



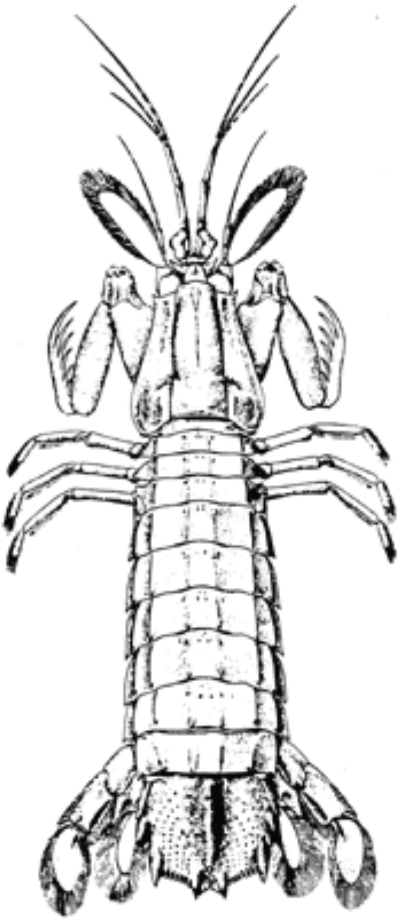
## Shrimp in South Carolina

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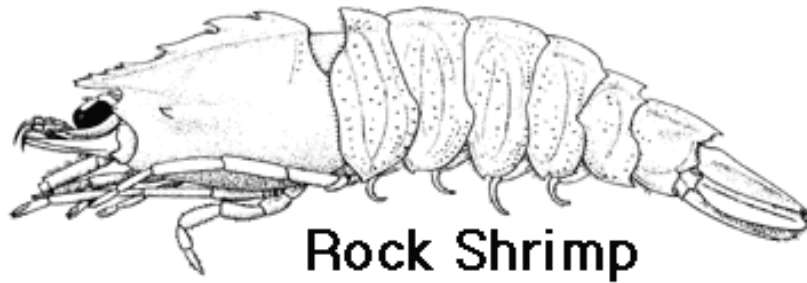
Shrimp are America's most valuable and probably most popular seafood. Whole cultures and maritime communities are based solely on these crustaceans. South Carolina has two important penaeid shrimp species, brown shrimp (*Penaeus aztecus*) and white shrimp (*Penaeus setiferus*). A third species, the pink shrimp (*Penaeus duorarum*), is relatively scarce. Methods of harvest range from large commercial shrimp trawlers to cast nets and drop nets.

Some long-time residents of the lowcountry of South Carolina may state that they prefer the flavor of one species over another, but taste tests would probably show that few people can distinguish one species from another by taste alone. Some experts claim that white shrimp taste better than the other species, but the difference is subtle.

On the East Coast of the United States, the edible shrimp species found in South Carolina occur in Chesapeake Bay and farther north, but the northernmost shrimp fishery is in Pamlico Sound, North Carolina. Other small shrimps are very abundant in South Carolina's waters but are of no commercial or recreational value. Among the most common of these are grass shrimp or hardbacks which are often seen jumping in tidal creeks and easily confused with the small juveniles of the food shrimps.



