MEETING AAAS

Findings From Undersea to Outer Space

WASHINGTON, D.C.—More than 6000 scientists, policy-makers, and journalists gathered here 17 to 22 February for the American Association for the Advancement of Science's annual meeting. A crowded agenda included everything from discussions of ethical issues to announcements of new results from a wide range of disciplines.*

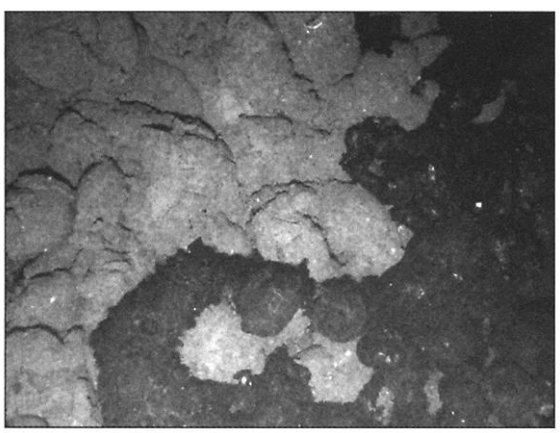
Going Deep for an Unearthly Microbe

Even though the late Carl Sagan had his eyes on deep space, his soon-to-be namesake comes from a different deep place: beneath the sea floor. Microbiologist John Baross and his team at the University of Washington, Seattle, have recovered a cunning new microbe from the scalding fluid ejected during a submarine eruption. The bug, which Baross hopes to name *Saganella*, appears to be as multitalented as the famous astronomer, author, and TV star.

Typical microbes live within a relatively narrow temperature range. Not the versatile *Saganella*, which thrives in extreme heat (50° to 90°C) and can survive relatively frigid room temperature as well, Baross reported. "The fact that proteins can operate across that range of temperatures is amazing," says Peter Fields of Stanford University in Palo Alto, California, who studies protein function in Antarctic fish. He believes that *Saganella* or another one of the rare subsurface organisms Baross has found "might be a record breaker."

The hunt for these "extremophiles"—microbes that often live in extreme environments without the light, oxygen, or other ingredients supposedly essential for life—is difficult. For the past several years, Baross and his team have chased down new seafloor eruptions, trying to reach the caldrons in time to collect samples from the spewing fluids. *Saganella*, recovered from a site off the Pacific Northwest coast, was identified when graduate student Melanie Summit grew organisms from this sample under various temperature regimes in the lab. Genetic analyses indicate that *Saganella* is not a bacterium but an unusual member of an ancient microbial group called the archaea. It has a metabolism unlike any Baross has seen before; he is not sure what its energy source is in the wild.

Saganella's existence has heartened those pursuing Sagan's goal of finding life in outer space. The microbe is "absolutely remarkable" and is a potential model for extraterrestrial life, says Kenneth Nealson, an astrobiologist at NASA's Jet Propulsion Laboratory in Pasadena, California. "If an organism can do this on Earth," he adds, "there's no telling what it could be doing someplace else." **–ELIZABETH PENNISI**



Home turf. An undersea eruption site in the Pacific is fertile ground for a hardy newly discovered microbe.

Rings Reveal a Supernova's Story

A rainbow of rings, invisible to the human eye, has revealed the inner workings of a nearby supernova. New spectra taken by the Chandra x-ray telescope tell a surprisingly clear story of the remnants of a stellar cataclysm, researchers at the meeting said.

Astronomers were ecstatic when the Chandra X-ray Observatory lifted off last July, providing them with the most sensitive x-ray eye ever launched (*Science*, 30 July 1999, p. 652). Not only does Chandra provide scientists with pictures of hot objects, but its spectroscope also yields spectra that reveal the energies of x-rays spewing from all kinds of targets. The satellite is able to place one of two diffraction gratings—one for lower energies and another for higher—in the path of incoming radiation. This turns an image into an x-ray rainbow, similar to how a prism splits visible light.

