Solving Microbial Mysteries

A major focus of the Extreme 2008 expedition is microbes — tiny organisms that have giant impacts on our world.

"For many years, the vents have been explored with little to no attention to viruses and protists," said chief scientist Craig Cary, professor of marine biosciences at the University of Delaware. "Yet because these organisms consume bacteria, they have the most dramatic effect on the bacterial communities that support the vent system. Our research programs are among the first to focus on these remarkable scavengers."

If you've ever had a cold or the flu, you've been the victim of a virus—a microscopic bundle of genetic material in a protein shell. A virus can't grow or reproduce unless it is inside another organism's cells.

K. Eric Wommack, associate professor of plant and soil sciences at the University of Delaware is leading the Extreme 2008 virus team, with co-investigators Cary, and Shannon Williamson of the J. Craig Venter Institute.

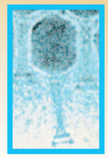
The scientists' main objective is to explore the abundant, but largely unknown, viruses within the hostile vent environment. They want to understand how viruses affect the composition and diversity of bacteria, which serve as vital links in the food chain, in addition to performing other major functions in ecosystem health.

Because viruses can significantly alter the biological characteristics of their microbial hosts, in some cases changing harmless bacteria into pathogens, it is possible that viruses at the vents are intimately involved in helping microbial life cope with the challenging conditions of the deep-sea ecosystem.

The viruses collected will be examined using high-throughput DNA sequencing technology and high-powered computing.

Data from the research will expand efforts to describe the full extent of genetic diversity on the planet, Wommack said, likely revealing new genes and protein groups and possibly entirely new *viral clades,* or families of viruses.

Kathy Atkinson, Univ. of Delaware



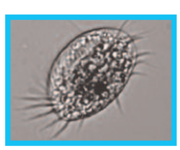
Dr. Eric Wommack, a virus researcher at the University of Delaware, holds pieces of a hydrothermal vent chimney. At right is a magnified bacteriophage — a virus that eats bacteria.

David Caron and his University of Southern California team are examining an overlooked link in the vent food chain—protozoa.

In other environments, these microscopic organisms act like tiny animals and hunt bacteria and other microbes for food. If Caron is correct, samples from the deep will show that protozoa feed on bacteria or the products of bacterial activity, and are, in turn, eaten by larger life forms.

"Protozoa are everywhere and they're in virtually every environment. They play this intermediate food web role in a number of these environments, and there's no reason to believe that they aren't doing the same thing in the vents. It simply hasn't been looked at to any degree," Caron said.

On a previous expedition, Caron's group placed glass slides and an artificial mini-reef around the vents in order to collect protozoa. On this trip, the researchers will retrieve and analyze the samples.



From left, Drs. Dave Caron and Karla Heidelberg and assistant Lauren Farrar from the University of Southern California assemble protist traps from sponges and glass slides in the ship's lab. The team observed ciliates similar to this shallow-water Euplotes species at the vents in 2007.

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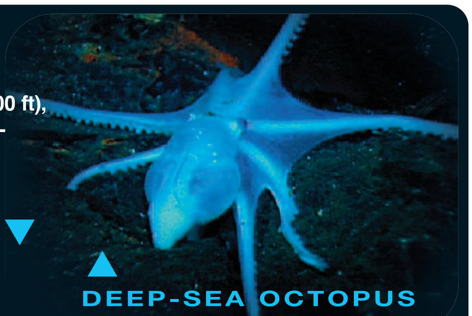

DEEP-SEA OCTOPUS

Hair-like projections ("cirri") line the webbed arms of this octopus. These projections may help it sense food in the darkness. This species is also equipped with paddle-like fins to help it swim.

Pompeii Worm Can "Take the Heat"

Below the Pompeii worm's feathery red gills is a structure that resembles a ball of yarn when not in use: the buccal feeding tube. The worm extends this tube to eat bacteria that grow in long filaments.

The current record holder for the most heat-tolerant organism on the planet is "Strain 121" collected at a hydrothermal vent site 200 miles off Puget Sound in 2003. It can reproduce at temperatures hotter than boiling — 250°F.

The heat-hardiest higher-order organism also hails from the vents. In 1998, University of Delaware marine biologist Craig Cary and his colleagues made international headlines when they determined that the Pompeii worm is able to survive a bath as hot as 176°F. The former record holder was the Sahara Desert ant, at 131° F.

The Pompeii worm is about 4 inches long with feathery red gills on its head. It is named for the Roman city of Pompeii, which was destroyed during an eruption of Mount Vesuvius in 79 A.D. The *Alvinella* in the worm's scientific name stems from the submersible *Alvin*. The worm lives in paper-like tube colonies attached to vent chimneys.

The worm displays a remarkably broad temperature gradient along its hairy body. By inserting a temperature probe called "the Mosquito," from the submersible *Alvin* into the worm's tube, Dr. Cary found that the worm's rear end sits in water as hot as 176° F, while its gill-covered head, which often pokes out of the worm's tube home, rests in much cooler water, only about 72° F.

A gray "fleece" of bacteria covers the worm's back. Scientists are working to access the genetic information tied up in the bacteria, which may reveal the genes involved in heat tolerance, metal detoxification, and cell-to-cell communication.

These findings are of interest to industry, as well as the scientific community, because they may yield enzymes capable of operating in hot, corrosive, high-pressure environments.