**Mantis Shrimp**



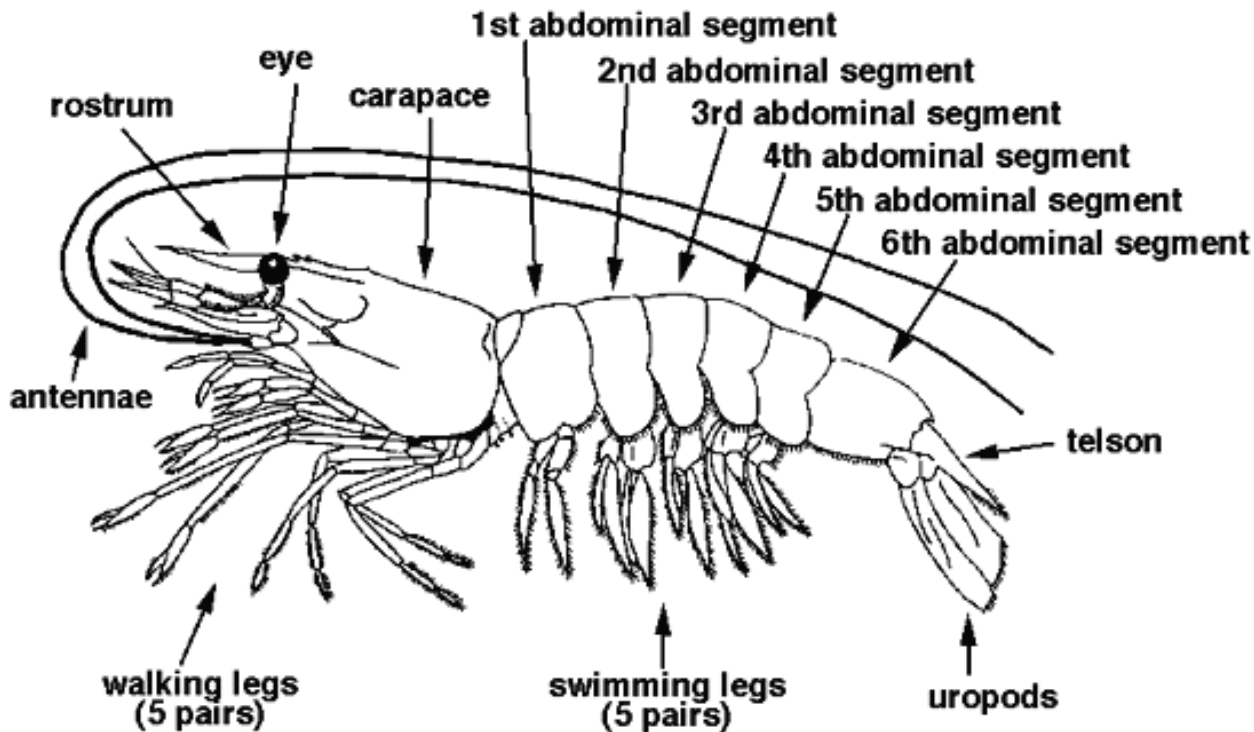
**Rock Shrimp**

A species called the rock shrimp occurs in South Carolina's offshore waters. Rock shrimp, so named because of its thick, hard shell, grow to a relatively large size, reaching five inches in total length. The species supports a large commercial fishery off Florida's east coast, but since they usually occur in 15 to 30 fathoms (90 to 180 ft.), they are of no recreational value. An inshore crustacean called the mantis shrimp (it's not a true shrimp) is frequently identified incorrectly as the rock shrimp. The mantis shrimp, or stomatopod, is a flattened crustacean that has front legs modified into long, stabbing appendages. Though mantis shrimps may be eaten, the meat yield is small and of rather poor quality.

### Identification of Shrimp Species

All three of the edible shrimp species look very similar but can be distinguished by careful examination of tail colors and subtle body features. Placed side by side, fresh white shrimp appear lighter in body color than brown or pink shrimps, thus the origin of the common names. Tail flippers (uropods) on white shrimp are typically black near the base with bright yellow and green margins, while brown shrimp tails have red, dark green and occasionally light blue pigmentations. Pink shrimp almost always have an azure color on the tail and they usually have a dark red spot on the side of the abdomen.

### Anatomy of a Shrimp



Brown and pink shrimps have grooves along the upper midline of the head and the upper midline of the lower region of the abdomen. The grooves on pink shrimp are slightly narrower than those of brown shrimp. White shrimp do not have grooves, and typically have longer antennae and a long rostrum (horn).

