



THE ORIGIN OF SOFT-SHELL CRABS

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YOUNG REVIEWERS:



ANA
AGE: 9



BENJAMIN
AGE: 10



VINCENT
AGE: 10

Soft-shell crabs are famous in seafood restaurants because they have a wonderful flavor, are easy to eat, and are highly nutritious! Soft-shell crabs are any regular edible crabs, but in their natural, soft-shell condition—because they have just shed their old shells, in an event called molting. Within a few hours after molting, while they are still in their soft-shell condition, these crabs are harvested and sold as soft-shell crabs. Crabs in the soft-shell condition have higher market value than crabs in the hard-shell condition. By understanding the origin of soft-shell crabs, we can improve the production of these crabs, as well as try to find ethical and sustainable ways to obtain them.

WHAT ARE SOFT-SHELL CRABS?

Images of crabs adorn the signboards and logos of most seafood restaurants, and who does not love to eat crabs? Crabs taste like

CRUSTACEANS

A large class of aquatic animals with exoskeletons, such as crabs, shrimp, lobsters, and krill.

EXOSKELETON

The hard, external covering of the body found in some invertebrates.

MOLTING

The shedding of an old shell by most invertebrates with exoskeletons.

ECDYSTEROIDS

A type of hormone that controls molting and reproduction.

PORTUNID

A swimming crab of the *Portunidae* family, characterized by appendages shaped like flattened paddles, for swimming.

other **crustaceans**, such as shrimp and prawns. However, due to their larger body size, crabs contain more meat compared to smaller crustaceans like shrimp and prawns. In most restaurants, crabs are consumed by cracking their hard outer shells to get to the delicious flesh underneath. However, crabs are also served in a soft-shell condition. In general, soft-shell crabs fetch a much higher price compared to hard-shell crabs. This is because soft-shell crabs have a higher nutritional value and, most importantly, they can be eaten whole! This avoids the hassle of prying open the hard outer shell to savor the juicy flesh inside. Therefore, soft-shell crabs are gaining popularity over hard-shell crabs as a healthy and convenient food choice. Are soft-shell crabs a totally different crab species? Where do they come from?

TO GROW IS TO MOLT

In some ways, crabs are similar to us! As we grow, we become taller and bigger. As a result, our clothes eventually do not fit us anymore and we need to get a larger size. Crabs increase in size as they grow, too! However, unlike us, crabs have hard shells called **exoskeletons** on the outsides of their bodies, which act like protective armor. The exoskeleton cannot expand as a crab grows, so crabs must shed their old shells so they can develop bigger shells, through a process called **molting** (Figure 1). The molting process is complex. Before molting, a new tissue layer forms underneath the crab's old exoskeleton. Molting is controlled by a group of hormones called **ecdysteroids**, which increase to a peak level and then drop drastically in concentration right before molting. This drop signals the crab to take in water so that it expands, cracking open its old exoskeleton so that it can emerge from it (Figures 1A–C). The process of expanding and emerging from the old skeleton typically takes several hours. After emerging, the crab is covered in a new, soft exoskeleton that will harden within a few hours (Figure 1D) [1]. During this short period, the crab expands its soft shell by taking in water like a balloon. This ensures that the new exoskeleton will be much bigger than the old one when it hardens, so the crab will have plenty of room to grow before the next molting. Crabs are exhausted and immobilized when they are in the soft-shell condition. Therefore, molting is extremely dangerous, as the newly molted crab is vulnerable to predators.

SOFT-SHELL CRAB PRODUCTION

So now you know that soft-shell crabs are crabs harvested right after they molt, while they are still in a soft-shell condition (Figure 2). Producing soft-shell crabs to sell, however, is a long process—it normally takes weeks after crabs are collected. In general, soft-shell crabs can be produced from any edible **portunid** crab species, including Atlantic blue crabs, blue swimming crabs, and mud crabs

Figure 1

The molting process of a crab. **(A)** The old exoskeleton slowly cracks open from the back of the crab. The white arrow indicates the crack in the old skeleton. **(B)** The crab inhales water to expand itself and increase the size of the crack. **(C)** Once the crack is wide enough, the crab emerges from the old skeleton. **(D)** In the first few hours, the newly emerged crab is in a soft-shell condition and is defenseless. Note the increased body size of the newly emerged crab compared to its old exoskeleton.

