Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2015; 3 (2): 251-256

Received: 15-04-2015
Accepted: 01-05-2015

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# Morphological description of the red frog crab *Ranina ranina* Linnaeus, 1758 (Brachyura: Raninidae) from South Western Mindanao, Philippines

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**Abstract**
The red frog crab *Ranina ranina* collected from the marine waters of south western Mindanao, Philippines was characterized using morphological characters and line drawings. The species showed variations in the carapace color. The number of white spot patterns on the carapace are more pronounced among large size individuals. Antenna shape is setaceous. The feeding apparatus is covered by a large, straight, thick but flattened maxilliped with a short and narrow exopodite, two straight broad basal segments endopodites and three narrow distal segments medio-laterally located in the secondary basal segment folded downward perpendicular to the medio-lateral portion and concealed when resting. Sexual dimorphism was observed on the shapes of the fronto-anterior margin and rostral lobe, setal lining in the palmar area of the dactyl and anterior of the ventral aspect of the chela. Structural variations was also observed ventrally in the 3rd and fourth ventral pleomeres in males.

**Keywords:** *morphology, pleomeres, color variation, maxilliped, carapace, setaceous*

## Introduction

The only extant species of its genus, the red frog crab *Ranina ranina*, is commonly called "spanner crab" in Australia, "krab giraffe" in Seychelles [1], "Kona crab" in Hawaii [2], and "curacha" in south western Philippines. The species is extensively dispersed all over the Indo-Pacific [1, 3]. Mauritius, Reunion, East Africa, East Indies to China [4]. In the Philippines, it was reported to be in abundance in the coastal waters of Sulu and Tawi-tawi [5], Basilan [6], and in Zamboanga City [7].

In the Philippines, *R. ranina* was taxonomically classified *R. ranina* (Linnaeus, 1758) [8, 9]. Many studies conducted on this crab species were mostly focused on the fishery aspect due to its economic significance [2, 6, 7, 10]. Many aspect of its biology remained to be explored such as the evolutionary history and ecology of this species [11]. With regard to its anatomical descriptions, the work of Fielding and Halley[2], Uchida[3], Onizuka [12] and Gordon [13] provided the most distinguishing morphologic characterization of *R. ranina.*

Descriptions of the external morphology of *R. ranina* were limited to those samples collected from selected geographic areas [3, 14, 15] but no published information were documented on those individuals collected from South western Mindanao in the Philippines thus this study was conducted.

## Materials and Methods

**Collection sites.** This study was conducted from June 2014 - January 2015. Samples of *R. ranina* were collected from the coastal waters of Sacol and Siasi Island (Figure 1). Sacol Island (6.9759° N, 122.2446° E) is located off the coast of Zamboanga City along the Moro Gulf while Siasi Island (5°32'13", 120°51'28" E) is a part of the Jolo group of islands comprising the Sulu archipelago in the south western part of Mindanao. Both islands are part of the Mindanao group of islands.

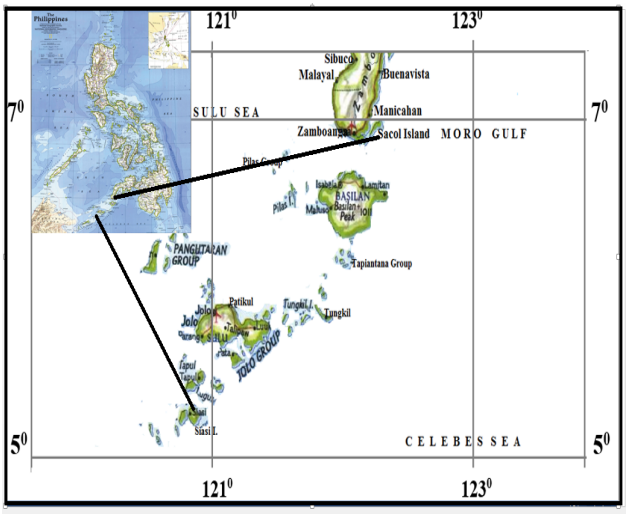


**Fig 1:** Map showing the geographic locations of the collection sites.

**Collection of specimen.** Crab specimens were collected through commissioned fishermen. Method of collection follows the procedure described in the work of Baylon and Tito [7].

