MORPHOMETRIC ANALYSIS OF THE RED FROG CRAB "CURACHA" RANINA RANINA FROM BALUT ISLAND, SARANGANI, DAVAO OCCIDENTAL

MICHELLE M. ELEMINO
Southern Philippines Agri-Business and Marine and Aquatic School of Technology, Institute of Fisheries and Marine Sciences

Corresponding Authors: michellemelemino@spamast.edu.ph

ABSTRACT

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The morphometric character relationships of females and males of the red frog crab Ranina ranina, locally known as "curacha," from Balut Island, Sarangani, Davao Occidental, were the primary goal of 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 females of R. ranina have a larger body size than males. This is due to differences in growth patterns, food availability, and size of maturity. In terms of body weight, females of R. ranina are typically smaller, reaching a maximum of 400 g, whereas males can attain a total body weight of up to 900 g. It is important to note that males must be large enough to dig female crabs out of the sand to reproduce successfully. The allometric regression model describes changes in soft tissue content (or total animal weight for crustaceans) relative to carapace width or length. This result is consistent with

the general trends of scaling with body size in animals.

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). The species may grow up to 150 millimeters (5.9 in) long and weigh up to 900 grams (2.0 lb). 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.

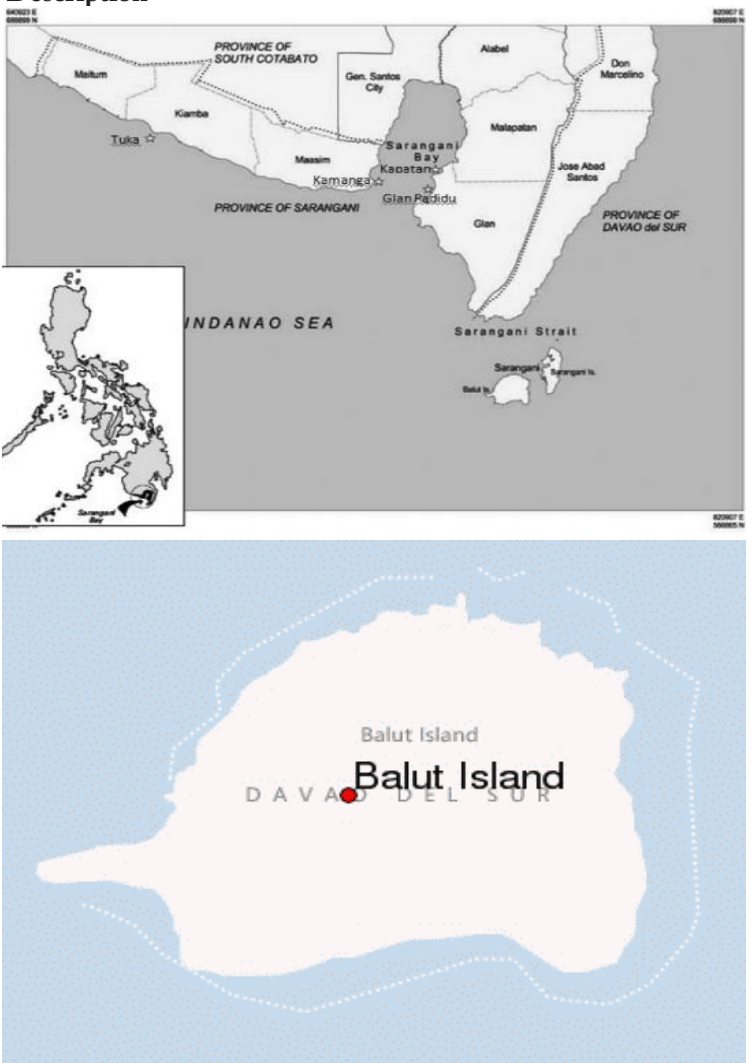
This red crab is the most prominent representative species of the family Raninidae. Low, rounded, scale-like spines wholly cover the carapace in large or small numbers, which are broader anteriorly. Eye stalks are set vertically and are longer than the others. Strong cheliped bears seven or eight teeth.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

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 body parts are generally used to determine sexual maturity in many decapods (Paul & Paul, 1990; Sainte-Marie et al., 1995; Jasmine, 2013). The morphometric analysis serves as a valuable tool for both taxonomists and ecologists to investigate intra- and interspecific morphological variations (Costa & Soares-Gomes, 2008), complementing genetic and environmental stock identification methods (Cadrin, 2000). Among brachyurans, the carapace, chelipede, pleopods/gonopods, and abdomen exhibit allometric changes in both sexes during their transition from juvenile to adult phases (Hartnoll, 1974).

