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Morphometric analysis of the red frog crab *Curacha Ranina ranina* from Balut Island, Sarangani, Davao occidental, Philippines

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Abstract

Morphometric characters relationships of the females and males red frog crab *Ranina ranina* locally named as “curacha” from Balut Island, Sarangani, Davao Occidental was the main goal in this study. The carapace width (CW), carapace length (CL), abdomen width (AW), abdomen length (AL), propodus length (PL), dactylus length and body weight were assessed. A total of 60 samples were sexed based on the shapes of the abdomens and examined in the laboratory. At the same time, the species body weight was also measured. Most of the females’ *R. ranina* has body size larger than males. This is due to differences in growth patterns, food availability and size of maturity. In terms of its body weight, females of *R. ranina* are usually smaller and reaching 400 g in weight while males can reach 900 g in total body weight. It is important to note that males must be large enough to successfully dig female crabs out of the sand to reproduce. The allometric regression found describes changes in soft tissue content (or total animal weight for crustaceans) relative to carapace width/length. This result is consistent with general trends of scaling with body size in animals.

Keywords: Morphometric, *Ranina ranina*, relationships, Sarangani Islands

Introduction

Ranina ranina (red frog crab or spanner crab) is a species of crab found throughout tropical and subtropical habitats. It is often fished for its meat and is the only known species in its genus. They inhabit depths of 10-100 meters (33-328 ft) on sandy-smooth substrata in which they bury themselves from where they attack small bottom-dwelling fish (Tahil, 1983; Kennelly, 1992) ^[15, 3]. The species may grow up to 150 millimeters (5.9 in) long and may weigh up to 900 grams (2.0 lb). *Ranina ranina* is mainly nocturnal and remains buried in the sand during the day. They are easily distinguished from other crab species in their habitat due to their red carapace and long midsection.

This red crab is the most prominent representative species of the family Raninidae. Low rounded scale-like spines wholly cover the carapace in large or small numbers, which are broader anteriorly. Eye stalks are set vertical and longer. Strong cheliped bears seven or eight teeth. Paddle-shaped walking legs, anterior and posterior borders hairy. Body reddish-brown in color with some ten white spots on the anterior part of the carapace (Kasinathan *et al.*, 2007) ^[2]. Red frog or spanner crabs are opportunistic feeders with their diet consisting of urchins, bivalve, mollusks, crustaceans, polychaete worms and fish. The largest commercial fishery of this crab is on the eastern coast of Australia (Queensland Fisheries, 2010) ^[10]. To feed, they ambush small fish and other organisms from their hiding places in the sand (Kennelly *et al.* 1994) ^[4].

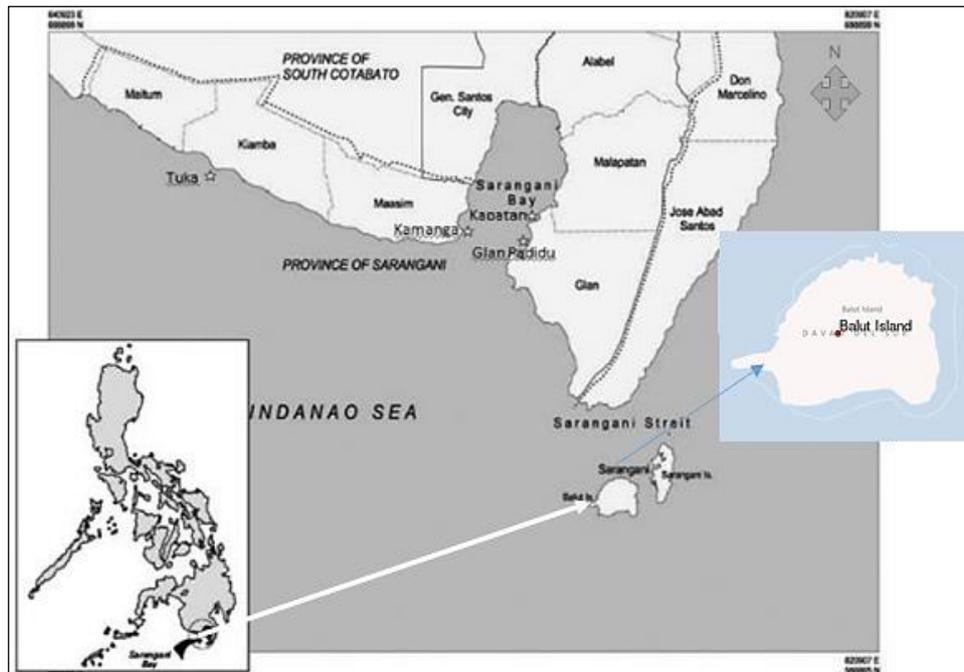
Growth is a morphometric relationship that relates the dimensions of parts of the body or an organ to the entire animal (Rodriguez, 1985). The external morphological characters and changes in the body parts are generally applied to determine sexual maturity in many decapods (Paul and Paul, 1990; Sainte-Marie *et al.*, 1995; Jasmine, 2013). The morphometric analysis serves as a handy tool for both taxonomists and ecologists to investigate intra and interspecific morphological variations (Costa and Soares-Gomes, 2008) and complement well with genetic and environmental stock identification methods (Cadrin, 2000). Among brachyurans, the carapace, chelipede, pleopods/gonopods and abdomen exhibit allometric changes in both the sexes during their transition from juvenile to adult phases (Hartnoll, 1974).

