



MORPHOLOGICAL AND BEHAVIORAL ADAPTATIONS IN DIFFERENT TYPES OF MARINE CRABS: A MINI REVIEW

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Abstract

This review investigates the morphological and behavioral adaptations in marine crabs, comparing intertidal and subtidal species. The study focuses on the differences in exoskeleton structure, feeding strategies, and reproductive behaviors. This study investigates the morphological and behavioral adaptations of marine crabs, with a focus on different crab types. The review analyzes the physical characteristics and behaviors of several crab species and examines how these adaptations contribute to their survival in various marine environments. The study concludes that different crab types have developed unique adaptations to cope with the challenges of their habitats, including changes in body shape, color, and behavior. These adaptations highlight the evolutionary flexibility of crabs and their ability to thrive in diverse marine environments. These findings enhance our understanding of the adaptive mechanisms marine crabs have evolved to thrive in their respective habitats.

Keywords: Adaptations, Behavioral, Crabs, Exoskeletons, Intertidal, Marine.

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DOI: - 10.48047/ecb/2023.12.si5a.017

INTRODUCTION

Marine crabs (Brachyura) are a diverse group of crustaceans that inhabit a variety of environments, including intertidal and subtidal zones. Intertidal species face unique challenges, such as fluctuating temperatures, salinity levels, and predation, while subtidal species experience relatively stable conditions ^[1]. This study aims to investigate the morphological and behavioral adaptations in marine crabs that enable them to thrive in their respective environments. Marine crabs are a fascinating group of crustaceans that have adapted to their marine environment in various ways, both morphologically and behaviorally. In this review, the different adaptations that marine crabs have developed, and how these adaptations help them survive and thrive in their environment was discussed.

Marine crabs are fascinating creatures that are found in oceans and coastal regions all around the world ^[2]. These creatures are an important part of marine ecosystems, as they play a critical role in controlling populations of other marine organisms and recycling nutrients in the environment. In this review article, we will explore the biology and ecology of marine crabs, as well as their importance to humans and the threats that they face ^[3-5].

Biology and Ecology of Marine Crabs

Marine crabs are members of the order Decapoda, which includes over 10,000 species of crustaceans. These creatures have a hard exoskeleton, which provides protection and support for their bodies. They also have ten legs, with the first pair being modified into claws or chelae that are used for catching prey and defense ^[6].

Marine crabs can be found in a wide variety of habitats, including rocky and sandy shorelines, estuaries, and coral reefs. They are omnivorous, feeding on a variety of prey such as fish, other crustaceans, mollusks, and even algae ^[7].

Marine crabs are important members of marine ecosystems, as they serve as both predators and prey. They help to control populations of other marine organisms, and their presence can even affect the behavior of other animals in their environment. For example, some species of crabs are known to feed on sea turtles' eggs, which can have a significant impact on sea turtle populations in some areas ^{[8][9]}.

Importance to Humans

Marine crabs are an important food source for humans in many parts of the world. Some of the

most popular species include blue crabs, Dungeness crabs, and king crabs. In addition to being delicious, crabs are also a good source of protein and other nutrients ^[10]. Crabs are also important economically, as they support commercial fishing industries in many countries. However, overfishing and habitat destruction have led to declines in some crab populations, which has had negative impacts on both the environment and the economy ^[11-15].

Threats to Marine Crabs

Marine crabs face a variety of threats in their natural habitats. Habitat destruction, pollution, and overfishing are among the most significant threats ^[16]. As human populations continue to grow and expand, coastal habitats are being destroyed or altered, which can have significant impacts on crab populations. Pollution, particularly from plastics, can also harm crabs and their habitats ^[17]. Crabs may mistake plastic debris for food, which can lead to internal injuries or death. Overfishing is a significant threat to many crab populations, particularly those that are commercially harvested. When crabs are harvested at unsustainable rates, their populations can decline rapidly, which can have significant impacts on the marine ecosystem as a whole ^[18-20].