The purpose of this study was to investigate and establish correlations between various morphometric characteristics in the Ranina ranina species from Balut Island, including carapace length (CL) and width (CW), cheliped propodus length (PL), dactylus length (DL), and abdomen width (AW). Similarly, this document aims to record the presence of this species in Southern Mindanao, Philippines, specifically 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 is located approximately 13 km (8.1 mi) from the mainland of Mindanao, separated by the Sarangani Strait. The Balut, Sarangani, and Olanivan Islands comprise 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, Sarangani Municipality. The crabs were immediately frozen and brought to the laboratory for examination. Identification was carried out using the published journal article "Morphological descriptions of the red frog crab Ranina ranina Linnaeus, 1758" by Matondo et al. (2015).

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 for 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 the third somite in females was considered as the abdominal width (AW) (Figure 3) (Kennelly & Watkins, 1994). Additionally, the specimen's body weight was measured using an analytical balance to the nearest 0.01 g.

Figure 2

A. Shape the dorsal aspect of the male abdomen.
B. Shape the dorsal aspect of the female abdomen.

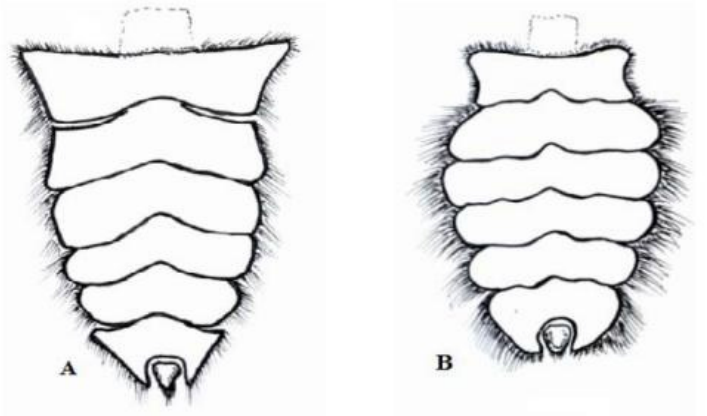
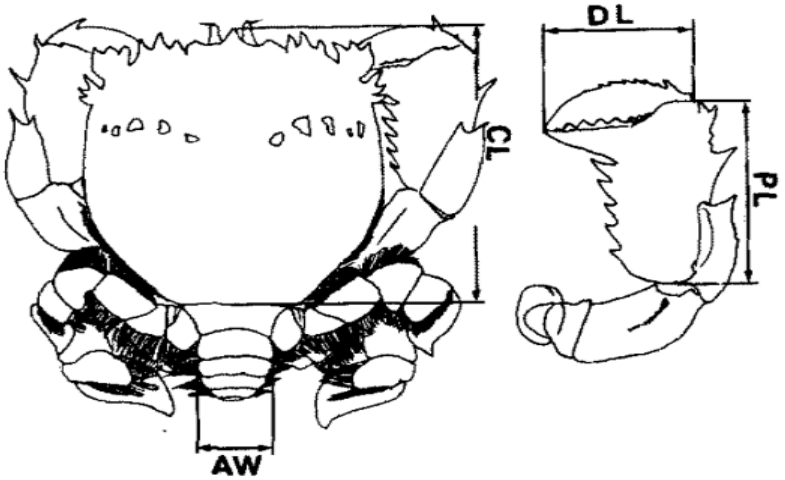


Figure 2
Measurement of morphometric characteristics in Ranina ranina. AW: abdomen width, CL: carapace length, CW: carapace width, DL: dactylus length, PL: propodus length.



Data Analysis

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

RESULTS AND DISCUSSION

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 a narrowly triangulate abdomen cover or tapering towards the distal segment, while females have a broad surface abdomen.

Figure 3
Distinguishing characteristics of female (A) and male (B) Ranina ranina showing their abdominal cover shapes.