**Line drawings.** Line drawings and descriptions for each structure was provided.

**Sample Imaging.** Crab carapace were photographed using Fujifilm camera model Fine Fix S2000HD S2100HD in macro mode, with a tripod to obtain a standardized picture.

**Technical terms and descriptions**. Technical terms used in the study are provided in figure 2.

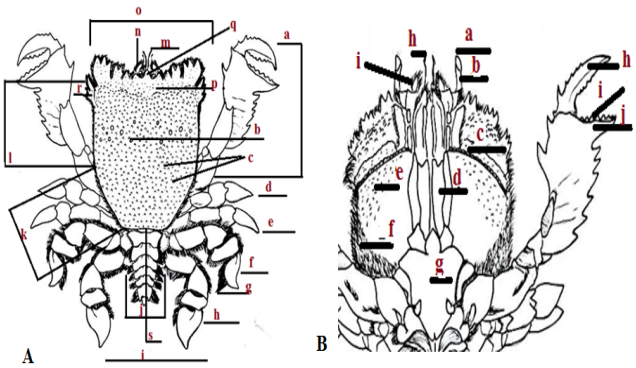


**Fig 2:** A. Morphological terms describing the *R. ranina* **A.** Dorsal aspect: a. 1st pereiopod, b. white spots c. tubercles d. 2nd pereiopod e. 3rd pleopod f. fourth pereiopod g. setae h. 5th pereiopod i. posterior aspectj. Pleopods k. postero-lateral aspect l. antero-lateral aspect m. antenna n. eye o. orbitofrontal aspect, p. dorso-anterior setal field q. rostrum r. antero –lateral lobe s. posterior border. **B.** ventral aspect including parts of the chela. a. eye b. eyestalk c. protogastric ridge d. 3rd maxillipede e. ventral tubercle processes f. ventrolateral setal field g. sternum h. dactyli i. chelar teeth j. pollex

## Results and Discussion

**General Description.** The detailed description of the general morphology of the carapace, head, thorax, the appendages, sternum, abdomen and the pleopods of *R. ranina* include the general morphology of the dorsal and ventral part of the male and female crab, orbito-frontal margin, head structures (eye, antenna and antennules, maxilla and the mandible) the appendages (maxillipeds and walking legs), the sternum, the abdomen and pleopods presented through line drawings. Only the carapace coloration is being presented through a picture. The general morphology of the male and female crab *R. ranina* is illustrated in figures 3 and 4 respectively.

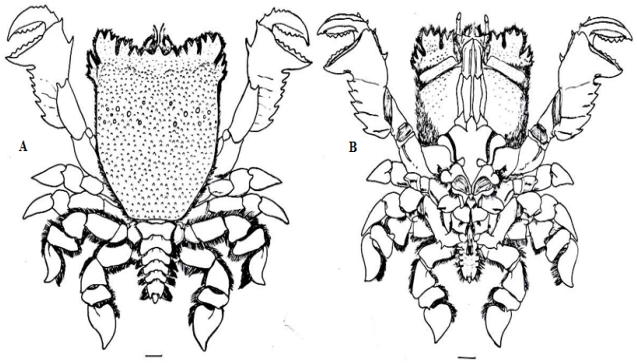


**Fig 3:** Line drawing of the dorsal (A) and ventral (B) view of a male *R. ranina* crab. CL-carapace length, CW-carapace width, Wt- weight (CL: 108mm CW: 81mm Wt: 326.36g) Bar scale: 10mm