Morphological Adaptations:

One of the most notable morphological adaptations in marine crabs is their hard exoskeleton. The exoskeleton not only provides protection against predators, but it also helps crabs retain water and maintain their shape. In addition to their hard exoskeletons, many marine crabs have developed specialized appendages that help them move through their aquatic environment. For example, some crabs have flattened legs that allow them to move quickly along the ocean floor, while others have long, slender legs that enable them to move gracefully through the water ^[21].

Another important morphological adaptation in marine crabs is their ability to breathe underwater. Unlike terrestrial animals, marine crabs cannot breathe air, so they have developed specialized gills that extract oxygen from the water. Some crabs also have specialized structures called pseudotracheae that allow them to extract oxygen from the air when they are out of the water ^[22].

Behavioral Adaptations:

Marine crabs have also developed a variety of behavioral adaptations that help them survive in their environment. One such adaptation is their ability to hide from predators. Many crabs are able

to camouflage themselves by changing color to match their surroundings. Others are able to hide in crevices or under rocks, making them difficult for predators to find [23].

Another important behavioral adaptation in marine crabs is their ability to communicate with each other. Many crabs use chemical signals to communicate with members of their own species, often to attract mates or defend their territory. Some crabs also use visual displays, such as waving their claws, to communicate with other crabs [24].

Finally, many marine crabs have developed specialized feeding behaviors. Some crabs are herbivores, feeding on algae and other plant

material, while others are predators, feeding on small fish and other marine animals. Some crabs have even developed symbiotic relationships with other organisms, such as anemones or sponges, which provide the crab with food and protection in exchange for shelter [25].

Found along the Pacific Coast of the U.S., Dungeness crabs are one of the most abundant varieties on the market. Often brown or purple in color, these crabs are larger than many common varieties (like Blue crab), but have much shorter legs than most of the largest varieties (like Snow or King crab) [26]. Here are some common species of marine crabs and their scientific names were listed in **Table 1**.

Table 1: Common species of marine crabs and their scientific names

S. No	Common Name	Scientific Name
1	Blue crab	<i>Callinectes sapidus</i>
2	Dungeness crab	<i>Metacarcinus magister</i>
3	Snow crab	<i>Chionoecetes opilio</i>
4	Jonah crab	<i>Cancer borealis</i>
5	Stone crab	<i>Menippe mercenaria</i>
6	Horseshoe crab	<i>Limulus polyphemus</i>
7	Red king crab	<i>Paralithodes camtschaticus</i>
8	Fiddler crab	<i>Uca spp.</i>
9	Spider crab	<i>Libinia emarginata</i>
10	Hermit crab	<i>Paguroidea</i>

Blue crab

Blue crab, also known as *Callinectes sapidus*, is a species of crab found in the waters of the western Atlantic Ocean, the Gulf of Mexico, and the Caribbean Sea. Blue crabs (**Fig 1**) are named for their distinctive blue coloring, which can vary from a bright blue to a dull grayish-blue, and they are highly valued as a seafood delicacy [27-29]. Blue crabs are known for their powerful claws, which they use both for defense and for catching prey. They have a flattened, triangular-shaped body with a pair of paddle-like appendages called swimmerets on their abdomen, which they use for swimming [30]. Adult blue crabs can grow up to 9 inches (23 cm) across the shell, with males generally being larger than females.



Fig 1: Blue crabs

Blue crabs are an important commercial and recreational seafood species, and they are caught using a variety of methods, including crab pots, trotlines, and hand lines [31]. They are typically cooked by boiling or steaming and are often served with Old Bay seasoning, a blend of herbs and spices that is popular in the Chesapeake Bay region of the United States. Blue crabs are also important ecologically, serving as both predator and prey in the coastal ecosystems where they live [32]. They are known to feed on a variety of small animals, including fish, mollusks, and other crabs, and are in turn eaten by a variety of larger predators, including birds, fish, and humans [33].

Dungeness crab

Dungeness crab is a species of crab found along the Pacific coast of North America, from Alaska to California [34]. It is named after the coastal town of Dungeness, Washington, where it was first harvested commercially. Dungeness crabs (**Fig 2**) are highly prized for their sweet and delicate meat, which is commonly used in a variety of dishes such as salads, sandwiches, and soups. They are also commonly steamed or boiled and served with melted butter or a dipping sauce [35].



