microstructures of high conductivity in dispersed, crystalline solid electrolytes. Reasons were given for the discrepancy between the theoretical predictions and the experimental results concerning the defect concentration profiles.

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1. Gleiter and Chalmers, in *Progress in Materials Science*, Pergamon, 1972, vol. 16.
2. Honeycombe, R. W. K., *Metals and Materials*, 1973, 7, 298.

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# Plant breeding and molecular biology: whither shall the twain meet?

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It is for the better part of a century now that the plant breeder has exploited the principles of Mendelian genetics in developing and evaluating new plant varieties for agricultural use. There is no quarrel over the fact that his efforts over the years have been enormously successful, nor over the one that he will continue to play the major role in all attempts at crop improvement for some time to come. (I have deliberately used the male personification here, for the gender distribution amongst this class of people is more biased than is the case in most other sciences.) Recent advances in plant molecular biology, particularly with regard to the identification, mapping and transfer of genes and traits from heterologous organisms into plants, nevertheless offer new approaches that merit the breeder's consideration. A symposium* was organized with the very intention of bringing the two communities of workers (the breeders and the molecular biologists) together, and the focus was upon the potential for molecular genetic approaches in the task of breeding for tolerance to abiotic and biotic stresses in crop plants.

Looking back upon the deliberations of the symposium, one could clearly discern the new gene *technology* in all its glamour: Agrobacterium-mediated transfer of a variety of genes into tobacco (a method matter-of-factly alluded to by so many speakers that I had constantly to remind myself that it did not exist eight years ago); successful gene transfer into rice protoplasts and regeneration of fertile plants therefrom (independently achieved and described by several groups); development and use of probes for restriction-fragment length polymorphisms (RFLPs); and other *in vitro* methods (with associated jargon!) routinely used by this tribe, such as pulsed-field-gel electrophoresis, linker scanning analysis, run-on transcription assays, subtraction hybridization, homology searches, gel-retardation experiments, particle-gun bombardment, and the like. Also in evidence were reports on the successful application of this technology in answering some questions of basic interest—on, for example, the biology of rice tungrovirus, or coat protein-mediated resistance to virus infection, or the regulation of gene expression during plant development or under varying environmental conditions such as anaerobiosis, salinity stress, or pathogen attack.

But there was little in the symposium to excite the bread-and-butter interests of the plant breeders in attendance. In part, this is because many of the fruits of the new technology are not immediately at hand, but rather remain largely as promises to be fulfilled in the coming years; to a greater degree, however, it reflects the lack of depth as exists at present in the molecular biologist's approach: although it is conceptually feasible (now or in the near future) to incorporate a gene of interest from *any* living creature into transgenic plants, the number of such candidate genes or strategies that have so far been identified from the standpoint of utility remains extremely limited (as typified by the fact that, of six independent presentations on the topic of genetic engineering for resistance to insect pests, as many as four dealt with the use of a protease inhibitor gene, and the remaining two with that of the insecticidal protein gene of *Bacillus thuringiensis*). Where important traits are controlled by multiple genes—a phenomenon which is more the rule than the exception in plant genetics—the application of the molecular biological approach for making transgenic plants becomes progressively more difficult.

The experienced breeder is also justifiably sceptical of the approach of 'single gene-engineering' of traits such as pest resistance or herbicide tolerance in new crop varieties, because the forces of natural selection operating in the field conspire to limit the timespan over which such traits retain their utility. This point, or even the ecological factors to be considered before the release of transgenic plants for use by the farmer, was only fleetingly touched upon in the final round-table discussions. On the other hand, the complexities inherent in the genetics of and breeding for resistance to diseases and insects, and for tolerance to water-, salinity- or

*International symposium on Molecular and Genetic Approaches to Plant Stress, organized by the International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi, 14–17 February 1990.

temperature-stress in cereal crops including rice, wheat, corn and sorghum, were outlined in several illuminating talks in the meeting.

Perhaps the one technique to emerge out of the molecular biologist's work which is immediately relevant to and applicable by the breeder is that of gene mapping with the aid of RFLP markers. This strategy bids fair to relieve the latter of much of the tedium and empiricism in his work, and the potential and power of this method, as well as some examples in which it had been gainfully employed, were adequately emphasized in the symposium.

The symposium had been organized in the expectation that 'the synergism of the whole plant genetic approach and the molecular approach to plant stress will be enormous', and with the call that 'the success of the meeting will be judged by the number of collaborative research programmes which emerge from it'. In fairness though, these objectives were perhaps a trifle ambitious—for, in the final analysis, it was clear that the molecular biologist has still some way to go before laying claim to becoming a credible partner in any such collaborative venture.

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