Morphometric characters

Table 1 presents the minimum, mean, standard deviation (SD), and maximum values of selected morphometric measurements of male and female Ranina ranina crabs. The carapace width (CW) of males (mean ± SD: 6.20 ± 0.59) was statistically higher than that of females (mean ± SD: 6.17 ± 0.56), with a t-value of 0.86 and $p < 0.05$. Conversely, the carapace length (CL) of males (mean ± SD: 7.09 ± 0.64) was statistically lower than that of females (mean ± SD: 7.28 ± 0.57), as indicated by a t-value of 0.24 and $p < 0.05$. Regarding abdomen width (AW), females exhibited a significantly greater measurement (mean ± SD: 2.45 ± 0.29) compared to males (mean ± SD: 1.64 ± 0.14), with a t-value of 1.64 and $p < 0.05$. In contrast, the dactylus length (DL) of females (mean ± SD: 2.22 ± 0.18) was statistically lower than that of males (mean ± SD: 2.29 ± 0.18), with a t-value of 0.13 and $p < 0.05$. These results demonstrate apparent sexual dimorphism in the morphometric traits of Ranina ranina.

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. The carapace length ranges from 7.0 to 8.99 cm, with 60% of females and 36.67% of males, indicating a high density among females. While 26.67% of females and 46.67% of males have 6.0-6.99 cm, and 13.33% of females and 16.67% of males range 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 carapace width of males and females was 6.20 cm and 6.17 cm, respectively. Females (86.67%) have carapace width ranges from 5.0 to 5.99 cm, and 13.33% of females have a carapace width of 7.0 to 7.99 cm. Males (16.67%) have reached a carapace width of 7.0-7.99 cm, and 83.33% are at a carapace width of 5.0-5.99 cm (Figure 5). Most females of R. ranina have a larger body size than males. This is due to differences in growth patterns, food availability, and size of maturity.

Figure 4

Distribution of length frequency of R. ranina in males and

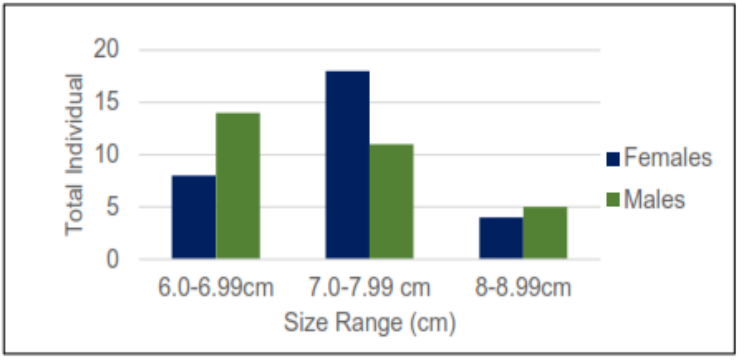
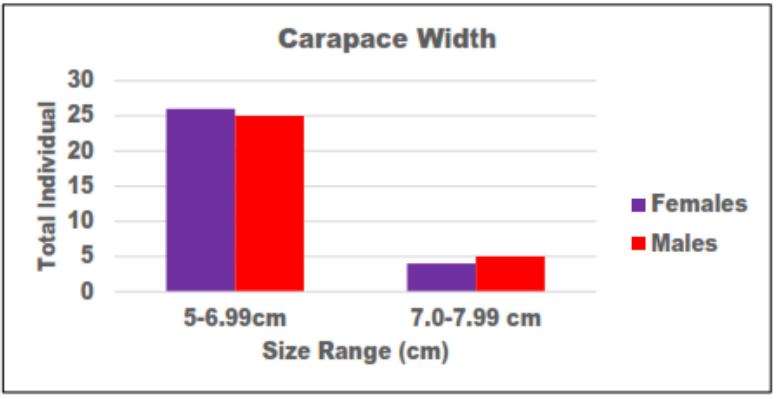


