

## MR. AND MRS. CRAB: HOW CAN WE TELL THEM APART?

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AGE: 12

Male and female mud crabs may look alike at first glance, but clear differences in physical characteristics exist. These variations between sexes are known as sexual dimorphism. Sexual dimorphism may help species to survive in their environments. We found that three mud crab species (orange, green, and purple mud crabs) showed similar patterns of sexual dimorphism. Males generally have larger body and claw sizes, whereas females have larger abdomens. Orange mud crabs also have a unique body shape variation compared to green and purple mud crabs. All mud crabs have spines along the top edge of their shells, and scientists have numbered these spines to identify them. Unlike the green and purple species, orange mud crabs are wider at spine 8 than spine 9. Sexual dimorphism in crabs might be linked to how they reproduce and where they live.

## SEXUAL DIMORPHISM

Male and female of a species with noticeably different features or characteristics.

## ESTUARY

The connecting zone between rivers and the open ocean.

## MANGROVE FOREST

Forest consists of tropical trees that thrive in salty, coastal waters.

### Figure 1

The sex of mud crabs can be determined by the shape and color of their abdomens. Females have broad, dark abdomens (red arrow) whereas males have narrow, triangular-shaped abdomens (blue arrow).

## TELLING MALES AND FEMALES APART: SEXUAL DIMORPHISM

In humans, it is generally easy to distinguish men and women by their visible characteristics. For example, most adult men have thick facial hair and deeper voices, while women lack facial hair and have softer voices, among other features. These differences between males and females of the same species are called **sexual dimorphism**. Such differences have various purposes. Some may exist to attract the opposite sex, such as the large, colorful tails of peacocks [1]. Other characteristics, such as larger antlers or horns, may be used to show dominance over other males in species like deer and antelopes. Sexual dimorphism exists in almost all animals, although in some species the male and female characteristics might not be as noticeable as they are in humans.

## SEXUAL DIMORPHISM IN CRABS

Crabs, like most animals, are sexually dimorphic too! We studied mud crabs, which are commonly found in **estuaries** and **mangrove forests** in the Asia Pacific region. You can easily tell male and female crabs apart just by examining their abdomen shapes. Males have narrow, triangular abdomens, whereas females have broader abdomens (Figure 1). There are differences besides the abdomens, too! We were interested to know exactly which characteristics

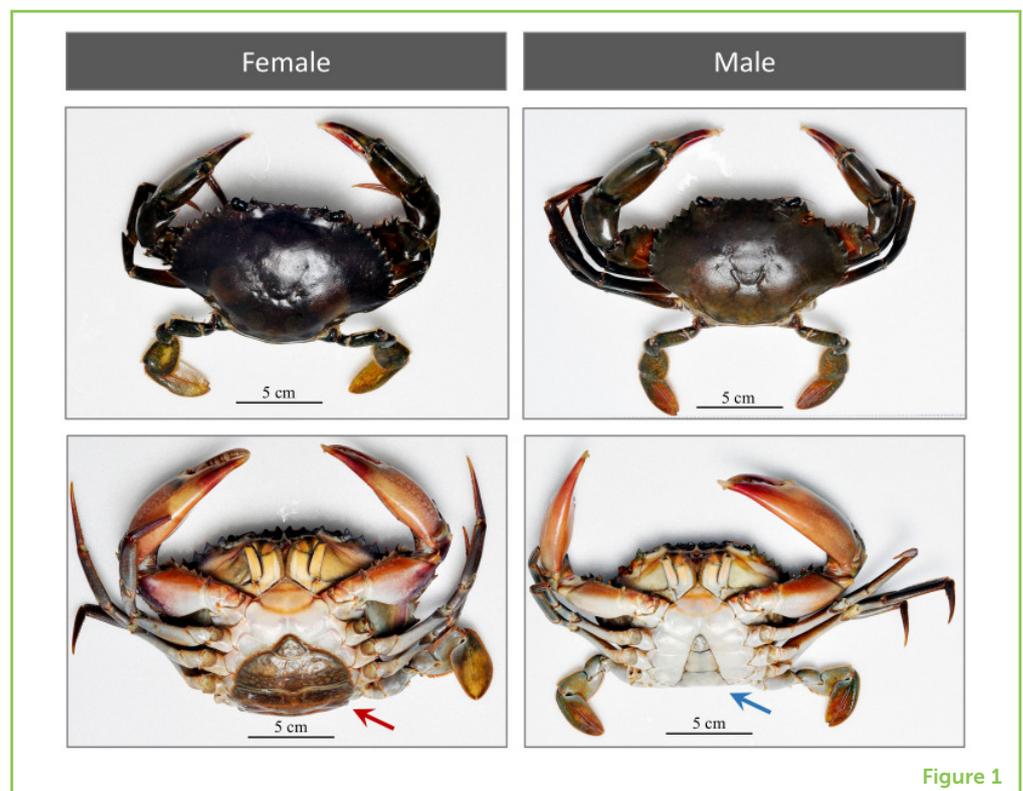


Figure 1

## CARAPACE

The hard shell covering the back of a crab.