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The purpose of the study was to investigate and establish correlations between different morphometric characteristics in *Ranina ranina* species from Balut Island, such as carapace length (CL) and width (CW), cheliped propodus length (PL), dactylus length (DL), and abdomen width (AW). Similarly, this is to give records of this species' presence in Southern Mindanao, Philippines, particularly in the Municipality of Sarangani, Davao Occidental.

Materials and Methods

Site Description: Balut Island is a volcanic island south of the tip of Davao Occidental province (5°24'00"N 125°22'30"E) in the Mindanao region, Southern Philippines (Figure 1). The island of Balut has located about 13 km (8.1 mi) from mainland Mindanao, separated by the Sarangani Strait. Balut, Sarangani, and Olanivan Islands make up the island group known as the Sarangani Islands. The group comprises the Municipality of Sarangani of Davao Occidental.



Sample Collection

Crab samples used in this study were purchased from Maveas Market, Balut Island, Municipality of Sarangani. The crabs were immediately frozen and brought to the laboratory for examination. Identification was carried out using the published journal on Morphological descriptions of the red frog crab *Ranina ranina* Linnaeus, 1758 by Matondo *et al.* 2015 [5].

Morphometric Measurements

The crab samples were sorted and sexed as males or females based on the shape of their abdomens (Figure 2). Measurements of the following body parts were assessed separately to each sex and measured to the nearest 0.1 mm: carapace width (CW), carapace length (CL), dactylus length (DL) and abdominal width (AW). Carapace width (CW) was taken as the distance between the lateral carapace margins. Carapace length (CL) was measured dorsally along the midline, between the frontal notch and the posterior margin of the carapace. The measurement of propodus length (PL) was taken from the base of the propodus to the fixed dactylus of the Chela. The maximum width across the second somite in males and third somite in females was considered as the abdominal width (AW) (Kennelly and Watkins, 1994) [4]. In addition, the specimen body weight was measured using an analytical balance to the nearest 0.01 g.

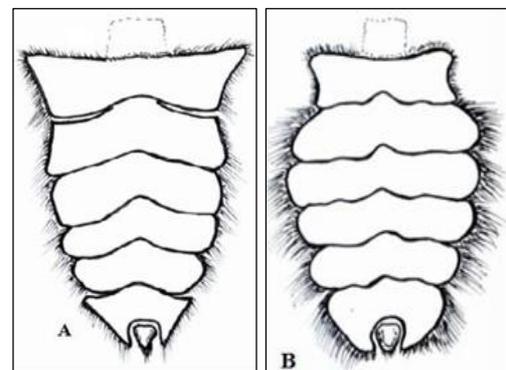


Fig 2: A. Shape dorsal aspect of the male abdomen. B. Shape dorsal aspect of the female abdomen

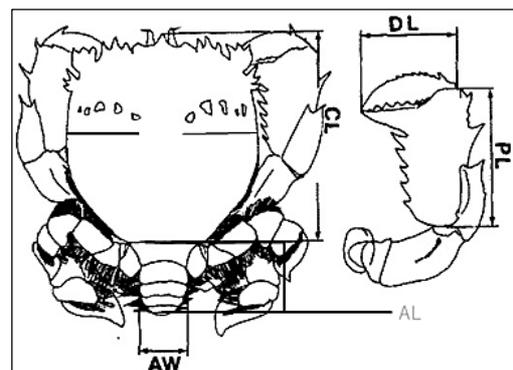


Fig 2: Measurement of morphometric characteristic in *Ranina ranina*. AW: abdomen width, CL: carapace length, CW: carapace width, DL: dactylus length, PL: propodus length

Data Analysis

The student’s t-test ($\alpha = 0.05$) was used to compare differences in the mean morphometric character measurements of males and females. Regression equations were calculated assuming an allometric growth equation ($Y = a + bX$), to determine relations between different morphometric characters in males and females.