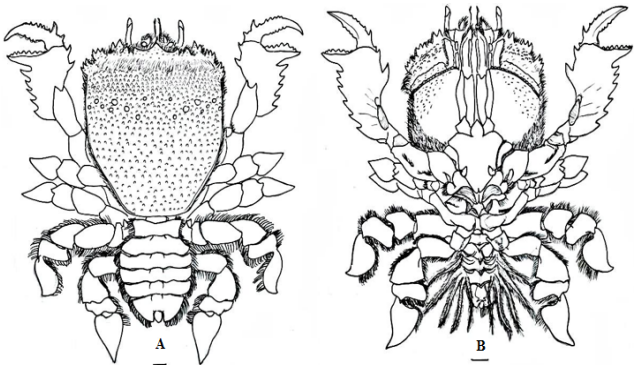


**Fig 4:** Line drawings of ventral (A) the dorsal (B) view of a female *R. ranina*, (CL: 106 mm CW: 89 mm Wt: 332.15g) Bar scale: 10mm

### A. The Carapace

**Shape.** *R. ranina* from south-western Mindanao has a wide, longer, ovate carapace described as longitudinally ovate[16]. Carapace width wider along the anterior 3rd portion of which the widest part measured is in line with the pattern of white spots across the dorsal carapace. The latero-posterior aspect is narrower than its anterior resulting to a shorter posterior boundary giving the carapace an ovate shape.

**Color.** Unlike any other decapod crustaceans, the carapace of *R. ranina* is characterized by its unique red-orange color. Individuals from Sacol Island in Zamboanga Peninsula were all characterized by a darker red orange shade while those from Siasi Island in Sulu Province were found to have dark red orange shade although some individuals have very light orange color especially the chelipede (Fig. 5 a and b respectively). The light orange variation occurs only among large size males. Crab fishers and vendors observed dark colored crabs inhabit muddy, sandy habitats while light colored crabs inhabit only sandy habitat. Since the habitat occupied is not uniform, the variation could be ecologically-influenced or a case of color polymorphism. Studies on color variation in the sand crab *Lepidopa benedicti* was shown to be influenced by size[17] not on the differences in habitat which is in contrast to *R. ranina*.

**Seta, white spots patterns, and texture**. The entire frontal and lateral margin of the crab are lined with short setae. Dorsally, posterior to the fronto-orbital spines is a narrow setal

field bounded by the base of the antero-lateral and fronto-orbital spines anteriorly and the hard tubercles posteriorly called the postfrontal depression [8]. A pattern of 12 uneven size white spots line across the upper third part of the dorsal carapace with two inferior but prominent parallel white spots centrally located. White spots are more prominent among large size individuals. The dorsal carapace has a rough texture due to the presence of spine -like structures called tubercles. The ventral portion is smooth with setal fields extending thinly along the lateral sides and grow wider towards the posterior aspect bounded by the episternite of sternite 5.


**Fig 5: A.** light orange-colored male *R. ranina* CL: 142.4mm CW: 128.3mm Wt: 990g **B.** dark orange-colored female *R. ranina* CL: 100.06mm CW: 86mm Wt: 450g

**The orbito-frontal and latero-anterior margin.** The orbito-frontal margin of the crab is characterized by an acute triangular rostrum bounded by symmetrical lateral rostral teeth. In large size males, the central rostral tooth is narrower and longer while in females, this is shorter but broader. Adjacent to the rostrum is the orbital spine where two lobes lie adjacent, a bifid frontal lobe and a trifid fronto-lateral lobe. In males, the fronto-lateral lobe with a broad proximal base is distinctly longer than the central rostral spine. The 3 short spines are directed antero-laterally while the bifid frontal lobe is shorter with 2 narrower spines directed forward creating a concave anterior. This gives the male anterior aspect a squarish shape with a deep medial groove (Fig. 6A) Anterolateral margin has a trifid lobe with a long superior spine; length of the two remaining spines decreases inferiorly and are directed distally. In females, the trifid fronto-lateral lobe is laterally inferior than the bifid lobe. This results to a rounded shape anterior margin (Fig. 6B). These observations are true to large size samples. However, in smaller, younger individuals, carapace variation is insconspicuous. This observation agreed with that of Uchida [3]. The protruding spines on the orbito-frontal and the latero-anterior margin carapace totalled to 21 spines.

