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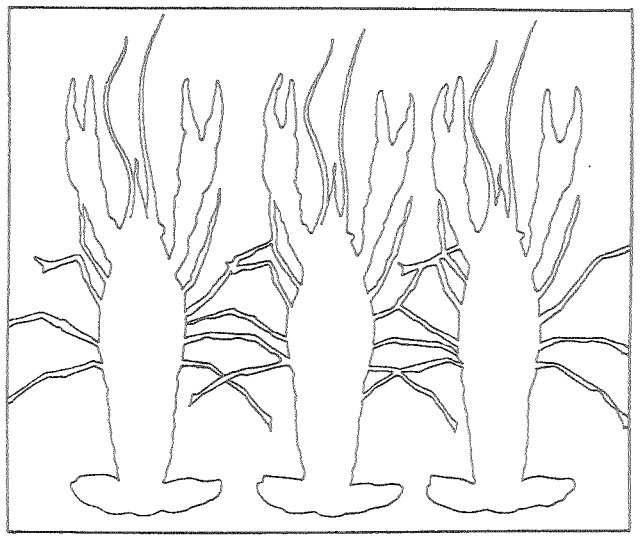
Crawfish in the Classroom



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he female crawfish usually enters an underground burrow, where she lays from 100 to 500 eggs. Fertilization takes place after the eggs are laid. The female secretes a glue-like substance called glair, which firmly attaches the newly laid eggs to her swimmerets. Even after the eggs hatch, the young crawfish remain attached to the mother until they have gone though two molts and are large enough to fend for themselves.

Excretory System. Paired kidney-like organs called the green glands, located on either side of the crawfish's body above the mouth, produce urine, which passes through excretory tubes into the bladder and then out of the body. The crawfish also excretes wastes in the form of ammonia through the gills, as water flows from the gill chambers, and carries the waste away from the animal's body.

Muscular System. Powerful abdominal muscles permit the crawfish to swim rapidly backward. Other important muscles include those of the claws, the mandibles, the stomach, and the various limbs. For scurrying back and forth, the crawfish uses its walking legs.

Ecology

Crawfish are polytrophic, which means that they eat a wide variety of organic material, both plant and animal. Ecosystems contain producers and consumers. Plants, for example, are producers, using a source of energy like the sun to produce the organic molecules that build body mass and fuel metabolism. Crawfish, however, are consumers. They cannot produce organic molecules from inorganic ones, and must obtain organic compounds for energy by eating producers and other consumers (Figure 6). When organisms die, decomposers like fungi and bacteria break down the organic matter for their own energy. The remaining inorganic nutrients are recycled back to plants. Therefore, an ecosystem can be seen as a chain, firmly linking producers, consumers, and decomposers.

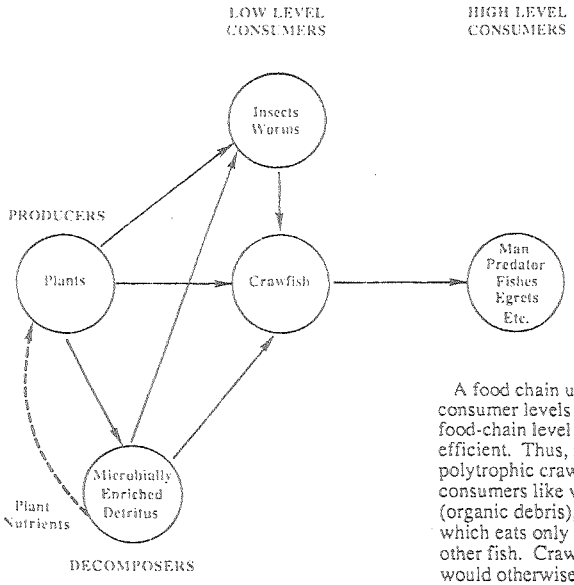


Figure 6

A food chain usually contains no more than three consumer levels because energy transfers from one food-chain level to the next are only about 10 percent efficient. Thus, more energy is available to the polytrophic crawfish, which eats plants, various consumers like worms and insects, and detritus (organic debris), than to, say, the largemouth bass, which eats only consumers such as crawfish and other fish. Crawfish recycle energy from detritus that would otherwise be lost to the ecosystem, actually consuming the microbes on the detritus. Crawfish are important in the functioning of an aquatic ecosystem because so many different creatures, including man, eat them.

Crawfish in the Classroom

Introduction

Freshwater crawfish are decapod (10-legged) crustaceans found throughout the world. North America has about 300 species of crawfish, Australia has 100, Europe has about 10, and western Asia has one. Though crawfish are cultivated there, Africa has no native species.

