NATURE|Vol 436|18 August 2005

M. TEMCHINE

The life aquatic

Cindy Lee Van Dover likes nothing better than to be on the ocean floor. **Emma Marris** meets the unconventional biologist who has devoted her life to studying the exotic ecosystems of the deep.

Some 2,300 metres under the sea, Richard Lutz was beginning to wonder whether he should worry. The deep-sea submersible *Alvin* in which he was riding had come to a shuddering halt. Next to him, the pilot stared intently out of the windows.

"We can't move," said Cindy Lee Van Dover, at the controls of a truck-sized craft stuck at the bottom of the ocean. "We are just going to sit here and think."

As Lutz, a marine biologist at Rutgers University, tells it, Van Dover's calm approach got them out of a potentially deadly situation that day in 1991. He was readying his handheld tape recorder to capture his last words, but after checking and rechecking *Alvin*'s controls, Van Dover concluded that the sub's front shield had probably scooped up hundreds of kilograms of mud. Hours later, she had managed to ditch enough weight to allow the sub to ascend safely to the surface.

Such deliberate cool in the face of danger is practically a requirement for deep-sea pilots. But it has served Van Dover equally well in her unconventional academic career studying deep-sea ecosystems. In a small field crowded with powerful personalities, she has sometimes irritated the establishment by not following a traditional path. Yet her trademark intensity — a quality she readily describes as "stubbornness" — has often helped her to ride out the storms.

Van Dover has racked up hundreds of hours in submersibles on the sea floor, including a period in the early 1990s when she spent more time on the ocean bottom than any other scientist. That experience, combined with her natural curiosity for all things oceanic, set the stage for her to make leaps of reasoning that might seem counterintuitive to her colleagues, but which sometimes result in startling new insights into vent creatures.

These creatures thrive in a peculiar environment that, at first glance, seems hostile to life. They live along cracks in the sea floor where water, superheated by volcanic activity, gushes out of towering chimneys. These hydrothermal vents are home to communities of fantastic organisms ranging from mats of bacteria living off sulphides to long, pale, red-tipped tubeworms that sway in the current.

All at sea

An invertebrate zoologist at heart, Van Dover finds this diversity inspiring. She is excited by, as she puts it, "all the weird ways you can be alive". Her explorations have taken her from the relatively well characterized vents on the mid-Atlantic ridge, to the rarely visited depths of the Indian Ocean and the seas around Fiji and Easter Island.

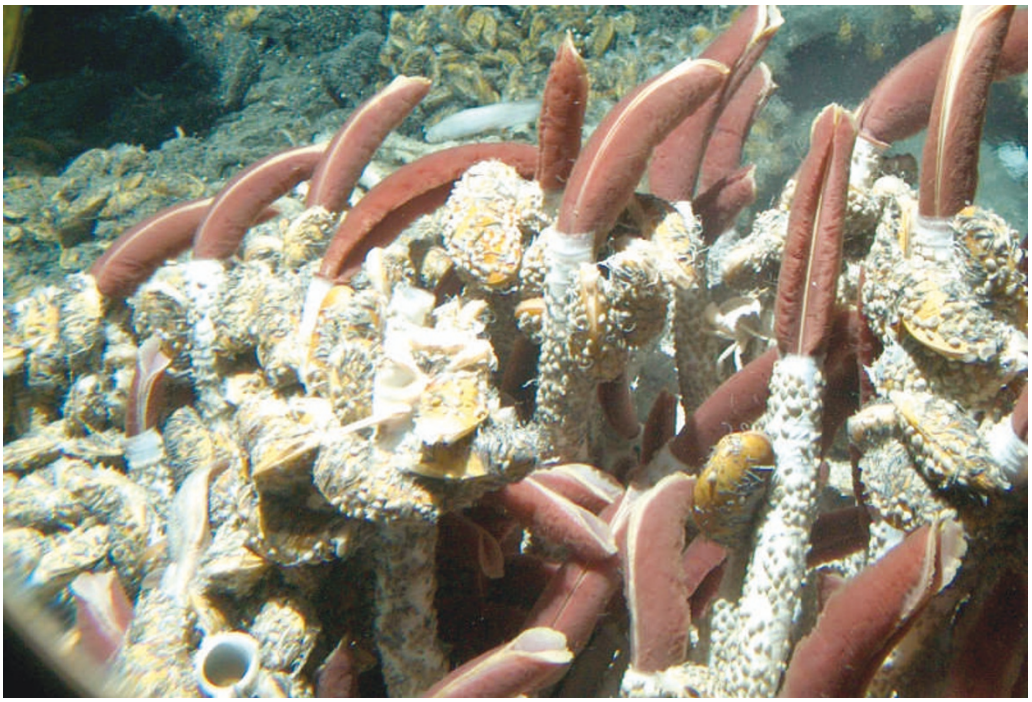
Yet despite all the time she has spent on — and in — the water, Van Dover still gets seasick on the first few days of a voyage. Not that she lets that put her off. "I love the romance of going to sea," she says with a smile."I love the phrase, 'I'm going to sea'."

This life-long passion arose when she was an undergraduate studying zoology at Rutgers. Fascinated by the bizarre biology of deep-sea creatures, she applied to the joint graduate programme in oceanography run by the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution (WHOI). When she didn't get in, she spent six years working as an itinerant lab technician and sharpening her mathematical skills until she was accepted on to the programme.

At the WHOI, Van Dover was soon making waves with a seemingly outlandish hypothesis: she believed that there may be a light source in the inky depths by the vents. Van Dover had been puzzling over a species of eyeless rift shrimp called *Rimicaris exoculata*, which had been recovered from the Atlantic. Watching videos of the shrimps at the vents, she saw two reflective patches running down their backs. But when she examined the specimens brought to the surface, she found that the preservation process had rendered the blotches invisible.