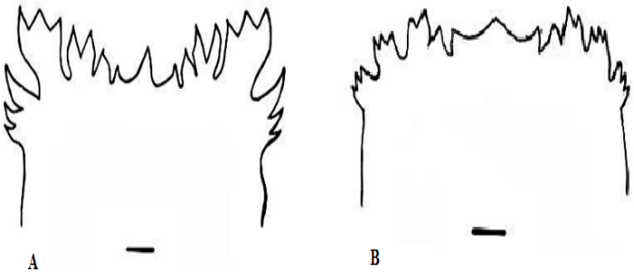


**Fig 6:** Orbito- frontal margin of the male (A) CL-108mm; CW-81mm and female (B) crab. CL-106mm CW-89mm Bar scale: 10mm

**B. The Eye, Antenna and Antennules**

The eye peduncle of *R. ranina* is three segmented, folding longitudinally. (Fig. 7A.), antenna is biramous (Fig. 7B), jointed at the base and extends forward from the anterior margin with many joints that tapers gradually from the base to the tip typical to that of a setaceous type. The antennules (Fig. 7C) are uniramous, short robust structure with a very short flagellum arising from the anterior of the 3rd endopod. Dorsal endodite and exodite of antenna and antennules were lined with setae.

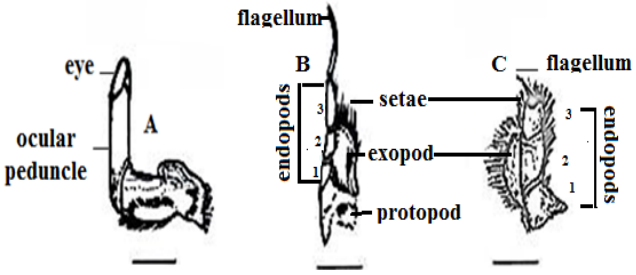


**Fig 7:** A. right eyestalk B. right antennae (dorso-medial aspect) D. antennule (dorso-medial aspect)
Bar scale: 10mm

**C. The Feeding Apparatus**

**The maxilla.** The maxilla of *R. ranina* are both small and thin. The 2nd maxilla (Fig. 8B) is anterior to the 1st maxilla (Fig, 8A).

**a. The first maxilla**. The first maxilla has a small endopodite lobe posterior to a bifid endites, flattened structurally bending medially. The endopodite has a fine line of short setae along its outer margin. The flat endite branched-out forming a bifid endite: a primary broader endite and a secondary narrow endite. The medial aspect of the endites are lined with long, thick setae.

**b. The second maxilla**. The 2nd maxilla possess a scaphognathite, a large structure that extends into the gill chamber. The outer margin of the scaphonagthite is thinly lined with setae. Its endopodite is slim and is almost as long as the primary endite adjacent to it. The lateral margins of the endopodites and endites are lined with thick setae. Both primary and secondary maxilla function in food handling.

**The mandible.** The mandible (Fig. 9A) is the hardest feeding apparatus of the crab. The basal segment is fused with the triangular gnathal lobe. Two segmented mandibular palp attached dorsally to the base of the gnathal lobe is concealed when resting. The dorsal aspect of the gnathal lobe (Fig. 9B) is concave where the gnathal teeth are located.

**The Maxillipeds.** Maxillipeds are modified appendages to serve as feeding accessory organs. In the thorax, they are arranged in descending order of appearance in a manner that the 3rd maxilliped (Fig. 10A) is anteriorly located while the 2nd (Fig. 10B) and the 1st maxilliped (Fig. 10C) are posteriorly located respectively.

**a. The 3rd maxilliped (mxd3).** The largest and the hardest among the mouthparts in *R. ranina* excluding the mandible. It has a flattened shape on the thorax and covers the entire mouthfield of the crab when resting. Endopodite has 2 straight broad basal segments and 3 narrow distal segments. The distal segment is medio-laterally located in the secondary segment folded downward perpendicular to the medio-lateral portion

and concealed when resting. Densely arranged setae present on outer margins of the endopodite. The exopodite is laterally located, short and narrow with setal rows on the outer margin and on the dorsal aspect. Flagella is unremarkable at the triangular tip of the secondary basal segment surrounded with setae.