Figure 5

Distribution of the width frequency of R. ranina in males and

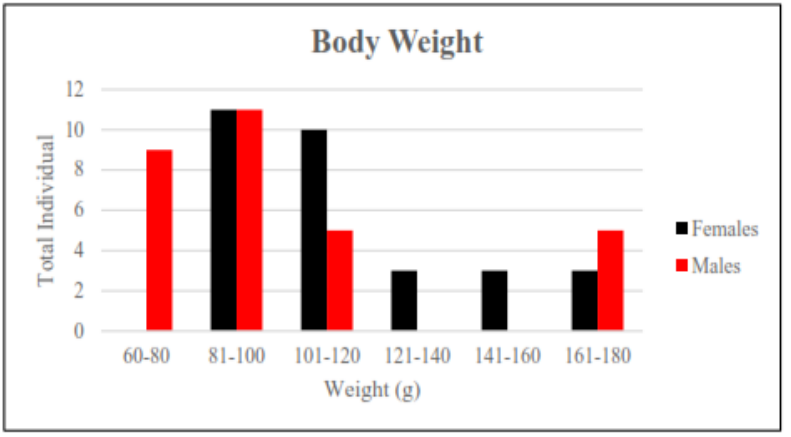


In terms of body weight, most female crab samples revealed higher values than males (Figure 6). Females have a minimum weight of 95 g and reach 170 g, while males range from 65 to 155g. This was also observed in the studies of Minagawa et al. (1993) and Fielding et al. (1976) on the female reproductive biology of R. ranina, where females are usually heavier than males, particularly during their incubation period, when they carry batches of eggs. This season generally happened from May to September. Hence, samples from this study were collected in August, which coincides with the high occurrence of ovigerous females and has an impact on the higher body weight values of females compared to males.

However, females of R. ranina are generally smaller, reaching a weight of 400g, while males can reach a total body weight of 900 g. This conclusion was supported by the study of Brown (1996), with similar observations made by Fielding et al. (1976) and Kennelly et al. (1992). It is important to note that males must be large enough to successfully dig female crabs out of the sand to reproduce (Skinner & Hill, 1986; Minagawa, 1993).

Figure 6

Distribution of weight frequency of R. ranina in males and



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 observed between width, length, and total weight, as indicated by 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 (Figures9 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.

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)	'r^2' 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

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

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). The same observation was also revealed in the carapace length and body weight, which are both positively correlated with correlation values of 0.74 and 0.81, respectively.

Figure 7

Scatterplots illustrating the relationship between carapace width (cm) and body weight (g) in Ranina ranina. Green circles represent female crabs, while blue circles depict male crabs.

