

The silver lining in the dark clouds gathering over nuclear science is a positive reaction from Congress so far this year. The House of Representatives has approved a 2006 spending bill that brings much of DOE's nuclear science budget close to current levels (*Science*, 27 May, p. 1241). Last week, a Senate panel added back even more, according to Dennis Kovar, DOE's associate director in charge of nuclear physics. At those funding levels—appropriately adjusted for inflation—Tribble says that DOE need not shut down a facility, although he warns that run times at the facilities

would still suffer. And level funding won't help a major new experiment being planned. The Rare Isotope Accelerator, says the panel, "can proceed only with a significant influx of new money."

An anemic budget would have ramifications for the next generation of U.S. nuclear scientists, too, say physicists. "If you close either [RHIC or JLab] at this time," says David Armstrong, a nuclear physicist at the College of William and Mary in Williamsburg, Virginia, "I in good conscience could not advise my students to pursue a career in nuclear science."
—CHARLES SEIFE

BEHAVIOR

Bird Alarm Calls Size Up Predators

A great horned owl may look like a more fearsome predator than a puny pygmy owl, but for small, agile birds such as chickadees, the maneuverable pygmy owl is probably the more lethal threat. Now, on page 1934, researchers report that black-capped chickadees have a sophisticated system of alarm calls that conveys information about the size of potential predators. The calls appear to help the chickadees mount a coordinated defense that is calibrated to the predatory threat.

Chickadees are social birds, and they gang up to "mob" predators and drive them away. "They dive-bomb the predator and make a lot of noise," says study author Christopher Templeton, currently a Ph.D. student at the University of Washington, Seattle. While Templeton was working at the University of Montana, he and his adviser, behavioral ecologist Erick Greene, noticed that chickadees responded differently to the sight of different predators. "They really harassed some predators and just ignored others," Templeton says.

The researchers suspected that the chickadees' calls might organize their defense. The birds make two different alarm calls: a soft, high-pitched "seet" call and the louder namesake "chick-a-dee" call. A previous study found that the "seet" call indicates the presence of predators flying overhead. The "chick-a-dee" call is used in a variety of situations, from signaling the presence of sta-

tionary predators to identifying flockmates.

The researchers recorded more than 5000 calls that birds made when various predators—including owls, hawks, and falcons from a local wildlife rehabilitation center—were placed in their woody outdoor enclosure. The recordings showed that, among other changes, the birds made more "chick-a-dee" calls and incorporated more "dee" syllables into each call when they saw



On guard. Black-capped chickadees vary their alarm calls according to the size of the predator that has been spotted.

a small raptor with a short wingspan. A 70-gram pygmy owl, for instance, might elicit four "dees" at the end of a call, whereas a 1.4-kilogram great horned owl might elicit only two. But not all small birds elicited more "dees": A harmless quail elicited fewer than two "dees" per call, on average. The researchers hypothesize that more "dees" mean more danger.

Next, the team played back recorded alarm calls through a hidden speaker and watched the chickadees' reaction. The birds mounted a more vigorous mobbing response when ▶

Science Education Review

The board that oversees the National Science Foundation is hoping that a new study of U.S. math and science education will help make the case for a bigger NSF education budget. The study, commissioned by the National Science Board, comes as the White House has proposed shifting precollege science and math instruction funds from NSF to the Department of Education. But many education researchers say NSF has a better track record on science-based reforms.

Although the study's exact focus is still unclear, board president Warren Washington says he'll be looking for outside education experts who have the political savvy to sell the report's conclusions.

—JEFFREY MERVIS

Auger Team Picks Colorado

A 15-nation consortium that studies ultrahigh-energy cosmic rays expects to announce its first results next week from the half-completed Pierre Auger Observatory in western Argentina. And this month, the physicists selected a site in Colorado where they hope to build its northern twin.

Each \$50 million observatory would consist of 1600 water tanks and 24 ultraviolet telescopes. A 3000-square-kilometer track on the high plains of southeastern Colorado won out over a site in western Utah because of easier access to private lands and better potential for expansion. The researchers hope agencies in their respective countries will provide enough money to complete the northern array by 2012.

—ROBERT IRION

Kennewick Man, Finally

Next month, after 9 years of litigation between scientists and the federal government, a dozen researchers will begin preliminary studies on the 9400-year-old remains of Kennewick Man. Access to the bones, now at the Burke Museum in Seattle, Washington, was arranged this spring, says Alan Schneider of Portland, Oregon, the scientists' lawyer.

The first round of study will examine what happened to the bones, found along the Columbia River in 1996, after the man's death. Schneider says further studies could be threatened by a proposed revision of the Native American Graves Protection and Repatriation Act that would broaden the definition of "native American." The bill (S. 536), he says, would allow tribes to block access to any such remains even if no connection with an existing tribe can be established.

—CONSTANCE HOLDEN

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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 Macquarie 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

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

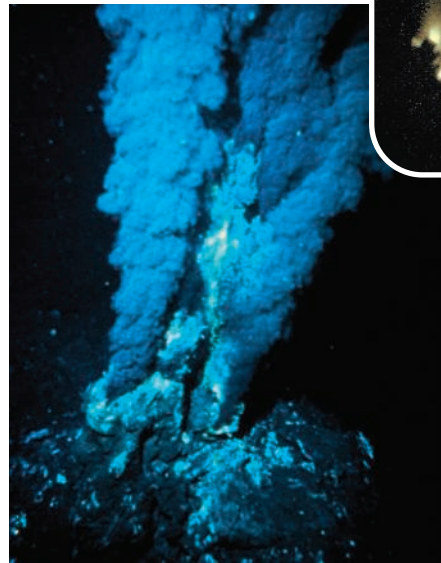
version of photosynthesis as a supplement to its main food. Then, “one of these preadapted cells might have drifted into rather shallower water, well away from the hydrothermal vents, to survive by using sunlight just as modern Black Sea bacteria do. And after that, the sky’s the limit,” Nisbet says.

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.



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

bacterium—known as GSB1 for the time being—requires light, sulfur, and CO₂ to grow, the team reports online 28 June in the *Proceedings of the National Academy of Sciences*.

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