**b. The 2nd maxilliped (mxd2).** Maxilliped 2 is smaller than maxilliped 3. The distal endopodite is slightly bent towards the medial line; exopodite follows the same curving direction. The exopodite is narrower but longer than the bent endopodite with 3 segments. Distal segment bearing rows of short setae an indication that this segments probably function to create water current over the mouthparts to help prevent the loss of food particles. An epipodite is present with gills.

**c. The 1st maxilliepede (mxd 1).** Among the 3 maxillipeds, the first maxilliped is the softest. The 2nd endopodite is folded into the medial aspect showing the dorsal side ventrally and slightly bend medially in a triangular shape with the exopodite curving in the same direction. Only 1 segment lined with setae at the distal endodite. A primary and secondary endite are present medially with mediolateral margin lined with setae. The same is true with the endopodite and the exopodite.

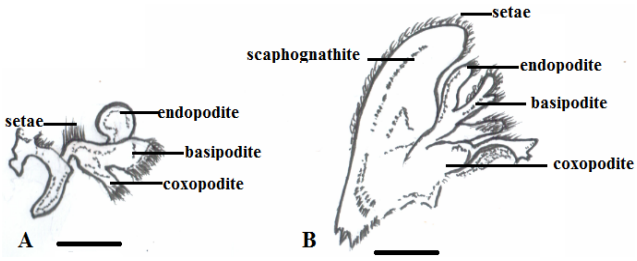


**Fig 8:** The first (A) and second maxilla (B). Bar scale: 10mm

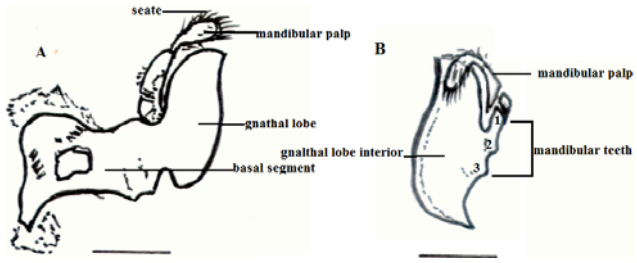


**Fig 9:** The mandible. A. The right external mandible. B. The interior of the gnathal lobe. Bar scale: 10mm

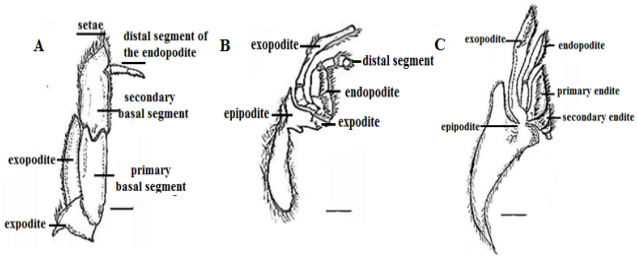


**Fig 10:** The Maxillipeds. A. right 3rdmaxilliped B. right 2nd maxilliped C. right 3rdmaxilliped Bar Scale 10 mm

**D. The Walking Legs.** The pereiopods are the 5 pairs of walking legs in crabs.

**The cheliped**. (Fig.11 A) The first walking leg is characterized by the presence of a large flat chela and a transverse dactyl. The dactyl of the cheliped is armed with 7 spines on the outer margin. The proximal spine is blunt and short but the adjacent spine is sharp and longer. Anterior to the sharp spines are 5 blunt and very short spines. The dactyl have rounded teeth with a pointed tip that curve downward. The outer and inner margin on the ventral side are lined with very thick short setae. The propodus is flat, lined with tubercles, with 2 prominent spines on the outer margin and 5 spines on the inner margin. The outer margin on the ventral view is also lined with thick growth of very short setae. It has outer rounded and inner narrowed semi-triangular teeth on the anterior of the pollex. The carpus has two parallel spines on the anterior outer margin with spines pointing upward in opposite direction. Setal lining in the chela is only conspicuous in large male samples but absent in females. The merus has an anterior solitary spine on the outer margin. Setal growth observed. Six prominent scale lines on the mid-dorsal aspect where setal growth was observed on the 3rd to the 6th lines with longer setal growth on the 5th scale line. The fused basi-ischium have blunt spinous process anteriorly on the outer and inner margin while the coxa are also lined with setae. The cheliped is used not only for movement but for food procurement too.

