# Bacterial "Missing Link" May Help More Plants Fix Nitrogen

ITHACA, N.Y. — What may be a missing link in the evolution of microorganisms, a bacterium that is both photosynthetic and nitrogen-fixing, has been discovered at the Boyce Thompson Institute for Plant Research (BTI).

Bacteria that "fix," or convert, nitrogen in symbiosis with legumes are widely known, as are those that derive energy from the sun through photosynthesis. But the newly discovered organism is the first known to combine the two capabilities.

Studying this bacterium could help genetic engineers to develop ways to incorporate nitrogen-fixation capabilities into crop plants that now lack them. Expanding plants' capability to fix nitrogen from the air would enormously decrease the need for chemical fertilizers.

The BTI scientists propose a new genus and species name for the organism, and are preparing a publicatoin describing recent work that demonstrates that the bacterium has photosynthetic capability. They are Joan M. Ellis, Mariangela Hungria, Bertrand D. Eardly, Nancy W. Rizzo and Allan R.J. Eagleshem. BTI is an independent research laboratory based at Cornell University.

They have tentatively named the bacterium *Photorhizobium thompsonum* — combining the previx "photo-" with the name rhizobium given to nitrogen-fixing bacteria. The bacterium was discovered serendipitously in sand used as growth medium in a BTI greenhouse.

"This is a completely new organism with characteristics of rhizobia as well as those of photosynthetic bacteria," said Eaglesham, the BTI plant physiologist who was studying nitrogen-fixing nodules on plant stems when the surprising bacterium turned up. "It may represent a primitive evolutionary form that could give hints of how nitrogen-fixing bacteria evolved and how the nitrogen-fixing nodulation in plants began."

The ability of certain plants to fix nitrogen has been a subject of intense study by agricultural scientists. In this process, leguminous plants such as soybeans and others in the pea family attract nitrogen-fixing microorganisms that are held in root nodules, allowing them to thrive in soil with little available nitrogen.

The rarer growth of nitrogen-fixing nodules on plant stems has been studied at BTI for about 10 years. Stem nodules do not normally appear on agriculturally important crops, but do occur on some plants living in flooded conditions, particularly weedy plants of the genera *Aeschynomene and Sesbania*. Stem nodulation is believed to aid plants when water cuts off most of the oxygen and nitrogen needed by root nodules.

Eaglesham and his BTI colleagues discovered the new bacterium while attempting to save *Aeschynomene indica* plants without nodules that were suffering from nitrogen-deficiency. Rather than destroy the dying plants, they transplanted them into sand from another greenhouse and flooded the roots with water. Within two weeks, nitrogen-fixing nodules appeared on the stems.

A subsequent series of tests showed that the nodules were caused not by a previously identified nitrogen-fixing bacterium in the sand, but by a completely new and different form that fixes nitrogen and conducts photosynthesis. The plant physiologists traced the sand to Virginia.

Then they learned that another *Aeschynomene* species, *A. virginica*, is native to fresh and brackish tidal waters from New Jersey to souther Virginoa. "Bacteria that produce nodules in *A. virginica* may have been present in small amounts of soil, which mix with sand during mining, and may be 'promiscuous' enough to form nodules on other *Aeschynome* species," Eaglesham said.

"It is an amazing coincidence," he continued. "The growth medium we have been using all along for plant studies of all kinds happens to be 'contaminated' with a microorganism that causes stem nodulation."

The plant physiologist said the bacterium does not fit in any one taxonomic classification. It doubles its numbers in less than six hours like the so-called "fast" bacteria of the genus *Rhizobium*, produces enzymes characteristic of the "slow" *Bradyrhizodium* genus, and conducts photosynthesis.

"This is some intermediate form," Eaglesham said. "Most known photobacteria are photosynthetic only under anerobic conditions. They live in marine environments or water-logged soils and turn on their photosynthetic abilites when there is not oxygen. This organism is photosynthetic in aerobic environments."

*Photorhizobium thompsonum* may be an evolutionary link to the first bacteria that tried to form nodules on plants, Eaglesham speculated. He noted that, even now, early stages of nodulation are more of a pathogenic interaction than a symbiotic relationship. The first plant cells that are penetrated by nitrogen-fixing bacteria collapse and die as the plant tries to contain the "infection."

A nitrogen-fixing bacterium that is particularly adept at penetrating plant stems and can produce some of its own food and energy from light would seem to have a competitive advantage — both during the evolutionary development of plant nodulation and in the future, as scientists attempt to expand nitrogen-fixing capabilities to more plant species, Eaglesham said.





## Water Quality Meeting Scheduled

EPHRATA (Lancaster) — The Octorara Young Farmers Association will be holding its next meeting at 7:30 p.m. on January 2, 1989 at the Octorara High School ag-education room. The night's discussion will center on determing water quality.

Attendees are invited to bring water samples to the meeting for testing. The water will be tested for copper, iron, hardness, acidity, and nitrates. Methods of correction and benefits of making corrections will be discussed. The sponsor of this meeting will be the Martin Water Co., with David Stoltzfus and Richard Breckbill as the speakers for the evening.

In the event of inclement weather, interested people should listen to WCOJ radio station for possible clsoing.

The association's next meeting will be on February 6 and will feature a discussion on pesticides.

## Livestock Feed Benefit Deadline Extended

YORK — York County livestock growers now have until March 31, 1989, to apply for benefits in the Emergency Feed Program (EFP) or Emergency Feed Assistance Program (EFAP). The original deadline was December 31, 1988. The EFP provides 50% cost-sharing on purchased feed while in EFAP eligible applicants may purchase USDA owned grain at reduced prices. Eligible applicants are those suffering at least a 40% loss of all feed production and have insufficient feed on hand until 1989 crops become available.

Interested persons may contact the York County ASCS Office at 120 Pleasant Acres Road. The phone number is 755-2801.

"Eligibility for participation in all programs administered by ASCS is established under law without regard to race, color, age, sex, religion, national origin or physical handicap."