Crawfish is a popular food in many parts of the world. Though 10 to 20 million pounds of crawfish are produced each year by Europe, Africa, and Australia, over 100 million pounds are harvested annually in the United States. Most of these are one species, the red swamp crawfish (*Procambarus clarkii*), taken from Louisiana's swamps, marshes, and 125,000 acres of crawfish culture ponds (Figure 1).

The red swamp crawfish is the species most likely to be found on U.S. dinner tables and in science classrooms. Native to the south-central United States, it is now found commonly throughout the country.

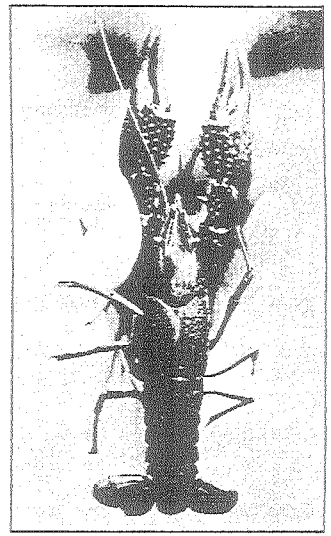


Figure 1

Classification

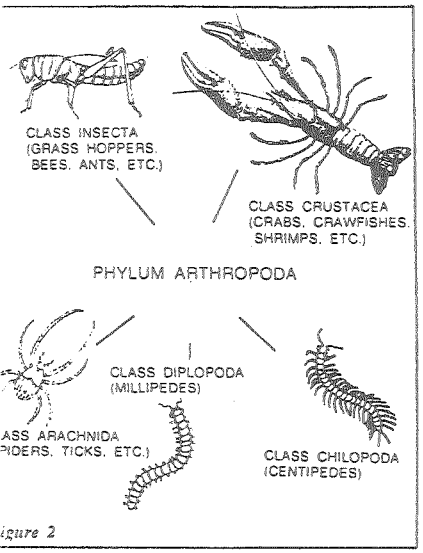
As a crustacean, the crawfish forms a class of the phylum Arthropoda,which includes other classes of invertebrates (animals without backbones) such as insects, spiders, and centipedes (Figure 2). The crawfish's closest relatives are fellow decapod crustaceans, the shrimp, lobster, and crab.

External Anatomy

The crawfish's body has three major sections--the head, the thorax (midsection), and the abdomen (including the telson, or tail). The head and thorax, which are fused together and enclosed by the carapace, are called the cephalothorax. The entire length of the crawfish's body contains 19 segments, or somites. These are most visible in the tail section of the abdomen. Attached to the somites are 19 pairs of jointed appendages, which are grouped according to function (Figure 3).

Appendages. Three pairs of appendages are attached to the head; these are the antennae, which are responsible for transmitting and receiving sensory stimuli, and the mandibles, which bite and tear food. The 10 pairs of appendages attached to the thorax include the maxillae and the maxillipeds, used in feeding, and five pairs of walking legs (pereipods), of which the large characteristic pincer claws, or chelae, of the crawfish are the first. The pincers are used to grasp food and also for combat and protection. The other four pairs of walking legs are used in locomotion and as cleaning tools for the body. The appendages on the abdomen, five pairs of swimmerets and one pair of uropods, are used primarily in swimming, mating, and transporting eggs and young. In the male crawfish, two pairs of the swimmerets are modified to transfer sperm during mating; in the female, the corresponding swimmerets hold developing eggs. The uropods are paddle-shaped and, along with the telson, form a tail fan used in swimming backward.

Exoskeleton. Crawfish have a hard outer shell, or exoskeleton, made primarily of inorganic calcium carbonate (chalk), along with a mixture of chitin and modified proteins. The shell must be shed periodically so that the crawfish can grow larger. This is called molting, and the crawfish goes through



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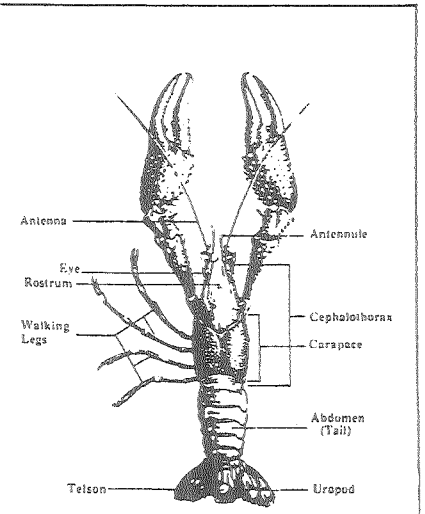

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it about 11 times before reaching maturity. After the crawfish attains its full size, it no longer molts.

