The Discovery of Hydrothermal Vents

25th Anniversary CD-ROM

The Symbionts

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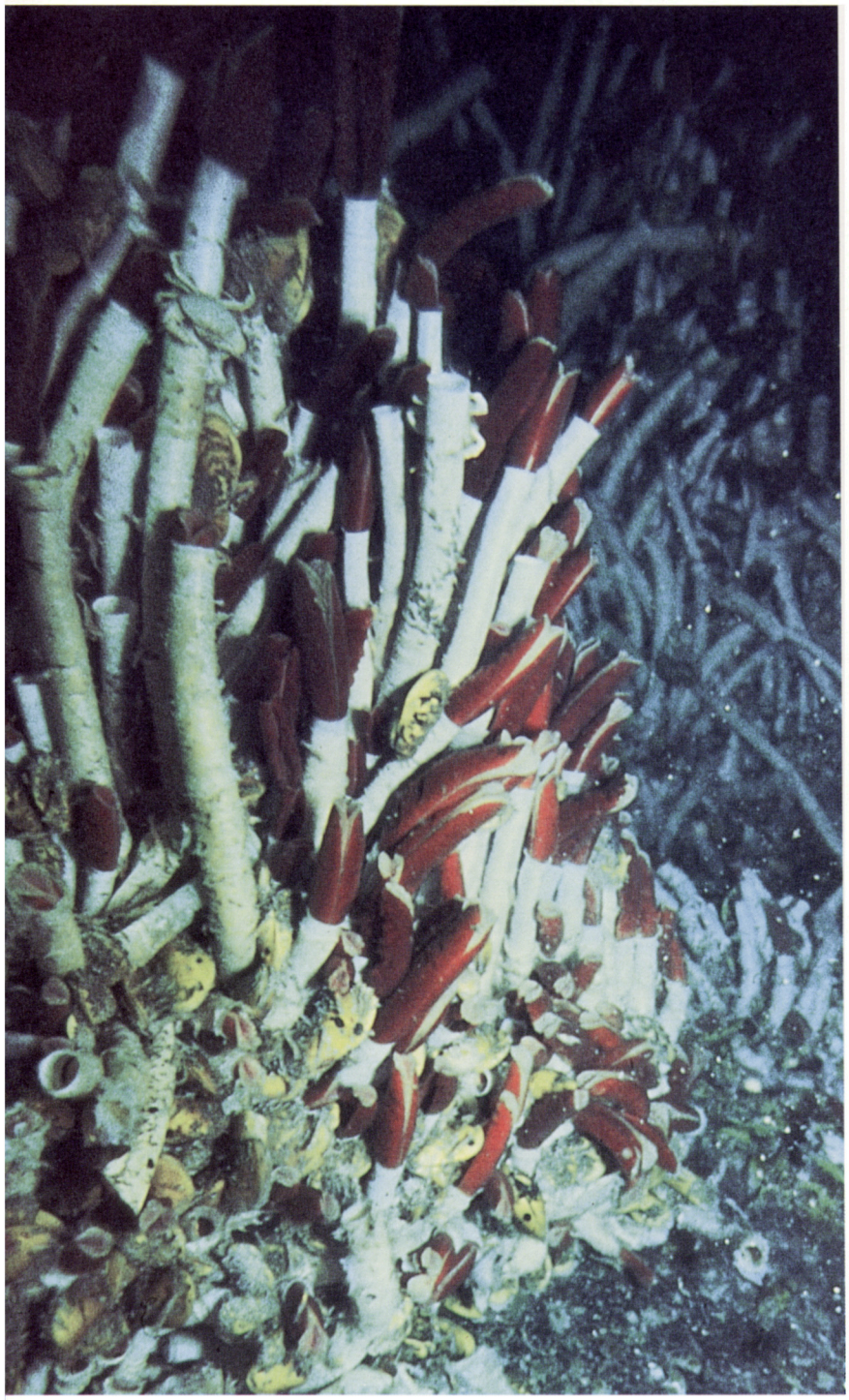
The Symbionts

Eight-foot tall tube worms. Jumbo clams, with shells the size of dinner plates. How did they grow so big? By making a home for bacteria.



