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Relative Growth of *Harpiosquilla raphidea* (Fabricius, 1798) (Crustacea: Stomatopoda) Male and Female Populations

(Pertumbuhan Relatif *Harpiosquilla raphidea* (Fabricius, 1798) (Crustacea: Stomatopoda) Populasi Jantan dan Betina)

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ABSTRACT

Morphometric analysis was carried out to find out changes in the growth pattern of male and female stomatopod, Harpiosquilla raphidea. *Six morphometric relationships were examined on 105 males and 105 females, ranging in size from 103 to 207 mm and from 104 to 222 mm in total length, respectively. In both the sexes, the relative growth of carapace length, propodus length of raptorial claw and total weight in relation to total length was found positively allometric. Telson width in both the sexes and abdomen width in males showed slightly negative allometry, while the abdomen width of females showed slightly positive allometry, indicating some variation in the growth between sexes which could be attributed to the energy requirement for maturation in females. The propodus of females was also found to be bigger than that of males. It is quite interesting as males only have larger chela in other crustaceans. It has a functional significance in that it is of immense help at the time of intense feeding during maturation of oocytes which requires higher energy.*

Keywords: Harpiosquilla raphidea*; morphometric characters; relative growth; stomatopoda*

ABSTRAK

Analisis morfometrik telah dijalankan untuk mengetahui perubahan dalam pola pertumbuhan stomatopod jantan dan betina, Harpiosquilla raphidea. *Enam hubungan morfometrik dijalankan pada 105 jantan dan 105 betina, masing masing bersaiz 103 ke 207 mm dan daripada 104 ke 222 mm jumlah panjang. Dalam kedua-dua jantina, pertumbuhan relatif panjang karapas, panjang propodus berkuku raptorial dan jumlah berat berkaitan dengan jumlah panjang didapati positif alometri. Lebar telson kedua-dua jantina dan lebar abdomen pada jantan menunjukkan alometri yang sedikit negatif, manakala lebar badan betina menunjukkan sedikit alometri positif yang memperlihatkan beberapa perbezaan pertumbuhan antara jantina yang mungkin disebabkan oleh keperluan tenaga kematangan oleh betina. Propodus betina juga didapati lebih besar daripada jantan. Ia adalah agak menarik kerana hanya jantan mempunyai kela yang lebih besar untuk krustasea lain. Ia mempunyai kepentingan bererti dan dapat membantu semasa makan yang memerlukan tenaga yang lebih tinggi sewaktu kematangan oocytes.*

Kata kunci: Harpiosquilla raphidea*; kepelbagaian morfometrik; pertumbuhan relatif; Stomatopoda*

Introduction

Stomatopods are a small group of marine malacostracan crustaceans rather distantly related to common shrimps and crabs. They are mainly distributed in world's tropical and subtropical regions upto a depth of 1300 m. At least 450 extant species have been described worldwide (Ahyong 2001; Veena & Kaladharan 2010). They contribute considerably to trawl by catches in the coastal fisheries sector in many parts of the world including India. In the present scenario of marine fisheries the catches from conventional fishery resources are not commensurating with the requirement, so the utilization of non-conventional fishery resource has become inevitable. Stomatopod has been utilizing for human food in many countries including India, where its demand is increasing day by day.

Among many stomatopod species, *Harpiosquilla raphidea* is a common species in southeast coastal waters of India. *H. raphidea* generally live on the level bottoms in the shallow coastal and estuarine water (Manning 1998). It has a good flesh yield and asymptotic length. They form potential sources of food, generate by-products like chitin/chitosan and are popular in ornamental aquaria (Balaji et al. 2009; Lakshmi Pillai & Thirumilu 2008). The recorded maximum size of this species is 36.6 cm from a mud flat in the Sumatera Island, Indonesia (Wardiatno & Mashar 2011). However, this species is commercially valuable in many countries including India. This puts increasing demand on the study of this species. There are some studies on the ecology (Lui 2005), behavior (Heitler et al. 2000), the ecological function of the eye retina (Cronin et al. 2000), the distribution (Abello & Macpherson 1990) and genetics (Barber et al. 2002) of stomatopods. However, published information on *H. raphidea* is very limited except in biology and population dynamics by Thomas

(2002), reproductive biology by Wardiatno & Mashar (2010) and population dynamics specially growth, life span and exploitation rate by Wardiatno & Mashar (2011). Unfortunately, there is no information on the relative growth of male and female *H. raphidea* populations.

