

# Molecular and Biological Aspects of Tospoviruses

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## I. INTRODUCTION

### A. Historical Aspects

Most members of the *Bunyaviridae* infect animals but some are able to infect plants. The plant-infecting viruses, which are propagatively transmitted by thrips species, are classified into a separate genus, *Tospovirus*, named after the type species *tomato spotted wilt virus* (Francki *et al.*, 1991). Since the late 1980s, when increased knowledge in the molecular biology of tomato spotted wilt virus (TSWV) allowed it to be included in the *Bunyaviridae*, a number of distinct tospovirus species are still being identified and classified within the same family.

The first report on the “spotted wilt” disease of tomatoes dates back to 1915 when Brittlebank described this plant disease in Australia (Brittlebank, 1919). Later it was demonstrated that the causal agent of the infectious disease was a virus (Samuel *et al.*, 1930) for which the name *tomato spotted wilt virus* was coined. The virus was shown to be spread by thrips (Pittman, 1927), a large family of minute insects (order *Thysanoptera*; family *Thripidae*). These discoveries were followed by an increasing number of publications on the occurrence of TSWV in many countries on a large number of host plants. These reports also led to some confusion since the virus was

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reported under many different names, e.g., tomato bronzing virus, Kromnek virus, pineapple yellow potyvirus, makhorka tip chlorosis virus, vira cabeça virus, and others (Best, 1968; Smith, 1972; Sakimura, 1962). This variation in nomenclature reflects the wide variation of disease symptoms, depending on virus isolate, host species, and the different regions where the disease was found. After World War II the occurrence of tomato spotted wilt disease declined in Western Europe and the United States, whereas in Eastern Europe, South America, and South Africa the virus remained a serious problem. The decline in Western Europe and the United States has been explained by the effective chemical control of the onion thrips, *Thrips tabaci*, which at that time were probably the most important vector of TSWV.

From the early 1980s on, a rapid emergence and marked geographic spread of TSWV has taken place (Barker, 1989; Marchoux *et al.*, 1991; Vaira *et al.*, 1993) which was preceded by a rapid expansion of another efficient vector, the Western flower thrips (*Frankliniella occidentalis*) (Mantel and Van de Vrie, 1988; Brødsgaard, 1989). Reports of new hosts accumulated at an exceptionally high rate (reviewed by German *et al.*, 1992) and, to date, TSWV is known to infect more than 650 different plant species, monocots as well as dicots, belonging to more than 70 distinct botanical families. Susceptible hosts include many important agricultural crops such as pepper, peanut, pea, potato, tobacco, and tomato, vegetables such as celery and lettuce, and ornamentals such as dahlia, chrysanthemum, gerbera, impatiens, and iris, and many weeds. TSWV ranks among the ten economically most important plant viruses, causing crop losses worldwide of more than \$1 billion (Goldbach and Peters, 1994). The disease is widespread in many agricultural production areas on all continents, mainly in the warmer climate zones, while in areas with a temperate climate the virus is prevalent in greenhouse cultivations. Furthermore, surveys have revealed the existence of a number of other tospoviruses in addition to TSWV, the economic impact of which still remains to be assessed.

## B. Classification of Tospoviruses

For a long period TSWV was classified as the single representative of a monotypic plant virus group, the "tomato spotted wilt virus group" (Matthews, 1979). With the unraveling of its molecular biology, this virus was shown to have properties in common with members of the *Bunyaviridae*. Therefore, TSWV has recently been classified as the prototype of a newly created genus within the *Bunyaviridae*, the genus *Tospovirus*. Using techniques like ELISA and sequence determination, it has been found that TSWV itself (i.e., as a single species) is in many instances responsible for infections worldwide of a wide range of plant species (de Ávila *et al.*, 1990). However, these studies also revealed the existence of a number of other, distinct tospovirus species (Table I). Impatiens necrotic spot virus (INSV) was the first virus recognized as a separate tospovirus (Law and Moyer, 1990). This virus has a distinct host range, infecting mainly ornamental plants such as impa-