### Life History

All penaeid shrimps have much the same life cycle. Spawning usually occurs in the ocean from near the beaches to several miles offshore. A single female produces between 500,000 and 1,000,000 eggs and may spawn several times. During mating, the male transfers a packet of sperm, called sperm- atophore, to the female. Brown and pink shrimps mate when the female's exoskeleton is still soft immediately after molting. The spermatophore is covered over by two "plates" that hold it in place. Spawning in the species may take place days later. Mating of white shrimp occurs between two "intermolt" (hard exoskeleton) individuals. The sperm- atophore is glued to the underside of the females and spawning occurs almost immediately. Eggs, which are fertilized as they are ejected past the spermatophore, are thought to sink to the ocean floor and after about 12 to 24 hours hatch into minute larvae which move into the water column.

Large concentrations of spawning brown shrimp have never been observed, although some commercial shrimpers have reported finding dozens and sometimes hundreds of "roe" brown shrimp in catches during October and November which appears to be the primary spawning period. Some spawning seems to occur during late winter or early spring because of the scattered presence of a few postlarvae in May and June.

## Life Cycle of a Shrimp



## 1. Eggs

Shrimp eggs are thought to sink to the bottom at the time of spawning. Egg diameter is less than 1/64 inch. Most spawning is believed to occur in high salinity oceanic waters.



## 2. Nauplius

There are five naupliar stages. The first stage is about the size of the egg and succeeding stages are slightly larger. Nauplii have limited swimming ability and usually are a part of the oceanic plankton.



## 3. Protozoa

The three protozoal stages range in size from 1/25 to 1/12 in. These planktonic forms are found in oceanic waters. Protozoa have undergone development of their mouth parts and the abdomen has begun to develop.



## 4. Mysis

There are three mysid stages ranging in size from 1/8 to 1/5 in. These are planktonic in the ocean. Mysids have early development of legs and antennae.



## 5. Postlarva

The two postlarval stages for white shrimp are about 1/6 to 1/4 in. Brown shrimp postlarvae are larger, up to 1/2 in. The walking and swimming legs have developed and the postlarvae appear as miniature shrimp. The second postlarval stage rides the flood tides into the estuaries, apparently becoming active during flood tide and settling to the bottom during ebb tides. The postlarvae ultimately settle in the upper parts of tidal creeks.



## 6. Juvenile

Postlarval shrimp develop directly into juvenile shrimp. Growth is rapid, up to 2 1/2 inches per month. Juveniles are similar to adults except they are characterized by a much longer rostrum (horn). Juveniles typically remain in the marsh creeks until reaching about 4 to 4 1/2 inches before moving into the deeper rivers.



## 7. Sub-adults

Sub-adults move into the deeper waters of the estuaries and may remain there for a month or more before moving seaward. These shrimp continue to grow but at a slower rate than juveniles. Sub-adults usually do not exhibit any signs of ovarian maturity.



## 8. Adults

Adults may be 5 to 8 inches in length. Adults are usually found in the ocean, but in dry years may delay migration until cold weather occurs. Spawning females are characterized by brightly colored ovaries that can be seen under the shell on the upper side of the body. Adults may be found near the beaches out to 5 or 6 miles from shore. Some species are known to migrate hundreds of miles along the coast.

The spawning season for white shrimp during spring is obvious by the large catches of mature shrimp by the commercial fleet. The exact timing of the spawning period seems to be set by water temperature during spring, but white shrimp typically spawn during May and early June with a few individuals spawning as late as July and early August. The initial larval stage, which looks like a tiny mite, is followed by about 10 larval phases, reaching the postlarval stage after about two weeks. Postlarvae look like miniature versions of adult shrimp. White and pink postlarvae are about 1/4 inch and brown postlarvae are about 1/2 inch in length. Brown shrimp postlarvae are thought to remain in the ocean bottom sediments during the winter. As ocean temperatures rise in late February and March, these postlarvae apparently become active and ride tidal currents into the estuaries. White shrimp postlarvae move into the estuaries about two weeks following spawning, usually in late May and June. The transport mechanisms that carry postlarvae into the estuaries are not fully understood, but it seems that the postlarvae will become active and move up into the water column during flood tide and settle to the bottom during ebb tide. Thus, this behavior moves postlarvae farther inshore every tidal cycle until they settle out in the nutrient-rich tidal creeks and marshes.