Results and Discussions

A total of 60 specimens of *R. ranina* (30 males, 30 females) were examined and analyzed. Figure 3 shows the distinguishing characteristics of male and female *R. ranina*. The abdomens of male crabs were distinguished by the possession of narrowly triangulate abdomen cover or tapering towards the distal segment while females have broad surface abdomen.

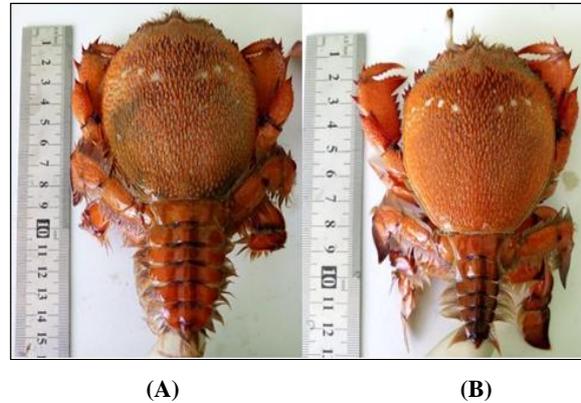


Fig 3: Distinguishing characteristics of female (A) and male (B) *Ranina ranina* showing their abdominal cover shapes

Morphometric characters

Table 1 shows the minimum, mean, SD and maximum values of the selected morphometrics of *Ranina ranina* of males and females crabs. The carapace width (CW) of males (Mean \pm SD; 6.20 ± 0.59) was statistically higher (CW: $t = 0.86$; $p < 0.05$) than the females (Mean \pm SD; 6.17 ± 0.56). Whereas, carapace length (CL) of males (Mean \pm SD; 7.09 ± 0.64) was statistically lower (CL: $t = 0.24$; $p < 0.05$) than

the females (Mean \pm SD; 7.28 ± 0.57). In terms of its abdomen width (AW), females AW (Mean \pm SD; 2.45 ± 0.29) was statistically higher (AW: $t = 1.64$; $p < 0.05$) than the males (Mean \pm SD; 1.64 ± 0.14). While dactylus length (DL), females (Mean \pm SD; 2.22 ± 0.18) was statistically lower (DL: $t = 0.13$; $p < 0.05$) than the males (Mean \pm SD; 2.29 ± 0.18).

Table 1: Minimum, mean, SD and maximum values in cm of the selected morphometric characters of *Ranina ranina*

Characters	Female (N=30)				Male (N=30)			
	Min	Max	Mean	SD	Min	Max	Mean	SD
Carapace Width	5.15	7.62	6.17	0.56	5.40	7.25	6.20	0.59
Carapace Length	6.20	8.89	7.28	0.57	6.05	8.05	7.09	0.64
Body Weight (g)	95	170	118.5	24.32	65	155	97.83	29.5
Abdomen Width	2.05	3.20	2.45	0.29	1.45	1.90	1.64	0.14
Dactylus Length	2.00	2.50	2.22	0.18	2.00	2.55	2.29	0.18

The distribution of length-frequency of *R. ranina* is shown in Figure 4. At about 60% of females and 36.67% of males ranges its carapace length from 7.0-8.99 cm which females showed high density. While 26.67% of females and 46.67% of males have 6.0-6.99 cm; and 13.33% of females 16.67% of males ranges from 8.0-8.99cm. On the other hand, the range of total width for males and females is 5.40 cm to 7.25 cm and 5.15 cm to 7.62 cm (Figure 6). The mean of males

and females carapace width was 6.20 cm and 6.17 cm respectively. Females (86.67%) has carapace width ranges from 5.0-5.99 cm and 13.33% of females has 7.0-7.99 cm. Males (16.67%) has reached the 7.0-7.99 cm and 83.33% at 5.0-5.99 cm carapace width (Figure 5). Most of the females’ *R. ranina* has a body size larger than males. This is due to differences in growth patterns, food availability and size of maturity.

