

Some Characteristics of a Virus from Virginia Crab Apple

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ABSTRACT

The herbaceous host range of a virus from a Virginia crab apple with stem-grooving symptoms was limited to two *Chenopodium* species. It was not possible to identify the virus by its host range, dilution end point (10^{-4} - 10^{-5}), thermal inactivation point (50-55 C), and particle length (613 nm). A distinctive characteristic of the virus, called HMV-A, was the induction of hypertrophied mitochondria in necrotic leaf areas. *Phytopathology* 61:431-432.

Additional key words: apple virus.

While studying ultrastructural changes effected by elongated plant viruses, we obtained from W. Allen, Vineland Research Station, Canada Department of Agriculture, a virus from a Virginia crab apple tree with stem-grooving symptoms; he favored (Allen, *personal communication*) placing the virus in the Type-2 group

of apple viruses (6, 7). We were able to transmit the virus only to *Chenopodium quinoa* Willd. and *C. amaranticolor* Coste & Reyn., but failed to transmit it to *Nicotiana glutinosa* L., *Petunia hybrida* Vilm. 'Blue Velvet', *Cucumis sativus* L. 'National Pickling', *Vigna sinensis* Endl. 'Blackeye', *Vicia faba* L., *Gomphrena globosa* L., and eight cultivars of *Phaseolus vulgaris* L., 'Black Turtle', 'Kentucky Wonder', 'Bountiful', 'Red Kidney', 'Tenderbest', 'Tendergreen', 'Great Northern', and 'Pinto'. Until purified virus preparations are obtained, however, the failure to transmit the virus from *Chenopodium* leaf sap to other hosts must be considered in light of the virus inhibitor known to be present in *Chenopodium* species (1, 5).

The primary symptoms in *C. quinoa* consisted of three or four local lesions, rarely more than 20, which became necrotic over several weeks, and finally appeared as markedly depressed angular blotches of mixed chlorosis and necrosis. Lesions were up to 3 mm in diam, but often three or more lesions coalesced. Systemic symptoms (Fig. 1-A), which appeared in 6-10 days, consisted of marked reduction in leaf size, and a vivid mosaic pattern of yellow and dark green, with circular and irregular necrotic areas, some along the midveins. Dwarfing and epinasty were common. Primary symptoms in *C. amaranticolor* were local lesions less than 1 mm, usually with reddish brown centers and

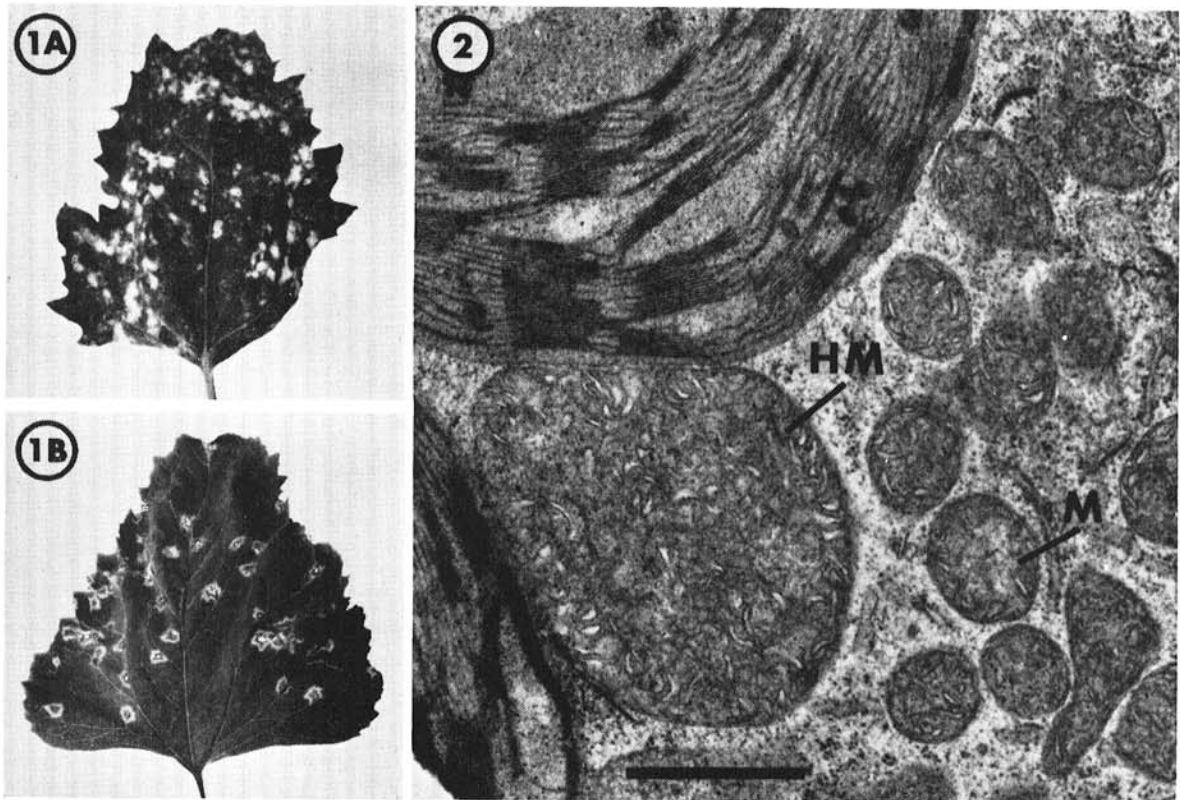


Fig. 1-2. 1) Leaves of (A) *Chenopodium quinoa*, systemically infected with the hypertrophic mitochondrial virus of apple, (HMV-A), and (B) *C. amaranticolor* with primary necrotic lesions produced by HMV-A. 2) Portion of mesophyll leaf cell of *C. amaranticolor* infected with HMV-A, showing hypertrophied mitochondrion (HM) and normal mitochondrion (M). The bar indicates 1 μ .