Natural mortality rates are extremely high for larval and juvenile shrimp. Probably less than one or two percent of the eggs spawned will survive to be adult shrimp.

## Nursery Habitat

Postlarval shrimp seem to settle out in the shallow waters in the upper ends of saltmarsh tidal creeks. Shrimp will remain in this "nursery habitat" about two or three months until they are about four inches in length. During high tide, juveniles

move into the marsh grass to feed and escape predators. At low tide, when the water level is below the saltmarsh grass, shrimp concentrate in creek beds. The smallest shrimp remain near the creek bank while larger juveniles tend to be in deeper creek waters. If the water is unusually clear, shrimp will seek the deepest areas available, presumably to avoid predatory birds, fish and crabs. In other regions of the Southeast where tides are

very small or nonexistent, juvenile white shrimp are known to remain in the saltmarsh grass until they are ready to move seaward.

Both brown and white shrimp seem to prefer muddy bottom but pink shrimp appear to do best on a sand/shell bottom. The predominance of mud bottoms in South Carolina's estuaries is probably why pink shrimp, juveniles and adults, are scarce, although their postlarvae are relatively common.

## Growth

Growth is very rapid while in the nursery habitat - up to 2 to 2 1/2 inches per month. Shrimp, like all arthropods, must molt (shed the old exoskeleton) in order to grow. Small shrimp may molt several times per week, but as they become larger, time between molts becomes greater. Ideal nursery habitat has brackish water that is about 25 to 40 percent sea water for white shrimp and 35 to 65 percent sea water for brown shrimp. Shrimp have been known to do well, however, in water that was near 100 percent sea water (such as in Murrell's Inlet) or in 10 percent sea water (such as in the Cooper River near Charleston).

Of the shrimp that reach an adult size, most die before they're eight or nine months old. The size record for white shrimp (just over ten inches) was caught by a commercial shrimper off Seabrook Island in July 1979. This individual had probably been spawned in May the previous year making it 14 months old. It's doubtful that any shrimp live longer than two years. Food

Stomach contents of shrimp are difficult to identify because the food is torn and shredded by the mouth parts. Shrimp are generally termed bottom-feeding omnivores, meaning that they will eat most organic materials - animal or plant - that they encounter at the bottom. One study suggested that small shrimp, less than about two inches in length, indiscriminately ingested the top sediment layer. Shrimp 2 to 2 1/2 inches selected the organic portion of the sediment and larger shrimp became more active predators, feeding on small animals. Animals commonly listed as food are polychaete worms, amphipods, nematodes, crustacean larvae, isopods, copepods, small fishes, grass shrimp, fiddler crabs and square-back crabs. Shrimp are also known to be cannibalistic. One researcher speculated that bacteria are the main living component in the food of shrimp. Shrimp are thought to scavenge dead animals which may be leftovers from other predators. The effectiveness of bait, particularly oily fish, indicates that shrimp are able to home in on odors.

## Disease

The most common diseases in local shrimp species are related to the presence of single cell protozoan parasites called micosporidians. These tiny animals invade various tissues of the shrimp and can cause the affected areas to appear grey or white. The affected areas may be confined only to the head or the reproductive system. However, the disease is often in the entire musculature resulting in what is commonly called the "cotton" condition. Cotton disease has been noted in white and brown shrimp but seems to be most common in white shrimp. It is also usually limited to larger individuals, but small shrimp have also become infected. At times the infection rate for severe cases may reach 10 or 15 percent. Minor infection, with shrimp having small specks of diseased tissue, may reach levels of 70 or 80 percent, but these specks are usually isolated to the head. Large individuals with cotton disease often have what appears to be dark blue or black bands across the abdomen. This seems to be an artifact of the disease.

