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Viruses of trees

33. VIRUSES OF TREES

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1. Perspective

Virus associated diseases are known in more than 40 genera of woody perennials hardy in the United Kingdom (Cooper, 1979) but relatively little is known of their importance except in fruit trees. Knowledge that apple mosaic virus can halve the extension growth of apple trees and decrease girth increments by one fifth suggests, however, that other viruses may threaten amenity trees and production forestry. Although viruses have been detected in the roots of economically important conifers, they have not been detected in their foliage although they are commonly found in that of broadleaved trees. Building on studies of fruit tree viruses made at many institutions, detailed investigations of broadleaved woodland and amenity trees were initiated hoping that the techniques evolved would facilitate the study of viruses in conifers whose detection may have been impeded by copious amounts of resins and related substances. This study was started in 1972 and has been done with the notable collaboration of Dr J.B. Sweet at Long Ashton Research Station.

Following the identification of cherry leaf roll virus (CLRV) in *Betula* spp in UK (Cooper & Atkinson, 1975), effects of the virus on the competitive and regenerative capabilities of birch have been studied. At an early stage, it was observed that seedlings from infected seed, although without foliar discoloration, tended to grow somewhat more slowly than virus-free plants from the same parents (Cooper, 1976*b*).

By comparing pollen from 6 virus-infected and 6 healthy trees it was found that CLRV did not consistently alter percentage germination or rates of pollen tube growth. During a 2-year period following pollination with virus infected pollen, none of the 12 recipient trees *(B. pendula)* became infected; however, some of their seeds were infected. Like *B. pendula,* none of 28 specimens of *Prunus avium* became systematically infected after being pollinated with CLRV-carrying birch pollen. It seems therefore that pollen is not a vehicle of CLRV spread between mature trees of different genera, but further confirmatory evidence is required. However, the evidence to hand is not incompatible with the known properties of cherry leaf roll virus particles, namely that isolates of CLRV from different host genera are serologically distinguishable. CLRV has also been investigated in species of *Juglans.* Although apparently absent from 230 plants of black walnut, *J. nigra,* it was found in 23 of 33 mature specimens of common walnut, *J. regia,* and in 32 of 1046 imported seedlings. As in birch, CLRV has been found to be transmitted in one seed batch of *J. regia* at a rate of 18 in 300 seed.

When assessing the importance of hedgerows as virus reservoirs, *Fraxinus* spp were examined knowing that ash dieback, a debilitating disease with progressive defoliation culminating in death, commonly afflicts virus-infected ash in North America, (Hibben, 1966, 1973; Lana & Agrios, 1974). In UK, where dieback is prevalent, (Figure 59), arabis mosaic virus (AMV) naturally infects *Fraxinus excelsior* (Cooper 1975, 1976*a*) and *F. americana* (Cooper & Sweet, 1976). However,

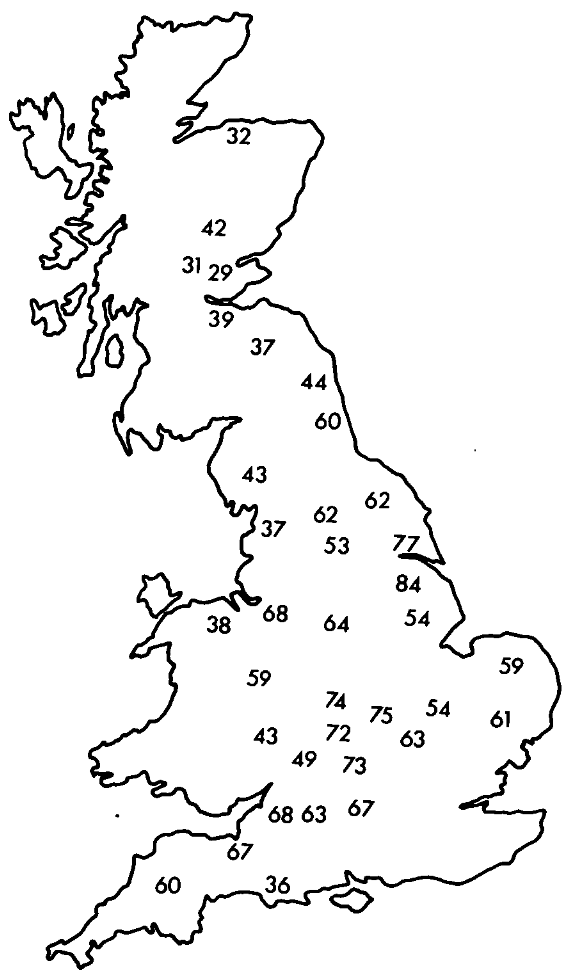

Fig. 59 *Frequency of ash dieback (trees with 10% or more branches from which leaves were absent except at the tips) recorded as a percentage of totals examined in each of 36 counties/metropolitan districts.*

tests made on more than 300 trees showed that dieback was not critically associated with the occurrence of AMV, a deduction supported by the occurrence of ash dieback in regions of Scotland where soils are not infested with the nematode vector of AMV (Taylor & Brown, 1976). Notwithstanding, tests are in progress to assess the long-term effects of AMV on ash in urban localities where its effects may be exacerbated by environmental stresses.

