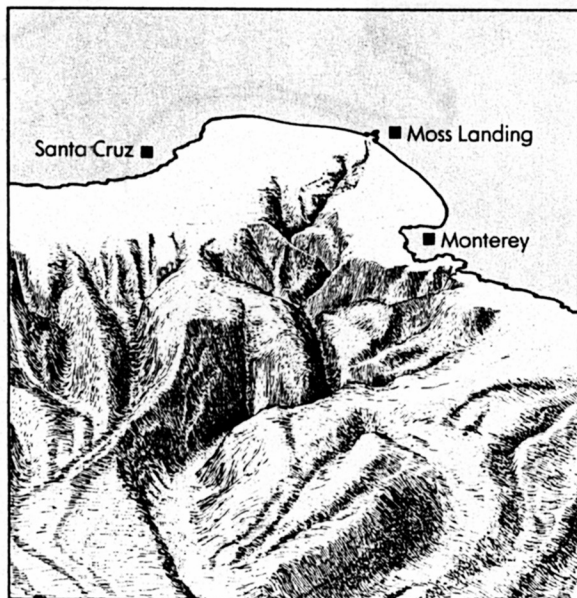


WHAT IS THE DEEP SEA?

Cold, dark and constant, the deep sea is the largest, but least known, region on earth. The deep sea floor extends under water from the edge of the continental shelf, across broad plains and down into trenches seven miles deep. The deep ocean covers about 60% of the earth's surface, but we know more about the moon than we know about the ocean depths.

Why do we know so little? It's difficult and expensive to sample miles below the surface. Oceanographers go to sea aboard huge research vessels equipped with echo-sounders, expensive deep water dredges, traps and submersible vehicles. Some scientists study the midwater fishes and invertebrates that swim or hover in the water; others focus on the benthic animals living on the ocean bottom. Midwater or bottom—only small areas of the ocean can be sampled at a time. Sampling lets us know about where different animals live and how they have adapted to the low temperatures, high pressure and darkness of the deep sea.

Monterey submarine canyon



MONTEREY CANYON

Just offshore in Monterey Bay lies a canyon about the same size and shape as the Grand Canyon. The huge chasm cuts the bay nearly in half, sloping down from a depth of about 60 feet at Moss Landing to nearly 12,000 feet at its end 60 miles out to sea. Because of the Monterey Canyon, we have deep sea habitats close to shore.

TEMPERATURE

Try a quick dip in Monterey Bay on a sunny day. The water temperatures here range from 50° to 60° F, shocking to the hardest of swimmers. Even on the warmest day, the bay can absorb a lot of radiant energy and heat from the sun without much change in temperature. Monterey Bay is so cold at the surface that it's hard to imagine the deep layers as colder yet. But 300 feet down, the ocean has cooled down another ten degrees. Below 3,000 feet, the water cools gradually to just above freezing and remains bitterly cold throughout the year without any seasonal change.

PRESSURE

Scientists who use submersible vehicles sometimes attach styrofoam cups to the sub's exterior to demonstrate how pressure increases with depth in the ocean. On the surface at an atmospheric pressure of 14.7 lbs./sq. in., a styrofoam cup stands about four inches tall. As the sub sinks down into the ocean depths, the scientist can watch the coffee cup gradually shrink as the pressure permanently compresses the styrofoam. Below 2,000 feet, under pressure 100 times greater than that at the surface, the styrofoam cup has shriveled to a fraction of its original size. In the deepest ocean trenches, pressure is a crushing 1,000 times surface atmospheric pressure.

Pressure probably limits where many marine animals can survive. Fishes with slow-adjusting gas bladders would explode if they migrated upward into reduced pressure. Changes in pressure may also affect deep sea animals by speeding up or slowing down their metabolism.

LIGHT

For all the sunlight pouring down on the ocean's surface, none reaches the deep ocean bottom. Some light reflects off the surface; some is scattered or absorbed in sea water. Tiny bits of soil or other particles in sea water scatter light energy, changing its downward direction and sending light back toward the surface or off at an angle.

Absorption converts light energy into heat. The longest wavelengths of light disappear in shallow sea water: ultraviolet and infra-red light are absorbed in the first three feet of water. Red and purple light vanish 30 feet down. Blue-green light penetrates deepest; in very clear water, blue-green light may reach 600 feet deep.

Scientists use light penetration to describe different habitats in the open sea: the upper sunlit zone, the middle twilight zone and the deepest zone of darkness.