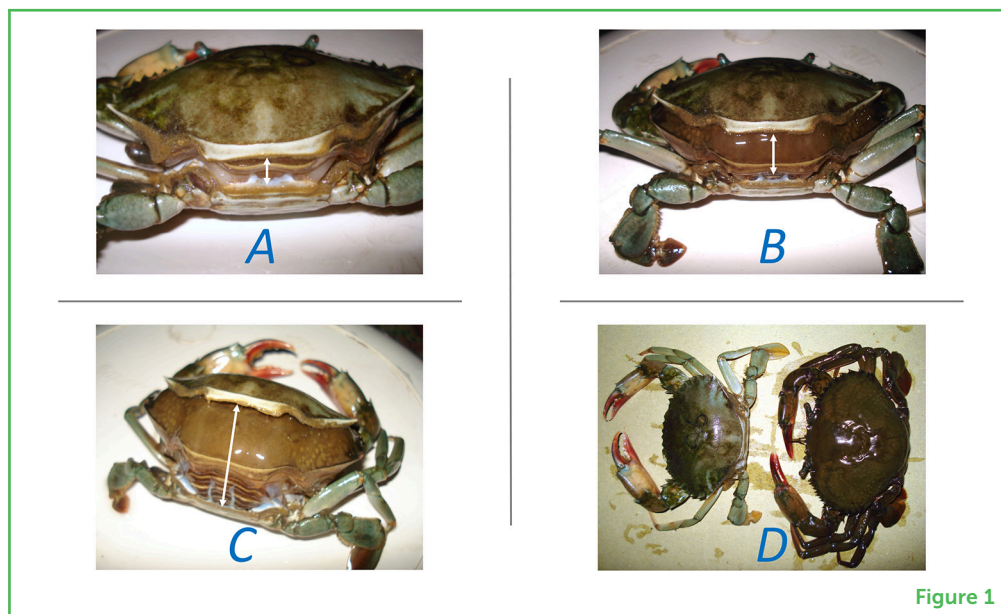


Figure 1

CANNIBALISM

The act of consuming another organism of the same species.

CALCIFICATION

The hardening of a tissue due to calcium build-up.

[2–4]. Crabs that have not yet matured (called sub-adult crabs) are commonly collected from the wild to generate soft-shell crabs. The size of sub-adult crabs may differ among species. For example, mud crabs with a body size of 5–8 cm, or Atlantic blue crabs of 4–5 cm are commonly captured for soft-shell crab production. Crabs are normally raised in individual cages throughout the production period, so that it is easier to see when they are molting (Figure 2D). They are also raised individually to avoid **cannibalism**, especially in mud crabs, which are prone to fight and feast on their friends when they are hungry or too crowded. Monitoring the crabs every 4–5 h is important so that crabs can be identified and harvested when they have recently molted. After they are harvested, the soft-shell crabs are immediately cleaned using fresh water, individually packed, and frozen at -20°C to ensure their freshness and quality. Frozen soft-shell crabs can then be easily packed and transported [5].

Soft-shell crabs have a higher market value than do hard-shell crabs. The value of soft-shell crabs also depends on the time of harvest after molting—the **calcification** (hardening) process of the new exoskeleton begins immediately. An exoskeleton that has a high water content and low levels of calcification is considered truly soft. This type of soft-shell crab is often pricier and can be turned into mouth-watering dishes for consumers.