In crustaceans, as growth progresses, certain dimensions of the animal's body may grow much more than others. Such information is very important to understand changes in the form and size of the abdomen, pleopods or chelipeds (Josileen 2011). However, form and size of organisms are closely related to their feeding (Rahman 2006; Rahman et al. 2009), habitat occupation (Rahman & Meyer 2009), ecology (Rahman & Verdegem 2010), behaviour and fitness in the environment (Rahman et al. 2010, 2008). Therefore, knowledge on relative growth is also useful for further studies on the life history, development of fishery, resource management and culture of this species (Josileen 2011). Analysis of relative growth is also a powerful tool for taxonomist and ecologist interested in inter-sexual morphological variation (Gopalakrishnan et al. 2013). Therefore, the present study aimed to understand the relative growth of male and female *H. raphidea*.

Materials and Methods

A total of 210 individuals (105 males and 105 females) of *H. raphidea* were collected from the by catches of trawlers in landing centers of Pazhayar (Lat. 11° 21' N; Long. 79° 50' E), Mudasalodai (Lat. 11° 29' N; Long. 79° 46' E) and Cuddalore (Lat. 11° 42' N; Long. 79° 46' E). The collected specimens were preserved in 10% formalin. All specimens individually measured total length (TL), carapace length (CL), abdominal width (AW), telson width (TeW) and propodus length (PrL) (Figure 1) according to Mori et al. (1998). All measurements were done to the nearest 0.1 mm with a vernier caliper. Total lengths were measured with body flattened. Measurements of individuals exhibiting body deformities (specimens with lost appendages and damaged appendages) were excluded from consideration. Total weight (TW) of the individuals was measured by means of an electronic balance up to nearest 0.1 g. The total length was chosen as the main reference dimension (Araneda et al. 2008; Asaduzzaman et al. 2010; Gopalakrishnan et al. 2013).

The regression analysis was carried out to explain the relationships between various morphometric characters (Gould 1966). The log transformed data was used to find the linearity of relationship ($\log y = \log a + b \log x$). The coefficient of determination (R^2) and significance ($p \leq 0.05$) were also calculated for each regression analysis. Statistical equality of morphometric relationships among sexes was tested using ANCOVA at $p \leq 0.05$ level of significance. Tangent values were calculated by converting the inverse tan of respective 'b' values to degrees. Allometries were determined using these tangent values. Allometry was decided as positive when the tangent value exceeded 45° and negative when the tangent value subsided 45°.

Results

Relative growth of *H. raphidea* did not show much variation between the sexes. The total length of the *H. raphidea* specimens collected ranged from 103 to 207 mm for males and 104 to 222 mm for females. The relationship between total length (X) and the morphometric measurements (Y) is shown in Figure 2. The regression value, standard error, correlation coefficient, tangent value and allometry for males and females are given in Table 1. The coefficient determination (r^2) values in all the cases were high (>0.89) and significant ($p<0.01$) indicating very close relations between total length and morphometric measurements. Tangent values were maximum for total weight and minimum for telson width. Carapace length, propodus length and total weight showed positive allometry and telson width showed negative allometry in

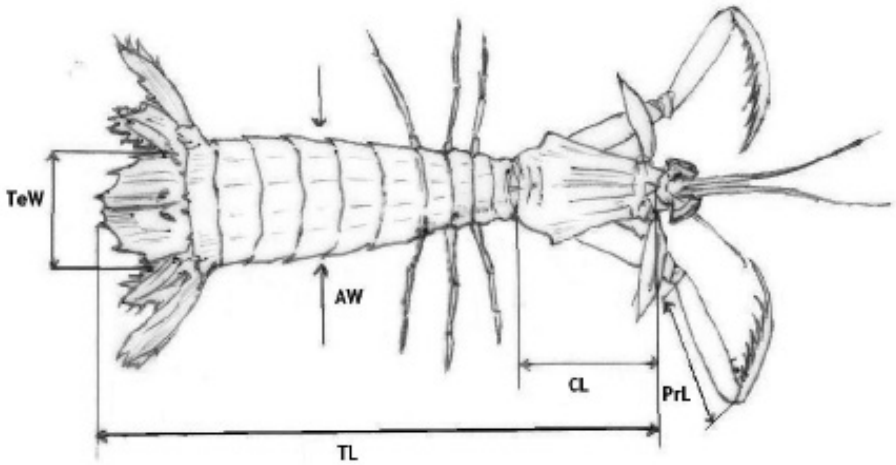

FIGURE 1. Morphometric measurements of *Harpiosquilla raphidea*. TL = Total length; CL = Carapace length; TeW = Telson width; AW = Abdomen width; PrL = Propodus length of the raptorial claw