The photic or sunlit zone is the most active layer of the ocean. In this shallow region, storm waves, tides and currents keep the water in motion. Upwelling mixes in natural fertilizers from deeper waters. In central California, the photic zone can reach 300 feet down. These waters are rich with life: microscopic plants called phytoplankton grow in this well-lit region, using light energy for photosynthesis. Planktonic animals like copepods, arrow-worms and larval fishes are also abundant here, feeding on the plants or on the plant-eaters.

Below the sunlit region is a twilight zone of faint light. This midwater zone extends from about 300 feet to 3,500 feet below the surface. Many fishes like the bristlemouths found in the twilight zone are migrators that swim up each night to feed in the richer photic waters above and return to the depths each day.

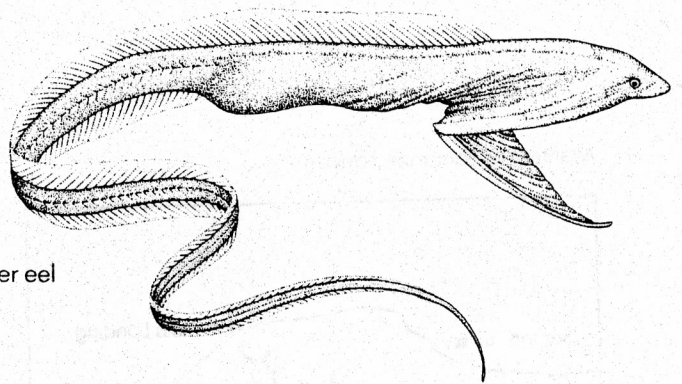
The deepest zones never see the light of day. In the darkness below 3,500 feet, the waters are cold and rich in nutrients, but without light, there is no plant production. Instead, the deepest organisms eat other deep sea animals or depend on other food raining down from shallower waters.

ADAPTATIONS IN DEEP SEA ANIMALS

Look at all the seaweeds, invertebrates and fishes crowded together on our rocky shores. Compared to these complex communities in shallow water, deep sea animals are few and far between, forming patches of life in the constant and seasonless depths. Most deep sea animals just don't look or act like their shallow water cousins. The unusual body shapes and colors and behavior of deep sea animals may seem strange to us, but these adaptations suit them for survival in their deep, dark habitats.

Camouflage

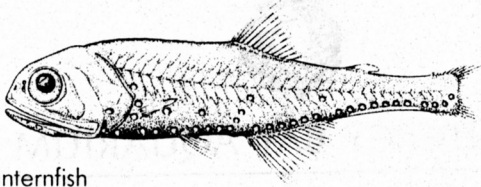
In the darkness of the deep sea, an animal's body color can camouflage it or attract attention. Transparent midwater invertebrates like the arrow-worms seem invisible in the dim ocean twilight. Midwater fishes like the hatchetfish have silvery skin that reflects light. In the deeper dark habitats, fishes like gulper eels have black skin to help them hide in the darkness, while red shrimps and purple jellyfish appear black in the absence of red light.



Gulper eel

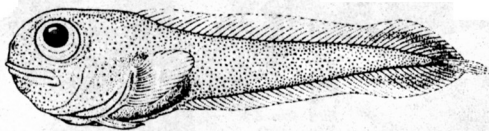
Bioluminescence

Bioluminescence, the production of light by living animals, is a common adaptation in deep sea fishes and invertebrates. Some animals grow luminescent bacteria in special body pockets; others produce their own light in body organs called photophores. In the darkness of the deep sea, animals can use light to inform, confuse or attract other deep sea animals.



Lanternfish

Some animals, like deep sea jellyfish and squid, use bioluminescence to escape danger. To distract predatory fishes, these escape artists release a bioluminescent substance and then swim away to safety in the darkness. Biological lights, like the luminous "bait" on the top fin of the anglerfish, can also help lure prey. Photophores arranged in specific patterns help fishes like lanternfishes to recognize potential mates. The lights may also work like tail lights on a car to help a lanternfish judge its distance from other fish in a school.



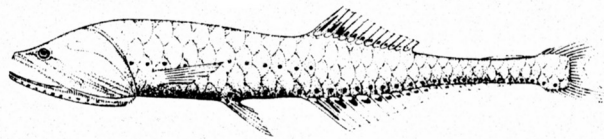
Tadpole snailfish

Vision

Besides making their own light, many midwater animals have visual adaptations to the darkness. Fishes and invertebrates in the twilight zone have large, well-developed eyes. Some have eyes that are dark-adapted to see more red; others have optical lenses that can detect bioluminescence or concentrate the dim twilight. In contrast to the twilight zone, many animals in the darkest depths have small, poorly developed eyes.

