Nitrogen Fixation in Maize

Scientists have long dreamed of being able to entice nitrogen-fixing bacteria to live in or on the roots of cereals just as they do on the roots of legumes. The idea is that the bacteria would help meet the plants' requirements for nitrogen-containing nutrients by fixing nitrogen—that is, by reducing atmospheric nitrogen, which plants cannot use, to ammonia, which they can. The hope is that this would enable farmers to decrease their dependence on expensive—with regard to both money and energy—synthetic nitrogen fertilizers without decreasing cereal crop yields. Although there is a long way to go before this goal is actually reached, if it ever is, recent research in Brazil is at least pointing in the right direction.

According to Johanna Döbereiner and Joachim von Bülow of the Universidade Federal Rural do Rio de Janeiro, some strains of maize or corn, growing under field conditions, have roots with the capacity to fix nitrogen. There were wide variations in the capacities of the strains tested, but Döbereiner says that the activity of roots from the best strain was almost as good as that of soybean roots. She attributes the nitrogen-fixing capacity of the maize roots to the presence in them of the bacterium *Spirillum lipoferum*. Döbereiner had previously found that this bacterium associates with the roots of a number of tropical grasses and fixes nitrogen almost as actively as do bacteria of the genus *Rhizobium* in legumes (*Science*, 12 July 1974).

There are some problems with potential applications of this discovery to agriculture. Döbereiner has shown, for example, that nitrogen fixation by *Spirillum* is optimal at soil temperatures between 31° and 40°C; little nitrogen fixation occurs below 25°C. She measured soil temperatures of between 26° and 31°C during the tropical summer of Rio de Janeiro, but soils in more temperate climates would be cooler than this.

Spirillum and Corn Grown in Temperate Climates

Preliminary work does indicate, however, that the roots of corn strains grown in a temperate climate can at least be infected with *Spirillum lipoferum*. Robert Burris of the University of Wisconsin has inoculated several strains of corn, including some common commercial varieties, with the bacterium, and is growing them in field plots in Wisconsin. He says that the bacteria will infect the roots, and confirms Döbereiner's observation that the bacteria are actually inside the roots and not just in a loose association around them. The plants are still immature, so it is too early to tell whether inoculation has any effect on yields. Inoculated plants do not look any better than uninoculated ones, according to Burris.

Obviously, a great deal more work will be required before the Brazilian research bears practical fruit. The effect of *Spirillum* infection on the quantity and quality of cereal yields is generally unknown and must be determined. Also needed is an analysis of the plant characteristics that favor infection and nitrogen fixation by the bacterium and a better characterization of the soil or climate conditions that limit these processes. Another unanswered question is whether *Spirillum* or some other bacteria can infect and fix nitrogen in the roots of additional cereals, especially wheat.

But the potential is there, and an international effort to attain that potential is under way. The Brazilian National Research Council is sponsoring the Program for International Cooperation in Training and Basic Research on Nitrogen Fixation in the Tropics to facilitate all aspects of the research at the Universidade Federal Rural do Rio de Janeiro. The program will include bringing qualified scientists from laboratories around the world to Brazil, where they can contribute some kinds of expertise currently lacking there and help train Brazilian students to do research on nitrogen fixation; at the same time, the visitors would benefit from the Brazilians' more extensive experience with *Spirillum lipoferum*.

An advisory committee consisting of members from the United States, Canada, the United Kingdom, and Australia will help the Brazilians coordinate research in laboratories throughout the world with that in Brazil. The National Academy of Sciences of the United States is coordinating this country's participation in the program.—J.L.M.

who died of SIDS between the ages of 2 and 5 months compared to that in controls (accident victims) in the same age group; victims of SIDS between the ages of 5 and 12 months did have a significantly greater brown fat retention than controls. Valdes-Dapena says that she cannot explain this discrepancy.

Although finding diagnostic criteria specific for SIDS is a major goal of investigators, Valdes-Dapena does not think that any one characteristic, such as percentage of brown fat retained, is adequate in this regard. She says that the average percentages for the different groups may differ significantly but that there are wide variations between the values found for members of the same group. There is also considerable overlap between those found in individuals in different groups.

Even if sleep apnea is one of the events culminating in sudden infant death, as the evidence indicates, a full understanding of the etiology of SIDS will still require an explanation of the cause of the apnea. One place to look for abnormalities in respiratory control is the brainstem—the location of respiratory centers that establish the basic rhythm of breathing. Naeye has observed two abnormalities in the brainstems of SIDS victims. One is an unusual proliferation of astroglial fibers. (Glial cells are nonneuronal cells necessary for the maintenance and function of neurons.) The other is a retardation of the formation of the membranous coverings of neurons. This would affect transmission of nerve impulses. Although Naeye cannot rule out the possibility that the alterations are the cause of prolonged sleep apnea, he currently thinks that they are the result of inadequate oxygen supply to the brain resulting from the apnea. A vicious circle could result, however, in which these changes lead to further loss of respiratory control and more apnea.

According to Harold Mars of Case Western Reserve University, there are preliminary indications that the formation of certain neurotransmitters, including dopamine, norepinephrine, and serotonin, is impaired in premature infants with apnea compared to premature infants with no apnea. The same was true for some but not all "near-miss" infants. (Neurotransmitters are chemicals involved in the transmission of nerve impulses.) Mars said that an enzyme required for synthesis of dopamine and serotonin appears to be lacking or very low in concentration in the brainstems of SIDS victims, but more data are required to confirm this.

Other investigators have been looking at respiratory control directly, especially at a reflex of newborn or very young animals that appears capable of counteracting the