LIMITATIONS OF SOFT-SHELL CRAB PRODUCTION

Soft-shell crab production is becoming a profitable business. Although the process of soft-shell crab production is well-established and can be carried out on a large scale, farmers must still collect a lot of sub-adult crabs from the wild. Crab farmers cannot produce

Figure 2

(A) A worker handling a newly molted crab with soft outer shell. (B) Soft-shell crabs are kept frozen to make sure they are fresh when they are shipped to restaurants. (C) Close-up of frozen soft-shell crabs. (D) A farm worker preparing crab boxes to individually house each sub-adult crab in a culture pond at Barru, South Sulawesi Province, Indonesia. Sub-adult crabs are put into individual cages to prevent cannibalism.

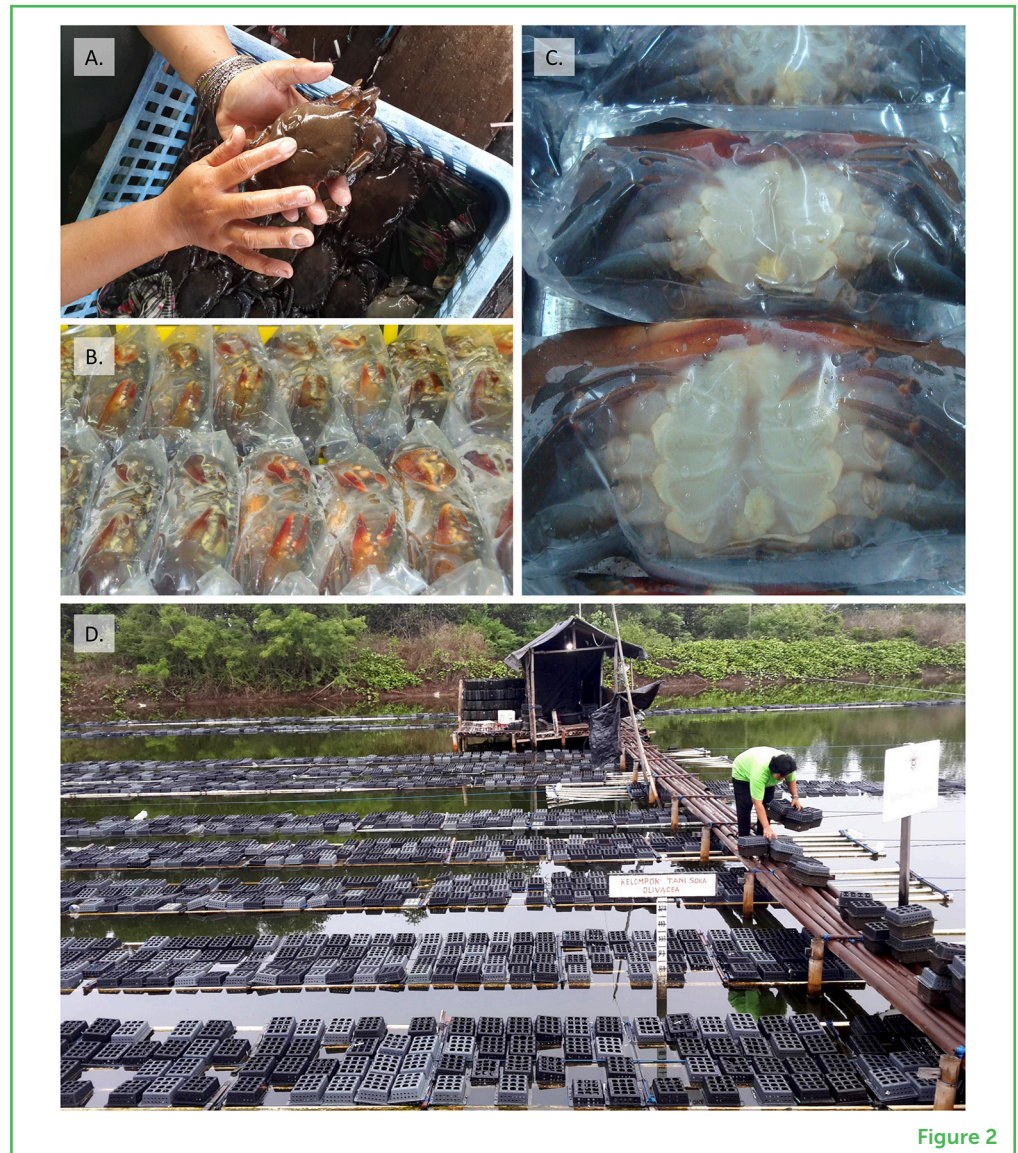


Figure 2

sub-adult crabs because of the low survival during the larval stages. However, wild sub-adult crabs are limited and seasonal. Additionally, collecting sub-adult crabs greatly reduces the overall crab numbers in the wild because those crabs are harvested before they can reproduce and repopulate the wild population (Figure 3). Therefore, uncontrolled crab fishing is not **sustainable**, as it leads to overharvest and threatens the health of the wild crab population. Overcoming the low survival of crabs during the larval stage is now the main priority, and scientists from various countries are working together to solve this mystery.