J. FREDERICK GRASSLE/WHOI

BESIDE A HYDROTHERMAL vent, deep down on the ocean floor where the sun never shines, a tall white tube worm, one of a forest of *Vestimentifera*, waves its red head. Is it eating? Yes, and no. This worm doesn't eat like other animals. It has no mouth, not gut, no anus. Says WHOI biologist Holger Jannasch, "It has given up eating altogether." It nourishes itself by taking in hydrogen sulfide gas from the hydrothermal vent fluid that passes up from a crack in the sea floor and mixes with oxygen from the surrounding seawater. Through a series of capillaries (very small blood vessels), both gases travel to the inside of the worm, where a colony of bacteria live. The worm actually eats the bacteria that it feeds.

EMORY KRISTOF © NATIONAL GEOGRAPHIC SOCIETY

Vent clams are very big – about ten times as big as clams we eat.

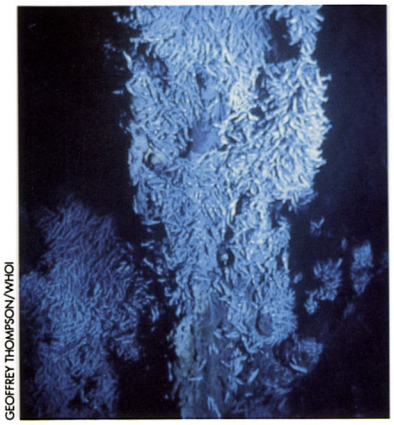
If the worm has no mouth, how do the bacteria get inside? Nobody knew the answer to this question for a long time. Then, in 1985 a zoologist named Meredith Jones from the Smithsonian Institution found a microscopic opening in a baby tube worm, which was itself no bigger than the white at the tip of your fingernail. Meredith said that the opening was "a single snout-like structure that appears to sort of snuffle up bacteria." It closes up as the animal gets bigger.

Another vent creature that makes a home for bacteria is the giant clam called *magnifica*. This clam feeds the bacteria that live inside it by taking in hydrothermal fluid through its foot, which it sticks directly into a crack on the sea floor.

Tube worms and other creatures living in a cluster near hydrothermal vents.

PEEK-A-BOO

At least one kind of vent shrimp has an "eye" in the middle of its back. But what does it look at?



GEOFFREY THOMPSON/WHOI

Bees at a hive: shrimp on a chimney.

TO ME, THEY LOOK LIKE bees dancing on a hive," says biologist Cindy Lee Van Dover, describing the odd white shrimp, called *Rimicaris exoculata* (Latin for "eyeless rift shrimp") that she travels deep into the ocean, to the Mid-Atlantic Rift, to study. These shrimp gather at hydrothermal vent chimneys. Sometimes, as many as 1500 shrimp, all moving and wiggling in a frenzy of feeding, have been counted in just one square meter (about one square yard) of a chimney's surface. These shrimp don't remind everyone of dancing bees. MIT chemist John Edmond once described these shrimp as looking "disgustingly like swarming maggots on a hunk of rotten meat."

Like most vent animals, vent shrimp make their living by eating bacteria that live in the poisonous vent fluids. Do shrimp that chow down on bacteria that live off poison taste good to eat? Cindy cooked one once. It did not turn pink. Gray to begin with, it turned an even uglier shade of gray. It tasted like a rotten egg, and had the texture of a rubber band.

How do these shrimp find the chimneys that hold their food? How did they come to live at the vents in the first place? Scientists are trying to answer these questions.

Though the shrimp have no eyes, they do have a bright reflective spot on their backs, right behind their heads. When studied in the laboratory, scientists discovered that this spot contains rhodopsin, a light-sensitive material found in the eyes of many creatures.