Shrimp with cotton disease are not thought to be harmful if eaten by humans. Because the texture and possibly the flavor of a diseased shrimp is impaired, it is probably best to discard these shrimp.

## Locomotion

Shrimp have three primary modes of locomotion. While feeding or resting on the bottom, shrimp will use their walking legs (periopods) for moving short distances. While migrating long distances, shrimp will use their swimming legs (pleopods). These appendages are located under the abdomen and beat in unison as the shrimp swims. Studies using tags suggest that shrimp may be able to swim two to five miles in a day. The third form of movement is the tail flex. This is a rapid contraction of the strong abdominal muscles which results in a powerful and rapid snap to the tail propelling the shrimp backwards. White shrimp commonly use this method to jump from the water. The tail snap or flick is a defensive mechanism allowing a shrimp to quickly evade predators.

## Offshore Migration

As shrimp become larger, they leave the brackish waters and move gradually toward the higher salinity waters of the ocean. Most shrimp probably leave the marsh creeks during ebb tides and this may be more pronounced at night. Shrimp usually begin moving into coastal rivers when they reach about 4 inches in length. Further growth occurs in the rivers until the shrimp are ready to move into the lower reaches of sounds, bays and river mouths. These lower reaches, termed "staging areas" by some biologists, serve to accumulate shrimp just prior to dispersal into the ocean. When white shrimp are in the staging areas, many will move into the shallow peripheral areas to feed at night. Brown shrimp do not appear to do this to the extent of white shrimp, preferring to remain in deeper waters at night. In years when shrimp are very abundant, they may migrate into the ocean at a size of about 4 to 5 inches in length. When not abundant, however, average size of shrimp may be 6 inches or more before they leave the estuaries. The difference in size between the years of high stock abundance and low abundance seems to be related to what is called "density-dependent" growth. When large concentrations of shrimp are in the tidal creeks, growth rates are reduced. This may be caused by competition for limited food resources or each shrimp may be spending more time protecting its space instead of feeding. Heavy rainfall, resulting in very low salinities, can force juvenile shrimp from nursery areas. When forced into the inhospitable open-water areas, growth and survival rates are poorer because of less available food and suitable habitat.

Extreme environmental conditions such as droughts or unusually warm fall weather may result in delaying emigration of white shrimp into the ocean. Tagged white shrimp released into coastal waters of South Carolina in September have been observed to remain in the estuaries for two months or more before moving seaward. Heavy rainfall or river discharge along with the accompanying drops in water salinity (salt content of the water) have been known to cause shrimp to move into the ocean prematurely.

In a wet year, the majority of the white shrimp may move into the ocean in August, about a month ahead of normal. The result would be a poor shrimp baiting season and poor harvest by commercial trawlers in October, normally one of the better months for shrimping. The areas typically most severely affected are Charleston Harbor and Winyah Bay which receive relatively large amounts of upstate river discharge.

Without significant rainfall and/or river discharge during fall, white shrimp appear to remain in the estuaries until water temperature falls to about 60-65 F and then migration seems to occur primarily during the large tides associated with new and full moons. Some experienced shrimpers claim that the condition known as "red legs" is indicative of the onset of migration. This phenomenon has not been investigated scientifically.

## Harvesting

### The Commercial Fishery

The commercial fishery in South Carolina is dominated by shrimp trawlers which may range in length from 17 to 85 feet. The larger boats are the most recognizable and account for most of the shrimp caught in the fishery. Trawling is allowed only in the ocean, except for limited periods during fall when trawlers may work in the lower areas of Winyah and North Santee Bays. Most shrimpers work within three or four miles of the beach. In recent years the annual total of resident trawler license sales has been around 600 and non-resident sales have fluctuated between 200 and 400.