Following Atanasoff's (1935) description of leaf symptoms in poplar, the pathology of the casual virus, poplar mosaic (PMV) has been studied in the Netherlands (Berg, 1964) and in UK (Mackay & Beaton, 1969) where it was thought to decrease growth of *P. x euramericana* clones such as Gelrica, by 25%. However, for this type of work it is desirable to have access to virus-free planting stocks. These have been obtained, using techniques developed for producing virus-free fruit trees. With J.B. Sweet, of Long Ashton Research Station, 9 clones without poplar mosaic virus were produced. One of these (Lons), unlike many others, develops obvious leaf symptoms when infected. For this reason it is now being vegetatively reproduced to enable damage assessments and other types of experiment to be done, including assessments of spread. However tests started in 1975, located at 3 sites and using clones Robusta, Regenerata and I-78, suggest that PMV, if it spreads from tree to tree, does so very slowly, a result justifying the planting of virus-free poplars at least in the UK where it is concluded that vegetative propagation is the most important and possibly the only means of spreading PMV. With R. Koster of Rijksinstituut, De Dorschkamp, and using virus-infected and virus-free *P. nigra* and *P. deltoides* it was found that poplar mosaic virus was not spread in seed or pollen.

The distribution of poplar mosaic virus-like particles and the general ultrastructural appearance of naturally infected poplar foliage (Atkinson & Cooper, 1976) closely resembles that attributed to potato virus M (a carlavirus) in *Phaseolus vulgaris* (Tu & Hiruki, 1971). However, unlike many carla viruses, PMV is not transmitted by species of aphids and mites. Until recently bioassays measuring, albeit inconsistently, the infectivity of leaf extracts by the production of foliar symptoms in test plants were the only way of detecting poplar mosaic virus. Now, however, virus can be detected in frozen poplar leaves (hitherto the inoculum needed to be fresh) using an enzyme-linked immunosorbent assay. It has been possible to confirm that virus concentrations are largest in leaves with severe symptoms. Typically, the oldest leaves which expand in cool weather during the spring are least affected and have the smallest concentrations of virus. The middle leaves of the current year's growth are usually the most severely diseased with the largest concentrations of viruses. The tip leaves become increasingly diseased with the passage of time—a pattern of symptom development that seems common in trees but which requires substantiation and explanation. Virus detection has additionally been improved in other ways. Thus the addition of 1% nicotine, 3.5% polyvinyl pyrolidone (MW 44000)), 0.1% thioglycerol and 0.02 m diethyl dithocarbamate to phosphate buffer increased by a factor of x 1000 the quantities of CLRV extracted from leaves of *Juglans regia.*

2. The way ahead

Added to the observations made by fruit tree virologists, results already obtained emphasize the widespread occurrence of viruses in trees of all sorts. However, our knowledge is scant. In particular, virtually nothing is known of the significance of viruses in woodland and amenity trees. Are they damaging and, if so, to what extent? Are they a threat to other types of plant? To this end, growth rate studies are being made with cherry leaf roll virus and birch; arabis mosaic virus and ash; and poplar mosaic virus and poplar; 3 model systems which will be kept under surveillance for long periods to investigate whether viruses diminish host vigour at constant rates or whether tree growth is, but temporarily, checked following infection.

Cherry leaf roll virus seems to have a predilection for perennial woody hosts yet little is known about its biology. Curiously it can be transmitted from infected pollen to seed but not to the mother plant—why? Why are most specimens of common walnut in southern England (albeit of a small sample) infected when fewer than 10% of seed carry the virus? Is the virus like others, transmitted in a variety of ways? What are these? To enable these questions to be answered effectively it is necessary to sustain work on virus characterization, enabling their separation and identification. In a small survey made of *J. regia,* more than 30 virus isolates were obtained. Are they all the same? Are the differences among them biologically significant? How should these be characterized? Increasingly virologists resort to a blend of physico-chemical and biological methods so as to gain insight into the ways in which viruses vary, relating chemical constitution to infectivity and serological properties.

The environments in which viruses exist are multidimensional. Viruses depend upon their vectors; they are influenced by the susceptibility and tolerance of their different hosts which in turn are likely to change at different stages of development and at different seasons. It must be recognised that the genetical variation within a single species population of plants is likely to be matched by comparable variation within viruses. In summary, the role of viruses in trees is a complex picture but one in which preliminary observations on woodland and amenity trees suggest that further work is needed, the amount of commitment being determined to a considerable extent by the hazard posed to plant growth and hence the ability of plants to compete with others.

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