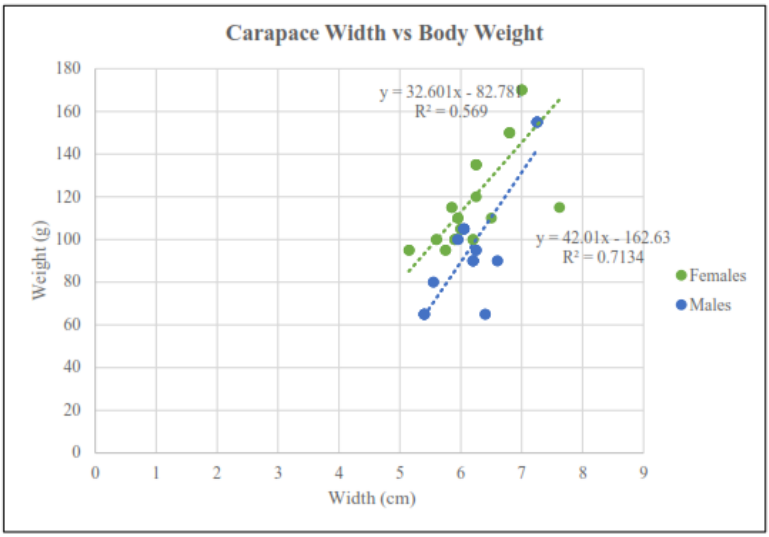


Figure 8

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

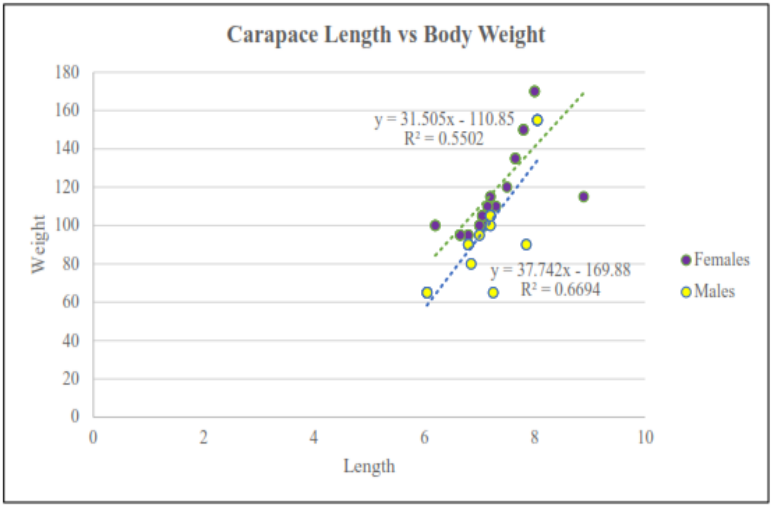


Figure 9
Carapace width (cm) and abdomen width (cm) in the female of R. ranina

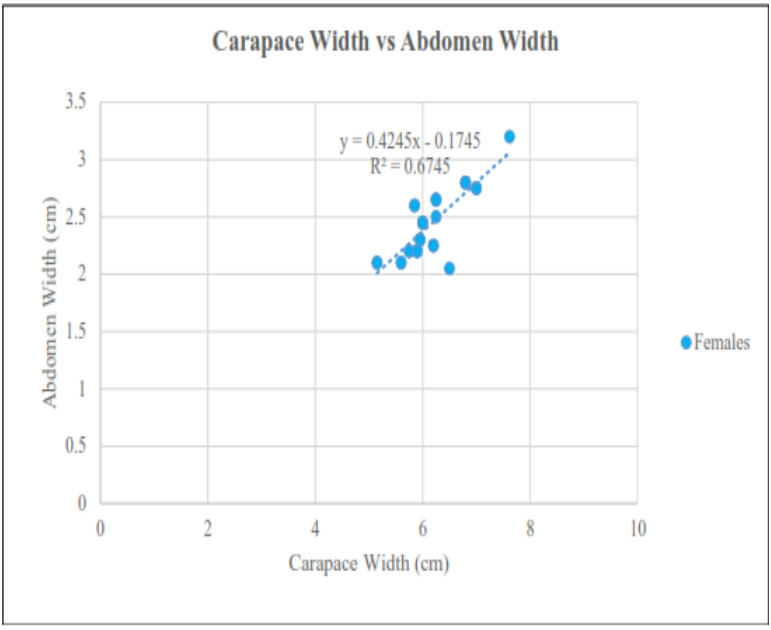


Figure 10
Carapace width (cm) and abdomen length (cm) in the female of R. ranina

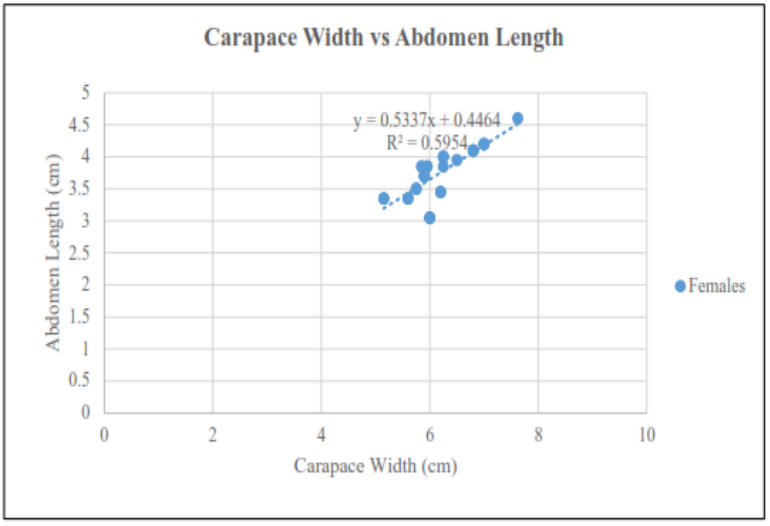


Figure 11