Before the crawfish molts, its shell steadily loses calcium carbonate, which is stored as two small stones, or gastroliths, in the crawfish's head. With the loss of calcium, the old shell weakens, becoming thin and brittle, and the crawfish is able to break it easily. Though this process takes days, the actual shedding lasts only a few seconds, as the crawfish first frees its appendages and then, with a flip of its tail, slips out of the old carapace, which has popped open.

After molting, the crawfish absorbs water and swells, often doubling in weight. Its new exoskeleton remains soft for about 12 hours, then gradually hardens as it absorbs calcium carbonate from the supply stored in the gastroliths and from food and water.

Crawfish can regenerate lost body parts, an ability that is most obvious after each molt. Missing claws are common, as they are frequently lost in fights with predators or other crawfish.

Color. Pigment-containing cells in the epidermis underlying the exoskeleton give each crawfish species its characteristic color. The red swamp crawfish is usually a dark black-red as an adult and greenish-brown as a juvenile, though color is influenced by environment. Crawfish exhibit protective coloration, blending with the color of the water in which they live. Juvenile crawfish become progressively darker as they draw closer to molting, one of the signs that molting is imminent. But when all crawfish are boiled, their color turns reddish orange.

Internal Anatomy and Physiology

Because crawfish are invertebrates, their internal structure is very different from that of vertebrates, animals with internal skeletons and backbones (Figure 4).

Digestive System. The crawfish's stomach is found behind its eyes in the cephalothorax. The stomach consists of two chambers; the first contains three hard, chitinous "teeth" (the gastric mill), which grind and crush particles of food. After the food has passed through the second chamber and the midgut, where enzyme-secreting glands begin the work of digestion and absorption, tubes take it into the hepatopancreas, called the "fat" by crawfish eaters. The hepatopancreas is the crawfish's major digestive organ and it is there that final digestion takes place. A short, straight intestine takes unabsorbed food through the abdomen to the anus, where it is excreted.

Circulatory System. From a simple, muscular heart, located above the intestine and behind the stomach, branching arteries carry clear blood to the crawfish's vital organs, where oxygen is exchanged for carbon dioxide and other wastes. Dilated channels, or sinuses, carry the blood back to the heart through and around body organs. The gills provide the deoxygenated blood with a new supply of oxygen before it returns to the heart. The crawfish has no veins, and this is why its circulatory system is said to be open.

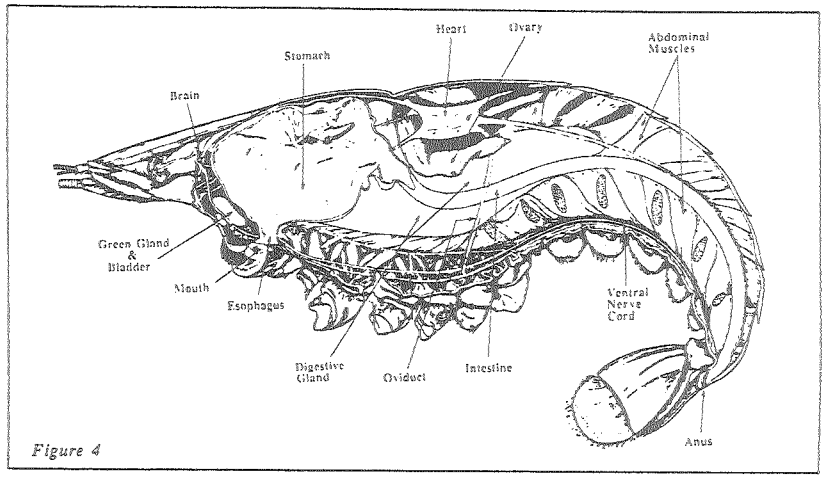

Figure 4

Nervous System. The crawfish's brain consists of three sets of ganglia, or "bundles" of nerve cells, above the esophagus. Two nerve cords, with branching ganglia in each segment of the crawfish's body, run the length of the abdomen. The crawfish possesses a highly developed sensory system, necessary for survival in its constantly changing environment. Numerous sensory setae (hairs) on its body enable the crawfish to maintain efficient senses of touch and balance, and its compound eyes provide excellent color vision.

Respiratory System. The crawfish obtains oxygen and eliminates carbon dioxide through its gills, which are located on either side of the cephalothorax in gill chambers that are outside the body but underneath the carapace. The gills draw oxygen from the water as it circulates through the gill chambers. So long as the gill chambers are moist, the crawfish can obtain oxygen, even though the animal is out of water.

