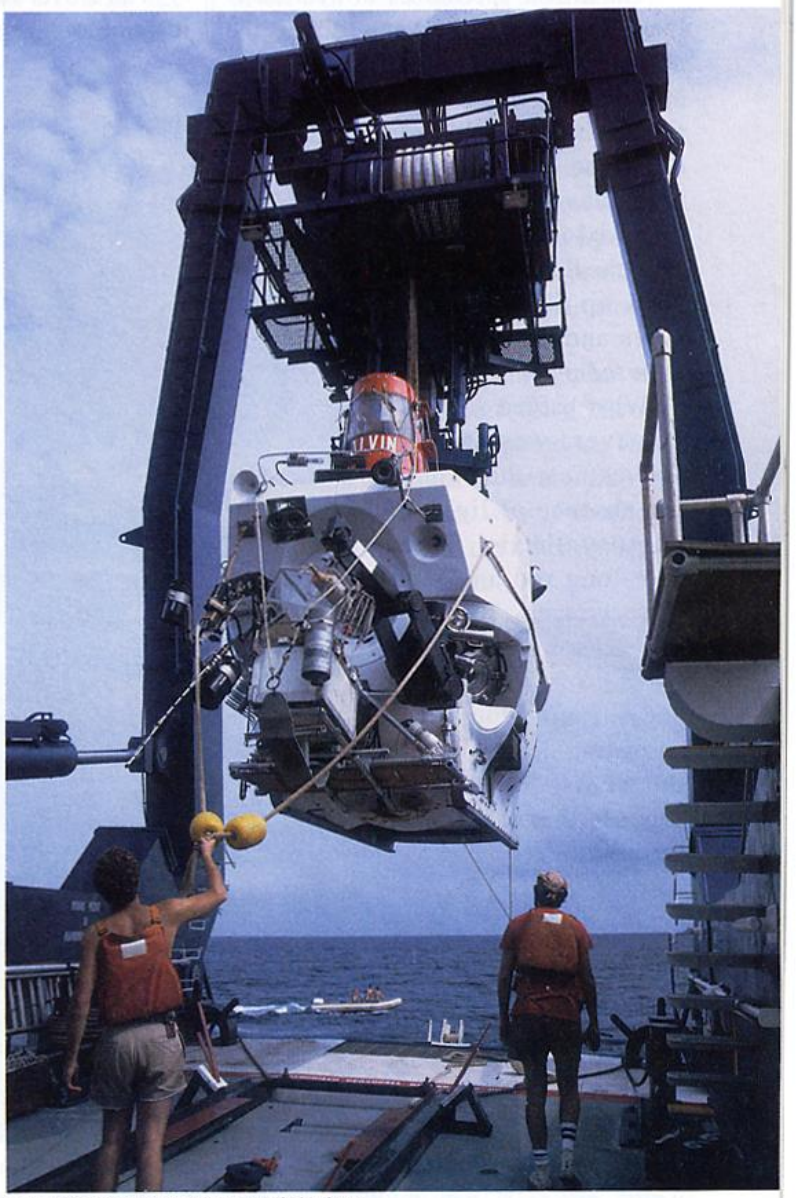
Discovering Science



Courtesy Woods Hole Oceanographic Institute

Alvin, the deep-sea submersible used to locate the Titanic, is propelled to the ocean floor by gravity

John Ost Woods Hole, Mass.

Two women—one just beginning her career in science, the other an accomplished researcher—are lured by the ocean's mysteries. For the scientist, each dive and discovery renews her passion for science. For the young student, her first voyage heightens the flame.

Off the New Jersey coast, marine ecologist Cindy Van Dover and her colleagues discovered that sewage sludge dumped into the deep waters between 1986 and 1992 had reached the ocean floor and entered the food chain. According to an article published last month in *Nature*, Van Dover, a visiting researcher at Woods Hole in Massachusetts, found traces of the sludge, which contains PCB and other carcinogenic agents, in the tissue of sea urchins and sea cucumbers which feed on the sediment two miles below the surface. Scientists had previously believed that the sludge would dilute in the ocean waters before reaching bottom.