Another limitation is that crabs tend to molt at their own pace—sometimes it takes more than a month! Therefore, farmers must grow and monitor them for a long period, which increases the production cost. Researchers are currently experimenting with various methods to help sub-adult crabs molt faster and in a more

SUSTAINABLE

Using natural resources in a way that will enable us to use them for a long time.

Figure 3

The life cycle of a mud crab begins when larvae (zoeae) hatch from mature females in the ocean. Zoeae grow into megalopae, which slowly migrate back to mangrove mud flats. In mud flats, the crabs continue molting and increase in size as they go through a juvenile (sub-adult) stage and eventually reach the adult stage. Male and female adult mud crabs then mate and the whole cycle repeats itself. Therefore, removing many sub-adults to produce soft-shell crabs for eating is unsustainable, as it results in fewer adults available to repopulate the original crab population.

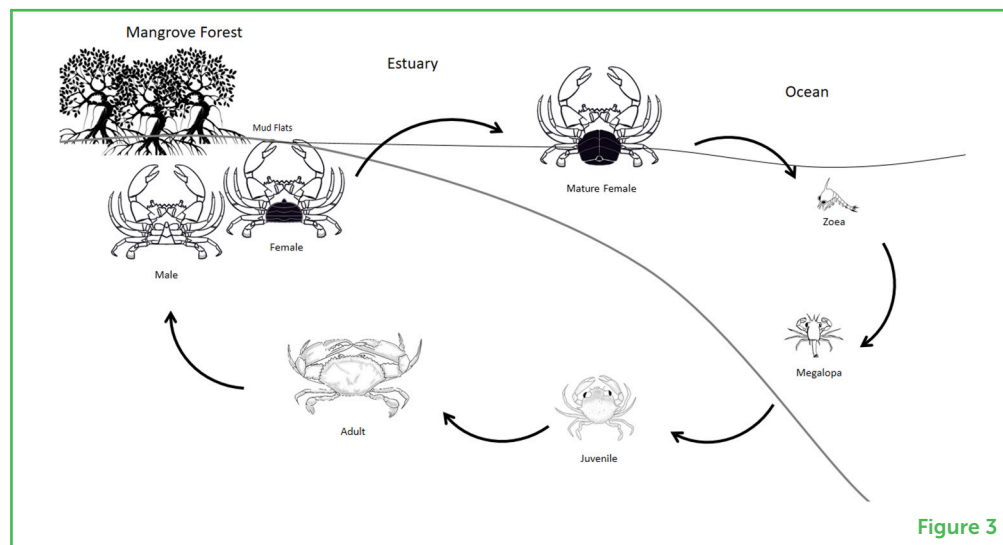


Figure 3

synchronized way, including the use of ecdysteroid hormones. If this is successful, farmers will be able to produce more soft-shell crabs easily, in a shorter time.