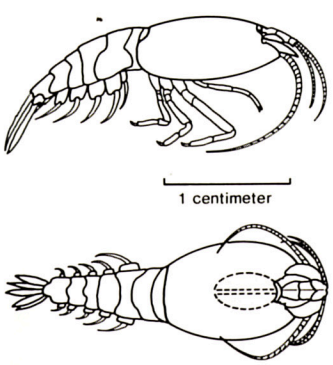
So, it would seem that these shrimp can "see"— or at least, they can tell whether or not something gives off light. But what light are they looking at? Isn't their world totally dark, except for the odd flash of light from a creature that glows in the dark?

Cindy Lee Van Dover and her colleagues wondered about this for a long time. They wondered if the vents themselves might give off some sort of glow, too faint for humans to see, but easy for a shrimp with a special deep-sea eye to detect.

The scientists thought about the ways in which such a light source could be useful to the shrimp. It could draw them to areas where they could feed, or warn them to stay away from water that was so hot it could kill them. Cindy had learned about a phenomenon called "black body" radiation, which causes hot things to glow, though that glow may be outside of the range of our visual spectrum. Might hydrothermal vents give off this "black body radiation?"

Cindy went on a cruise with other scientists to test out this idea. They used a special camera, that could photograph this very low-level glow, if it existed. When they got the pictures back and developed them, they were excited to see that they were right. Vents glow. And the shrimp may be there to see the glow.

The preceding material is adapted from an article called "Do 'Eyeless' Shrimp See the Light of Glowing Deep-Sea Vents?"by Cindy Lee Van Dover that originally appeared in Oceanus *Magazine, Volume 31, Number 4, Winter, 1988/89.*



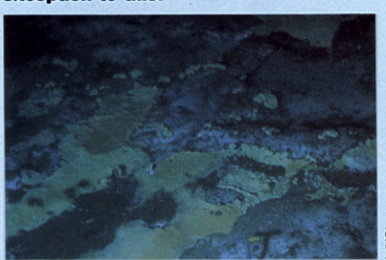
WHOI GRAPHICS DEPARTMENT

***Rimicaris exoculata*, up close.**

WHAT'S FOR LUNCH?

The diet of vent animals may seem boring to us: bacteria, bacteria, bacteria. But where that source of food is plentiful, these creatures seem to flourish.

In most people's minds, bacteria are bad things that cause disease," says WHOI biologist Holger Jannasch, who has dived many times to hydrothermal vents. "But these tiny organisms are everywhere. They are extremely important in the recycling of matter. They are as important a part of our own food chain as trees or cows. In the deep sea, the bacteria are the basis of whole animal communities that are brand new and surprising to us. We always thought life on earth was supported by the sun. It's an important fact, it's what you learn in school. Now we know there is a big exception to this."



WHOI

A mat of vent bacteria.

FROM HERE TO THERE

How does a new vent community start? Nobody knows for sure.

Hydrothermal vent communities come and go quickly, especially in the Pacific, where their life span is measured in tens of years. When a vent stops giving off hydrothermal fluid, what happens to the animals that live there? Most of them die. But somehow, new vent communities are settled by new organisms. Since the larvae of these animals have no way of travelling under their own power, how does this happen?

Lauren Mullineaux, a biologist at WHOI, thinks that the microscopic larvae of some of these animals, particularly vent clams, might rely on the flow of sea water to transport them. She thinks they may travel upward with hydrothermal vent fluid. At a certain level, the larvae may join with the current that flows throughout the ocean.

Nobody knows how these travelling larvae find their way to their next source of chemosynthetic bacteria. "I wish we could put a tag on one, so we could follow it," says Lauren. In fact, she and other scientists have been trying to develop a genetic tag that would tell them, even in very general terms, where a clam's ancestors came from. Someday, they hope they will know.