should organize his work with foreign colleagues, nothing more," says Igor Milovidov.

There is little doubt, however, that unflattering media attention also played a role. In June a presidium official told RAS institute chiefs at a closed meeting that the directive would be scrapped. That decision was made public last month, as most researchers were headed to their summer dachas. A notice in the academy's weekly newsletter, *Poisk*, revealed that the internal directive has been superseded by a seemingly benign measure requiring scientists to inform superiors in writing about their foreign activities.

Although the revision may end the controversy, some observers are discouraged by how few scientists bothered to complain about the original directive. Says microbiologist Garry Abelev of the RAS Center for Oncology in Moscow, "I expected that many more people would have protested."

–ANDREY ALLAKHVERDOV AND VLADIMIR POKROVSKY

Andrey Allakhverdov and Vladimir Pokrovsky are writers in Moscow.

EVOLUTIONARY BIOLOGY

A Molecular Approach To Mushroom Hunting

The oldest land plants just got a lot older. Generally considered to date back 450 million years, land plants may actually have been around 300 million years earlier, says S. Blair Hedges, an evolutionary biologist at Pennsylvania State University, University Park. Moreover, fungi and green algae could have evolved as much as 1 billion years ago, he and his colleagues report on page 1129.

Biologists have long wondered what the first terrestrial pioneers were and when they first drifted to shore. Many suspect that these land-lovers were fungi living in association with either green algae or cyanobacteria—the great, great, great ancestors of modern lichens and organisms called arbuscular mycorrhizae. The exact nature of these first plants, however, as well as when they arose, is unclear because there's scant fossil evidence earlier than 450 million years ago. So to nail down the origins of the first fungi and land plants, Hedges and his colleagues decided to take a molecular approach.

By searching through GenBank, they obtained sequences for 119 proteins from a wide variety of fungi, both aquatic and terrestrial. They compared the same protein from pairs of species; depending on the pairs, each comparison involved between five and 88 proteins. The fewer the sequence differences, the more closely related the species. Based on these calculations, they built a family tree and determined when the various fungal groups split off from one another.

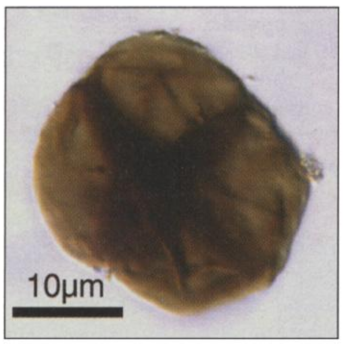
They were astounded. "We had no idea fungi evolved so early," Hedges recalls. "But we were finding these very old divergences." According to their analysis, most of the fungi branches split off between 1.5 billion and 966 million years ago—not 660 million to 370 million years ago, as previously reported. In particular, the Glomales order, which includes terrestrial fungi, took root about 1.3 billion years ago, suggesting that's when the first land plants came into existence.

Because the dates differ so radically from earlier analyses of either the fossil record or other DNA, "I expected [the paper] wouldn't get accepted," says Hedges. So the team members checked—and double-checked. They analyzed new species—a green alga, a moss, several higher plants, as well as a pathogenic and nonpathogenic yeast—to see where they landed along this new evolutionary timeline. These new data enabled them to place their fungal tree into a broader context and calculate divergence times for plants as well. The data confirmed their initial findings.

These new results "are surprising," agrees Linda Graham, a plant evolutionary biologist at the University of Wisconsin, Madison. Analyses of a ribosomal subunit gene from modern fungi had placed their origin just 600 million years ago. Furthermore, the oldest lichen fossils are a mere 400 million years old, while the most primitive mycorrhizae have been found in fossil fungi dating from 460 million years ago. As for higher land plants, the first fossils—represented by spores—are 520 million years old, although some biologists question whether the spores actually came from higher plants.

But Graham is nonetheless supportive. "This is probably the most complete study that I know of. They used several [proteins] and as many organisms as they could find data for," she explains.

This early origin is impressive, concurs Paul Strother, a paleobotanist at Boston College, who says that Hedges's results bolster a recent trend. "There's a 25-year history of people



Late bloomers. Fossilized spores, possibly from higher plants living 500 million years ago, are still much younger than the first terrestrial fungi.