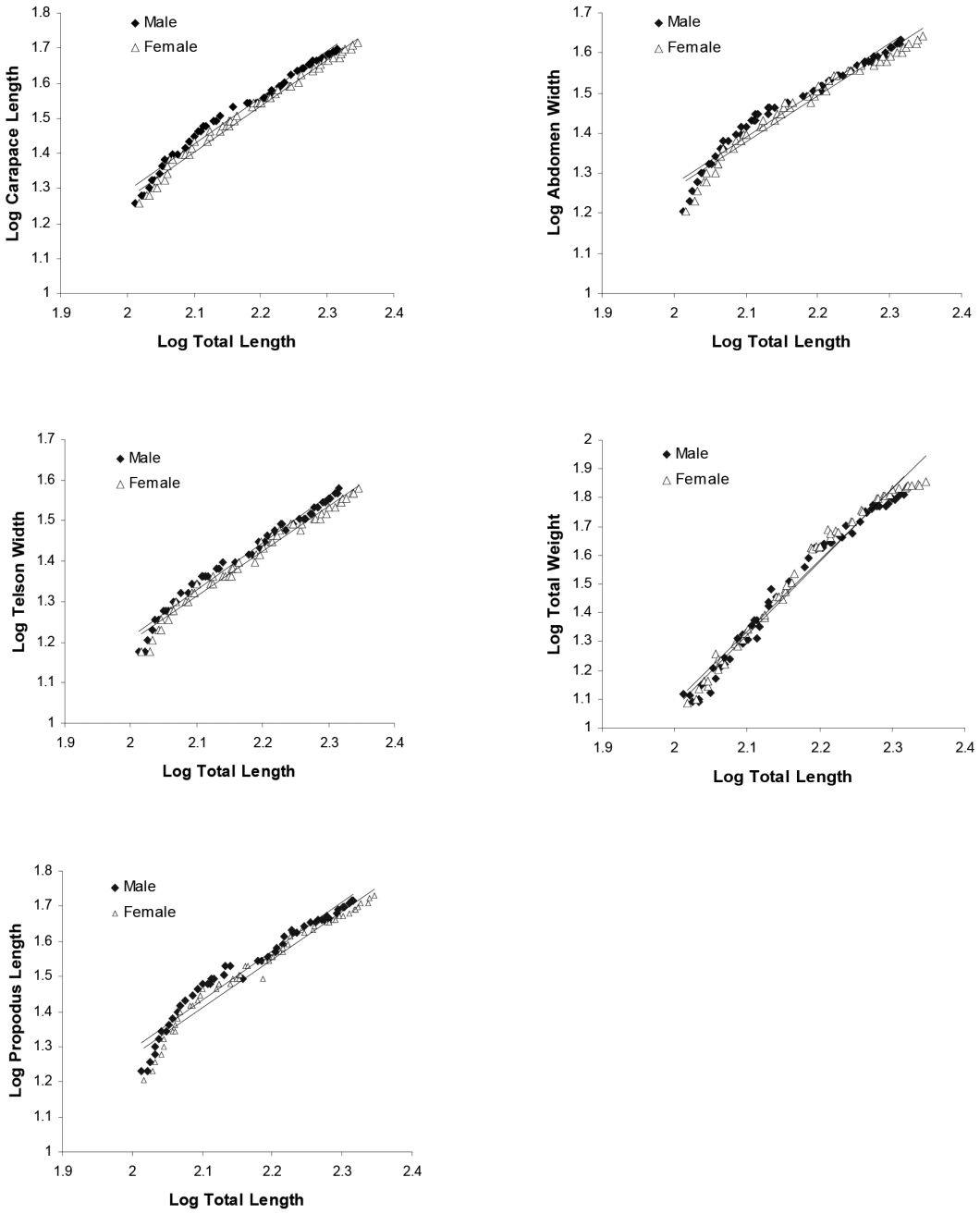

FIGURE 2. Regression plots of different morphometric characters against total length of male and female *Harpiosquilla raphidea*

both males and females (Table 1). Meanwhile abdominal width showed a positive allometry in female and a negative allometry in males.

Growth of abdominal width and total weight showed significant variations between males and females ($p<0.05$), while growth of carapace length, telson width and propodus length did not show significant variation between males and females ($p>0.05$) (Table 2). Overall, the growth of abdominal width and the total weight were higher in females than in males. In both males and females, total weight and telson width showed minimum and maximum growth respectively in relation to total length (Table 1).