Feeding

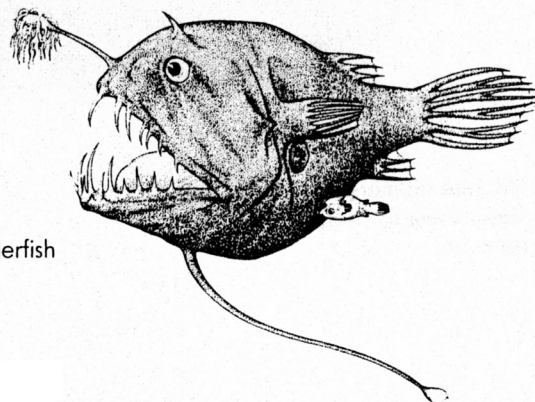
In the deep sea where food is scarce, animals have adapted to make the most of every meal. Compared to the sleek, muscular tuna of shallower water, a deep sea fish doesn't need as much food to support its small, flabby body, weak muscles and lightweight skeleton. A fish like the gulper eel with its huge mouth, unhinging jaws and expanding stomach can engulf and swallow a fish larger than itself. Some fishes migrate to areas with more food. Fishes like bristlemouths swim upward to feed in shallow water at night and return to the depths during the day. Other fishes feed in shallow water while they're young, moving into deeper water as they mature.



Bristlemouth

Reproduction

How does a deep sea animal ever find a mate in the darkness? A fish with keen vision may focus on attractive lights and shapes; one with an acute sense of smell follows its nose. Incredibly different in size and shape, some male and female anglerfish have developed mating behavior that keeps them together for life. The tiny male anglerfish uses his keen sense of smell to search out the larger female and then bites on to permanently attach himself as a parasite on her. The parasitic male anglerfish relies on the female for nutrition; his main function is to produce sperm for reproduction.



Anglerfish

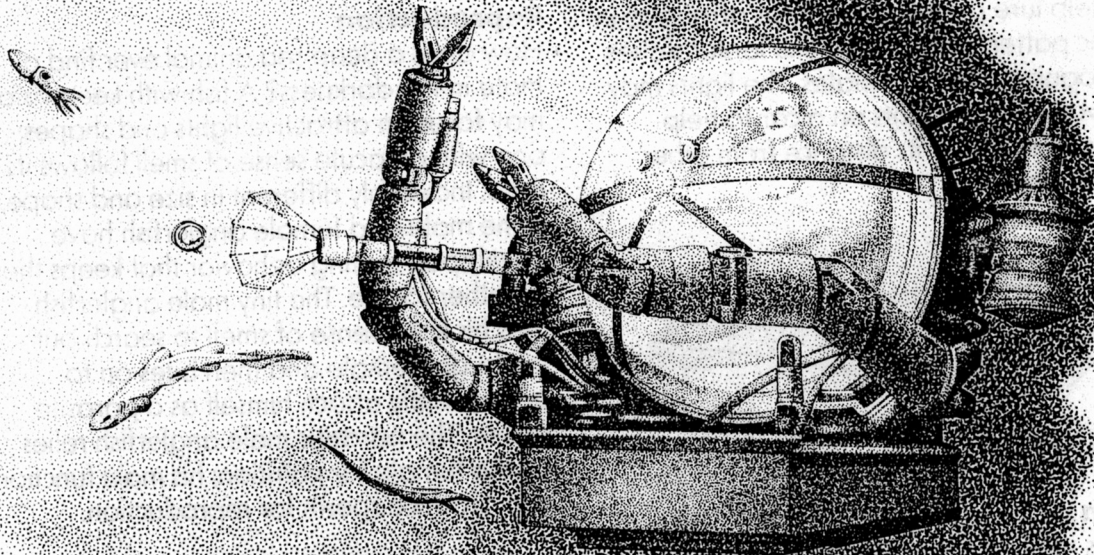
Some animals like arrow-worms have adapted in the opposite extreme, eliminating differences between the sexes by developing both male and female sexual organs. A hermaphrodite, an animal that is both male and female, can make both eggs and sperm. A normal female animal must locate a male of the same species to reproduce; encounters with other females (half the population) won't be successful. In contrast, any two hermaphrodites can mate and when they do, twice as many eggs can be fertilized at one time. A hermaphrodite that can fertilize its own eggs has added insurance that it can reproduce even if it never finds a mate.

The strange-looking animals of the deep sea probably have many other adaptations that we don't yet understand. There's still a huge, mysterious world of animals deep below for us to explore.



MONTEREY BAY AQUARIUM

EDUCATION DEPARTMENT



Scientists use submersibles like *Deep Rover* to study the deep sea.