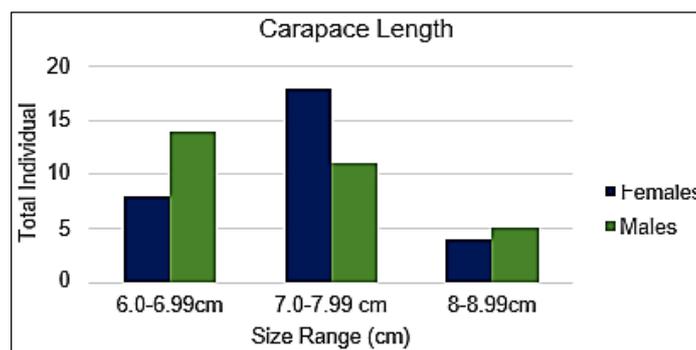


Fig 4: Distribution of length frequency of *R. ranina* in males and females

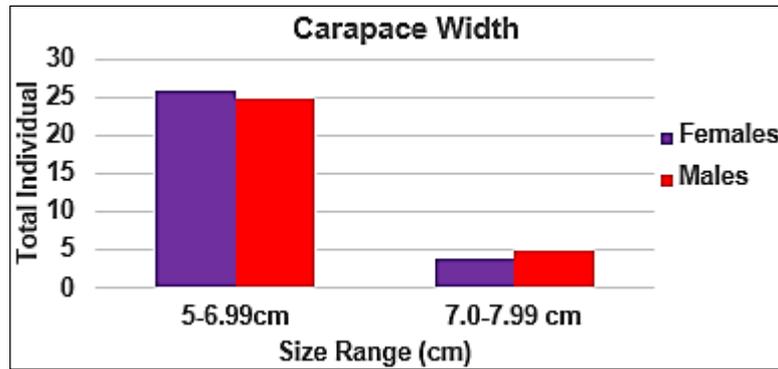


Fig 5: Distribution of width frequency of *R. ranina* in males and females

In terms of its body weight, most of the female crab samples revealed high values or heavier rather than males (Figure 6). Females have a minimum weight of 95 g and reach 170 g while males range from 65-155g. This was also observed in the studies of Minagawa *et al.*, 1993 and Fielding *et al.* 1976 [6] in the female reproductive biology of *R. ranina* that females are usually heavier than males specifically when they are on their incubation period, which they carry batches of eggs within. This season generally happened from May to September. Hence, samples from this study were collected in August which fall within the high occurrence of

ovigerous females and give effect on the high body weight values of females rather than males.

However, generally, females of *R. ranina* are usually smaller and reaching 400 g in weight while males can reach 900 g in total body weight. This conclusion was indicated in the study of Brown 1996 with the same observation by Fielding *et al.*, 1976 and Kennelly *et al.*, 1992 [3]. It is important to note that males must be large enough to successfully dig female crabs out of the sand to reproduce (Skinner and Hill 1986; Minagawa 1993) [12, 7].

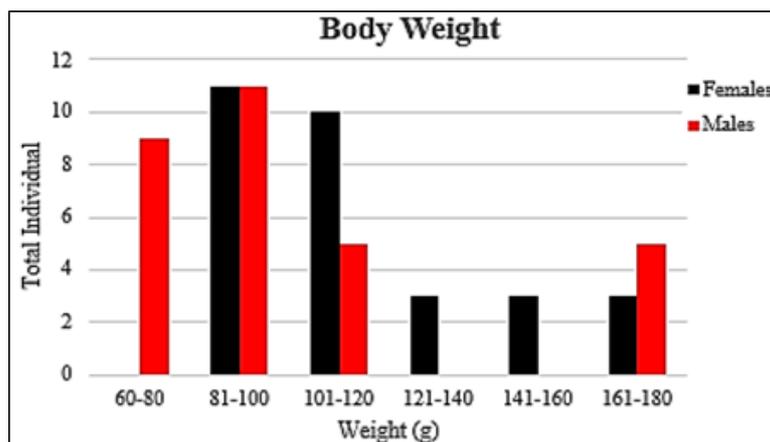


Fig 6: Distribution of weight frequency of *R. ranina* in males and females

Interrelationship of different morphometric characters

The scatter diagram for males and females was obtained by plotting the different morphometrics of individual crabs (Figures 7 and 8). From the data presented, a distinct relationship was found between width, length, and total weight, as judged from the closeness of the scattered dots. Furthermore, to study the interrelations between different morphometric characters between sexes, females' carapace width and length were regressed on abdominal length and width; and abdominal width was regressed on abdominal length. While in males, carapace width and length were regressed on propodus length (Figures 9 to 15). Allometric

equations and correlation coefficient (r) values between different variables in males and females of *R. ranina* are shown in Tables 2 and 3.

