

interactions between the  $M_r$  41 kDa viral Rep protein and the host factors, Rep was first over-expressed in *Escherichia coli* and its biochemical properties have been investigated. Using wheat dwarf virus (WDV) and tomato yellow leaf curl virus (TYLCV) as examples, we have demonstrated that Rep acts as a sequence specific endonuclease at the viral origin of replication. It becomes covalently linked to the 5'-end of the cleaved strand and subsequently joins single-stranded origin sequences *in vitro*. In addition, deletion analysis has shown that this nicking-joining activity maps to the amino-terminal domain of the Rep protein. Hence, the carboxy-terminal domain that contains a conserved nucleoside triphosphate (NTP) binding site is not necessary for the *in vitro* cleavage-joining activity; however, a functional NTP-binding domain is required for the full activity of the Rep protein in the replication cycle of the virus. *In vitro* phosphorylation assays have shown that cell extracts contain kinase activities that specifically phosphorylate Rep. Elucidation of the *in vivo* significance of the biochemical properties of the geminivirus Rep protein will help to unravel the molecular mechanisms involved in virus-host interactions.

**Identification and characterization of wheat dwarf geminivirus from France.** M Bendahmane<sup>1</sup>, F Jouanneau<sup>1</sup>, F de Kouchkovsky<sup>1</sup>, H Lapiere<sup>2</sup>, I Lebrun<sup>2</sup>, B Gronenborn<sup>1</sup> (<sup>1</sup> CNRS, Institut des sciences végétales, F-91198 Gif-sur-Yvette; <sup>2</sup> INRA, station de pathologie végétale, F-78026 Versailles, France)

Wheat dwarf, a prevalent disease in Northern and Eastern Europe, is transmitted by the leafhopper *Psammotettix alienus* (Dahlb). The disease 'pieds chétifs' of wheat, which has been reported in several departments of central France, is also transmitted by *P. alienus*. The typical symptoms of leaf streaking, severe stunting and reduced seed set resemble very much wheat dwarf. By molecular analyses we have identified the causative agent of 'pied chétifs' as wheat dwarf geminivirus (WDV). A novel simple and rapid method for purification of circular DNA from small amounts of plant tissue was developed and used to clone the genome of WDV-F (isolate France). We have sequenced the complete genome of WDV-F and have proven its infectivity by agroinoculation. Transmission by *P. alienus* of WDV-F from agroinoculated wheat (*Triticum aestivum* L) to healthy tester plants resulted in the

development of disease symptoms characteristic of wheat dwarf. The DNA sequence of the WDV-F genome consists of 2 750 bases and differs by only 1.3 and 1.4% from that of WDV isolates from Sweden and Czechoslovakia, respectively. A comparison of the sequence variation among the European WDV isolates with that of various isolates of maize streak virus (MSV) and other geminiviruses of Poaceae is presented. The implications for geminivirus evolution and distribution is discussed.

**Transmission of geminiviruses by vectors.** PG Markham (*John Innes Centre, Colney Lane, Norwich, Norfolk, NR4 7UH, UK*)

Geminiviruses are single-stranded DNA viruses with genomes of 2.5–3 kb, encapsidated in quasi-isometric particles which place them in the family *Geminiviridae*. Geminiviruses are transmitted by either whiteflies or leafhoppers (one exception is a treehopper). Discussed here are the leafhopper-transmitted geminiviruses, which infect monocotyledonous hosts, particularly maize streak virus (MSV). The actual losses caused by these viruses are difficult to establish but MSV has certainly limited production in many areas of Africa for at least the last century, and still causes epidemics. MSV is one of a complex of streak viruses that effect monocotyledons in Africa. There are a number of similar geminiviruses found in monocotyledons in Australia, Vanuatu, Japan, Asia and Europe. Indeed all these viruses may have a common origin in African grasses. All are leafhopper-transmitted and appear to have specific vector species. MSV is transmitted by several species of *Cicadulina* but the efficiency of transmission varies between species. *Cicadulina mbila* is the most efficient vector and has adapted readily to maize. In Australia the striate mosaic viruses are transmitted by different biotypes of *Nesoclutha pallida*, adapted to different hosts. The success of a virus-vector relationship depends on a number of interactions: symptoms, localisation of the virus in the plant, the feeding behaviour of the insect, the variety of plant, ecological factors, environment and other influences.

Monocot-infecting geminiviruses have a genome with 4 open reading frames, which code for replicative genes in the complementary sense (C) and a movement protein and the coat protein (CP) in the virion sense (V). In MSV point mutations in either C1 or V1 affect host range or have an effect on symptoms. The coat protein is