The commercial shrimp trawling fishery has three basic seasons. The first is the so-called "roe shrimp" season in May or June. This season is opened when management biologists determine that an adequate supply of eggs has been

spawned. The roe shrimp season is usually less than a month in duration and landings are dependent upon the severity of the previous winter. Following mild winters, heads-off landings are often 400 to 600 thousand pounds. Following severe winters, landings of roe shrimp are usually less than 50 thousand pounds and often zero.

The second season is for brown shrimp. This fishery usually begins in June and ends in August, although significant quantities of brown shrimp have been landed in October when stock abundance was very high. Good years for brown shrimp have landings of 1.3 to 2.0 million pounds (heads off).

The fall white shrimp season is typically the largest except in years following severe winters. These shrimp are the offspring of the spring spawn. Landings of young-of-the-year white shrimp by the commercial fleet usually begin in August and peak in September and October. The season usually lasts through December and into January in some years. White shrimp that overwinter in our estuaries to be our primary spawning stock. During winters in which water temperature falls to 46 F or below for seven to ten days, most of the overwintering brood stock are wiped out. In some years, cold-related mortalities have been noted as far south as the Georgia-Florida border. Following cold kills, the roe shrimp harvest is usually less than 50,000 pounds and often zero. Fall commercial landings also suffer being less than 20 percent of the long-term average.

If an adequate number of spawners is present, the next most important factor for white shrimp abundance seems to be water salinity in the nursery habitat in August and perhaps July. Low landings seem to be related to unusually dry summers resulting in higher than average salinity values. However, unusually wet summers can be detrimental also. Moderate rainfall and river discharge appear to create ideal conditions for white shrimp in most of the State's coastal marshes.

The number of spawners does not seem to be a problem with brown shrimp since the immigration of postlarvae every year seems to be relatively constant. The best years for brown shrimp seem to be those with relatively mild spring temperatures that allow brown shrimp to begin growing soon after moving into the nursery habitat. Brown shrimp are thought to grow and survive best in water salinities slightly higher than half strength seawater. Unusually wet spring and early summer weather probably has detrimental effects on brown shrimp.

Many other factors may affect abundance of both species. These may include abundance of predators or food availability. Some fish species and blue crabs are known to feed heavily upon shrimp. Availability of healthy habitat and clean water are also thought to be important for good shrimp production. Unfavorable winds could transport larvae away from the coast or heavy predation on larvae, by a concentration of jellyfish for example, could have serious effects.

## Aquaculture

Scientists in South Carolina are among the world's leaders in investigations into the culture of marine shrimp. Some of the first studies in the United States were conducted in the 1950's at the old Bears Bluff Laboratories. Today, researchers at the Waddell Mariculture Center near Bluffton are providing technical assistance to several companies that are growing shrimp in ponds in the state. The preferred species for culture is the Pacific Coast white shrimp, *Penaeus vannamei*. This species grows faster than the local shrimp species, but creation of a local hatchery could entice farmers to use the native species.

## Conservation

As more and more people move to the coast, pressure on our shrimp resource will continue to increase. To ensure that citizens, both commercial and recreational, will continue to have an ample supply of shrimp, everyone must take steps to conserve the resource. It is important that no shrimp be wasted. Shrimpers should utilize all shrimp that they catch, and if shrimp are too small, larger mesh nets should be used or shrimping activities should be postponed until shrimp grow to a useable size. Those individuals who catch more than their fair share of the resource not only violate the law but may force fishery managers to create tighter restrictions for all users. The legal daily limit for shrimp is 48 quarts (heads-on) or 29 quarts (heads-off) per boat or seining party.

## Glossary

*estuary*

The part of the wide, lower course of a river where the current is met by tides of the ocean.

*emigration*

To migrate from an area: shrimp emigrate from the estuary as they become adults.

*fishing mortality*

The death of aquatic animals resulting from fishing efforts by man.

*fishing pressure*

The collective amount of fishing activity that affects aquatic animals.

*immigration*

The migration of animals into an area: postlarval shrimp immigrate into an estuary from the ocean.