narrow, chlorotic, oak-leaf halos (Fig. 1-B). Occasionally infection became systemic, producing a fine chlorotic mottle which proceeded from the base of the leaf to the apex.

The thermal inactivation point, determined twice with undiluted sap from systemically infected *C. quinoa* leaves, heated for 10 min, and assayed on both *Chenopodium* species, was between 50 and 55 C. The dilution end point was 10^{-4} - 10^{-5} . Dimensions of the virus particles were determined from electron micrographs of 104 particles in leaf exudates stained with 2% phosphotungstic acid (Fig. 3, inset). The data are shown in the histogram (Fig. 3). The mean particle length was 613 ± 78 nm, while the mode was 625-650 nm. The width was 18-20 nm. No similar particles were found in healthy controls.

The virus showed characteristics of both Type 1 and Type 2. The stem-grooving symptoms in Virginia crab apple suggest a Type-2 virus (6), but we were unable over 18 months in all seasons of the year to transmit

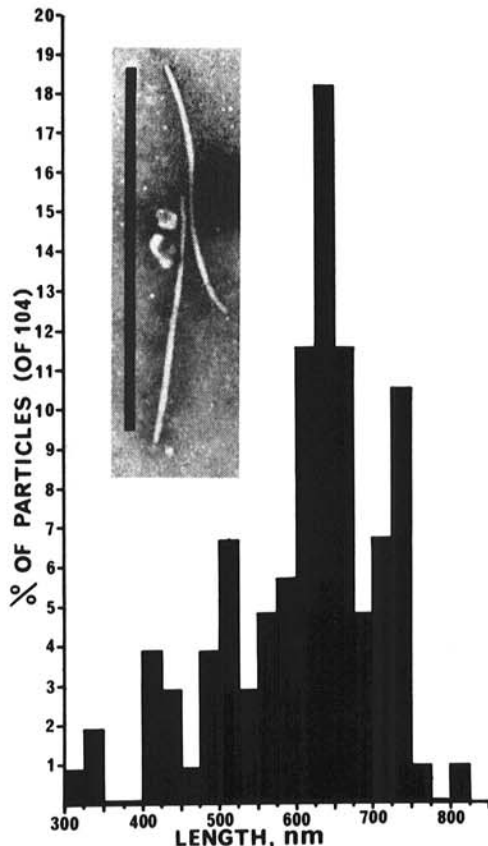


Fig. 3. Histogram showing distribution of particle lengths of HMV-A. Inset shows negatively stained virus particles. The bar indicates 1 μ .

the virus to herbaceous hosts reported to be susceptible to Type-2 viruses (6, 7). The thermal inactivation point was close to that of the Type-1 virus, C-8 (4), but higher than those for other Type-1 viruses, Cadman's *Prunus* isolate (2) and Cropley's chlorotic leaf spot virus (3). Inactivation temp reported for Type-2 viruses appear to be somewhat higher, 60-63 C for the C-431 isolate (7), and 63-67 C for the E-36 isolate (6). The dilution end point of 10^{-4} - 10^{-5} is the same as that of the Type-2 virus C-431 (7), although another Type-2 stem-grooving virus, E-36, has an end point of 10^{-3} - 10^{-4} (6). Similarly, the end points reported for Type-1 viruses are 10^{-3} - 10^{-4} (2); never more than 10^{-3} (3); and 10^{-4} - 10^{-5} (4). Reported particle lengths for Type-2 viruses range from 612-674 nm (4, 7), but since there are no published measurements for any Type-1 virus (2, 3, 4), our measurements are of doubtful assistance in identification.

We are unable, therefore, to place this virus clearly in either group. It would not be accurate to refer to it as a "stem-grooving" virus, since this would imply a Type-2 virus (6, 7). We prefer to focus attention on a different kind of characteristic, revealed in ultrathin sections of the *Chenopodium* leaf cells. In local lesions of the primary infections of *C. quinoa* and *C. amaranticolor*, and in necrotic areas of systemically infected *C. quinoa*, the mesophyll cells contained hypertrophied mitochondria which attained an enormous size compared to normal mitochondria (Fig. 2). These made up about 10% of the total number of mitochondria, and were found in lesions prior to necrosis and in cells bordering the lesions. Details of structure, formation, and breakdown of the hypertrophied mitochondria, with other pathological effects of the virus on cell ultrastructure, will be published separately. But since these abnormal organelles provide such a distinctive and striking characteristic of this virus, we have called it the hypertrophic mitochondrial virus from apple, or HMV-A.

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