Last May, Naomi Darling, 20, and her high school biology teacher, Peter Amati, 48, embarked on a U.S.-Russian scientific expedition aboard the ice cutter U.S.S. Nathaniel E. Palmer. The voyage into the largely unexplored region was the first expedition by scientists since 1917, when a British research vessel broke apart in the ice cover.

Darling and four other young scholars from across the country were selected for the Antarctica trip through the National Science Foundation's Young Scholars Program, which offers 6,000 outstanding high school science students throughout the United States the opportunity to work with scientists during the summer months. The foundation asks each applicant to identify the teacher who was "most responsible for influencing his or her interest in science." Darling chose Amati, who was invited to join the voyage.

Few people will ever see the pristine beauty of Antarctica, but nature's aesthetic beauty was not the only reason Darling and Van Dover were drawn to science. They both possess an inquisitive nature—"have a need to know," according to Van Dover—which they must satisfy. Both found role models and colleagues who share their enthusiasm for science, who make them think, work and discover. By comparing their experiences, we may begin to understand how they discovered science.

Alvin

"I want people to know that the sea floor is such a magical and mysterious

place," explains Van Dover. "Everything is up for grabs. From the start of the descent until you return to the ship, you know you can make a major discovery whether you actually find a new species or piece together some major new relationship between the marine biology and geology in the region."

Van Dover specializes in hydrothermal vent research. The vents, discovered only 15 years ago, are hot springs which spout from fissures in the Earth's crust along the ocean floor. At temperatures above 350°C, dissolved metals and gases from the Earth's hot mantle spew up through the fissures and enrich the sea floor sediment.

What baffled scientists, however, was that life thrives near the vents in the absence of light and photosynthesis. Three-foot-long red and white tube worms, foot-long white clams, mussels and a variety of smaller crabs and shrimp populate the spreading centers around the vents. Similar to a process that takes place around terrestrial hot springs, sulphur bacteria draws sustenance from the vents by oxidizing hydrogen-sulfide. The bacteria, in turn, become the basis in the food chain, nourishing the animals living by the vents.

Van Dover describes the animals living around the vents as delightfully weird, different than anything she has ever seen. She has studied some of the strange anomalies that occur along the fissures. For example, she discovered that the shrimp near the vents have eyes. "I wanted to know," she recalls, "are these eyes on the shrimp? If so, what are the shrimp looking at and how are the eyes related to the unique environment they live in?"

A generalist, Van Dover asks probing questions and then collaborates with other specialists to find the answers. Scientists discovered that the vents emit a glow. One hypothesis is that the glow allows the shrimp to see in the dark. "I'm not a specialist in photosynthesis, light or microbiology. If I don't ask these questions, maybe they won't get answered. I needed to know if it matters that there is light on the sea floor."

Van Dover is not only driven by her insatiable curiosity. The discovery of hydrothermal vents offers a new frontier. She says that scientists have explored less than one percent of the ocean vents. She points to a map on the door. Scientists have only explored the spawning centers off the west coast of North America, the Philippines and the mid-Atlantic ridge. "But, we've never been to the Indian Ocean," she says. Her voice becomes excited, her eyes widen. "We have no idea what exotic life has emerged there. If you want to make a discovery today, I would send you to a very precise longitude and latitude, which the submersible has not explored. And you will make a discovery that hits the front pages."

Courtesy Woods Hole Oceanographic Institution

Marine ecologist Cindy Van Dover, a visiting researcher at Woods Hole in Massachusetts, who piloted Alvin

The ocean's beauty and strangeness have a powerful hold on her. In 1990, Van Dover became a pilot of Alvin, the deep-sea submersible used to locate the Titanic. She describes a descent:

The cramped cabin or sphere has a warm, burnished look. There's room for a pilot and two scientists on board. The orange lights allow your eyes to adjust to a dim environment. Soft lights save power for the scientific equipment, video systems, hydraulic systems and thrusters, which maneuver the craft along the bottom. Gravity propels Alvin to the ocean floor.

"Yet, there is no sense of motion," says Van Dover. "You don't feel like you're dropping 30 meters per minute, and you don't sense the fall unless you look out the port. Streams of light streak by the window as the animals light up when disturbed by the passing submersible."