The allometric regression found describes changes in soft tissue content (or total animal weight for crustaceans) relative to carapace width/length. This result is consistent with general trends of scaling with body size in animals (Peters, 1983; Schmidt-Nielsen, 1984) [15]. In the present study, females are slightly heavier than males until they attain 50-70 mm carapace width. Thereafter males are heavier than females at any given length.

Table 2: Allometric equations and correlation coefficient (r) values between different variables in males of *R. ranina* (Linnaeus, 1758)

Independent Variable (x)	Dependent Variable (y)	Allometric growth equation (y= a + bx)	'r2' value
Carapace Width	Propodus Length	PL = 1.9123 + 0.1279 CW	0.285
Carapace Length	Propodus Length	PL = 2.2779 + 0.069 CL	0.0678
Carapace Length	Body Weight	BW= - 169.88 + 37.742 CL	0.6694
Carapace Length	Abdomen Width	AW= 0.2893 + 0.1909 CL	0.7403
Abdomen Width	Abdomen Length	AL= 0.818 + 1.4455 AW	0.5294
Carapace Width	Body Weight	BW= - 162.63 + 42.01 CW	0.7134

Table 3: Allometric equations and correlation coefficient (r) values between different variables in females of *R. ranina* (Linnaeus, 1758)

Independent Variable (x)	Dependent Variable (y)	Allometric growth equation (y= a + bx)	r ² value
Carapace Length	Body Weight	BW= - 110.85 + 31.505 CL	0.5502
Carapace Length	Abdomen Length	AL= - 0.3831 + 0.5666 CL	0.6947
Carapace Length	Abdomen Width	AW= - 0.8909 + 0.4585 CL	0.8144
Abdomen Width	Abdomen Length	AL= 1.4226 + 0.9479 AL	0.5017
Carapace Width	Body Weight	BW= - 82.781 + 32.601 CW	0.569
Carapace Width	Abdomen Length	AL = 0.4464 + 0.5337 CW	0.5954
Carapace Width	Abdomen Width	AW= - 0.1745 + 0.4245 CW	0.6745

A strong positive correlation was found between the male carapace width and body weight with females (0.84 and 0.75 respectively). And same observation was revealed in the carapace length and

body weight which both are positively correlated with 0.74 and 0.81 correlation values.

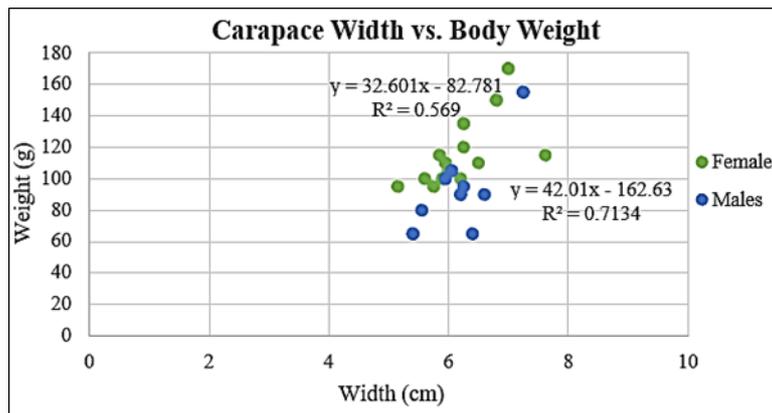


Fig 7: Scatterplots of carapace width (cm) and body weight (g) relationship comparison of *R. ranina*: females (green circles) and males (blue circles)

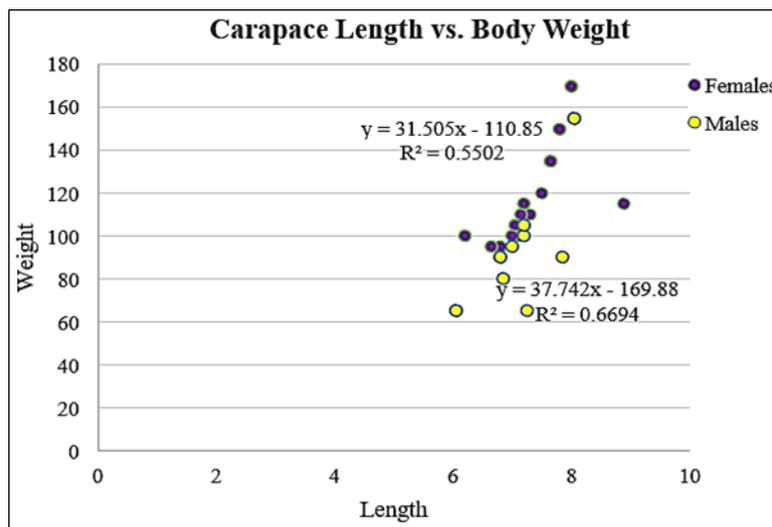


Fig 8: Scatterplots of carapace length (cm) and body weight (g) relationship comparison of *R. ranina*: females (violet circles) and males (yellow circles)

