Fusing the cells of two plant species

It would be nice if botanists could grow a plant that has the hardiness of crabgrass, needs no more water than a cactus, produces fruit with the texture of an apple and the flavor of an orange and has edible roots. But in practice it hasn't been possible. Most attempts to cross different species of plants or animals yield sterile offspring, if any. Thus a horse and an ass can be crossed to produce a mule, but the mule cannot reproduce.

Now researchers at Brookhaven National Laboratory have developed a new method of producing hybrids that bypasses the normal barriers to reproduction between different species. Peter S. Carlson, Harold H. Smith and Rosemarie D. Dearing have grown a mature hybrid plant from fused genetic cells of two species of tobacco. The method thus bypasses sexual reproduction, and its restrictions, altogether.

The biologists isolated cells from leaves of the two species and removed the cellulose walls surrounding the cells by exposing them to enzymes capable of digesting cellulose. Some of the wall-less cells (protoplasts) were then fused by simple chemical manipulations to form new self-reproducing cells that contained an entirely new set of genetic characteristics. Protoplasts had been previously fused by researchers in England, but they remained as cells.

The Brookhaven biologists then placed the fused cells in a regenerative culture medium that would support the growth of only those fused cells containing the genetic information for the desired hybrid. When the fused cells grew into colonies they were removed from the regenerative medium and placed in another medium where the hybrid developed rudimentary shoots and leaves. The final step was to graft these shoots onto freshly cut stems of one of the parent plants where they grew into fertile, mature plants. The hybrid produced by this method, called parasexual hybridization, was identical to a hybrid produced by conventional methods from the same two species, except that the new hybrid is fertile and can reproduce to begin a whole new species of tobacco.

The researchers point out that parasexual hybridization could have an enormous effect on agriculture because it would permit crossbreeding between widely divergent plant species to produce entirely new crops. Existing species could also be modified by this method to give them higher yield or resistance to disease.

It will be a while before parasexual hybridization can actually be practiced, as the method requires more development. But "the remaining problems are technical rather than theoretical," says Carlson. "We know what can be done using a model system. Now the crucial task is to characterize the special requirements of the individual species and hybrid desired from parasexual reproduction." The method may eventually be applied to mammals, but that, notes Carlson, would be much more complicated and lies far in the future. □

Brookhaven National Laboratory

Carlson, Dearing, Smith: Parasexual hybridization with two tobacco species.

Particulate emissions: Many unsolved problems

State, Federal and local pollution-abatement officials—as well as industry—have tended to see the problem of particulate air pollution in an oversimplified way. If a utility removes 90 percent of the particles from the gas coming from its stacks, it views its accomplishment as a solid 90 percent gain in particulate abatement. A new National Academy of Engineering report points out that particulate pollution is far too complicated to allow such gross measurements to be meaningful all by themselves.

For instance, the report, issued late last week, says: " . . . Collection efficiencies [of abatement devices] for the finest particles, which play a key role in air-pollution effects, are significantly less than for larger particles." With certain fibrous filters used as industrial particle collectors, the lowest collection efficiency occurs when particles are 0.1 to 1.0 micron in size, a range "which is particularly important . . . with respect to visibility, health effects and weather modification."

Although the report calls the inability of many industrial particle-collection systems to capture these smaller particles the single most serious problem, it mentions a number of other difficulties and complexities. One obvious one is the chemical and physical makeup of particles released into the air. Some particles are far more harmful than others. "There is a pressing need for detailed physical and chemical information on the nature of particulate emissions from various sources." Of special importance are hazardous trace metals and organic compounds, says the report.

Another problem is the difference between the claimed efficiency of collection devices and their real efficiency. Electrostatic precipitators give an electric charge to particles, then collect them by attracting them to an electrode with an opposite charge. They are generally regarded as the most efficient collection devices. But the precipitators are subject to many difficulties. For instance, low-sulfur coal, desirable for abatement of sulfur oxides, decreases their efficiency. And the charging wires in the precipitators tend to break because of vibration. Says the report with regard to these problems: ". . . Reported emissions may understate the true average because they are often measured only on the best of newest units operating under optimum conditions."

A final problem is the one of "secondary particulates" formed from gases after the gases have entered the air. In some cities, such as Los Angeles, secondary particles make up the largest percentage of all particulates, and scientists are learning more about their formation. For instance, photochemical smog reacts with sulfur dioxide to form sulfuric acid, which in turn reacts with ammonia to form ammonium

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sulfate particles (SN: 3/4/72, p. 151). This conceivably could become an even larger problem in Eastern industrial cities where there is less smog but a great deal more sulfur dioxide than in Los Angeles.

