they heard a small predator alarm call. More birds got involved, and they approached closer to the speaker and kept up the mobbing for a longer period of time in response to a small predator alarm call than in response to a large predator call.

"The work … shows us that even very common species that we may take for granted have evolved to have very elaborate and exacting systems of communication," says James Hare, who studies ground squirrel alarm calls at the University of Manitoba in Winnipeg, Canada. Historically, researchers have thought alarm calls signaled information about either the type of predator or the degree of threat, says Daniel Blumstein of the University of California, Los Angeles, who studies marmot communication. The new study helps break down this "false dichotomy" by showing that chickadee calls tell of both, Blumstein says.

It also adds to evidence that complex communication arises in the animal kingdom wherever there's a need. "These results should begin to redress the still-pervasive bias that sophisticated signaling can only arise amongst our primate kin," says Christopher Evans, an animal behavior researcher at Macquaire University in Sydney, Australia.

–GREG MILLER

MARINE BIOLOGY

Microbe May Push Photosynthesis Into Deep Water

The announcement this week of a bacterium that appears to derive energy from light despite living in the inky depths of an ocean threatens to overthrow the dogma that photosynthesis depends on the sun. The microbe may also offer clues about life on early Earth—or on other planets.

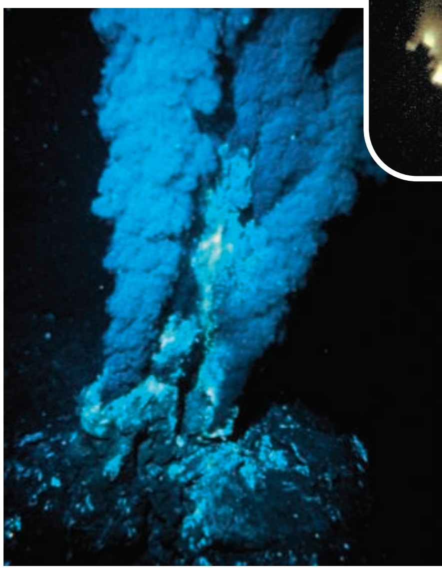
Not everyone is convinced yet that the bacterium, discovered in 2003, is a natural resident of the deep sea. But if true, it could be a crucial piece of the puzzle of how photosynthesis evolved. "The results break new ground and are indeed surprising," says Bob Buchanan, a microbiologist at the University of California, Berkeley.

Since their discovery in 1977, deep-sea hydrothermal vents have offered up a surprising menagerie, including 2-meter tubeworms and eyeless crabs, that thrives near the caustic 350°C effluent that burps out. In the late 1980s, Cindy Van Dover, a marine biologist at the College of William and Mary in Williamsburg, Virginia, found a vent-dwelling eyeless shrimp with a light-sensitive patch on its back. Because of the superheated water, vents glow with infrared radiation, but the shrimp's light-gathering pigments seemed geared for much higher frequencies of light.

The explanation came in 1996 when a team led by Alan Chave, an oceanographer at the Woods Hole Oceanographic Institution (WHOI) in Massachusetts, proved that the water around the vents produces additional light. The extra glow is too weak to be detected by human eyes but has a frequency well into the visible spectrum. Researchers still don't agree on the mechanism by which the vents make this deep-sea illumination, but its discovery prompted another question: Does the phenomenon sustain any life?

Bacteria 80 meters below the surface of the Black Sea eke out a living from similarly dim light. These so-called green sulfur bacteria have the most efficient photosynthesis known, sponging up every stray photon that penetrates the water column. So, in an effort partly funded by NASA's Astrobiology Institute, Van Dover teamed up with Thomas Beatty, a microbiologist at the University of British Columbia in Vancouver, Canada, Robert Blankenship, a biochemist at Arizona State University in Tempe, and others to see if similar bacteria were living off the vent light. In 2003, they descended 2.4 kilometers in the WHOI research submarine *Alvin* to retrieve samples from a pair of vents that lie along the volcanically active Pacific Ridge. Back on the ship, they added the samples to various nutrient media to see what might grow.

Defying the long odds, the team now describes the first example of an organism that seems to live off a light source other than the sun. The bacterium—known as GSB1 for the time being—requires light, sulfur, and CO_2 to grow, the team reports online 28 June in the *Proceedings of the National Academy of Sciences*.



A light at home. Deep-sea hydrothermal vents such as this one emit a mysterious glow (*inset*) that may support photosynthetic bacteria.

CREDITS: NOAA; (INSET) DELANEY, SMITH, VAN DOVER, CANN & FOSTER

To help culture the exotic bacterium, the team recruited Jörg Overmann, a microbiologist at the University of Munich, Germany, and discoverer of the Black Sea green sulfur bacteria. Although oxygen is thought to be toxic to all green sulfur bacteria, they unexpectedly found that GSB1 seems unbothered by it. The team proposes that the turbulent vent environment makes exposure to oxygen-rich water unavoidable for the bacterium, requiring it to adapt.

The big question, according to Euan Nisbet, an Archaean geologist at Royal Holloway, University of London, U.K., is whether GSB1 is a missing link in the evolution of photosynthesis. "Of what use is half of photosynthesis?" he asks, referring to Darwin's puzzle of how evolutionary change through baby steps can create complex structures such as eyes that require multiple parts to function. Nisbet argues that a deep-sea microbe on the early anoxic Earth could have developed a primitive method for detecting the direction of the vents through infrared radiation, setting the stage for a later vent microbe to develop an inefficient version of photosynthesis as a supplement to its main food. Then, "one of these preadapted cells might have drifted into rather shallower water, well away from the hydrothermal vents, to survive by using sunlight just as modern Black Sea bacteria do. And after that, the sky's the limit," Nisbet says.

Another open question, says Buchanan, is whether GSB1 "is a long-term resident in the area surrounding the vent or whether it … spends much of its life elsewhere." To quash such doubts, Beatty is planning a mission to isolate photosynthesizers from other vents.

And what about the vent glow that may power such microbes? Its source remains "quite a speculative issue," says Chave, with explanations ranging from chemical reactions in the vent effluent to sonoluminescence, the flash produced by imploding bubbles. Little work has been done on the phenomenon since its discovery, "both because defining the mechanism would require some difficult measurements … and because interest has waned," says Chave. He hopes, however, that GSB1's discovery "will regalvanize the interest."

–JOHN BOHANNON

John Bohannon is a science writer based in Berlin.