*natural mortality*

The death of animal life through natural causes; e.g. predation, disease, natural environmental stress, etc.

*periopods*

On shrimp, the five pair of walking legs used in locomotion.

*plankton*

Usually small animals, including larvae and postlarvae, that are transported by tidal and wind-driven ocean currents.

*pleopods*

On shrimp, the feather-like appendages located on the underside of the tail. Used primarily in swimming.

*postlarvae*

In shrimp, the first stage in the life cycle which takes on the shrimp-like appearance and follows the larval stages. Postlarval shrimp are usually 4-12 mm in length. Shrimp immigrate into the estuaries as postlarvae.

*spawning*

The release of eggs by shrimp or fish. Eggs are usually broadcast and either sink to the bottom or drift as plankton.

*spermatophore*

In shrimp, the "packet" that contains the sperm. The spermatophore is attached to the female shrimp near the gonopore, either on the outside of the exoskeleton or under exoskeletal plates depending upon the species.

*stock*

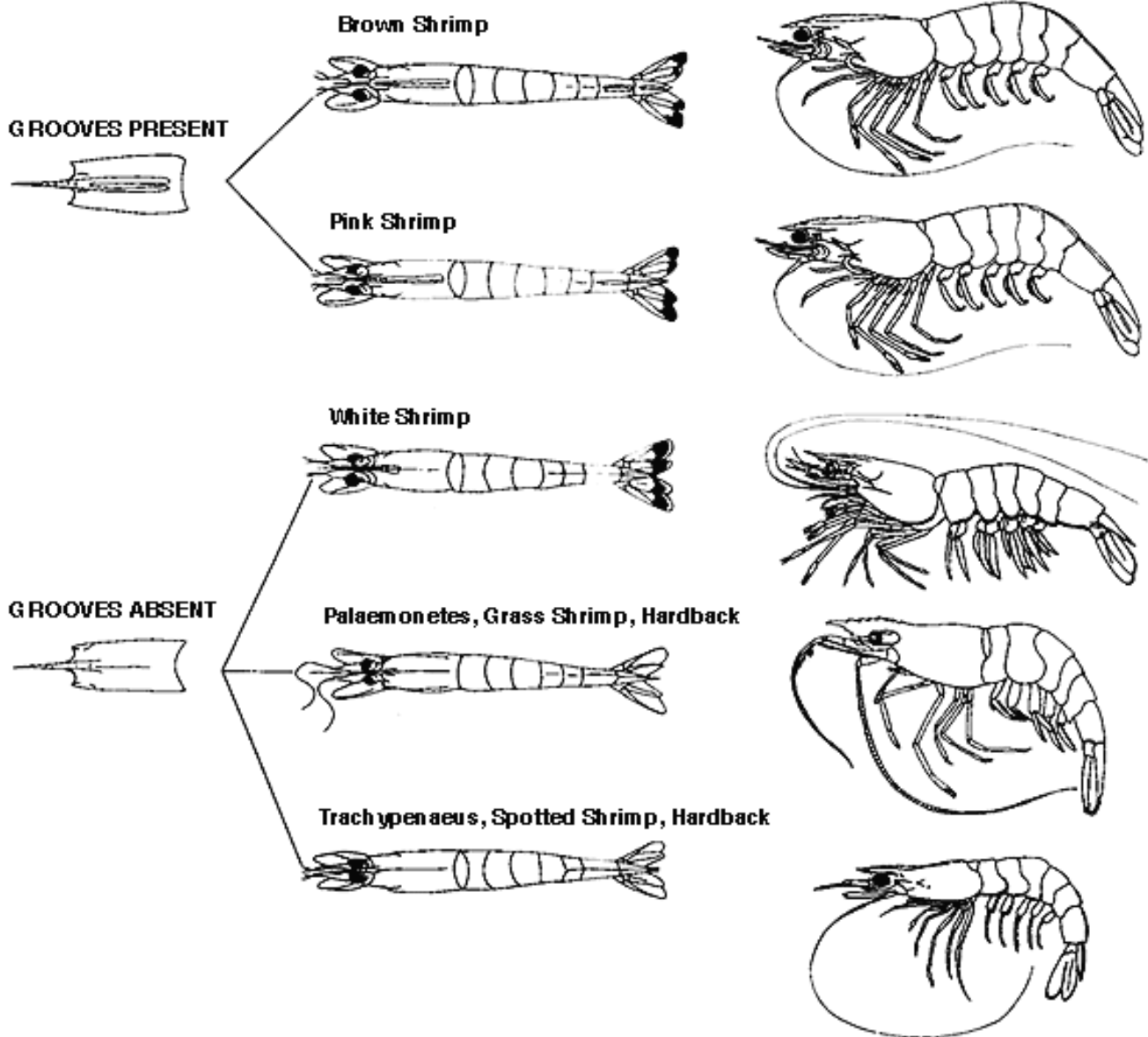
Animals of the same species, usually aquatic or marine, that reproduce with one another and live in the same general geographic area.