Making all of these problems more difficult to deal with is a paucity of reliable data. Current measurement systems, says the report, are largely aimed at the kinds of gross gauging of emissions and of ambient air quality mentioned earlier. " . . . Major gaps exist in instrumentation for sampling and measuring the characteristics of particulate pollution." Needed is a nationwide monitoring system ". . . able to describe particle size, shape, concentration, composition, and light-scattering potential and the carrier-gas characteristics associated with the emission source."

The NAE report says that to achieve all this, as well as to do necessary research and development to develop more efficient control devices, will require particulate R&D expenditures by the Environmental Protection Agency about 10 times the current $500,000 (the amount spent in fiscal 1972). In addition, the NAE panel says there should be cooperative programs jointly funded by EPA and the industries involved.

The NAE report acknowledges frankly and describes candidly the immense technical problems associated with particulate pollution in a way that was rare in official reports a few years ago. But apart from its recommendation that industry contribute at least some money to the large R&D effort required, the new report is like the earlier ones in that it scarcely touches on economic questions. □

Collisions at 205 GeV: Twice as many particles

If a physicist were asked what he expected to see when a proton with 200 billion electron-volts energy (200 GeV) struck a stationary proton, one of the first items in his reply would be "lots of secondary particles." This expectation is quite borne out by the early analyses of the first experiment at the National Accelerator Laboratory at Batavia, Ill. A group of 19 physicists report in the Aug. 21 PHYSICAL REVIEW LETTERS that on the average eight secondary particles per collision were produced at 205 GeV, and some collisions produced as many as 22. The average is nearly twice that for 28-GeV protons. Analysis continues to see what species are among the secondaries and what light their production may throw on the many theoretical questions about the behavior of matter and basic physical laws at such high energy. □

A genetic linkage in manic-depressive illness

Heredity has long been thought to be a contributing factor in the development of manic-depressive illness. Results from studies of families and twins pointed strongly to a possible genetic transmission of the disease, but the hypothesis could not be proved until a definite mode of transmission was demonstrated. Four years ago George Winokur, Vassant Tanna, Theodore Reich and Paula Clayton, working at Barnes Hospital in St. Louis, showed that one form of manic depression could possibly be transmitted via the X chromosome. Color blindness, known to be transmitted on the X chromosome, and manic-depressive illness were consistently associated in two families that were studied.

Ronald R. Fieve and Joseph Fleiss of the New York State Psychiatric Institute and Julien Mendlewicz of the University of Brussels now have strong evidence that manic-depressive illness is transmitted via the X chromosome. Last week in Copenhagen at a meeting of the International College of Neuropsychopharmacology they reported on a study of 80 diagnosed manic-depressive patients. Studies of the patients' families revealed a close linkage association in seven families who had both the color-blind marker and the manic-depressive illness.

A second line of evidence for the theory was reported in a separate paper. Fieve and Mendlewicz found six families in which manic-depressive illness and the Xg^a blood group occurred in successive generations. The Xg^a blood group is a well-known genetic marker that is also transmitted via the X chromosome.

The evidence is now convincing, says Fieve, but it does not mean that all cases of manic-depressive illness are transmitted by the X-linked gene. The disease itself is divided into three main subtypes. Two are called unipolar. They include patients whose illnesses are only depressive or only manic. The third subtype, called bipolar, includes patients who have had both manic and depressive episodes. All of the families studied with the X linkage are of the bipolar subtype. And they may be only a subtype of that subtype.

But at least for those persons who have the family history and the X linkage there is now a known mode of transmission that separates them from other manic-depressive types. Once this is established, explains Fieve, these individuals could be subjected to a variety of biochemical tests in the hope of finding one or more defective enzymes or possible abnormal secondary metabolites in the spinal fluid, blood or urine. If a specific enzyme deficiency is operative, it is conceivable that early intervention (diet or drug) could prevent the onset of the illness. Regardless of whether such advances are possible, lithium carbonate has now been shown to be effective in treatment of manic and depressive phases of the disease.

Fieve: Manic-depressive psychosis is a disorder characterized by severe mood swings. Some forms of it may be transmitted via a sex chromosome.

Lucy B. Lazzopina

Fieve, who was a pioneer in the use of lithium to treat manic-depression, says a person can be stabilized on the drug for life with an 80 to 85 percent chance that there will be no or only minor recurrences of the disease. This treatment, he says, should eventually replace electroconvulsive therapy.

Winokur, now at the University of Iowa in Iowa City, agrees that Fieve's work shows specifically that a large percentage of manic-depressive illness is transmitted in the X-linked fashion. "This puts the locus for manic-depressive or bipolar psychosis somewhere on the short arm of the X chromosome," he says. Like Fieve, he believes this work should be a model for the studies of other mental illnesses. The next step, he says, is to do linkage studies on depressive patients.

Fieve also intends to look for genetic markers or other evidence of genetic transmission in the unipolar diseases. He believes the same model should be followed in looking at schizophrenic