## CHELIPED

The entire limb containing the large claw.

## Figure 2

For this study, we measured various body parts including carapace length (CL), internal carapace width (ICW), carapace width at spine 9 (CW), carapace width at spine 8 (8CW), the right cheliped's propodus length (PL), the right cheliped's propodus width (PW), the right cheliped's merus length (ML), the right cheliped's dactyl length (DL) and the right cheliped's propodus depth (PD). We also measured abdomen width (AW).

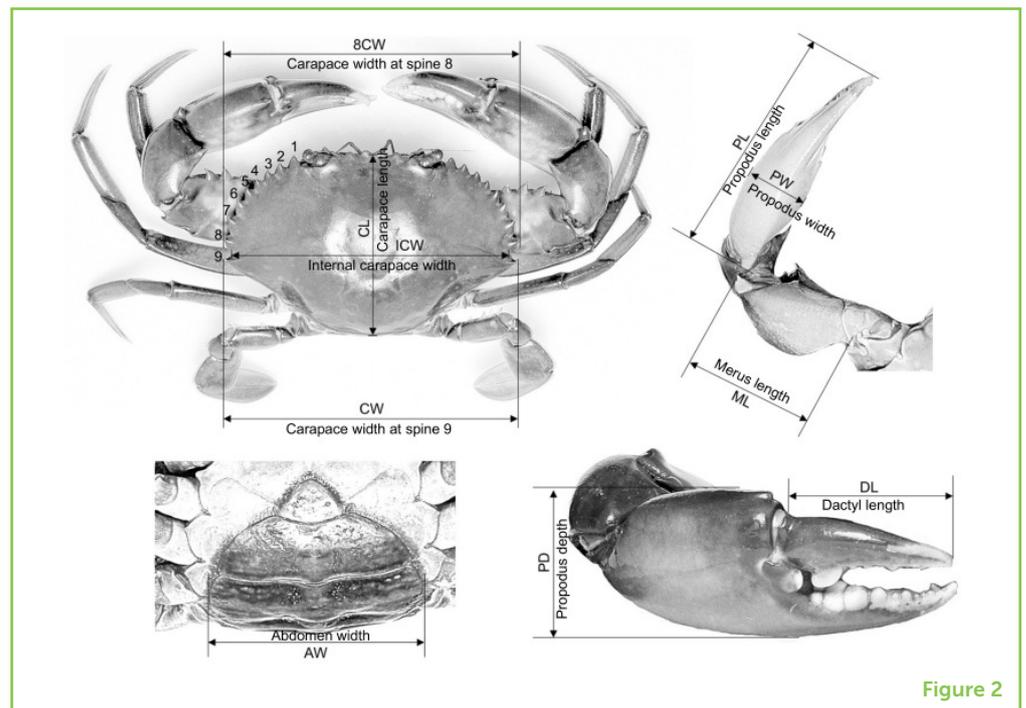


Figure 2

We found that, in general, sexual dimorphism patterns are similar among orange, green and purple mud crabs. In all three species, the abdomens of females are larger than those of males. Males normally have larger bodies than females, as measured by carapace width at spine 9, internal carapace width, carapace length, and carapace at spine 8. In addition, males also have larger chelipeds. Chelipeds have three main parts: the propodus, the merus, and the dactyl (Figure 2), and males commonly have larger dactyl length, propodus length, and propodus width. We also discovered an interesting feature of orange mud crabs. In Figure 2, you can see that mud crabs have spines along the top edges of their carapaces. Scientists number these spines from 1 to 9, to more easily refer to them. In the orange mud crab, the carapace width at spine 8 is similar or larger than the carapace width at spine 9. However, purple and green mud crabs both have the widest carapace at spine 9 instead of spine 8 (Figure 3).

### Figure 3

When we look closer at the last two spines (spine 8 and spine 9) of the carapace of mud crabs as marked in yellow triangle, it is obvious that the spine 9 of orange mud crab would not exceed the length of spine 8, but the spine 9 of purple and green mud crabs are always longer than their spine 8.

