 indicate allometric growth. In the present study, the carapace width and carapace length with body weight relationship of *P. sanguinolentus* on the Trang seacoast were found to have values for the exponent 'b' remaining below 3. Further, the calculated carapace width and carapace length with body weight relationships were allometric.

Conclusion

The examination of carapace width and length with body weight relationships of *P. sanguinolentus* in the coastal of Trang in southern Thailand can provide useful data for study on biology and stock assessment of the species. Consequently, the aim of assessing the carapace width and length with body weight relationships presented an opportunity for crab biologists to derive length estimates for *P. sanguinolentus* that are weighed but not measured. Based on all previous and available knowledge, no information currently exists on the length-weight relationships of *P. sanguinolentus* from coastal sea regions, even in Thailand.

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