**The 2nd and 3rd pereiopod (**Fig. 11B and C**).** They are described to be the digging legs**.** Their dactyls are semi-flat, narrowed, concave inward on the ventral surface and have pointed tips characteristics for digging tools. The merus in pereiopod 2 (P2) is longer but the carpus and propodus are wider and shorter unlike in pereiopod 3(P3). The distal end of the carpus is tapered but not narrowed. In P3, the distal end of carpus is tapered narrowly, long with a broad proximal end allowing it a narrow bending angle resulting to a more flexed leg. However, the general shape of their legs are similar. This could be so because pereiopod 2 and 3 are highly modified to shovel sand forward from underneath their body[17].

**Pereiopod 4 (**Fig. 11D) **and Pereiopod 5 (**Fig.11E**)**. Pereiopod 4 (P4) has a more extended leg than P2 and P3. The merus is robust though shorter and the carpus is triangularly short allowing more flexion movement with a rectangular propodus. The dactyl is shaped like a paddle with a pointed tip and known to shovel sand forward[18]. P5 is highly modified to be the swimming legs although it also help in the digging process[18]. Its highly modified dactyl is broad with a pointed tip. All segments in P5 are almost flat and the lateral aspects are covered with setae except the outer margin of the dactyl. The ischium is fused with the
merus instead of to the basis and the coxa is covered by the 1st segment of the abdomen. Both P4 and P5 have broadened terminal segments.

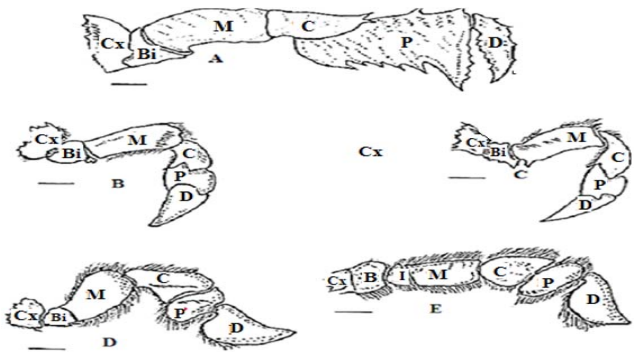


**Fig 12:** The locomotor tools of *R. ranina*. A-E right pereiopods 1-5 respectively. D-dactyl P-propodus C-carpus, M-merus, Bi- Basi-ischium, Cx-coxa, Bar scale: 10mm

**E. The sternum.** The sternum of *R. ranina* is highly modified

which can be associated with their burrowing characteristics[12]. Thoracic sternites 1-3 are fused with fully developed sternites 4 and 5 (Fig. 12). The sternal shield extend only up to the level flanked by the bases of the first ambulatory legs. Ventrally, sternite 6, 7 and 8 are not clearly visible since the sternum somewhat bends posteriorly. These morphological characteristics are similar with what have been mentioned in the work of Gordon[13].

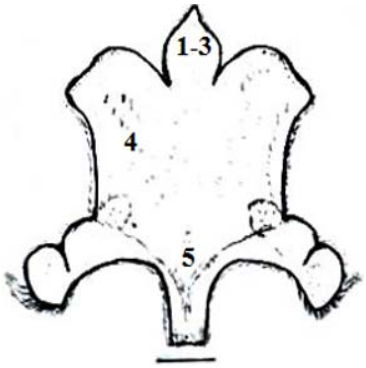


**Fig 12:** The sternal shield of *R. ranina* Bar scale: 10mm

**F. The Abdomen and Pleopods.** The sexually dimorphic abdomen of *R. ranina* are composed of 6 unflexed abdominal segments called pleomeres and the small ovate shaped terminal segment telson which contains the anus (Fig. 13 A and B). Male abdomen assume a narrow triangular shape while it is broader and rounded in females serving for accommodation of the fertilized eggs[19]. The first pleomere in males is broader than in female. The dorso-lateral aspect of the abdomen is lined with short seta.