CONCLUSION

Soft-shell crabs are regular edible crabs that have recently completed the molting process. Soft-shell crab production is a promising money-making industry with high market demand due to the excellent taste of the crabs and the unique eating experience. However, the reliance of the soft-shell crab industry on the capture of wild sub-adult crabs is still unsustainable, and it puts tremendous pressure on the currently decreasing wild population. For soft-shell crabs to remain a sustainable food source, it is important to only use farm-produced sub-adult crabs in the soft-shell crab producing process.

ORIGINAL SOURCE ARTICLE

Waiho, K., Ikhwanuddin, M., Baylon, J., Jalilah, M., Rukminasari, N., Fujaya, Y., et al. 2021. Moulting induction methods in soft-shell crab production. *Aquacult. Res.* 52, 4026–42. doi: 10.1111/are.15274

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YOUNG REVIEWERS

ANA, AGE: 9

Hi, I am Ana, I was born in Mexico City in April 2013, I am 9 years old, I live with my mom and my grandparents. We have a dog with whom I play a lot. I am currently studying third grade of primary school, my favorite subject is mathematics. I like to swim, play chess, visit places, and sometimes dance, help cook. I love animals, I would like to be a veterinarian. My favorite food is fried tacos, spaghetti, and chocolate ice cream. I do not like soda, I like nothing with gas. Thanks to Frontiers for Young Minds for this review experience.

BENJAMIN, AGE: 10

In school I like science, history, and math. Outside I enjoy playing sports, especially football. I have a pet stick insect called Twiglet, who mostly just does nothing, but sometimes likes to climb on my hands. Oh, and my favorite food is pasta.





VINCENT, AGE: 10

Hello, my name is Vincent and I do not like to study from books. I much rather look at nature and learn from what I see. I like finding insects in the woods and keeping track of my garden's ant nests. Sometimes I leave some sugar at the entrance of the nest and I have noticed that some of them have grown in size. My mum is not very excited about this, because ants are now marching into her kitchen looking for more sugar. I also own a stick insect called Florian and she likes to eat brambles. She has grown quite a lot and is starting to lay many eggs: which means that I have expanded the colony! I also like technology, maybe I will use both my interests together when I grow older.

AUTHORS

AORTA XIAN LIN LING

I am currently an undergraduate student in the Aquatic Resources Science and Management programme at University Malaysia Sarawak (UNIMAS). I am interested in crab aquaculture and hope to learn more about crabs and do research with experienced crab researchers in the future.

HANAFIAH FAZHAN

I am a researcher at the Institute of Tropical Aquaculture and Fisheries, Universiti Malaysia Terengganu. My passion for crustaceans, especially crabs, started when I was working with them during my Ph.D. studies. To me, crabs are fascinating creatures! They have amazing adaptation abilities and furthermore, edible crabs are delicious! I study the relationships between crab populations based on their structure and their genes. By doing so, I hope to understand how they relate to each other and how adaptation occurs!

GHAZALI AZMIE

I am a senior research officer at the Institute of Tropical Aquaculture and Fisheries, Universiti Malaysia Terengganu. My main research area is crustacean reproductive biology, with a special focus on the breeding and reproductive functions of mud crabs. I think crabs are very unique and interesting animals, there is a lot more to learn about them—I really enjoy working with crabs!

YUSHINTA FUJAYA

I am a lecturer and researcher at Hasanuddin University, Makassar, Indonesia. I started working in crab cultivation during my university years—from my bachelor's to my Ph.D. After that, I developed a soft-shell crab production technology using herbs. That is why I am often identified with crabs—some friends call me the Queen of Crab. My work is really fun and I love it.

KHOR WAIHO

I am a senior lecturer at the Institute of Tropical Aquaculture and Fisheries, Universiti Malaysia Terengganu. I obtained my Ph.D. in the field of aquaculture, and I am currently focused on the reproductive processes of aquaculture species, especially crabs! I think that crab culture is an emerging industry with vast possibilities!
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