MICROBIOLOGY

Multitasking Is This Plankton's Trademark

One of the organisms responsible for red tide, which can kill marine species and close down fisheries, is proving to be quite ingenious in how it manages its metabolism. Like many other so-called cyanobacteria, *Trichodesmium* processes nitrogen to make ammonia and also produces oxygen by means of photosynthesis. Usually these two activities are chemically incompatible, leading researchers to wonder what goes on inside this filamentous plankton. Now, after 40 years of speculation, researchers think they have figured out how *Trichodesmium* seemingly manages both processes at once.

The work "is starting to peel back how [*Trichodesmium*] gets away with what it gets away with," comments Douglas Capone, a microbial ecologist at the University of Southern California in Los Angeles. This organism is key to providing marine life with nitrogen, thereby stimulating ocean productivity, he adds.

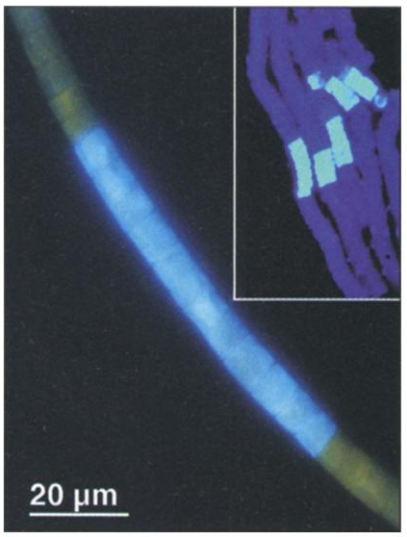
As reported on page 1534, this cyanobacterium carefully balances the amount of time it spends on photosynthesis and nitrogen fixation, shifting from one process to the other. "We're showing a decline in photosynthesis when nitrogen fixation is high," says study coauthor Ilana Berman-Frank, a phytoplankton ecologist at Rutgers University in New Brunswick, New Jersey. This prevents oxygen, a byproduct of photosynthesis, from damaging the nitrogen-fixing enzyme nitrogenase. Such damage precludes an organism from performing both processes at the same time or in the same cell.

Richard Dugdale, now at the Romberg Tiburon Center for Environmental Sciences at San Francisco State University, first discovered that *Trichodesmium* fixes nitrogen some 40 years ago. He brought a mass spectrometer on board a research ship to make field measurements of the plankton's metabolism. At the time, most microbiologists believed that nitrogen fixation occurred only at night or in specialized cells called heterocysts that don't make oxygen. Unlike other cyanobacteria, *Trichodesmium* lacks these cells, and skeptics ridiculed Dugdale's observations as "nitrogen fiction."

Over the years that fiction became fact, but still no one could figure out how this organism managed to fix both carbon (by means of photosynthesis) and nitrogen at the same time—and during the day at that.

To find out, Berman-Frank and her colleagues used a technique called fast repetition rate fluorometry to track photosynthesis as it occurs by measuring the fluorescence patterns. They monitored nitrogenase activity at the same time. The experiment showed that the oxygen-producing enzymes worked all day, except for a several-hour-long midday siesta, during which nitrogenase activity was in full swing.

Then Berman-Frank and her collaborators took an even closer look at what was going on inside individual cells. Hendrik Küppe of the Institute of Microbiology in Trebon, Czech Republic, used a customized microscope that tracked oxygen production by monitoring the changing fluorescence that occurs during photosynthesis.



Room of its own. Fluorescent antibodies light up filaments' centers, revealing localized nitrogen fixation in *Trichodesmium*.

They found that cells could shut down photosynthesis within 15 minutes to allow nitrogen fixation to occur. They also found that this shutdown often occurred only in parts of the filament, often at their centers. Thus they think the cells have exquisite control of where and when these two processes go on.

"These are very elegant experiments," notes Jonathan Zehr, a microbial ecologist at the University of California, Santa Cruz. Adds Edward Carpenter, who is also at the Romberg Tiburon Center, the study "goes a long way to explain how the organism does this."

Because *Trichodesmium* is ancient compared to other cyanobacteria, Berman-Frank and her colleagues think that its mechanism for orchestrating photosynthesis and nitrogen fixation is a primitive one and that specialized cells came later. "This may be a missing link and a precursor to how cyanobacteria evolved," agrees Capone. But Zehr isn't so sure. He thinks *Trichodesmium* species themselves could represent a highly specialized group of organisms that simply branched off early from other cyanobacteria. Nor is he convinced that this new work gets to the bottom of this paradox. "I don't think it's totally solving the riddle," he says. —ELIZABETH PENNISI

CREDITS: (LEFT TO RIGHT) I. BERMAN-FRANK *ET AL.*; P. BAGLA

ScienceScope

Delayed Again German researchers hoping to work with human embryonic stem cells are braced for yet another delay, while a Japanese group has won approval from its university to move ahead.

Germany has a law that forbids embryo research. But the DFG—Germany's science funding agency—was scheduled to decide on 7 December whether to fund a grant application from University of Bonn neuroscientist Oliver Brüstle to work with cell lines imported from abroad (*Science*, 8 June, p. 1811). Last week, Bundestag leaders of both the ruling and opposition parties urged DFG chief Ernst-Ludwig Winnacker to put off the decision until parliament debates the issue. If Winnacker agrees, the debate could be difficult for stem cell research backers. An ethics commission advising the Bundestag, for instance, this week voted 17–7 against allowing importation of the cells.

Brüstle, frustrated, says the nearly 2 years of discussions soon "must reach a conclusion." If the DFG delays, his application could be considered at the next meeting of the grants panel on 1 February.

In Japan, a national board must now review a stem cell research proposal approved 5 November by Kyoto University.

Indian Reshuffle A hawk has replaced a hawk as principal scientific adviser to the Indian government. A. P. J. Abdul Kalam (right), who spearheaded India's missile and nuclear program for more than 4 decades, resigned this week amid rumors that he was frustrated by bureaucratic delays in implementing a new technology policy he had crafted. He has been replaced by Rajagopala Chidambaram, until recently head of the country's atomic energy program and a major force behind the May 1998 nuclear tests.

Appointed 2 years ago, Kalam was the first chief scientist to also hold the rank of cabinet minister and report directly to the prime minister. But it was never clear what his duties entailed, and he reportedly was miffed at a lack of executive authority. Unlike Kalam, Chidambaram will not hold the rank of cabinet minister.

Kalam says he is joining the Indian Institute of Science in Bangalore to fulfill his wish to work more closely with students. Indian Science Minister M. M. Joshi says that "there were no differences between Kalam and the government."