protoplast or tissue culture and the use of tissue cultures in the manipulation of ploidy (D. Ingram *et al.*, University of Cambridge). Hundreds of lines of potato and wheat plants derived from culture are being evaluated by state and commercial breeders.

The application of precise gene transfer to yield new cultivars seems some way off, even though crop plants such as potato have been successfully transformed and taken through a tuber generation (G. Ooms *et al.*, Rothamsted). The reason is the absence of genes, and even of the knowledge of which genes, to transfer. Since this problem stems largely from gaps in understanding of plant biochemistry, many of the techniques described above are being used to investigate aspects of plant metabolism.

Nitrogen and carbon metabolism have been the first to be attacked. The contribution of the *Rhizobium* genome to nitrogen fixation in the root nodules of legumes is being analysed rapidly and genes for fixation, nodulation and symbiosis have been characterized (J. Downie and A. Johnston, John Innes Institute, and see these columns in *Nature* **306**, 639; 1984). Plant genes involved in the symbiosis that have been isolated include that for leghaemoglobin (D. Collinge *et al.*, Aarhus University) and, more recently, glutamine synthetase (J. Cullimore *et al.*, Rothamsted). Cloning of other genes important in nitrate and ammonia assimilation is reasonably advanced only in prokaryotes (J. Wootton, University of Leeds). Genes for both subunits of ribulose bisphosphate carboxylase have been isolated; since that for the large subunit can be expressed in *Escherichia coli*, the way is open to explore structure–function relationships through *in vitro* mutagenesis (R. Ellis, University of Warwick, and A. Gatenby, Plant Breeding Institute). Directed *in vitro* mutagenesis affecting the active site of the single-subunit carboxylase of *Rhodospirillum rubrum* has already been achieved (S. Gutteridge and G. Lorimer, Du Pont de Nemours, Wilmington). Nitrogen and carbon metabolism have also been investigated with defined biochemical mutants. This has led to a better understanding of the pathways and their regulation as well as to new lines of barley with greater amounts of nutritionally essential amino acids in the seed (S. Bright *et al.*, Rothamsted).

Another active area of molecular biological investigation is the level at which genes are controlled in the defence mechanisms of plants against disease and stress as well as in the normal development of plants. For example, considerable progress has been made in identifying mRNAs involved in the early steps of phytoalexin (plant fungicides) biosynthesis (K. Hahlbrock *et al.*, Max-Planck-Institut, Köln), and the heat-shock proteins of plants and their mRNAs have been identified (F. Schoffl *et al.*, Bielefeld, FRG and Athens, Georgia). In both systems the synthesis of mRNAs appears to be largely controlled at the level of transcription. Other systems, yielding equivalent information, include the induction, by light, of the genes of certain chloroplast proteins (T. Gallagher *et al.*, University of Warwick) and the activation of genes involved in fruit ripening (D. Grierson *et al.*, University of Nottingham).

In summary, despite the activity and considerable progress reported, the genetic manipulation of crop plants is still only getting underway. For the present, improvements in agricultural plants will continue to come from that older and well-established technique of genetic manipulation, plant breeding. This technology (as described by J. Bingham, Plant Breeding Institute) is highly sophisticated; it can safely be predicted that the earliest successes of the recombinant DNA approach will enhance that sophistication rather than replace it. □

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Discovery of a comet

IN October 1892, when the American astronomer E.E. Barnard took the dry plate shown below, comet photography was not novel. As early as 1858, Donati's Comet was recorded on wet collodion plates by an English photographer named Usherwood. Sir David Gill obtained remarkably fine dry plates of the Great September Comet (1882 II), and cometary spectra were successfully photographed the previous year. But the image below marks the first photographic discovery of a comet.

It was a measure of the increasing role of photography in studying celestial bodies that only a month earlier Barnard had made what proved to be the last visual discovery of a satellite (Jupiter V, or Amalthea). In the course of his monumental survey of the northern Milky Way, Barnard photographed a field in the constellation Aquila with the 15-cm Willard portrait lens at Lick Observatory, California. When the plate was developed, a comet (1892 V) — or rather the trailed image produced by the comet's motion over four hours with respect to the background of distant stars — serendipitously appeared dead centre. Barnard had failed to spot it visually despite continuous observation through the guiding eyepiece during the long (260 min) exposure. As he later wrote, "Nothing whatever was known of its existence until it was shown on the photographic plate. It was then looked up in the sky and observed with the micrometer, i.e. visually through a telescope. . . Its history is complete, and until better evidence is forthcoming it will stand as the first comet whose original discovery was made by photography".

With a telescope of larger aperture, visual corroboration was immediately forthcoming. Photographs taken on succeeding nights were used to determine the orbit, recalculated by D. Yeomans in 1974 to yield a perihelion distance of 1.43 AU and a period of 6.52 years. **Jon Darius**

The photograph is one in an exhibition 'Beyond Vision' at the Science Museum, London from 19 April, and is reproduced here by courtesy of the Royal Astronomical Society. A book of the same title will be published in April by Oxford University Press.