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BIOLOGY

RNA Molecules May Carry Long-Distance Signals in Plants

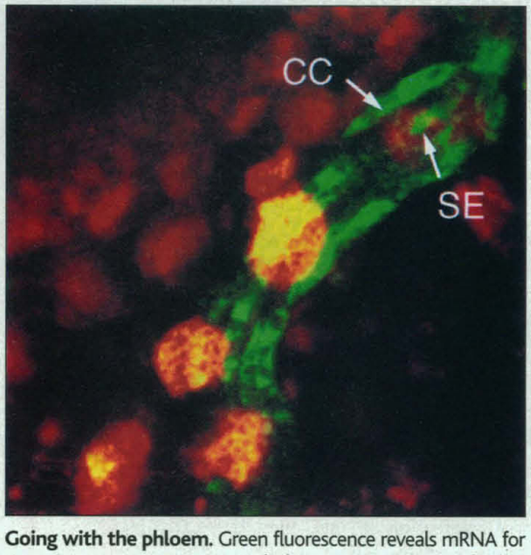
Like all multicellular organisms, plants have a long distant transport system that carries nutrients and messenger molecules to far-flung organs. But plant biologists had thought that plants send only small and simple signaling molecules along these highways, a set of pipelines throughout the plant called the phloem. Large molecules, they thought, could not negotiate the narrow access channels leading to the phloem. On page 94, however, researchers report the discovery of a carrier protein that can apparently truck large RNA molecules into the phloem, suggesting that RNA transport may be part of a plant "information superhighway."

"The work identifies what may be an essential component in a new system plant cells use to talk to each other," says Richard Jorgensen, a molecular geneticist at the University of Arizona in Tucson. "We're getting at the components of a system that controls how RNA is moved between cells and around the plant."

The finding, by William Lucas, a plant cell biologist at the University of California, Davis, and colleagues, provides the first glimpse into the mechanism of a transport system that might control gene expression in distant cells. This "highway" could help resolve some long-standing mysteries about how information travels among plant parts such as leaves and flowers, researchers say. Not everyone is persuaded that the new protein actually carries RNA from cells into the phloem, but the work fits with previous clues that plants use big molecules to transmit information, says Robert Turgeon, a plant physiologist at Cornell University. "There's a possibility that what we're looking at, in fact, is a very sophisticated situation where regulation occurs by macromolecules over very long distances," he says.

The researchers made their discovery by extrapolating from the behavior of plant viruses. Scientists knew that to spread infection throughout a plant, these microbes must move large nucleic acid molecules into the phloem, where they enter a high-pressure stream that sweeps them to distant tissues. To get into this stream, a molecule must pass through narrow channels that feed into cells called sieve elements, which form the phloem tube. The channels are ordinarily too small to allow passage of a big nucleic acid, but viruses somehow manage to widen them with so-called viral movement proteins.

Lucas's team guessed that the viral movement proteins were mimicking plant proteins that do the same thing. To find the plant counterparts, the researchers applied an antibody against a viral movement protein to pumpkin phloem sap, where it bound to a 16-kilodalton protein called CmPP16. They then detected this protein and the RNA that encodes it in the sieve elements, which themselves have no nuclei—and thus don't produce RNA—or machinery to make proteins. That suggests that the protein and RNA had moved in from adjacent cells. To test the idea, they injected CmPP16 and a variety of RNA molecules into plant cells and found the molecules in neighboring cells.



Going with the phloem. Green fluorescence reveals mRNA for the carrier protein in sieve cells (SE) and companion cells (CC).

Finally, by grafting a piece of a cucumber plant onto a pumpkin plant, the researchers showed that CmPP16 and its mRNA can move long distances. In phloem sap from the cucumber graft, they found the pumpkin CmPP16 and its mRNA, indicating that these large molecules had traveled into the graft. Together, the findings suggest that CmPP16 acts like a viral movement protein, ferrying RNA into the phloem. "This is the first plant-encoded movement protein that's been found," says Jorgensen.

But not everyone is convinced. The work doesn't actually show that CmPP16 and its mRNA traverse the channels that enter the phloem, and so doesn't rule out the possibility that the protein and mRNA found in the sieve elements are remnants from immature sieve elements, which do contain nuclei, says Turgeon. And the microinjection technique used in the experiments delivers such an overwhelming load of molecules into cells that finding the molecules nearby doesn't necessarily reflect a natural system for moving them into the phloem, says James Carrington of Washington State University.

Even if CmPP16 is actually trucking RNAs into the phloem for long journeys, at the moment no one is quite sure what those RNAs are doing. "It's nice work, and now what we need are good functional tests to assign significance to these proteins and nucleic acids in the phloem," says Carrington.

Researchers already have several ideas, based on previous hints that RNAs might be used in plant signaling. Cells receiving distant RNA molecules could translate them directly into new proteins, for example. And plants are known to battle viruses by dispatching some kind of messenger molecule to distant cells, where it degrades viral RNA. This system requires that the "turn off" message be sequence specific, suggesting that the messenger is a nucleic acid, possibly another RNA. Plants could use a similar mechanism for developmental or physiological purposes, says Jorgensen. A hint that they do comes from the current study, where two cucumber proteins that may be related to CmPP16 disappeared during the grafting experiment. Lucas says that when the pumpkin RNAs arrived in new tissue, they may have shut down production of those proteins.

