8. Biotechnology and Transgenic Plants

Some uses of molecular biology in the study of plant viruses have been mentioned. Since they have dsDNA genomes, viruses of the caulimovirus group were the first plant viruses completely cloned and sequenced ***(21)***. Clones containing complete caulimovirus genomes were infectious when inoculated mechanically to plants, allowing for investigation of gene function by deletion or mutation. An early hope was that foreign genes could be inserted into the caulimovirus genome, which would act as a mobile vector. This proved not to be practical, because large insertions were not stably maintained ***(22)***. The greatest practical usefulness in the caulimovirus genome turned out to be its promotor elements, which allowed for gene expression in a more or less tissue-nonspecific fashion.

Transformation of plants with segments of viral genomes or with other genes has led to some spectacular results over the past 10 yr. The first of these was the demonstration of resistance to plant virus attack by expression of the TMV CP gene from tobacco plants ***(23)***. Since then, resistance has been induced by transformation with the CP genes of many plant viruses in different host plants (**ref. *24***; *see* Chapter 3). More recently, other viral genes including the replicase and movement protein genes, have been used to effect resistance in plants. The demonstration that resistance could occur in the absence of translation of the transgene in some cases has led to continued questions about the mechanisms of CP-mediated resistance (*see* **ref. *25*** for review; *see also* Chapter 53).

Plant protection is the ultimate goal of most plant virus research; the elucidation of the virus life cycle through the use of transgenic plants may be a separate goal or a byproduct of the more applied research. For example, one of the most convincing experimental demonstrations that the 30-kDa protein of TMV was directly involved with cell-to-cell movement came from expression of the 30-kDa protein gene in plants, complementing the function of a mutant that was deficient in the 30-kDa gene and was not able to move systemically ***(26)***.

9. Future Directions

Plant virology has entered a stage in which virus characterization is less important as a research goal than it was only a few years ago, since viruses from almost every group have been examined at the primary nucleotide sequence level. At the same time, methods for determining host components required for infectivity and factors involved in the plant defense response have improved dramatically, and their associated genes can be manipulated for plant improvement. Twenty years ago viruses were the one plant pathogen that little could be done about in terms of control, except for removal of infected plants. Now, engineered resistance against plant viruses has become commonplace in