Normally, astronomers point the instrument at distant (and thus small) sources, so they can create a spectrum for an entire object, says astrophysicist Kathryn Flanagan of the Massachusetts Institute of Technology (MIT) in Cambridge. But such readings often provide little detail, because the spectroscope blends the incoming x-rays from the entire source together, producing a homogenized image. To get around this problem, Flanagan and her team last year decided to look at a large supernova remnant located a mere 200,000 light-years away in the Small Magellanic Cloud. The glowing ring, named E0102-72, takes up more than 40 arc seconds in the sky, an enormous size compared to usual targets.

Still, the astronomers weren't sure they would be able to interpret the spectra produced by such a giant. Whereas distant point sources produce tiny spectral dots, larger objects are seen as a series of rings, potentially creating a horribly fuzzy picture. But "as soon as we saw what the image looked like, we knew we were in luck," says Flanagan. "It was sharp."

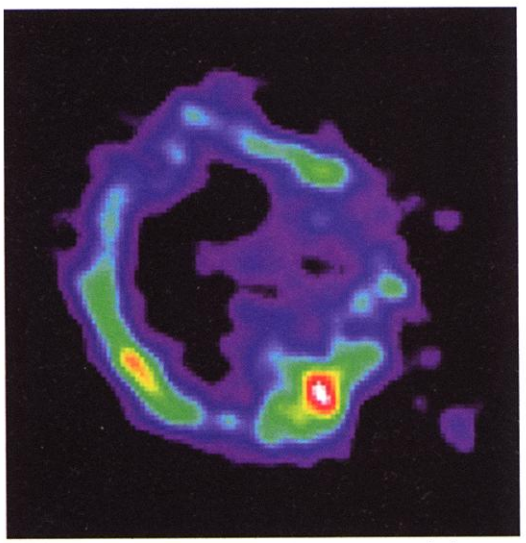
The images were so clear that Flanagan was able to analyze the supernova remnant's structure and even detect ripples left behind by shock waves spreading through surrounding gas clouds. When such powerful shock waves hit, they rearrange atomic structures, stripping electrons from gas atoms. In this case, the spectra indicated a small gas ring near the supernova's center that was rich in the neon and oxygen ions typical of recently shocked regions. It was nestled within a larger ring flush with related, more highly charged ions that form in the wake of the wave—pointing to an inward-moving shock wave. "Your eye is able to follow the progress of the shock," says Flanagan. As an added bonus, the Doppler effect changes the wavelengths of light emanating from moving gas clouds, which made it possible for Flanagan's team to figure out how fast different regions of the ring are traveling.

The findings are "quite intriguing," says Wallace Tucker, an x-ray astrophysicist at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. "I've always felt that the spectrograph is the dark horse of Chandra to produce some important results, and this is proving to be true."

The MIT group plans to look at a more complicated supernova remnant in the Large Magellanic Cloud, and sometime next year

CREDIT: NOAA/PMEL

* See *Science*, 25 February, p. 1374, for coverage of an early session at which the nearly complete genetic sequence of the fruit fly was announced.



Dead ringer. Ionized oxygen ring helps astronomers understand the death of the star at its center.

they will point the x-ray spectrograph at a large remnant in our own galaxy: Cassiopeia A. Says Flanagan: "I wake up in a cold sweat thinking of what that's going to look like."

–CHARLES SEIFE

Power From Pond Scum

Suppose you could fuel your car by dipping a hose into your garden pond. That's roughly the idea behind a 25-year-old dream of using solar-powered microbes to convert water into oxygen and hydrogen, the cleanest fuel there is. At the meeting, scientists described two new methods for coaxing algae into churning out hydrogen.