Carapace length (cm) and abdomen length (cm) in the female of R. ranina

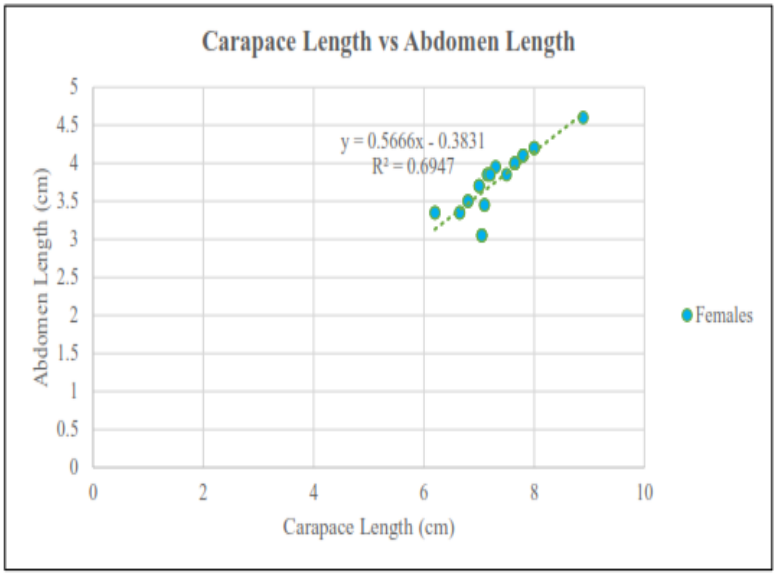


Figure 12

Carapace length (cm) and abdomen width (cm) in the female of R. ranina.

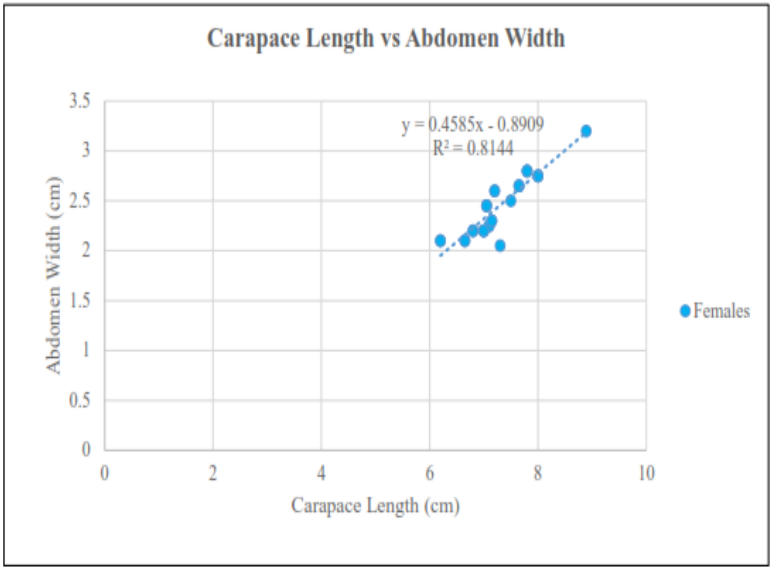


Figure 13

Abdomen width (cm) and abdomen length (cm) in the female of R. ranina.

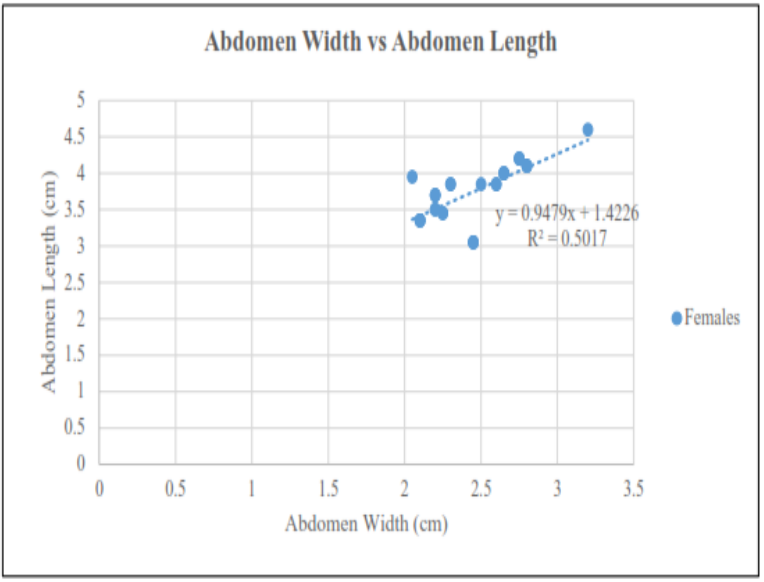


Figure 14

Carapace width (cm) and propodus length (cm) in the male of R. ranina.

