AGRICULTURE

More bacteria on the fertilizer force

Bacteria living in nodules on roots of soybeans, peas and alfalfa have long been appreciated for their innate ability to "fix" atmospheric nitrogen into forms useful to the plant. Researchers at the International Rice Research Institute in the Philippines now have discovered that bacteria living free in the soil can also contribute a substantial amount of biologically useful nitrogen. They found that free-living bacteria growing around the roots of rice plants enrich the soil with as much as 10 to 21 kilograms of nitrogen per hectare (2.47 acres) during one growing season.

This discovery opens new possibilities for reducing rice farmers' dependence on expensive fertilizers. The investigators plan to determine which strains of rice and what soil conditions encourage the greatest nitrogen fixation by bacteria. Eventually it may be possible to inoculate seeds with appropriate strains of bacteria for fields that lack nitrogen fixers.

Wheat construction: Three-part problem

The recipe for modern bread wheat involves adding one part each of three primitive wheat species, because bread wheat contains three complete sets of different chromosomes. Moshe Feldman at the Weizmann Institute in Rehovot, Israel, is mimicking nature and mixing up a new batch of bread wheat. He has already created plants containing two chromosome sets and is currently breeding those plants with another primitive wheat.

Until recently only two of the primitive ancestors of bread wheat were known; the third was assumed extinct. However, Feldman came across a strange wheat plant, first in an empty lot and later on a specimen-gathering field trip. That wheat was identified as a separate species, *Triticum searsii,* and examination of its chromosomes indicated that it was the missing contributor of bread wheat chromosomes. Genetic variations of *T. searsii* and the future laboratory-amalgamated wheat should help biologists transfer desired genetic traits into commercial varieties of bread wheat.

Strange taste of mechanization

As the cost and problems of manually harvesting citrus fruit increase, mechanical harvestors are becoming more important. Currently all promising mechanical harvesting procedures involve first loosening the fruit with a chemical agent. The chemicals used, which have names like Release and Pik-off, damage the fruit's peel and thus cause the fruit to release ethylene, which promotes loosening. The chemicals affect the composition, and therefore the taste, of the resultant orange juice.

Manuel G. Moshonas and Philip E. Shaw have now identified the constituents responsible for the taste change. Those compounds have never before been found in citrus fruit. The researchers at the U.S. Citrus and Subtropical Products Laboratory in Winter Haven, Fla., detected six phenolic ethers in all the chemically treated oranges. The amount of each unusual compound was below the quantity a person can taste, but one, eugenol, was near its flavor threshold. The flavors of the compounds are additive, so their combined effect is apparently sufficient to cause an off flavor to the orange juice. Eugenol is currently used in spice combinations to give a clove-like flavor. The other compounds are also already found in foods.

At present, juice from manually harvested oranges dilutes any special flavor of juice from mechanically harvested fruit. However, the researchers warn in the November-December Journal of Agricultural and Food Chemistry that as mechanical harvesting becomes more widespread, flavor problems will increase. Use of smaller quantities and shorter exposures of more potent chemicals may minimize detrimental flavor effects.

PHYSICAL SCIENCES

Energy storage — with quarks

What can you do with a quark if you can't pull one loose from the subatomic particle in which it is bound?

What you can do with them, suggest Peter G.O. Freund and Christopher T. Hill of the University of Chicago in the Nov. 16 Nature, is use the peculiarities of the structures quarks build to make a reality of a frequent hope of science fiction inventors — power from matter-antimatter annihilations. The inescapable inhibition to such schemes has always been control. You can't store ordinary matter, say hydrogen, in ordinary antimatter, say antisteel. The combination explodes.

But in the light of present-day quark theory, Freund and Hill figure, it is possible to imagine unordinary kinds of matter and antimatter that will annihilate with each other but not with ordinary matter (or antimatter). The theory now has six possible quarks and six antiquarks, called up, down, strange, charm, top and bottom. Ordinary neutrons and protons are made only of up and down quarks, and annihilation depends on a given quark meeting its antiquark.

The criterion for not annihilating with protons or neutrons is thus not having antiup or antidown quarks. Two examples of possible particles posed by Freund and Hill are the B^+ (bottom-up-up) and the M^+ (antibottom-up). Both of these seem as if they would be stable against radioactive decay. They would not annihilate with neutrons or protons, but would with each other (because of the bottom quark in one and antibottom in the other). They are both positively charged and so could pick up an electron and form stable hydrogenlike atoms.

In fact, diatomic B and M gases might form and be stored separately until needed. Bringing them together and inducing annihilation yields about 10 billion electron-volts per reaction.

All this is predicated on the existence of Bs and Ms, for which there is no experimental evidence yet. But if not these particular combinations perhaps others are possible. "Stable quarks would, therefore, offer the possibility of storing very high (useable) energies within small volumes. The technological possibilities are self-evident," Freund and Hill point out.

Impure films: The story of O

More and more of our technology is coming to depend on getting the effects we expect from thin solid films. Those films are products of a high order of applied science and technology themselves, but so dependent is their function on details of composition and structure that mysteries and surprises are not uncommon.

One such affair involves amorphous silicon hydrogen alloys. These films are made in generally two ways, by condensation from a radiofrequency glow discharge in silane gas (SiH_4) or by sputtering in an argon-hydrogen mixture. Of practical interest are the optoelectric properties of these films: dark conductivity, photoconductivity, photoluminescence and photoabsorption. Films made by glow discharge have 10 to 100 times the photoluminescence of the sputtered variety, and the sputtered variety does not come near the 5.5 percent efficiency for solar energy conversion reported for the glow discharge kind.

M.A. Paesler, D.A. Anderson, E.C. Freeman, G. Moddel and William Paul of Harvard University reasoned that an impurity entering one process and not the other might make the difference. As they report in the Nov. 20 Physical Review Letters, they thought oxygen the likely culprit and deliberately introduced it.

Films with oxygen turn out to behave more like the glow discharge films. The oxygen seems to enter the structure, not by bonding to hydrogen, but by forming a bridge between two silicons. And so, this is somehow, as they call it, "The story of O."