The patches, which had never been noticed before, looked like some kind of sensor. Van Dover guessed that they might be highly modified eyes for sensing light. But why would a shrimp in the lightless depths need eyes?

To find out if there was any light to respond to, Van Dover asked researchers going on a vent-mapping expedition to use a sensitive camera, designed for astronomical imaging, to take pic-



VAN DOVER LAB

Regular trips piloting *Alvin* (right) have allowed Cindy Lee Van Dover (left) to study the rich ecosystems found at deep-sea vents.

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tures of the seemingly pitch-black chimneys. Sure enough, the passengers aboard *Alvin* sent a brief message to the surface: "Vents glow."

Van Dover suggested that the shrimps use their 'eyes' to keep them close enough to the vents to feed on bacteria, but far enough away to prevent them from being cooked by the ferocious heat[1]. Other biologists gradually accepted the idea, convinced by her marshalling of the evidence. "I learned a lot from seeing those eyes and learning how to prove that they are eyes," she says. "You can't do science by assertion."

Driving force

The shrimp discovery propelled Van Dover into the media spotlight, although some within the small community of vent biologists were less than thrilled by the amount of attention she attracted. "I had a mentor who was not happy," she says. Not for the last time, she found herself at odds with some senior researchers in her field. And her next move took her colleagues even more by surprise.

In 1989, with her PhD fresh in her hand, Van Dover decided that the best way to get to the sea floor regularly would be to become a pilot for *Alvin*. Owned by the US Navy and run by the WHOI, the submersible has made more than 4,000 dives since it was commissioned in 1964, including a visit to the wreck of the *Titanic*.

To learn the sub's inner workings, she began memorizing blueprints and perfecting electrical repairs. It was not an easy job. Some of *Alvin*'s other pilots did not welcome her into their exclusively male club. Many of her academic colleagues thought she was throwing away a promising career in research. But Van Dover persevered, determined to spend as much time as she could at the bottom of the sea.

After being certified as *Alvin*'s first and so far only female pilot, Van Dover spent three years nearly constantly at sea. She dived as often as every other day, spending her hours out of the water monitoring other dives from the boat or repairing the sub. Although the hours were long and the work tough, she says she got an unparalleled education: "I was essentially a postdoc to everybody who came aboard that ship."

Thanks in part to her pilot experience, Van Dover has visited the ocean floor more than 100 times, 48 as pilot-in-command. Although she never gets bored of the destination, the lengthy descents have become tiresome. "I wish I could just snap my fingers and be at the bottom," she says. These days, she often gives up her seat in the sub to a student.

Van Dover retired as a pilot in 1991, and now serves on a committee overseeing the building of a new sub to replace *Alvin*. But she remains fond of the vehicle she once knew so intimately. "She's a sweetheart," Van Dover says. "I still go kick her tyres when I'm anywhere near her."

Conquering *Alvin* took an intensity of purpose that characterizes Van Dover's career. "She is just so focused," says Robert Vrijenhoek, a deep-sea biologist at the Monterey Bay Aquarium Research Institute in Moss Landing, California, who has sailed with Van Dover many times. "She sets her mind on doing something and you collaborate with her, and by George it gets done."

After her stint as *Alvin* pilot, Van Dover wrote a popular-science book about the deep sea called *The Octopus's Garden*. She found that writing had a therapeutic effect, allowing her to work through the stresses of pilot training and of trying to scramble back onto the academic track. "It was catharsis," she says.

Making a splash

Many of her peers see her first as an ambassador of vent science. "A very eloquent writer who has done some great communicating to the general public," is how Charles Fisher, a vent biologist at Pennsylvania State University, describes her. "Her research is easy to explain and sexy, and there is nothing wrong with that."

Van Dover returned to academia in 1992, first at the WHOI, and later at Duke University in Durham, North Carolina, and the University of Alaska in Fairbanks. Now she is based at the College of William and Mary in Williamsburg, Virginia. When she isn't teaching, she is back at sea taking long cruises to the vents.

She admits that she works on whatever interests her most, and she rounds up whomever she needs to get the job done. "I've really been an opportunist," she says. "When I see a good story, I go for it."

Her most recent finding was published just this summer, and in some ways it picks up where she left off as a graduate student. While hunting for microscopic life around vents at the East Pacific Rise, Van Dover and her team found photosynthetic bacteria living in the black depths[2]. If further research shows that the creatures live by the vents all the time, and don't just visit from brighter areas, then these bacteria would be the first organisms ever found to photosynthesize without sunlight. Astrobiologists are thrilled about this finding, envisioning distant dark planets teeming with photosynthetic life.

As for the source of the light at the vents, that remains a mystery. It can't be explained by thermal radiation from the vents alone, as too much of the light is in the visible part of the spectrum. Possible sources include sonoluminescence, in which imploding bubbles emit a brief flash of light, or sulphide oxidation by bacteria.

For now, Van Dover says she will leave that question for other specialists. She has moved on to study shellfish diseases — in particular a virulent condition that turns the flesh of giant vent mussels black. The myriad life-forms by the vents are likely to provide her career with plenty more twists and turns, but whichever path she takes it will lead only one way in the end: straight to the bottom. ■

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1. Van Dover, C. L., Szuts, E. Z., Chamberlain, S. C. & Cann, J. R. *Nature* **337,** 458–460 (1989).
2. Beatty, J. T. *et al. Proc. Natl Acad. Sci. USA* **102,** 9306–9310 (2005).