New plant gene pools —
Sex no longer a problem

Scientists at NRC's Prairie Regional Laboratory are by-passing nature's sex barriers in the production of new kinds of hybrid plants. The process, called "somatic cell fusion" could lead the way to a new agriculture revolution.

"A hungry world looks on." So commented the National Geographic in May 1976 in the summary of its description of a new technique in biology for producing plant hybrids — cell fusion. If the potential of this research tool is realized, world food production may be greatly increased by the introduction of a range of new plant types — cereals able to grow in drier climates, citrus fruits more resistant to frost, and corn capable of manufacturing its own fertilizer in the manner of legume plants. The magazine accorded a significant role in the field to Dr. K. N. Kao of NRC's Prairie Regional Laboratory, a geneticist responsible for one of the key developments in fusion.

The great promise of the technique, and the reason for the optimism of world agricultural scientists, lies in the fact that it circumvents the restrictions that nature puts on sexual reproduction across species lines. Quite simply, "matings" between widely different species which were undreamed of 10 years ago now seem not only possible, but in some cases have actually been carried out.

To cross two plant species by the technique, somatic or body cells (from roots, stems or leaves) are first stripped of their tough, outer cellulose walls with enzymes. The naked cells, or protoplasts, are then placed in solution with a special chemical called PEG (polyethyleneglycol) that causes them to stick together, thereby fusing or pooling their internal contents to form single cells.

It turns out that fusion is possible between almost any two plant cells. Brome grass and pine trees, about as far apart on the evolutionary scale as it is possible to get, fuse easily in the protoplast condition. In fact, a recent edition of Science (Vol. 193, No. 4251, 1976) tells of an interkingdom fusion, the union of a plant and an animal protoplast.

Dr. Kao, the discoverer of PEG-mediated fusion, is quick to point out, however, that simple protoplast union is not the same as true hybrid formation. Fusion, it appears, is the easy part. To form true hybrid cells, the chromosomes from each parent must mix to give a single nucleus, and this is where nature draws the first of its lines in defining possible crosses. Few fusions between distant plant relatives lead to hybrid cells and, in many cases where it does occur, the chromosomes of one parent are ejected as the cells continue to divide.

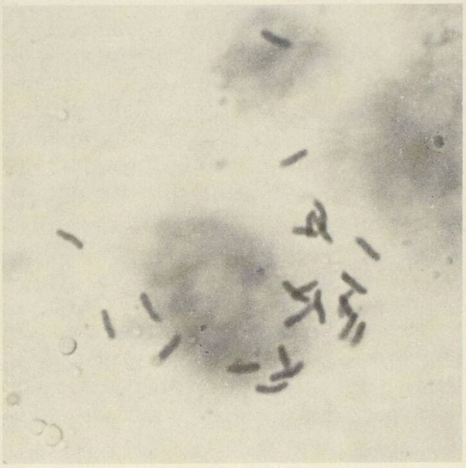
Last year, for example, Dr. Kao succeeded in producing a hybrid cell line from a species of tobacco (N. glauca) and soybean, two plants that are well separated in evolution. As the hybrid divided and reproduced in cell culture, it gradually eliminated the tobacco chromosomes, stabilizing after about eight months with all the soybean chromosomes and only a few from tobacco. "The shape and size of the tobacco chromosomes are quite different from the soybean," says Dr. Kao, "and it is easy to confirm under the microscope that we still have both kinds present in the cells."

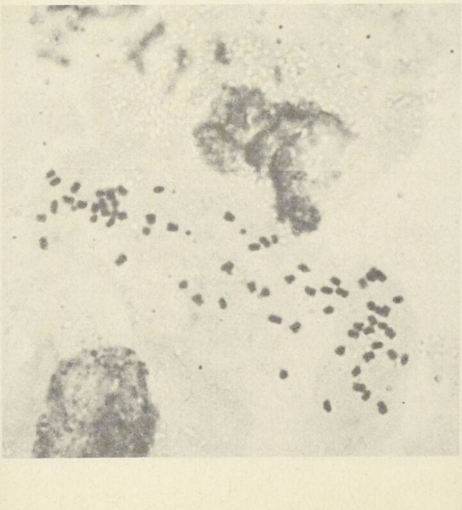
As further proof, NRC biochemist Dr. Leslie Wetter showed that the hybrid manufactures certain enzymes from both the soybean and the tobacco parent lines.

Kao and his fellow scientists at the Saskatoon Laboratory find the result encouraging. It means that genetic material can be transferred successfully between widely different plant species. Though his hybrid is essentially a soybean, it contains distinct tobacco characteristics. What scientists are now interested in is the degree of this genetic exchange. How much and what kind of genetic material can one plant species accept from another?

For Dr. Kao, the next and perhaps most critical step will be the generation of a mature plant from the hybrid cell culture. And it is here, at the stage scientists call "morphogenesis", that nature very likely will set the most rigorous limits on the hybridization process. While it is one thing to synchronize the events in chromosome duplication (the critical part of hybrid cell formation), it is quite another to harmonize the growth and development steps that distinguish each parent. □

Wayne Campbell





The longer, bar-like chromosomes of *N. Glauca* (top left) are quite distinct from those of soybean (bottom left) under the light microscope. The resultant hybrid, shown at right undergoing cell division two days after fusion, contains both chromosome types.

Sous le microscope, les chromosomes en forme de bâtonnets de *N. Glauca* (en haut, à gauche); ils sont plus longs que ceux du soja (en bas, à gauche) dont ils diffèrent totalement. Leur hybride, que l'on peut voir à droite en cours de division cellulaire, deux jours après la fusion, contient les deux types de chromosomes.

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