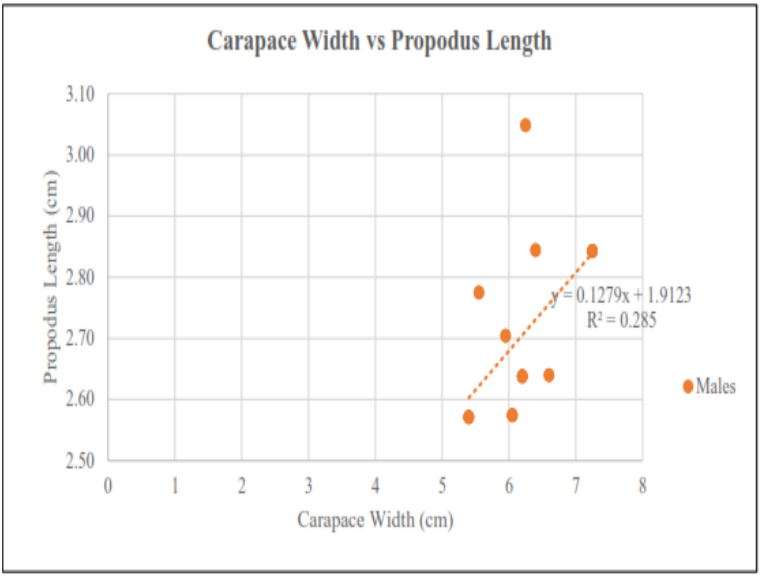
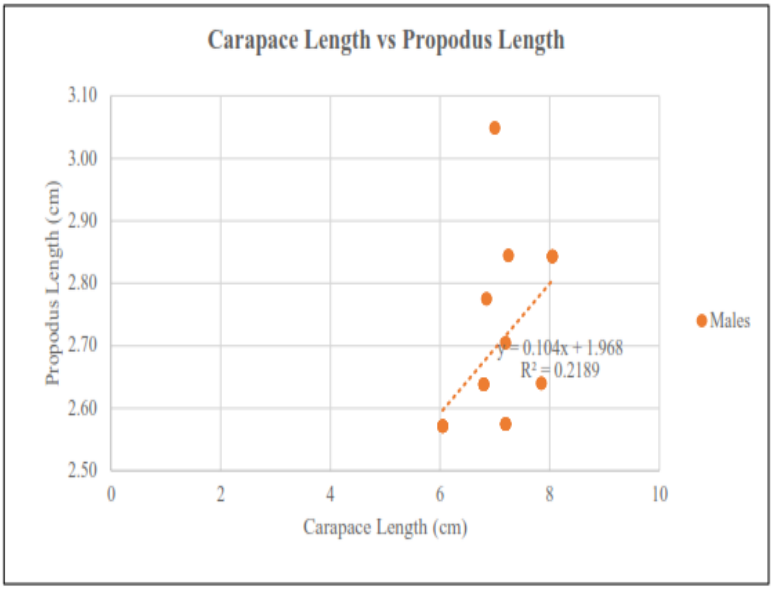


Figure 15

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) indicate a marked deviation from the growth pattern. The exponential values (b) for carapace length-weight in males and females are 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 the 1% level
	Female	7.98	Significant at the 1% level
Carapace Length-Total Weight	Male	5.05	Significant at the 1% level
	Female	1.05	Not significant

CONCLUSION AND RECOMMENDATIONS

Conclusion

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. During the juvenile stage, 36.67 percent (23 females and 15 males)

had carapace lengths ranging from 6.0 to 7.99 cm and were classified as being in the juvenile stage. Furthermore, based on its exterior morphometric characteristics, the Ranina species discovered at the research site is comparable to those found in the Tawi-Tawi and Sulu regions.

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 They were found to be heavier than the male species in the study because Samples were taken in August, which falls during their incubation phase.

Recommendations

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. 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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