On the ventro-anterior side of the male abdomen, 2 pairs of pleopods are located on segment 1 and 2 (Fig. 14 A). These male pleopods are responsible for transferring the sperm to the female during copulation process. Gonopod 1 (Fig.14B) is straight, proximally broad but gradually tapering distally, and marginally flattened dorso-ventrally, forming a lateral flap on the ventral side. The tip of the terminal segment is curve $90^0$ to the base. Setae lined the length of the proximal base towards the flap as well as along the distal segment. Gonopod 2 (Fig. 14C) is slender and shorter than gonopod 1. The proximal base is a bit broader and gradually tapered distally. The distal segment is enclosed in the proximal base of gonopod 1. The tip of the terminal segment is very thin and tapered.

It was observed dorsally that in males, the 6 pleomeres individually lies in one plane. Meaning, each pleomere is intact individually. Surprisingly, it was observed that ventrally, in the 3rd and 4th pleomere, there is a lateral symmetrical invagination extending medially (Fig. 15A) forming two partially overlapping segments that looks like two additional abdominal segments have been added ventrally. However, the depth of the invagination did not reach the dorsal aspect. Hence, such structural variation in the 3rd and 4th pleomere is not visible dorsally. It was also noted that setae grow along the invagination lines. However, such structural variation was not observed in the female abdomen (Fig. 15B) and none whatsoever have been reported in this species hence, the physiologic significance of these structures in the 3rd and 4th pleomeres is still unknown.

In females, ventral aspect (Fig. 16A) of the abdomen shows the attachment of paired biramous pleopods (Fig. 16B) responsible for the attachment of the fertilized eggs on segments 2-5.

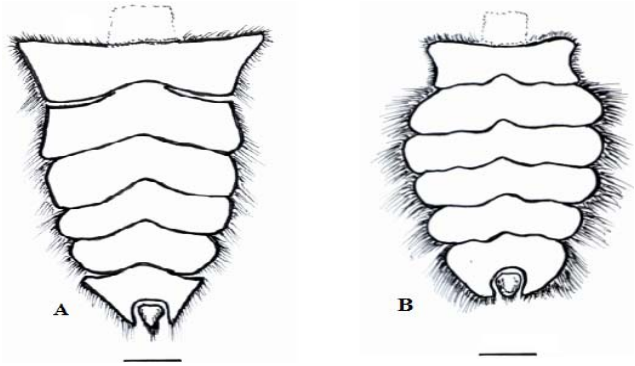


**Fig 13:** A. Shape dorsal aspect of the male abdomen (setae removed) B. Shape dorsal aspect of the female abdomen (setae removed) Bar scale: 10mm

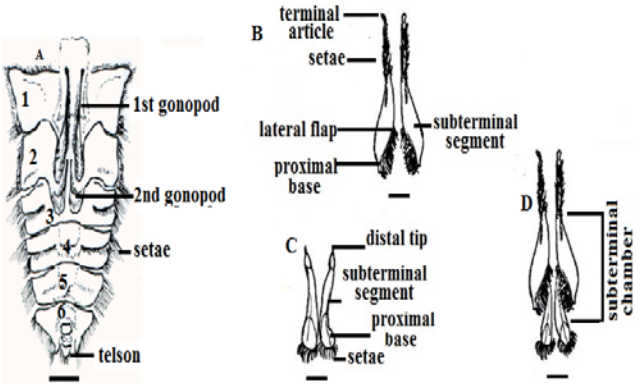


**Fig 14:** A. ventral aspect of the male abdomen with setae; 1-6 are abdominal segments B. the 1st gonopod C. the 2nd gonopod D. the subterminal chamber Bar scale: 10mm