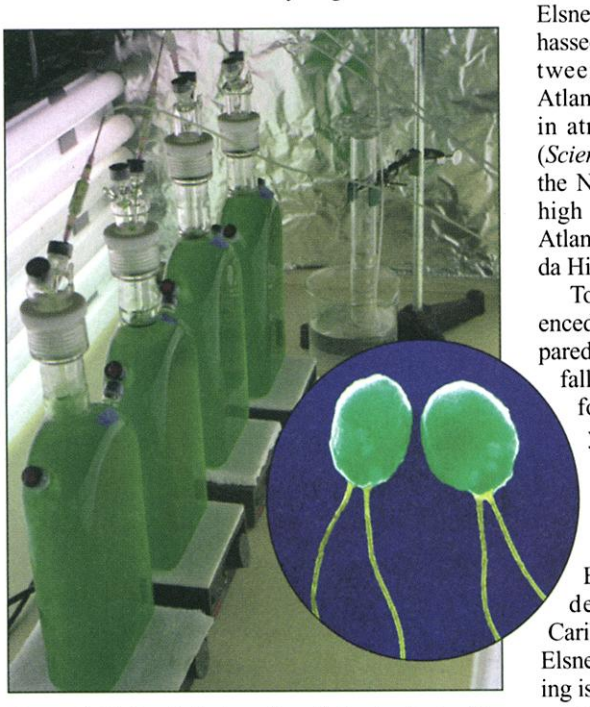
As the only product of burning hydrogen is water, hydrogen-fueled vehicles would produce no pollution, making the gas—which can be produced renewably—an attractive alternative to nonrenewable oil. But although energy researchers have tinkered with microbes that produce hydrogen since the 1973 oil embargo, they've never achieved very high yields. Green algae, for instance, could potentially produce plenty of hydrogen, because they can directly split water into hydrogen and oxygen, in a process that's the biological equivalent of electrolysis. But there's a major catch: As these one-celled plants make hydrogen, they also produce oxygen through photosynthesis; this oxygen shuts off the hydrogen-producing enzyme, hydrogenase. As a result, the algae produce only trace amounts of hydrogen.

At the meeting, researchers described two tricks for getting around this problem. Tasios Melis of the University of California, Berkeley, and coworkers at the National Renewable Energy Laboratory (NREL) in Golden, Colorado, worked with algae called *Chlamydomonas reinhardtii* that are common in fish ponds and aquaria. The team showed that if they starved the algae of sulfate salts, the microbes could no longer maintain a protein complex needed for producing oxygen photosynthetically and went straight down the hydrogen-producing metabolic pathway. As they reported in the January issue of *Plant Physiology*, the team was able to get an average of 3 milliliters of hydrogen per hour to bubble up from a 1-liter bottle of algae. After 4 days of production, they had to let the algae switch back to normal photosynthesis to rebuild burned-up proteins. "For the first time, we've been able to produce bulk gas using a green algae, which should be the most efficient organism," says NREL biologist Michael Seibert.

The second approach, described by biophysicist Elias Greenbaum of Oak Ridge National Laboratory in Tennessee, is to leave a lot of nitrogen gas above the bottled algae so that the oxygen wafts out of the water and doesn't stop the reaction. Oxygen does eventually build up, but then Greenbaum flushes it out with nitrogen. Greenbaum was able to equal the Melis group's output for 58 days, "by far the world's record for sustainable production" from microbes, he says. He thinks he can ramp up even further by using oxygen-tolerant algae mutants being bred by the NREL scientists.

The researchers still have a long way to go. Right now, they're only producing a small fraction of the hydrogen that theoretical models suggest they can, and they want to study the biochemical pathway of hydrogenase to figure out how to get more. Even at 10-fold higher yields, however, you'd likely need a large (45-square-meter), shallow pond to produce enough hydrogen to power one car. And the pond would have to be located in a place with lots of sun, like the U.S. Southwest. Still, experts say the technology is worth pursuing as an alternative to using photovoltaics or wind power to split water. "We don't know which technology will come out ahead," says NREL process analyst Margaret Mann.

–JOCELYN KAISER



Green fuel. Bottled algae *(inset)* deprived of sulfur pump out hydrogen.