Indeed, an RNA messenger system might solve long-standing puzzles about how differ-

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ent parts of plants talk to each other. For example, scientists have long known that some substance travels from leaves to buds, conveying the signal to flower in response to cues such as day length. But no one knows the identity of this messenger. The new results inspire speculation that it is an RNA, says Winslow Briggs, a plant physiologist at the Carnegie Institution of Washington at Stanford. For those studying traffic on the plant information highway, the new RNA-transport molecule could be a good ride.

–EVELYN STRAUSS

HUMAN GENETICS

Iceland OKs Private Health Databank

Ending months of furious and, at times, bitter debate, the Icelandic parliament has given a private company permission to build a database containing the health records of the entire nation. But critics of the legislation, passed 16 December by a sizable majority, immediately pledged to find ways to block its implementation.

The new law grants one company, deCODE Genetics from Reykjavik, the right to establish and commercially exploit a nationwide database created through agreements with hospitals, clinics, and individual physicians to submit their patients' medical records. The company expects this information to greatly speed up its search for disease-causing genes, on which diagnostic tests and therapies could be based. Icelanders belong to a very homogeneous gene pool, making disease genes much easier to spot here than in other populations.

The Icelandic government hopes the database, which will also be available to health officials, will improve the country's health care system. It also sees genetics as a promising way to generate high-tech jobs for the country's small, fish-based economy. "We have quite a few people abroad who have educated themselves in this field. Now, they can come home and work on this," says Siv Fridleifsdottir, vice-chair of the Committee on Health in the Althingi, the Icelandic parliament. But the deCODE bill, introduced last spring and then revised over the summer, has touched off a sulfurous battle within the research community (*Science*, 14 August 1998, p. 890, and 30 October 1998, p. 859). "This has totally destroyed the scientific atmosphere," says

Solid majority. Iceland's parliament says yes to deCODE's databank.

Eirikur Steingrimsson, a geneticist at the University of Iceland.

Critics of the bill say it violates basic ethical principles because patients will not be asked for their consent before their records are deposited in the database. They argue that there should be more safeguards to secure privacy, and that one company should not have the commercial rights to a whole nation's gene pool. Over the past few months, dozens of medical, scientific, and patients' organizations testified against the bill in committee hearings. "We look at this as a black day in the medical and scientific community," says psychiatrist Tomas Zoega, chair of the Ethics Committee of the Icelandic Medical Association. "But the battle will keep on going."

deCODE's founder and president, Kari Stefansson, says that many opponents have acted out of professional envy rather than ethical concerns. "A subpopulation of people working in biomedicine in Iceland feels that we have disrupted their lives simply by our size," says Stefansson, a former Harvard University geneticist. "They have great difficulty recruiting people in their labs and competing with us." Now that the bill is passed, he adds, "I expect that there will be a lot of reconciliation." Adds University Hospital gastroenterologist Bjarni Thjodleifsson, who is working with deCODE on a genetic study of inflammatory bowel disease, "This is a revolutionary bill, and people are unduly paranoid about their position. As the dust settles, matters will clear up, and trust can be obtained."

With only two defections from the ruling coalition, the bill passed parliament by a vote of 37 to 20. Still, the debate opened many wounds in the body politic. Critics claim that deCODE had too much influence in drafting the bill. In particular, they point to a last-minute addition that allows deCODE to link the database's medical information to existing genealogical records and to genetic information that the company collects in its own studies—an arrangement that critics say will make it relatively easy to identify individual patients and learn sensitive details about them. "I have never witnessed such a stronghold [on the parliament] by one company that has interests in a law," says Social-Democrat Össur Skarphedinsson, chair of the health panel.

But Stefansson says the company was not trying to hide anything. "This [database link] had been the idea that was discussed from day one," he says. "If the politicians say they didn't know about it, they are being very disingenuous." He also denies that the company has received any special favors. "You can have a stronghold simply by the power of your idea."

Despite their defeat, deCODE's critics haven't given up. One recourse, says Zoega, is to ask the Icelandic and European courts to overturn the law on the grounds that it violates an individual's right to privacy. In addition, the bill allows individuals to notify the surgeon-general if they oppose use of their data, and the medical association may place ads and provide patients with the necessary forms, he adds. Already, 44 general practitioners and 109 hospital specialists have pledged not to send information to the database unless a patient specifically requests them to do so. "We will certainly be dragging our feet," Zoega says about participating in the data collection.

–MARTIN ENSERINK

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ASTROPHYSICS

Has a Dark Particle Come to Light?

PARIS—A strange new particle may have left its mark in a mountain in central Italy. Its appearance, which has yet to be confirmed, would not be entirely unexpected, but it would have profound implications. Reclusive and ponderous, in this case with about 60 times the mass of the proton, such WIMPs (for weakly interacting massive particles) could account for some or all of the mysterious dark matter that astronomers believe far outweighs the galaxy's glowing stars and gas clouds.

Hoping to detect particles of dark matter, researchers have set up WIMP detec-