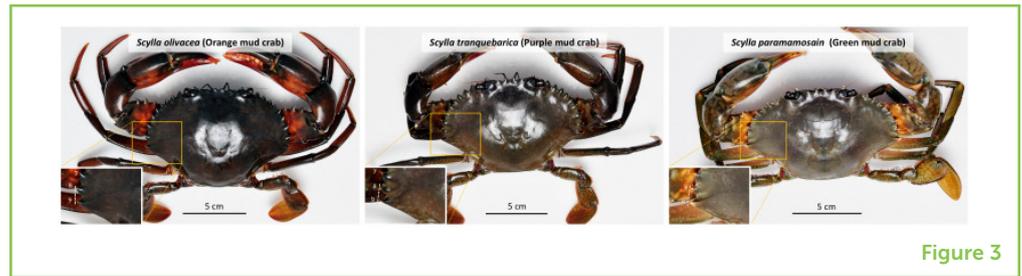


Figure 3

## WHY DOES SEXUAL DIMORPHISM EXIST IN MUD CRABS?

The rounded, darkened abdomen of the female mud crab is a key feature that allows us to differentiate the sexes in these animals. When a female mud crab matures, her abdomen increases in size and broadens, changing from a triangular shape into an oval shape. It is important for females to have broad abdomens because this is where they attach and incubate their eggs. Wider abdomens allow females to carry more eggs, which means that they can produce more cute mud crab babies! Unlike females, the abdomens of male mud crabs remain almost the same color and shape throughout their lives. Male mud crabs use their abdomens to cover and protect their **gonopods**, which are important male sex organs used to transfer sperm to females during mating. However, since males do not need to incubate eggs, the broadening of their abdomens is unnecessary [2].

Males, however, have much larger chelipeds compared to females. Chelipeds are important tools for feeding, defending territory, and protecting the crabs. The chelipeds of mud crabs are very powerful and can easily fend off predators and crush the shells of clams and other prey. In a fight for food or space, males with larger chelipeds often defeat those with smaller chelipeds. Male mud crabs also use their large chelipeds to attract their lovers and even to fight with their rivals over females [3]! Therefore, larger chelipeds are an advantage because they allow males to show their dominance.

## THE ORANGE MUD CRAB IS DIFFERENT

We know that the carapace width at spine 9 (the last spine) of green and purple mud crabs is larger than the carapace width at other spines. However, in orange mud crabs, we noticed that the carapace width at spine 8 is surprising similar to or larger than the carapace width at spine 9. Why? To solve this mystery, we need to think about the habitats of the three mud crab species. Orange mud crabs usually live in mangrove forests near the mouths of rivers. Their less spiny bodies and their smaller body size allow them to burrow into the mud and move easily within the mangrove root system. In comparison, green and purple mud crabs live in estuaries and coastal areas with a lot

### GONOPODS

Reproductive organs of male crabs that transfer sperm to the female during mating.

of open space and sandy bottoms. Their larger carapace width may protect them against predators in the open waters [4, 5].

## WHY SHOULD WE STUDY THIS TOPIC?

Mud crabs are an important source of food for humans so, on a practical level, it is important to understand the sexual dimorphism of these species so that we can try to selectively grow crabs with the largest body size— males. In terms of which species are best to cultivate, this is highly dependent on the species available in a given location; but if all three species are available, then the most dominant species would be a great candidate, due to their higher availability.

Beyond this practical reason, studying the sexual dimorphism of a particular species helps us understand how that species interacts with its environment, how it behaves, and how it evolved. Variations in certain body parts can be related to specific functions, such as self-protection, the ability to adapt to the surrounding environment, mating, and establishing dominance. Describing the sexually dimorphic characteristics in mud crabs not only allows scientists to better understand these interesting species, but it also helps us appreciate nature's amazing diversity.

## ORIGINAL SOURCE ARTICLE

Fazhan, H., Waiho, K., Fujaya, Y., Rukminasari, N., Ma, H., and Ikhwanuddin, M. 2021. Sexual dimorphism in mud crabs: a tale of three sympatric *Scylla* species. *Peer J*. 9:e10936. doi: 10.7717/peerj.10936

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## YOUNG REVIEWER



### IGOR, AGE: 12

I live in Brazil, on the beach. I like Lego, travel, surf, and love to read. In the future, I will become an architect and I love science. In my house I have a huge yard with a tree house.

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I am an undergraduate student, currently studying in the Aquatic Resource Science and Management Programme at Universiti Malaysia Sarawak. My current interest is aquaculture, and I am still in the process of enriching my knowledge in this field.

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I am a researcher at the Institute of Tropical Aquaculture and Fisheries, Universiti Malaysia Terengganu, with a burning interest in solving the still entangling mystery of crab taxonomy and classification. I am also interested in understanding the relationships between various crab populations and determining whether environmental factors affect their genetic similarity or diversity. I hope that our work will spark interest in young readers to understand how organisms adapt to their environments!



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I am an undergraduate student majoring in marine biology at Universiti Malaysia Terengganu. I am interested in crustacean biology, reproductive physiology, and conservation.

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