How to Steer a Hurricane

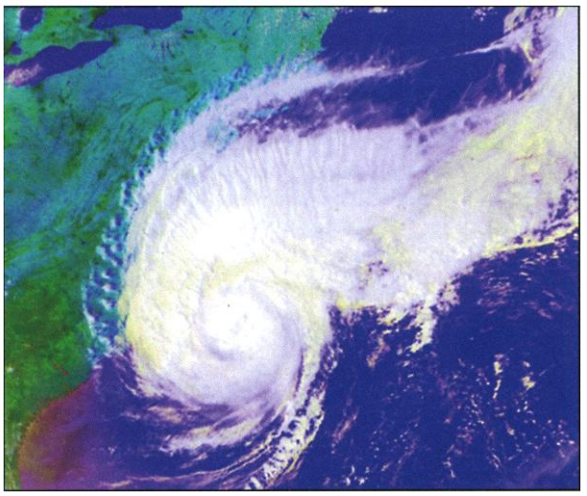
When the weather turns hot and sticky, hurricanes force thousands of American coastal dwellers to batten down their hatches. Some storms ravage states along the Gulf of Mexico, while others menace the Eastern Seaboard. Now, researchers have proposed that a long-term climate pattern over the Atlantic Ocean steers most hurricanes toward one region or the other, but not both, for decades to millennia at a time.

Climatologists already knew about a connection between the famed El Niño–Southern Oscillation (ENSO) in the tropical Pacific Ocean and hurricanes in the Atlantic. Warm El Niño patterns seem to suppress major Atlantic storms, while hurricanes flourish during cooler La Niña seasons. Although that global link helps explain the number of storms, it doesn't predict where they'll strike. So climatologist James Elsner of Florida State University in Tallahassee and his colleagues looked for ties between hurricane tracks and the North Atlantic Oscillation (NAO), a seesaw shift in atmospheric pressures over the ocean (*Science*, 12 February 1999, p. 948). When the NAO is intense, a fair-weather ridge of high pressure dominates the north-central Atlantic. During a weak NAO, this "Bermuda High" sags southwest toward Florida.

To see whether NAO fluctuations influenced hurricane tracks, Elsner's team compared weather records with hurricane landfall reports from the last 150 years. They found a suggestive statistical link: In years of strong NAOs, most major hurricanes curved along the southern margin of the high-pressure ridge and then turned north to plow into the East Coast. But when the Bermuda High drifted farther south, it deflected big storms through the Caribbean Sea and into the Gulf of Mexico. Elsner will describe the results in an upcoming issue of the *Journal of Climate*.

Although the NAO pattern waxes and wanes, Elsner notes that it often lingers for

CREDITS: (TOP) NASA/MIT; (BOTTOM) DOE/NREL



Storm warnings. Atlantic climate trends may control where hurricanes, such as last year's Dennis, make landfall.

decades at a time. This may explain why the biggest storms tend to strike either the Gulf Coast or the Atlantic Coast in batches that persist for 20 to 30 years, he says. Furthermore, team member Kam-biu Liu, a climatologist at Louisiana State University, Baton Rouge, found signs that the NAO may steer hurricanes over even longer periods. Ancient layers of sand washed inland by the most powerful hurricanes suggest that clumps of storms bombarded the Gulf Coast for 2500 years, followed by a millennium of relative calm. Other preliminary work examining thousands of years of hurricane deposits in Virginia and Cape Cod appears to show that a quiet Gulf Coast means a stormy East Coast, and vice versa, Liu says.

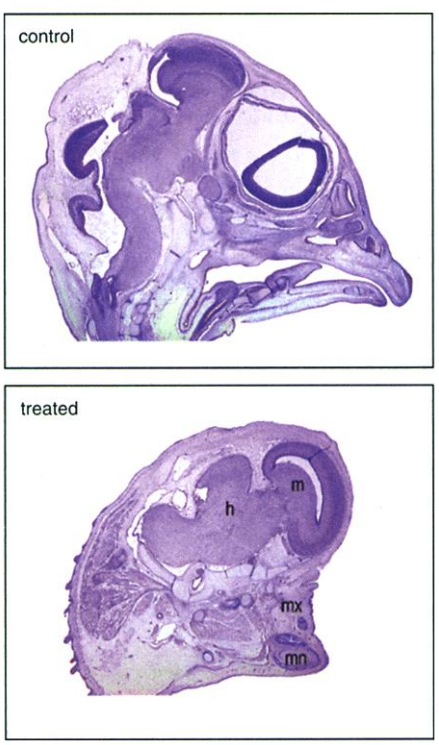
"The evidence seems strong for a link" between the NAO and hurricane tracks, says climatologist Kerry Emanuel of the Massachusetts Institute of Technology in Cambridge. But "until more rigorous statistical tests are done, I think the jury is still out." If Elsner's team can prove its case, however, forecasters could eventually use the Atlantic climate to predict which stretches of coastline may bear the brunt of storms during a given season. **–ROBERT IRION**

