Tubular Structures Associated with Maize Rough Dwarf Virus
Particles in Crude Extracts: Electron Microscopy Study

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Tubular structures enclosing single rows of virus particles have been repeatedly found associated with infection by maize rough dwarf virus (MRDV). They have been seen in ultrathin sections of leaves from both infected maize (Gerola & Bassi, 1966) and wheat plants (Gerola et al., 1966) and also sections of some tissues from viruliferous planthoppers Laodelphax striatellus Fallén (Vidano, 1966). During further work on MRDV, still in progress in our laboratory, we have recently noticed that such tubular structures can survive in crude extracts of diseased plants and often they still contain the row of virus particles.

The extracts were made from the leaf enations of MRDV-infected maize plants (cv. ‘Wisconsin 641 AA’) and the procedure described by Lovisolo (1967) was followed in a slightly modified form. The plants had been infected with viruliferous planthoppers one to two months previously and showed the typical symptoms of the disease. The enations were cut from the leaf veins with a razor blade and crushed in 0.85% saline using a glass pestle. The preparations were then mixed with an equal volume of 2% potassium phosphotungstate at nearly neutral pH and examined in a Siemens Elmiskop II electron microscope.

Numerous MRDV particles were seen in the preparation either scattered or in groups. In addition, some particles were found enclosed in straight, unbranched tubules with open ends (Fig. 1a). The tubule walls consisted of a single layer about 10 nm. thick; the tubules were 110 to 120 nm. wide and of different lengths, some of which had evidently arisen by breakage of longer structures (Fig. 1b). The longest tubule found was about 3,000 nm. long with 31 virus particles inside, while the shortest tubular fragment found in the preparations was only long enough to contain two virus particles.

All the particles enclosed in the tubules had a diameter of about 70 nm. Most of the particles not in the tubules had the same diameter, but some were only about 50 nm. in diameter (Fig. 1b, c, d, arrows). The appearance of the particles has been described elsewhere (Lovisolo, 1967).

All the tubules contained only a single row of virus particles though some clusters of empty and broken tubules were found.

Using methods described elsewhere (Conti, 1969) some preparations were injected into MRDV-free L. striatellus and proved to be highly infective (M. Conti, unpublished results).

Tubules similar to those described here have been found associated with other leafhopper-borne plant viruses such as clover wound tumour (Shikata & Maramorosch, 1966), rice dwarf (Shikata, 1966), rice black streaked dwarf (Shikata, 1968) and pangola stunt viruses (Kitajima & Costa, 1970). They have also been found in the testicule cells of Typhlocyba douglasi Edw. infected with a virus considered to be similar to clover wound tumour virus (Maillet & Folliot, 1967).

Tubules have also been found in plants infected with nepoviruses such as cherry leaf roll (CLRV), strawberry latent ringspot (Walkey & Webb, 1968, 1970; Roberts & Harrison, 1970) and tobacco ringspot viruses (TRSV) (Davidson, 1969; Roberts, Christie & Archer, 1970; Walkey & Webb, 1970). These tubules closely resemble those associated with leafhopper-transmitted plant viruses though they have a smaller diameter and their wall is of...
two layers (Walkey & Webb, 1968). Dahlia mosaic virus (Kitajima, Lauritis & Swift, 1969),
turnip yellow mosaic virus (TYMV) (Hitchborn & Hills, 1968), and some other viruses
also cause tubular structures to form in infected plant cells.

The tubules associated with TYMV are built of protein serologically related to the virus
particles (Hitchborn & Hills, 1968), but it is not known whether the MRDV tubules consist

Fig. 1. MRDV particles and associated tubules in crude extracts from maize leaf enations: (a) single
tubule enclosing MRDV particles; (b) tubular fragments of the same tubule after rupture; (c) MRDV
particles enclosed in the portion of tubule on the right and scattered in the preparation; some
50 nm. particles – indicated by arrows as in (b) and (d) – are also present; (d) tubular fragment with
MRDV particles heavily penetrated by potassium phosphotungstate.
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of virus particle proteins (MRDV particles probably contain more than one protein, TYMV particles contain a single type of protein).

The function, if any, of the tubules is uncertain. The tubules in TRSV- and CLRV-infected plants may be involved in movement of virus particles from cell to cell through plasmodesmata (Davidson, 1969; Roberts et al. 1970; Walkey & Webb, 1970). Vidano (1966) has suggested that the MRDV tubules have a similar function, whereas Gerola & Bassi (1966) have suggested that they are a cell reaction to confine virus spread.

As far as we know the only other report of tubules enclosing virus particles being found in crude extracts is that from Walkey & Webb (1968) who were working with nepoviruses.

The origin of the 50 nm. particles found in the preparation is unknown. They might be incomplete, immature or even degraded 70 nm. particles of MRDV, and it is noteworthy that 50 nm. particles have never been observed inside the tubules, which may protect the enclosed virus particles when being prepared for microscopy. The 50 nm. diameter particles closely resemble those found in purified suspensions of MRDV by Wetter et al. (1969). These particles are being investigated further jointly with the 'Institut für Landwirtschaftliche Virusforschung', Braunschweig, West Germany.

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REFERENCES


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