DISCUSSION

Allometry is extensively used to define the growth of species (Rahman & Hafzath 2012). The difference in the relative growth between one part and the whole organism or between one part and another is considered as standard and is termed allometry (Huxley & Teissier 1936; Rahman & Hafzath 2012). As the male and female grew, other body dimensions of *H. raphidea* were changed significantly (with very high co-effiecient determinations) in relation to the total length. There is no previous study comparing these significant changes of different body dimensions in

TABLE 1. Values of relative growth parameters: Intercept (a), Regression coefficient (b), Standard error (SE), coefficient of determination (R^2), Angle of tangent and allometry for different morphometric characters against total length of male (M) (mean ± SD: 150.9 ±33.5 mm, range: 103-207 mm) and female (F) (150.8±34.7, 104-222) *Harpiosquilla raphidea*. CL, AW, TeW, PrL and TWe indicate carapace length (mm), abdominal width (mm), telson width (mm), propodus length (mm) and total weight (g), respectively * Indicates significant ($p \leq 0.01$)

Measures /TL	Sex	Range	Mean±SD	Intercept (a)	Slope (b)	SE	R^2	Significance (*P* value)	tangent	allometry
CL	M	19-51	34.7±10.2	–1.2876	1.2906	0.0212	0.971	*	52°13”	+
	F	18-53	34.4±10.9	–1.3580	1.3153	0.0159	0.985	*	52°45”	+
AW	M	16-43	28.5±7.9	–0.5645	0.9197	0.0300	0.896	*	42°36”	–
	F	16-45	30.6±8.0	–0.9388	1.1014	0.0246	0.952	*	47°45”	+
TeW	M	15-38	27.7±7.4	–0.4314	0.8287	0.0236	0.919	*	39°38”	–
	F	15-39	26.1±6.4	–0.4813	0.8473	0.0178	0.957	*	40°16”	–
PrL	M	16-52	35.1±10.2	–1.4946	1.3940	0.0316	0.947	*	54°20”	+
	F	16-53	34.4±10.5	–1.4819	1.3774	0.0294	0.956	*	54°01”	+
TWe	M	12.4-66.1	35.3±18.5	–3.8553	2.4718	0.0397	0.975	*	67°58”	+
	F	11.7-74.1	37.4±20.6	–4.0488	2.5571	0.0360	0.979	*	68°38”	+

TABLE 2. Difference between log–log regressions of morphometric variables against total length of male and female mantis shrimp *Harpiosquilla raphidea* based on analysis of covariance (ANCOVA). * = Significant ($p<0.01$); ns = not significant; CL = Carapace length; AW = Abdominal width; TeW = Telson width; PrL = Propodus length, TWe = Total weight

Variables	Difference among slopes		
measures/TL	F	Probability	Significance
CL	1.4794	$p>0.05$	ns
AW	10.6445	$p<0.01$	*
TeW	0.2861	$p>0.05$	ns
PrL	–0.5134	$p>0.05$	ns
TWe	86.1355	$p<0.001$	*

relation to the total length of *H. raphidea*. However, similar significant relations were also observed by Paschoal et al. (2013) in the shrimp *Palaemon pandaliformis*. Similar relationships between different body dimensions were also reported by Peiro et al. (2011) in the crab (*Austinixa aidae*).

The growth of carapace length appears to be faster than the total length, due to the presence of big muscles of the raptorial claws. The animal becomes more aggressive when it grows and the carapace needs larger size and stronger muscles for the fast movement of the raptorial claws (Caldwell & Dingle 1976; Dingle et al. 1973). The positive allometric growth of abdominal width in females might be attributed to the maturation of these individuals when they grow (Kodama et al. 2004; Vila et al. 2013). According to Vila et al. (2013), ovaries generally extend along the abdomen during maturation which resulted in broadening of this part. The negative allometric growth of the abdominal width in male might be due the shape of testis, which was narrow and did not cause any extra broadening of the abdomen. However, allometric growth of the abdomen is clearly distinct between males and females, indicating evident sexual dimorphism in *H. raphidea*. This type of distinct abdominal growth of male and female are also observed in some aquatic animal including crab (*Uca cumulanta*) (Pralon & Negreiros-Fransozo 2008). The high positive allometry of weight in relation to total length in both male and female is conforming to the cube law, which indicates the weights vary as the cubes of the dimensions. However, this study also gives evidence that the weight of female is higher than male in relation to total length of the *H. raphidea*. This result in a way agree with Tanuja (1996), who also recorded higher total weight in relation to total length in females than in males in the other mantis shrimp *Oratosquilla nepa*.

In different crustaceans the chelae have been found to be bigger in males than in females and their role has been related to different functions like courtship behavior and feeding habit (Elner 1980; Hartnoll 1982). The stomatopods are highly carnivorous and chief predatory activity in them was reported by Caldwell et al. (1989). In the present study the propodus of females was found to be bigger than the males. This result concurs with Thomas

(2002). According to Thomas (2002), the propodus of female Stomatopod is generally bigger than the propodus of male Stomatopod especially at the time of maturation. The larger size of propodus in females could be of immense help in the feeding activity. Generally, at the time of maturation, females has more intense feeding activity than male Stomatopod. Piccinetti and Piccinetti (1970) also reported the similar result in *Squilla mantis* L.

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