CREDITS: (TOP TO BOTTOM) UNIVERSITY OF CHICAGO; PAUL K. STROTHER/BOSTON COLLEGE

ScienceScope

Women Wave Two years after admitting that its female researchers lacked administrative power, the Massachusetts Institute of Technology's top management is taking on a different look. This week the renowned Whitehead Institute announced that molecular biologist Susan Lindquist of the University of Chicago will take over as director when Gerald Fink steps down in October.

Lindquist, a member of the National Academy of Sciences who is known for her work in heat shock proteins and fruit flies, joins a growing coterie of women in senior administrative positions at MIT. In the past year alone, the institution has promoted or plans to promote women as associate chiefs of the cancer center, electrical engineering, and computer science; associate head of chemical engineering; director of the nuclear science lab; and associate provost. "This is an astounding amount of progress in a single year in terms of diversity in the leadership—particularly of science and engineering," says MIT biologist Nancy Hopkins, a key player in the 1999 report that focused on inequities among tenured women faculty members.

Stationary Target? In Washington, when things get tough, the tough assemble a blue-ribbon panel—ideally with Nobel Prize winners. That's what NASA hopes will smooth over White House and congressional concerns about the direction of the agency's financially troubled space station effort.

NASA and the White House sparred for months over the scope and membership of the panel, which was finally announced last week. Among the members are two Nobel laureates: physiologist Richard Roberts of New England Biolabs in Beverly, Massachusetts, and Robert Richardson, research vice provost at Cornell University. The 19-member team—the latest of a half-dozen to review the program over the past 15 years—will report by 1 November on how to fix management problems and a nearly $5 billion overrun.

According to sources close to the panel, NASA hopes the chair, retired aerospace executive Thomas Young, will bless the agency's current plans, while the White House trusts that the vice chair, Admiral Thomas Betterton, will press for more radical ways to control the spiraling costs.

working on this stuff pushing back the date" with ever more sophisticated analyses, he points out.

Strother is also searching for the first plants, and he, for one, is convinced that the fossil spores come from higher plants, not simpler organisms. And if these plants existed 520 million years ago, as the fossil record suggests, then there was likely to have been a complex ecosystem that included fungi from even earlier times. Indeed, "it's reasonable to assume that plants and fungi were together before, or were getting together as, plants invaded land," asserts John Taylor, a mycologist at the University of California, Berkeley.

Based on the group's new data, Hedges has proposed that early plants contributed to the sudden rise in oxygen and the widespread glaciation that occurred some 650 million years ago. But on that count, he loses the support of Taylor and others. Researchers don't really know what caused those changes. But to attribute them to land plants "doesn't really fit with the geological evidence or with our geochemical understanding of the carbon cycle," notes Harvard University geochemist Daniel Schrag. Graham suggests that these early land plants were likely rare and took up little carbon dioxide; otherwise, she says, some fossil record should exist.

For now, Hedges is sticking to his theory, challenging geologists and biologists alike to go out and prove him right—or wrong.

–ELIZABETH PENNISI

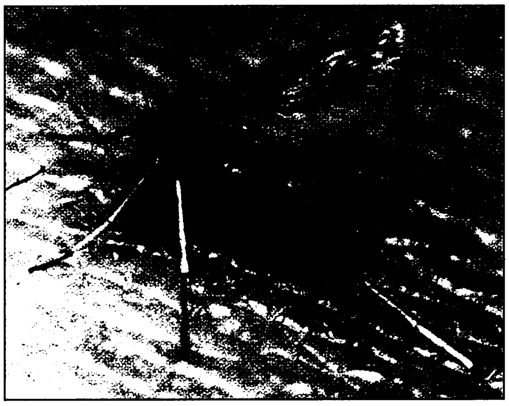
INFECTIOUS DISEASES

Sand Fly Saliva May Be Key to New Vaccine

The saliva of a fly may save human lives—if researchers can transform it into a vaccine. A new study shows that sand flies, minuscule insects that transmit a tropical disease called leishmaniasis, also secrete a protein in their saliva that protects against that disease, at least in mice. The team, led by José Ribeiro of the National Institute of Allergy and Infectious Diseases (NIAID), believes a similar vaccine may one day protect humans.