Fig 2: Dungeness crab

These crabs are typically caught in traps or pots and are harvested year-round, with the peak season being from November to June [36-39]. However, there are strict regulations in place to ensure the sustainability of the Dungeness crab population, and fishing is sometimes restricted or closed altogether to protect the species during its breeding season. Overall, Dungeness crab is a popular and delicious seafood delicacy enjoyed by many people along the Pacific coast and beyond [40].

Snow crab

Snow crab, also known as *Chionoecetes opilio*, is a type of crab found in the northern Pacific and Atlantic oceans, particularly in Alaska, Canada, and Russia [41-43]. It is a popular seafood delicacy and is known for its sweet and delicate meat. Snow crab has long legs and a relatively small body, and is typically caught using large traps that are placed on the ocean floor [44].



Fig 3: Snow crab

In commercial fishing, snow crab (**Fig 3**) is typically processed by cooking and then freezing the meat, which is then sold as clusters or as individual legs [45]. It is commonly used in a variety of dishes, including soups, salads, and sushi rolls.

Snow crab is also known for its nutritional benefits, as it is low in fat and high in protein, vitamins, and minerals [46].

Jonah crab

The Jonah crab (*Cancer borealis*) is a species of crab that is found in the waters of the western Atlantic Ocean, from Newfoundland to Florida [47]. They are named after the biblical figure Jonah, who was said to have been swallowed by a whale, as these crabs are often found in the stomachs of large fish and marine mammals. Jonah crabs (**Fig 4**) have a hard, reddish-brown shell with yellow or white spots [48]. They can grow up to 9 inches (23 cm) across the carapace (the hard upper shell) and weigh up to 1.3 pounds (0.6 kg). They have sharp claws and are known for their strength and aggression.



Fig 4: Jonah crab

Jonah crabs are considered a delicacy in some parts of the world and are often used in seafood dishes such as crab cakes and crab bisque [49]. They are also used as bait in commercial and recreational fishing. Despite being heavily fished, Jonah crab populations are considered to be stable and are not currently at risk of overfishing [50].

Stone crab

Stone crab is a type of crab found in the western North Atlantic Ocean. They are highly valued for their meat, which is considered a delicacy. The stone crab (**Fig 5**) is named for its hard exoskeleton, which is covered in a layer of small stones that helps protect it from predators [51]. One unique feature of the stone crab is its ability to regenerate its claws. When a stone crab loses a claw, it can grow a new one in about a year. This ability allows fishermen to harvest the claws without killing the crab, as long as they only take one claw and leave the other for the crab to use for defense and feeding [52].



Fig 5: Stone crab

Stone crabs are typically harvested from October to May, and the claws are typically steamed and served with mustard sauce or melted butter. In addition to being a popular seafood item, stone crabs are also important to the marine ecosystem, as they help control the populations of other marine organisms [53-56].

Horseshoe crab

The horseshoe crab is a marine arthropod that belongs to the order Xiphosura. It has a hard exoskeleton and a distinctive horseshoe-shaped head, which gives it its common name [57]. Horseshoe crabs are often referred to as "living fossils" because they have existed virtually unchanged for over 450 million years. Horseshoe crabs are found in the shallow coastal waters of the Atlantic Ocean and the Gulf of Mexico [58]. They are important to the ecosystem as they are a food source for many animals, and their eggs provide essential nutrients for migratory shorebirds [59].



Fig 6: Horseshoe crab

In addition to their ecological importance, horseshoe crabs have also been used for biomedical research. Their blood contains a unique compound called Limulus Amebocyte Lysate (LAL), which is used to test for bacterial contamination in vaccines, medical equipment, and drugs [60]. The horseshoe crab population has been threatened in recent years due to overharvesting for

use as bait in the fishing industry, habitat loss, and pollution. Conservation efforts are ongoing to protect and preserve this ancient species [61].