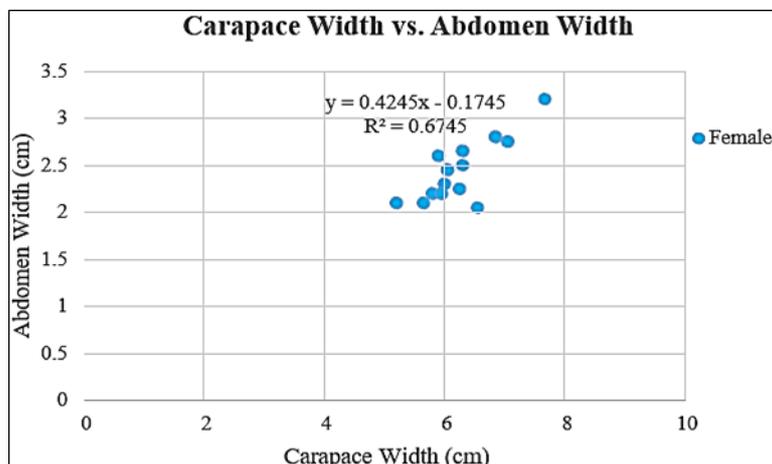


Fig 9: Carapace width (cm) and abdomen width (cm) in the female of *R. ranina*

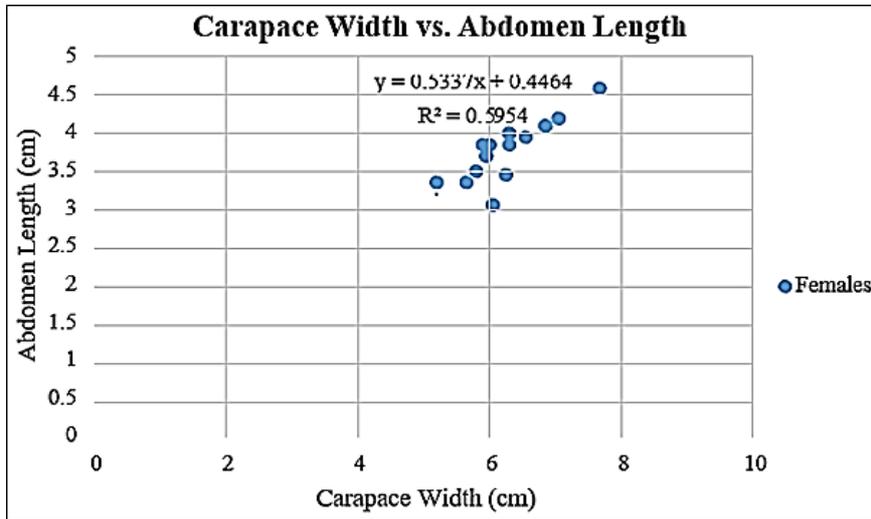


Fig 10: Carapace width (cm) and abdomen length (cm) in the female of *R. ranina*

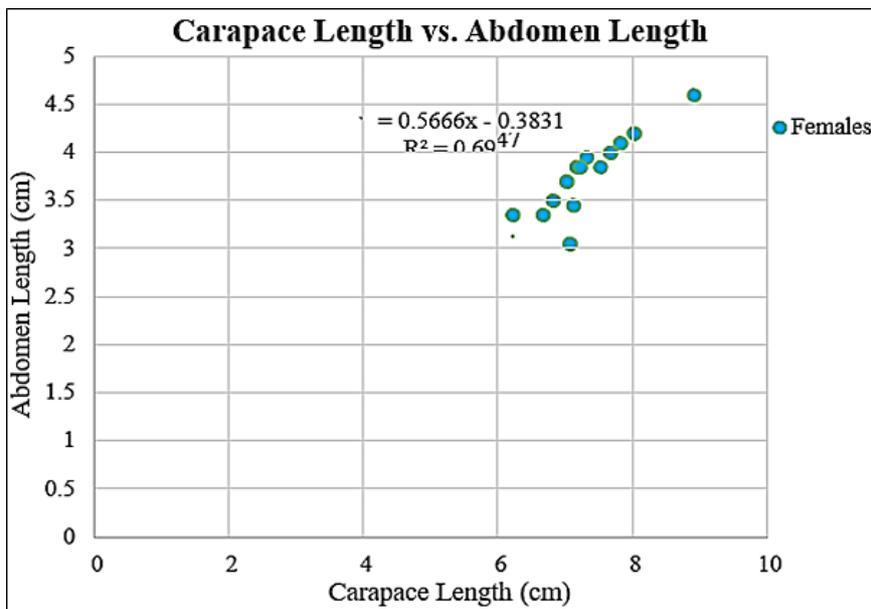


Fig 11: Carapace length (cm) and abdomen length (cm) in the female of *R. ranina*