Reproductive System. The testes in male crawfish and the ovaries in female crawfish are located beneath the heart. The male crawfish has paired sperm ducts that lead to openings at the bases of the fifth pair of walking legs attached to the thorax. The female crawfish has paired oviducts leading to openings at the third pair of walking legs. In mating, sperm is transferred from the male to the female on the abdominal swimmerets and stored in a receptacle on the female's abdomen (Figure 5). After mating,

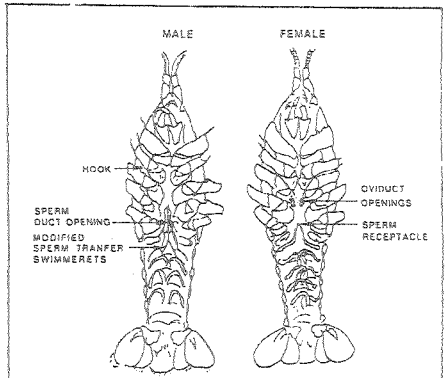

Figure 5

Crawfish in the Classroom

Crawfish are interesting for students of all ages. Younger students will enjoy watching the animals respond to visual and tactile stimuli and will be intrigued by such behavior as molting and feeding. Older students may conduct physiological studies and examine internal anatomy through laboratory dissection. All students will enjoy field trips to observe and collect crawfish and other aquatic organisms.

Another interesting classroom activity is to place several small crawfish in a suitable container with a small amount of water and several inches of mud. By the next day, the crawfish will have constructed burrows, complete with "chimneys." Home economics classes can prepare crawfish recipes, develop their own, and study the nutritional value of crawfish.

Crawfish are found in most bodies of water in coastal Louisiana, but seasonally flooded ditches and irrigation systems are the best places to look for them. They may be dipped out with small nets or "caught" with a bit of stew meat or bacon on the end of a string. If there is no ready natural source of crawfish, they may be obtained at seafood markets. Biological supply houses are good sources, but very expensive. State wildlife and fisheries agencies can usually locate crawfish and fish farms almost always have crawfish on the grounds.

How can crawfish be kept alive? They can be grown easily in an aerated aquarium, but they will eventually eat the plants and any fish present and burrow in the gravel. An alternative is to place each crawfish alone in a high-sided container; four to six inches square is a good size for housing a crawfish one to two inches long. Tap water aged 12 hours should just cover the crawfish's back. The animal will quickly exhaust the oxygen in the water but it will be able to obtain more oxygen by raising its carapace above the water and using atmospheric oxygen. If the crawfish cannot do this, it will "drown." Water depth is important for another reason also: the crawfish will be unable to molt if there is not enough water to support its body.

What do crawfish eat? They may be fed leafy green vegetables, carrots, pieces of raw fish, goldfish food, composting leaves, and dog and cat food. A crawfish will eat one to three percent of its body weight per day, stopping several days before molting. A crawfish can be fed two or three times per week. The day after feeding, the uneaten food should be removed and the water changed. Crawfish should not be overfed; many classroom crawfish are "killed with kindness."

How can crawfish be bred? When a mature male crawfish is placed in the container of a female crawfish, mating should take place within an hour. If they do not mate, they should be separated and the male returned to the female's container in about a week. After mating, the male should be removed.

Two weeks to two months later, the female will lay dark brown eggs, which will be attached to her swimmerets with glair. It is obvious when the female is about to lay eggs, as distinct white patches appear around the swimmerets. At 70 F, the eggs will hatch in two to three weeks. In another three weeks, the young molt twice before becoming detached from the mother, though in confinement they may cling to her for almost two more months, attracted by a substance she secretes called a pheromone.

Suggestions for the Teacher

This publication can be used with the following curriculum guides from the Louisiana Department of Education:

Bulletin 1613, science, grades 4 through 6, pages 112-114.

Bulletin 1643, biology, page 7.

Bulletin 1614, life science, page 4 (animals typical of Louisiana habitats) and page 12, section vi (animals).

Bulletin 1792, environmental science, page 5 (heterotrophs), page 9 (food webs), and page 44 (wildlife).

You may wish to use the videotape, Crawfish: A Culinary Crustacean, which is about the harvesting and processing of crawfish and is produced by the Louisiana Sea Grant College Program. If you send a blank tape and $2 for postage and handling, Sea Grant will copy the tape for you free. Otherwise, send $10 for a 1/2-inch VHS tape or $20 for a 3/4-inch U-Matic tape.

The book, Red Swamp Crawfish: Biology and Exploitation, by J.V. Huner and J.E. Barr, is also available from Louisiana Sea Grant for $10.

To order either of these, write to the Louisiana Sea Grant Communications Office, Center for Wetland Resources, Louisiana State University, Baton Rouge, La. 70803-7507.

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