ons. "The question is, where has the other stuff gone?" says Rauch.

Cen and Ostriker's simulations suggest that most of it is still wafting out there in intergalactic space. As gravity continued its work, the simulations show, the clouds collapsed into a network of filaments. "The metaphor of waves breaking is right," said Ostriker: The collapse generated turbulence and shock waves, which heated the baryonic "froth" from less than 100,000 degrees kelvin to more than 1,000,000 degrees. That's hot enough to ionize all of the neutral hydrogen but not so hot that the plasma would outshine the obscuring gases in our own galaxy by very much.

Evrard is reserving judgment on some of the conclusions until he sees the details of the physics code, which Cen and Ostriker will report later in a paper they say is now under review at *Science*. But just after Ostriker finished his presentation, he got the kind of response every theorist dreams of. Q. Daniel Wang, an astronomer at Northwestern University, raised his hand and said that he may already have found a faint gleam from the filamentary plasma in measurements from the Roentgen x-ray satellite (ROSAT). In one observation, Wang may have seen the warmest part of the network directly (see graphic). In another, he attempted to subtract out the foreground glare of our galaxy, revealing what could be the general background glow of the network.

Wang says he has already been awarded observing time on AXAF—scheduled for launch later this year—which has better sensitivity and spatial resolution than ROSAT can muster. More evidence for the misplaced baryonic matter, if it's there, could come quickly.

–James Glanz

MICROBIOLOGY

Possible New Weapon for Insect Control

In the past 15 years, genetic engineers have created new strains of crop plants with their own built-in insecticides: bacterial toxins that can kill insect pests that munch on the plants. It's an elegant scheme, promising to keep harmful insects in check without exposing other organisms to insecticidal sprays. But so far the plant genetic engineers have had to rely on only a few types of toxins, from the bacterium *Bacillus thuringiensis* (Bt). This has raised concerns that the target insects will become resistant to the Bt toxins, leaving the plants defenseless. Now, scientists have identified a promising new group of toxins that might eventually be used instead of Bt, or in combination with it.

On page 2129, a team led by Richard ffrench-Constant, an insect toxicologist at the University of Wisconsin, Madison, reports the discovery of proteins that the bacterium *Photorhabdus luminescens* uses to kill a wide variety of insects, including common pests. "This provides evidence for a category of insecticides that we didn't know about before," says David Fischhoff, president of Cereon Genomics, a Monsanto subsidiary, in Cambridge, Massachusetts.

The researchers also showed that the toxins work when eaten by an insect pest—a prerequisite for use in genetically altered plants. They now hope that toxin genes from *P. luminescens* can eventually be used, like the Bt toxin genes, to produce new strains of insect-resistant plants. Combining the new toxins with Bt could ease the resistance problem, they say, in part because an insect is very unlikely to become resistant simultaneously to two toxins, as long as they kill by different mechanisms.

This quest for new insecticide genes has led researchers to some odd places, including the gut of certain roundworms, the heterorhabditid nematodes, where *P. luminescens* resides. Some gardeners use this nematode as a natural form of insect control. It wriggles into the circulatory system of an insect and releases the bacteria, which produce something that "turns the insect into soup," as ffrench-Constant puts it. The nematode reproduces in the carcass, producing tens of thousands of young, each of which swallows a dose of bacteria before emerging and seeking new victims. "It makes *Aliens* look like a picnic," says ffrench-Constant.

Although scientists have known about this phenomenon for some time, no one had chased down the *P. luminescens* toxin. David Bowen, Michael Blackburn, and Thomas Rocheleau in ffrench-Constant's lab have now done so by growing *P. luminescens* in lab cultures and tracking the toxic activity to proteins purified from the broth in which the bacteria were grown. They found it in a high–molecular-weight protein fraction, composed of four complexes, designated A through D, each of which weighs about a million daltons.

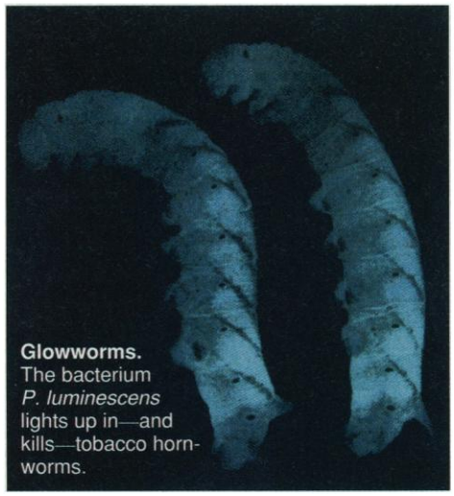

PHOTO: R. BHARTIA, C. DIZACK

Glowworms. The bacterium *P. luminescens* lights up in—and kills—tobacco hornworms.

Because *P. luminescens* normally enters the insect circulatory system, ffrench-Constant and his colleagues didn't know whether the toxins could kill when taken by mouth. But when they fed complex A to tomato hornworms, the insects died. The team has since found that complex D also has high oral toxicity, while B and C have little effect on the tomato hornworm. The researchers don't yet know exactly how the toxins work.

To find the toxin genes, the Wisconsin team raised antibodies to the complexes and used them to probe a library of *P. luminescens* genes expressed in cells of the bacterium *Escherichia coli*. Once the researchers identified the genes, they went on to prove that the isolated proteins, and not a minor component in their test mixtures, were indeed the toxins. They did this by engineering *P. luminescens* bacteria that couldn't produce the proteins.

As predicted, bacteria missing either complex A or D were less toxic to insects than the wild-type strain, while a strain lacking both complexes was harmless. "The nematodes have been used for some time in insect control as an organic gardening tool, but it's only now that we're beginning to understand the molecular basis for how the bacteria kill the insect," says ffrench-Constant. "In doing that, we've discovered a potential biopesticide."

Many challenges remain before the newly discovered molecules might be used in crops, however. When the researchers introduced the toxin genes into *E. coli*, for example, the bacterial cells made the proteins but did not secrete them, and they were not toxic. This result suggests it might be difficult to coax plants to produce the proteins in active form. The researchers are currently trying to identify other molecules that *P. luminescens* requires to export the toxins from the cell and activate them. In addition, tests are just getting under way to see if the toxins are safe for humans and wildlife, as the Bt toxins are. Still, scientists are encouraged.

"It's always good to find a novel way to control insects," says Bruce Tabashnik, an entomologist at the University of Arizona, Tucson. And, he adds, because many insect-killing nematodes harbor bacteria, there may be other, related insecticidal toxins. "It's a whole new realm, waiting to be explored," Tabashnik says.

–Evelyn Strauss

Evelyn Strauss is a free-lance writer in San Francisco.