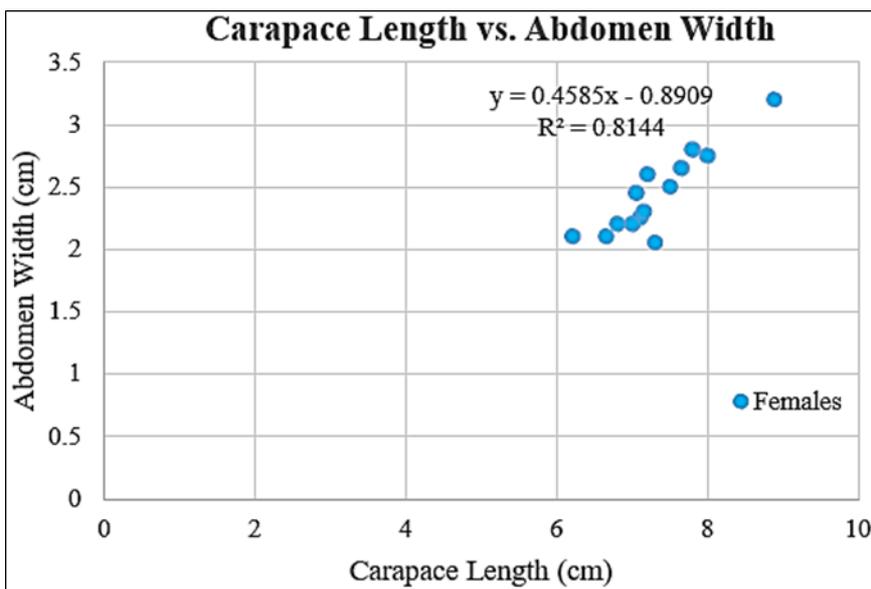


Fig 12: Carapace length (cm) and abdomen width (cm) in the female of *R. ranina*

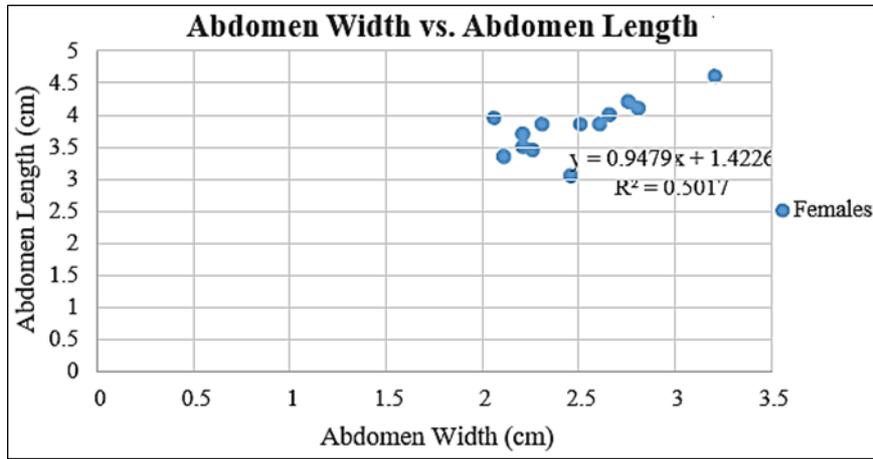


Fig 13: Abdomen width (cm) and abdomen length (cm) in the female of *R. ranina*

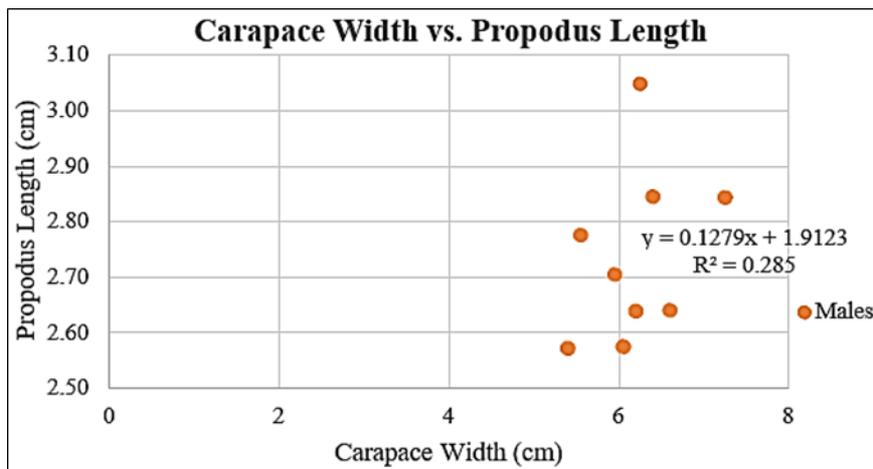


Fig 14: Carapace width (cm) and propodus length (cm) in the male of *R. ranina*

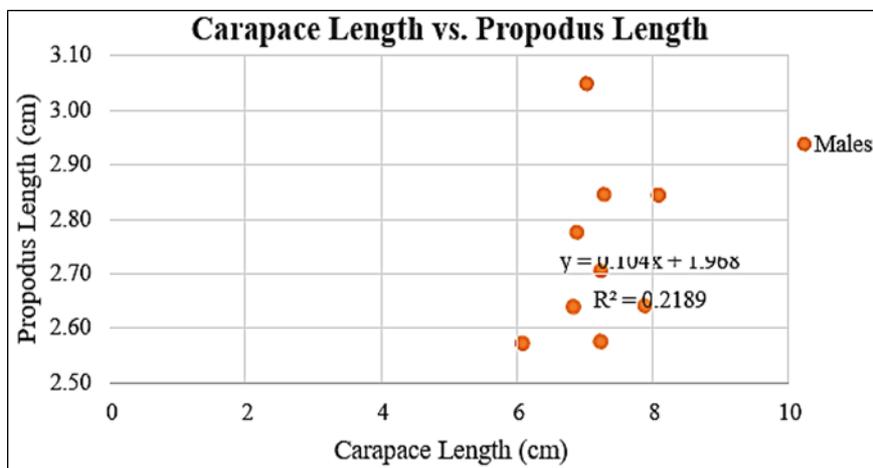


Fig 15: Carapace length (cm) and propodus length (cm) in the male of *R. ranina*

The exponential values (b) for the carapace width-weight relationship in males and females (1.630 and 2.457, respectively) show that there is a marked deviation from the growth pattern. The

exponential values (b) for carapace length-weight in males and females (0.313 and 2.554, respectively). The ‘t’ values are given in Table 4.

Table 4: The ‘t’ values for the carapace width/length and total weight relationship in males and females of *Ranina ranina*

Relationship	Sex	‘t’ values	Remarks
Carapace Width-Total Weight	Male	3.97	Significant at 1% level
	Female	7.98	Significant at 1% level
Carapace Length-Total Weight	Male	5.05	Significant at 1% level
	Female	1.05	Not significant

Conclusions

1. It was determined that, of the crab samples examined, 63.33 percent (23 females and 15 males) had carapace lengths ranging from 8.0 to 8.99cm and were capable of reproducing and were at or near the end of their reproductive cycle. When it came to the juvenile stage, 36.67 percent (23 females and 15 males) had carapace lengths ranging from 6.0-7.99 cm and were deemed to be in the juvenile stage. Furthermore, based on its exterior morphometric characteristics, the *Ranina* species discovered at the research site is comparable to the *Ranina* species found in the Tawi-tawi and Sulu regions.
2. It was found that female *Ranina ranina* had larger bodies than males. This is because growth patterns, food availability, and mature size all vary. Females were found to be heavier than male species in the study due to the fact that samples were taken in August which fall during their incubation phase.

Recommendations

1. Further research is needed to determine the current condition of the *R. ranina* fishery and the best management practices for this species in Southern Mindanao.
2. Further study into the reproductive biology of the *R. ranina* species in order to determine its gonadosomatic indices and fecundity levels.

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