Monitors and gauges fill the high-tech sub, but to drive it safely, the pilot uses all of her senses. "You can hear the oxygen hissing and CO_2 scrubber working," says Van Dover. "But, sometimes, the scientist nudges a knob and the hissing stops. I react to the noise before any monitor or bell reports the problem."

Each dive elicits a visceral response, equal parts fear and awe. Once Van Dover settled Alvin on the ocean floor and shut down its systems, she could feel the darkness, sense the ocean's weight overhead. As she stared out the viewport past the green external lights that illuminate the gloom, she knew that life forms abound in the darkness that no scientist has ever seen on the surface. Their discovery awaits Van Dover and her fellow explorers.

Antarctica

When Darling and Amati set sail for Antarctica aboard the U.S.S. Nathaniel

Palmer in Punta Arenas, Chile, neither had any expectations of making a scientific discovery. Both, however, were deeply affected by the scientists they met and the region they explored during their journey.

The expedition had two goals, according to Steven Ackley of the Army's Cold Region Engineering Labs at Dartmouth College: recover the scientific team on the ice floe and perform sea ice and oceanographic experiments en route. The students received their training the previous summer at their respective laboratories. The teachers received their training on the ice.

"Each of us had four-hour ice watches on the bridge," recalls Darling. The observers used sonar to spot and measure icebergs, which the U.S.S. Palmer left in its wake as it rocked and bored through the ice sheet. Frequently, the ship stopped to allow scientists to collect the first detailed data about the sea ice cover and ocean water in the Weddell Sea. First, a crane would gently lift an hourglass-shaped device called a Rosette into the ocean to collect water samples for concentration-temperature-depth analysis. The samples, collected by the students, measured the water salinity and temperature at various depths.

Another crane lifts a sled holding the physical ice survey team and their equipment over the side of the ship and onto the ice floe. Darling, Amati, California Young Scholar Brett Castillo and his science teacher, John Cavenaugh, are part of the physical ice survey team.

The four scholars stretch two 100-meterlines in the shape of "T" across the floe. Amati and Castillo use meter sticks to measure snow-depths along one T-line while Darling and Cavenaugh use levels and lasers to map the topology—the change in the height of the ice—along the other T-line. The data they collected will help scientists more accurately interpret satellite photos of Antarctica's ice cover.

Most of the ice samples were collected in the dark because there were only six hours of twilight from dawn to dusk during the winter season. One night, Amati and Castillo had to reposition their T-line when Amati came upon open water less than 75 meters from the ship. Amati's flashlight helped him record snow-depth readings in his notebook and occasionally kept him from slipping off the edge.

"It was hard writing in a notebook while wearing gloves," Amati says. It was difficult working on the ice when temperatures hovered between minus 20 and minus 30 degree centigrade and the snow cover measured waist deep. Beards and eyebrows became ice-cached, labored steps hastened fatigue.

Despite the hardships, young and old scholars were profoundly affected by the research experience. Darling says before the trip she had planned to major in architecture, but because she was intensely moved by her visit to Antarctica she now plans to find a way to combine her talents in civil engineering with her interest in the polar region.

For California high school science teacher Cavenaugh, the trip reaffirmed his vocation. "The most important benefit I've received from the trip is a renewed appreciation of doing science," says Cavenaugh. "After 16 years in the classroom, you lose sight of why you want to teach science. After working on this project, I understand better now the value of what I teach."

Just as Van Dover was captivated by the ocean floor, scientists, students and teachers were all moved by their journey to Antarctica—its power, raw beauty and delicate environment. But, none more than Amati will carry the experience of the voyage and the exhilaration of the place back into his classroom.

On the final work day disassembling the ice camp, Amati was one of the last workers to leave the floe. A crescent moon had risen. As twilight quickly turned to darkness, Amati decided, in his words, "to seize the moment." His video camera slowly surveyed the abandoned ice floe, which just hours before had bustled with human activity, and he whispered:

"This place is so pristine, so wild. People do not live here for a reason. I don't think they are supposed to. This is the land of penguins, seals, kril and algae and that's the way it should be left." For Amati and the other explorers, science is their passion. ■