19th Century (Canova, 1962). SBWMV and WYMV were observed in Europe only in the 1960s.

Studies on the susceptibility of old French cvs were undertaken for understanding the presence of these viruses before the 1960s and to search for new sources of resistance.

In the 1930s in the west of France about a dozen cvs were characterized based on their susceptibility to a soil-borne fungi *(Lagena radicicola)* (Ponchet J, unpublished results) but the symptoms recorded resembled those of soil-borne mosaic viruses. We have shown that these cvs have similar characteristics to cvs susceptible or resistant to SBWMV. Moreover, in the plots observed earlier to be infested by *L radicicola*, *Polymyxa graminis* and SBWMV were also present. Owing to the large-scale incidence recorded in the 1930s, it may be considered that SBWMV was probably present in that zone at least from the beginning of the century.

The characteristics of 158 sources of bread wheat growing in a plot having the SBWMV-WYMV complex were analysed. These sources consisted of landraces and the first wheat cvs registered in the French catalogue.

Two thirds of the sources showing mosaic symptoms contained SBWMV and WYMV. Like the modern wheat cvs grown in France, cvs showing a specific susceptibility to SBWMV (30%) were much more frequent than those showing specific susceptibility to WYMV (1%). The cv Noe, which was widely used for wheat breeding programmes at the beginning of the century, is included in the category of cvs uniquely susceptible to SBWMV.

Studies are in progress to define the mechanism of resistance against these 2 viruses, which represented one third of the sources tested.

McKinney H (1923) *J Agric Res* 23, 771

Canova A (1962) *Annali Acc Agric Bologna* 73, 291-299

Genomic variability of bymoviruses. HH Steinbiß *(Max-Planck Institut für Züchtungsforschung, Carl-von-Linné-Weg 10, D-50829 Cologne, Germany)*

Barley yellow mosaic (BaYMV), barley mild mosaic (BaMMV), oat mosaic (OMV), rice necrosis mosaic (RNMV), wheat spindle streak mosaic (WSSMV) and wheat yellow mosaic viruses (WYMV; possibly a strain of WSSMV) all have 2 positive-sense, single stranded, 3'-polyadenylated RNAs, separately encapsidated in 2 filamentous particles. These viruses were all recognized as members of a genus of the family *Potyviridae* named bymoviruses, and they are transmitted by *Polymyxa graminis* Ledingham, a soil-borne plasmodiophorous fungus with worldwide distribution.

Due to the mode of transmission, the cultivation of resistant cultivars is probably the only means of controlling bymoviruses. Genetically engineered resistance has failed to date. In 1988, symptoms of BaYMV were detected on resistant cultivars simultaneously in England and Germany. Restriction mapping of BaYMV-2 and sequence comparison with BaYMV-G revealed several minor variations, but no resistance-breaking mechanism has been identified. Interestingly, the similarity between BaYMV and BaYMV-2 seemed to be more pronounced for RNA1 than for RNA2. This likely indicates that RNA2 molecules of bymoviruses are particularly unstable and prone to deletions as shown for RNA2 of mechanically transmitted isolates of BaMMV and BaYMV. These deletions affect domains of the putative 73 and 70 kDa proteins, which are obviously not essential for replication but may the important for the transmission of BaMMV/BaYMV by *Polymyxa graminis*. Additionally, RNA viruses generally show high mutation frequencies because of a lack of the proofreading enzymes that assure fidelity of DNA replication. Therefore, population of RNA viruses do not consist of a single genome species of defined sequence, but rather of heterogeneous mixtures of related genomes (quasispecies).

Molecular basis of the interactions between luteoviruses and aphids. JFJM van den Heuvel *(DLO Research Institute for Plant Protection (IPO-DLO), PO Box 9060, NL-6700 GW Wageningen, The Netherlands)*

Luteovirus are single-stranded RNA viruses which infect a wide range of mono- and dicotyledonous plants in which they replicate almost exclusively in the phloem tissue. They are transmitted by aphids in a circulative manner. Briefly, this implies that virus particles are ingested along with phloem sap from infected host plants and transcellularly transported through the hindgut into the haemocoel. The virus particles acquired are retained in an infective form in the haemolymph for the aphids' lifespan, apparently without replication. Upon contacting the accessory salivary glands, they may be transported

through this gland, eventually arriving in the salivary duct from which they are excreted with the saliva during feeding of the aphid. Luteoviruses display a high degree of vector specificity at the various transmission barriers in the aphid. These well-developed specificities suggest an intimate association between a luteovirus and its vectors in which both surface domains of the viral capsid and sites or substances in the aphid are involved. The role of the viral capsid in conferring aphid transmissibility to a luteovirus has been convincingly demonstrated. Recently, aphid-derived components suggested to be involved in virus transmission were revealed by a protein blot-based virus overlay assay.