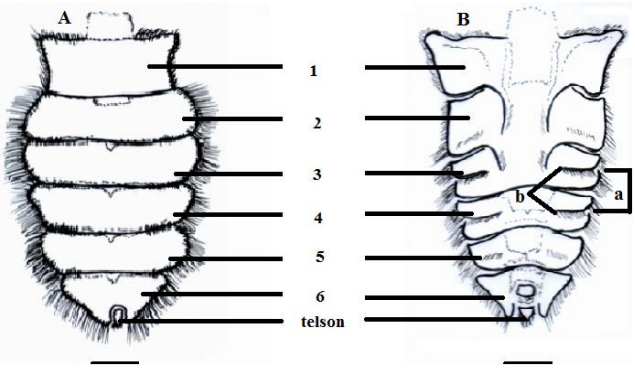


**Fig 15:** A. Ventral portion of the female abdomen B. Ventral portion of the male abdomen. (a. invagination groove in the 3rd and 4th pleomere; b. the overlap in the 3rd and 4th pleomere)

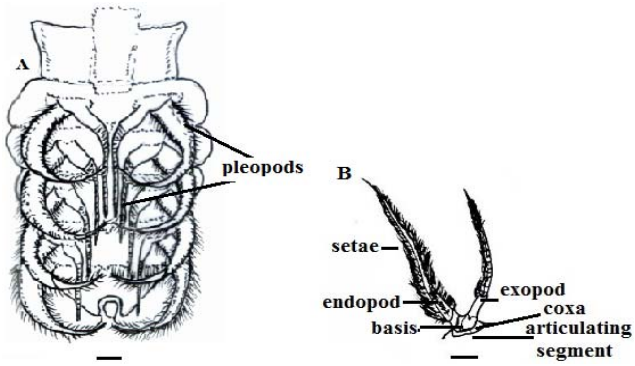


**Fig 16:** A. ventral aspect of the female abdomen B. The biramous pleopod in female. Bar scale: 10mm

### F. Other morphological observations

Figure 14A shows a female crab with asymmetrical growth (arrow) in the chelipede, a classic example of autotomy in *R. ranina.*

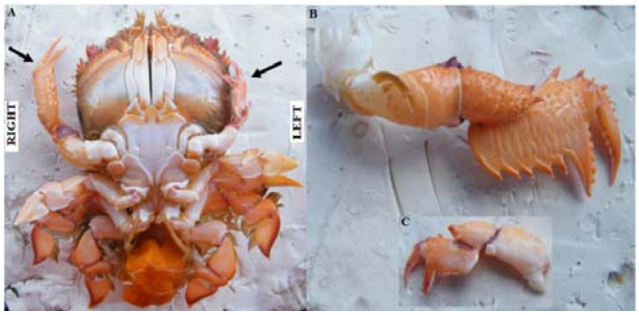


**Fig 14:** A. Observed asymmetrical growth in chelipeds B. normal growth in the right chela C. autotomized growth in the left chela. CL-94mm CW-82mm Wt- 300g

### Conclusion

While many of the described morphological characters in *R. ranina* from Southwestern Philippines are similar with those which have been already published, color variation however were observed between individuals. The very light orange to dark red-orange color variants including the 12 white spots pattern on the dorsal carapace were not described in previous studies were distinct characters that can be used to distinguish *R. ranina* from southwestern Mindanao. Also the current study have shown that the shape of the fronto-anterior margin, the shape of the rostral lobe, and the structural morphology in the 3rd and fourth ventral pleomere were also sexually dimorphic in this species. Furthermore, this study also provided the morphological description of the mouth parts which could help in understanding the feeding activity of the species

### Acknowledgement

The senior author would like to acknowledge the administration of the Western Mindanao State University, Zamboanga City, Philippines for its faculty development program and the Commission of Higher Education (CHED), Philippines for the study grant. Likewise, the technical assistance of Mr. Reynaldo Matondo is also acknowledged.

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