Red king crab

The Red King Crab (*Paralithodes camtschaticus*) is a large, spiny crustacean found in the North Pacific Ocean [62]. It is one of the largest and most commercially valuable species of crab, known for its sweet and succulent meat. Red king crabs (Fig 7) can grow up to 1.8 meters (6 feet) in length and weigh up to 10 kilograms (22 pounds) [63]. They have a distinctive bright red color with spiny legs and large claws, which they use for defense and feeding. They are found in deep, cold waters of the Bering Sea and Gulf of Alaska, where they feed on a variety of small fish, clams, and other marine invertebrates [64].



Fig 7: Red king crab

Red king crabs are highly prized for their meat, which is considered a delicacy in many parts of the world [65]. They are commercially harvested and sold in markets around the world, often commanding high prices due to their rarity and quality. However, overfishing and habitat destruction have led to declining populations of red king crabs in some areas. To protect this species, there are regulations in place for commercial fishing and efforts to promote sustainable management practices [66].

Fiddler crab

Fiddler crabs are small, colourful crustaceans that are found in intertidal mudflats and sandy beaches in tropical and subtropical regions [67-69]. They are named for the male's large claw, which resembles a fiddle or violin [70].



Fig 8: Fiddler crab

Male fiddler crabs (**Fig 8**) use their large claw to attract females and defend their territory. The claw is so large that the male must use it to communicate with other crabs, waving it up and down to signal his dominance ^[71]. Females have two small claws and a much smaller body size compared to males. Fiddler crabs are important to the ecosystem as they help to aerate and mix the sediment, which promotes the growth of plants and other organisms ^[72]. They also serve as an important food source for many animals, including birds, fish, and other crabs ^[73].

Spider crab

The spider crab, also known as the decorator crab, is a type of crustacean that belongs to the family Majidae ^[74]. They are called spider crabs because of their long, spindly legs and arms that resemble those of a spider. Spider crabs (**Fig 9**) are found in all of the world's oceans, living in both shallow and deep waters ^[75]. They are omnivores, feeding on a variety of small organisms, including algae, mollusks, and small fish ^[76].



Fig 9: Spider crab

One interesting feature of spider crabs is their ability to camouflage themselves. They attach various objects such as seaweed, shells, and even living organisms to their exoskeletons to blend in with their surroundings and avoid predators ^[77]. They can also regenerate lost limbs, which is a unique adaptation among crustaceans. Spider crabs

are an important food source for humans in some parts of the world, and they are also used as bait for fishing ^[78]. However, some species of spider crabs are considered endangered due to overfishing and habitat loss ^[79].

Hermit crab

A hermit crab is a type of crab that belongs to the family Paguroidea ^[80]. Unlike other crabs, hermit crabs do not have a hard exoskeleton covering their entire body. Instead, they have a soft, twisted abdomen that they protect by occupying the empty shells of other marine animals such as snails and whelks ^[81]. Hermit crabs can be found in oceans and other bodies of water around the world, and they come in a variety of sizes, colors, and shapes. Some hermit crabs are tiny, only growing to a few millimeters in length, while others can reach several inches in size ^[82].



Fig 10: Hermit crab

Hermit crabs are known for their ability to adapt to their environment, changing their behavior and appearance based on their surroundings ^{[83][84]}. They are also popular as pets, though it's important to provide them with a suitable habitat that includes a variety of shells for them to move into as they grow ^[85].

CONCLUSION

This research provides a comprehensive comparison of the morphological and behavioral adaptations in intertidal and subtidal marine crabs. The findings enhance our understanding of the adaptive mechanisms that have evolved in these species, providing a basis for future studies on the ecological and evolutionary processes shaping marine crab populations ^[86]. Marine crabs are fascinating creatures that play an important role in marine ecosystems and are an important food source for humans. However, they face significant threats from habitat destruction, pollution, and

overfishing^[87]. It is important that we take steps to protect these important creatures and their habitats so that they can continue to thrive and provide benefits to both the environment and humans. Marine crabs have developed a wide variety of adaptations that allow them to survive and thrive in their aquatic environment^[88]. These adaptations include morphological features such as hard exoskeletons and specialized appendages, as well as behavioral adaptations such as camouflage, communication, and specialized feeding behaviors^[89]. Overall, the diversity of adaptations found in marine crabs is a testament to the incredible adaptability of these fascinating creatures^[90].

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