Adaptation and application of immuno-PCR method to study the interactions of aphids and barley yellow dwarf luteoviruses. JQ Guo [1], H Lapierre [2], JP Moreau [1] *([1] INRA, unité de zoologie; [2] INRA, unité de pathologie végétale, F-78026 Versailles cedex, France)*

The immuno-PCR method was adapted to amplify the French isolates of barley yellow dwarf, PAV, MAV and RPV luteoviruses in aphids. The sensitivity of this RT-PCR allowed for detection of 1 pg/ml of purified PAV virus preparation, and for a 128-fold dilution of a single viruliferous aphid *(Rhopalosiphum padi)*. Conventional PCR could detect such single aphids with only an 8-fold dilution, even though the virus accumulated to near 1 ng/aphid in a 5 d acquisition feeding on infected barley.

PAV virus was detected by immuno-PCR from the gut, salivary gland, hemolymph and legs, but not from the stylet and head of aphids of *R padi*.

PAV, MAV and RPV viruses were recovered by immuno-PCR in the hemolymph of virus-carrying *R padi*, *Sitobion avenae*, *Metopolophium dirhodum*, *Diuraphis noxia*, *Myzus persicae*, *Aphis fabae* and *A gossypii* after a 2-d inoculation feeding on healthy barley.

In a serial transfer test, *R padi* efficiently transmitted PAV and RPV, *S avenae* efficiently transmitted PAV and MAV until the last transfer at 13 d on barley. The Md-Nord clone of *M dirhodum* occasionally transmitted PAV and MAV, but not RPV, for up to 11 and 7 d transfers. Infrequent transmission of PAV was also found during the transfers of 7–11 d by *D noxia*, but not MAV and RPV.

Virus content (405 OD value) in a batch of 10 aphids of *D noxia* was much lower than that of *R padi*, *S avenae* and Md-Nord of *M dirhodum*. The decrease of virus content in the aphids was biphasic following the serial transfers. The initial decrease occurred rapidly after the first transfer. In the second phase, the decrease trend differed among the aphid species, but without being bound to virus transmission. Immuno-PCR could detect PAV, MAV and RPV viruses in the aphids of 4 species until the last transfer at 13 d, with the exceptions that for RPV in *D noxia* and in the Md-Nord clone it was only to 7 and 11 d transfers, and for MAV in *D noxia* to 11 d transfer.

Therefore, the aphid gut, as a barrier to the virion passage into the aphid's hemocoel, may not play a role of specific selection among these luteoviruses.

Intraspecific variations for transmission of BYDV-PAV and -MAV isolates by the aphids *Sitobion avenae* and *Rhopalosiphum padi*. E Sadeghi, CA Dedryver, S Tanguy, G Riault *(INRA, laboratoire de zoologie, domaine de la Motte, F-35650 Le Rheu; 65, route de Saint-Brieuc, F-35042 Rennes cedex, France)*

PAV transmission by S avenae

Fifty *Sitobion avenae* clones were collected in January 1990 in the area of Rennes on wheat, barley and oats, and tested for their ability to transmit a local isolate of BYDV-PAV (PAV4) to barley (cv Express). The acquisition and inoculation conditions were standardized: 20°C; L16/D8; 2 d acquisition; 5 d inoculation; 3 fourth instar larvae/test plant; 3 repetitions of 20 test plants/clone. Transmission percentages make a continuum from 3% for the worst transmitting clone to 92% for the best. There was however a non-negligable intraclonal variance. There was no non-transmitting clone but 5 clones were very bad vectors (less than 10% transmission). Deep green clones transmit significantly less than clones of other colors. Clones collected on wheat and oats transmit significantly less than clones collected on barley.

These results incited us to study the possible role of aphid stylet activities on interclonal variations of PAV transmission (Prado and Tjallingii, 1994). Two very different clones were compared by the technique of EPG (electropenetrography: Tjallingii, 1978): Sa5 (3% transmission) and Sa1 (50%) on barley and wheat. Preliminary results show that clone Sa5 feeds very badly on barley, with long non-feeding periods, few and short