The Brains Behind the Face

Beauty ads claim that retinoic acid, better known as vitamin A, removes wrinkles from aging faces. But new findings suggest that it is even more important for very young faces. Retinoic acid helps direct the proper development of both the face and the forebrain, which governs higher thought and reasoning, scientists reported at the meeting. The study is the first to implicate a single genetic pathway in the development of both the forebrain and the face, researchers say, and it may provide insights into some birth defects.

Although doctors have long observed that brain and facial defects usually occur together, researchers were not aware that the two structures had developmental genes in common. Because the brain provides a sort of scaffolding for facial features, scientists assumed that if something went wrong in brain development, the face would simply lack structural support and become deformed. But the new research suggests that problems with one gene pathway may cause both kinds of defects, says developmental biologist Harold Slavkin of the National Institute of Dental and Craniofacial Research in Bethesda, Maryland.

That pathway involves *sonic hedgehog*, a versatile developmental gene that was first discovered through its role in limb growth and patterning. Previous work by several groups had shown that it is also important for early head development. But what controls the gene? In the limbs, retinoic acid will turn *sonic hedgehog* on and off. To find out if that happens in the face, a team led by developmental biologist Jill Helms of the University of California, San Francisco, applied a molecule that blocks the retinoic acid receptor to the head region of developing chicks. They found that the populations of cells destined to become face and forebrain no longer expressed the correct genes and as a result stopped dividing and began to undergo programmed cell death. The chicks never developed a forebrain, forehead, nose, or eyes. However, if the researchers later applied extra retinoic acid, or extra doses of Sonic hedgehog and another growth factor, the chicks developed nearly normal features.



Head trip. Chicks are unable to form forebrain and upper face properly when retinoic acid signaling is blocked (*bottom*).

Scientists who had looked for signs of retinoic acid in the early face and forebrain had failed to find any sign of the molecule, Helms says. But she says that may be because its presence is fleeting and vitally important only within a narrow developmental window. When her team treated slightly older embryos with the blocking molecule, it had no effect.

Although the patterning of the midbrain and the hindbrain are well studied, Helms is "at the forefront" in the effort to sort out the earliest patterning of face and forebrain, Slavkin says. The work may also have practical implications: Helms notes that proper amounts of vitamin A during key stages of pregnancy might help prevent some birth defects. **–GRETCHEN VOGEL**

Science Gains at State Department

Secretary of State Madeleine Albright says she is just weeks away from announcing a new long-term plan to incorporate scientific expertise into U.S. foreign policy. That promise, announced in a 21 February speech at the meeting, was applauded by researchers who have been pressing the State Department to infuse more science savvy into its diplomatic corps, although some said they wanted details before passing judgment.

Albright's speech is the department's most prominent response so far to a National Academy of Sciences (NAS) report issued last October that laid out a 12-step plan for improving its technical expertise (*Science*, 15 October 1999, p. 391). Albright requested the report in 1998, after researchers expressed alarm about the dwindling number of scientifically trained diplomats serving in embassies and headquarters. To reverse that trend, Albright said she hoped to have a new science adviser on board by April and to release a plan that will look beyond the end of the Clinton Administration. "It will lay out my long-term vision for [upgrading science at the department]," she said. "This will be a multiyear, multi-Administration, bipartisan mission."

After the speech, authors of the NAS report—including Robert Frosch of Harvard University in Cambridge, Massachusetts—were pleased by the high-profile commitments. But they also agreed with a State Department official, who predicted that change is "going to be a long-term process."

–DAVID MALAKOFF

CREDITS: (LEFT TO RIGHT) NOAA/NATIONAL CLIMATIC DATA CENTER; J. HELMS/UCSF