If true, it would be one of the strangest vaccines ever produced. Almost every existing vaccine directly targets a pathogen—whether it's a virus, a bacterium, or a parasite. Instead, this vaccine goes for one of the vector's proteins. By eliciting an immune response to sand fly saliva, the vaccine is thought to cause local changes in the skin whenever a sand fly bites, making it much more difficult for the parasite *Leishmania* to colonize that area. "It's a very intriguing and promising approach," says epidemiologist Barbara Herwaldt of the Centers for Disease Control and Prevention in Atlanta.

The vaccine would also be a welcome new weapon in the battle against leishmaniasis, says Herwaldt. About 2 million people a year in Africa, Asia, South America, and the Mediterranean come down with the disease, which can take very different forms, depending on which one of about 20 *Leishmania* species is involved. A type called visceral leishmaniasis is deadly when untreated, whereas so-called cutaneous leishmaniasis can cause terrible disfigurements of the face. No good leishmaniasis vaccines exist.



Flying vaccine? A salivary protein from sand flies protects mice from leishmaniasis.

Ribeiro and his colleagues have long studied the saliva of blood-sucking mosquitoes, ticks, and flies for clues to the infection process. These insects have developed a small drugstore of chemicals in their saliva—for instance, blood vessel dilators and anticlotting agents—that help them guzzle blood fast and easily. Components of these cocktails help the insect-borne parasites as well: Without them, some would be unable to cause an infection. Ribeiro and a colleague discovered this in 1988 when they tried to infect mice. Simply injecting the parasite didn't cause disease, but injecting it along with a bit of fly saliva—as would happen in nature—did.

That finding suggested that if the researchers could somehow make the immune system block the action of saliva, that would prevent *Leishmania* infection as well. Indeed, 3 years ago, Ribeiro's team showed that when mice were inoculated with minute amounts of sand fly saliva, they didn't get sick when the parasite was injected along with saliva 2 weeks later.

Of course you can't vaccinate people with insect spit. But in their new study, which appears this week in the *Journal of Experimental Medicine*, Ribeiro's team has produced what may be a workable vaccine. They first isolated the 12 major proteins in the saliva of *Phlebotomus papatasi*, an important vector of *Leishmania major*, which causes cutaneous leishmaniasis in Africa. They identified one protein, which they called SP-15, that seemed best at protecting mice from infection. Although they don't know what SP-15's function is, they produced a DNA vaccine based on it. Vaccinated mice could eliminate the parasites, while a control group developed large skin ulcers and was unable to clear *Leishmania*.

Ribeiro suspects that vaccinated animals develop a localized immune reaction, called delayed hypersensitivity, when they come into contact with saliva. Immune messenger molecules called cytokines and certain types of immune cells are recruited to the skin site, making it inhospitable for the parasite.

"You prevent the implantation of the organism. ... That's a very interesting new concept in vaccine development," says Antonio Campos-Neto of the Infectious Disease Research Institute in Seattle—and it may work in other insect-borne diseases as well, he says. Even so, Campos-Neto would like to see more evidence of the vaccine's efficacy; for one, the researchers tested the vaccine in a mouse strain that is not as susceptible to leishmaniasis as some others.

One drawback of the strategy may be that about 30 sand fly species are *Leishmania* vectors, each with its own saliva composition, and SP-15 may not work for many of them. But, says Emanuela Handman of the Walter and Eliza Hall Institute of Medical Research in Melbourne, Australia, "there's nothing to stop people from pulling [saliva] genes from those sand flies, too." And Handman points out one advantage of the saliva vaccine: Because it doesn't target *Leishmania* proteins, it would be very difficult for the parasite to evade it by mutating some of its genes. "This really points the way forward," says Handman.

–MARTIN ENSERINK

FIGHTING BRAIN DRAIN

Ireland Gives Its Stars A Big Pot o' Gold

HERTFORDSHIRE, U.K.—Known for a high-tech buildup that has earned it the nickname Silicon Bog, Ireland has now taken a major step in shoring up the basic research end of its R&D pipeline.

Last week, Science Foundation Ireland (SFI), the country's nascent grants agency, announced that 10 scientific stars will share $67 million. The money is a down payment on an ambitious effort to stem the country's accelerating brain drain problem: The foundation will dole out another $530 million over the next 5 years for a host of measures

CREDIT: J. M. C. RIBEIRO/NIAID