*uropod*

In shrimp, one of the four appendages on the shrimp's tail that form the fan which is brightly colored in some species. The fan is used in helping shrimp move themselves backwards quickly.

## South Carolina Shrimp





Three shallow-water species of shrimp are recreationally and commercially important in South Carolina. A description of these is provided (A,B, & C) together with two similar (D and E) but less important species that often confuse the layman.

A) *Penaeus setiferus*

Common Name- White Shrimp

Remarks: Pale to whitish color with the tail edged in green. No groove present along the base of either side of the rostrum or along the head. Antennae twice as long as the body. Last tail segment keeled. Rostrum slightly longer than that of the brown or pink shrimp.

B) *Penaeus aztecus*

Common Name- Brown Shrimp

Remarks: Brownish in color. Groove present along the base of both sides of rostrum and along the length of the head. Tail edged in red and blue. Antennae less than twice as long as the body and rostrum not as long as that

of the white shrimp.

C) *Penaeus duorarum*

Common Name- Pink Shrimp, Hopper and Brown-spotted Shrimp

Remarks: Brownish in color and often somewhat darker than the brown shrimp. Usually a prominent dark spot on each side of the tail. Grooves on the head along the rostrum and the last segment of the tail similar to the brown shrimp but less pronounced.

D) *Palaemonetes vulgaris*

Common Name- Grass Shrimp, Hardback (Not a recreational or commercial species).

Remarks: Occur throughout estuarine waters in great numbers. Frequently confused with white shrimp. Average between 1 and 2 inches in length with a relatively long rostrum with teeth on the lower edge. Stubby in appearance, head larger in proportion to the tail than in the other species.

E) *Trachypenaeus constrictus*

Common Name- Spotted Shrimp, Hardback (Not a recreational or commercial species).

Remarks: Occur in inshore waters and along beaches just offshore. Light brown to pinkish in color with grayish spots on its tail. Short rostrum not grooved on each side.

**Special Note**

This publication was made possible in part from funds from the sale of the South Carolina Marine Recreational Fisheries Stamp and the US Fish and Wildlife Service Sportfish Restoration Fund. Help ensure outdoor enjoyment for future generations by strictly adhering to all rules, regulations, sea-sons, catch limits and size limits. The South Carolina Department of Natural Resources publishes an annual Rules and Regulations booklet that lists all saltwater fishing regulations. Have an enjoyable fishing trip by reading these requirements before you fish.

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The South Carolina Department of Natural Resources is the advocate for and steward of the state's natural resources. The Department of Natural Resources develops and implements policies and programs for the conservation, management, utilization, and protection of the state's natural resources based upon scientifically sound resource assessment and monitoring, applied research, technology transfer, comprehensive planning, public education, technical assistance and constituent involvement. The Department of Natural Resources is proactive in protecting the state's natural resources for use and enjoyment by future generations of South Carolinians.