Elektronmikroskopievereniging van Suidelike Afrika PRETORIA (1973)

ULTRASTRUCTURE OF A FUNCTIONAL SENESCENCE PROCESS

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The rôle of cell death is becoming increasingly recognised as a functional event in certain developmental processes of both plants and animals (e.g. 1, 2).

Xylem is presumably fully functional for water conduction only after the protoplasts of its constituent cells have completely degenerated and disappeared. Much work has been done on the process of xylem wall deposition prior to any obvious events associated with protoplast degeneration. In general, however, developmental events leading to xylem cell death have not received much critical attention (3).

Autophagic activity by the vacuole(s) of xylem elements becomes very noticeable during that developmental phase when active secondary wall deposition is proceeding. Invagination of the tonoplast, the first visible sign of autophagy of cytoplasmic components, is illustrated in Figure 1. At this stage there is evidence for the export of wall material from the protoplast to the extracellular space and the whole appearance of the cell is indicative of considerable metabolic activity. The plant cell vacuole is by now established as a major lysosomal compartment (4); Figure 2 shows scattered cytoplasmic material and Figure 3 illustrates disorganised membranous cytoplasmic components during their breakdown in the lysosomal vacuole.

Although autolysis is ultimately precipitated by tonoplast dissolution and collapse of the protoplast away from the wall, it is probable that individual organelles partially contribute to their own destruction. Figure 4 shows that acid phosphatase, an enzyme whose cytoplasmic distribution is usually associated with lysis, occurs within mitochondria prior to autolysis of the cell. This hydrolytic enzyme also occurs in the extra-cellular space, itself a lysosomal compartment (5), and associated with the wall. Dissolution of the tonoplast is accompanied by the appearance of vesicles around the periphery of the vacuole (Fig. 5). These vesicles may represent rounded-off fragments of the tonoplast itself.

Ultrastructurally-visible events, particularly involving the activity of lysosomal compartments appear to contribute to the degeneration and death of xylem element protoplasts. Xylem is fully-functional as the water-conducting system in a vascular plant only when the protoplasts of its constituent elements have disappeared. Thus a study of the xylem system provides information about a cellular developmental process which involves systematic removal of cytoplasmic constituents presumably redundant to the particular concerted activity of secondary wall deposition. This developmental process ultimately terminates in autolysis of the protoplast, so providing the functional elements of the water-conducting system of the plant.

References.
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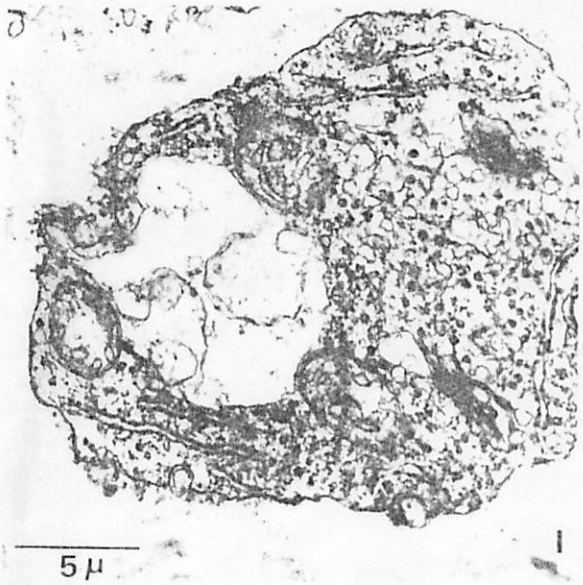

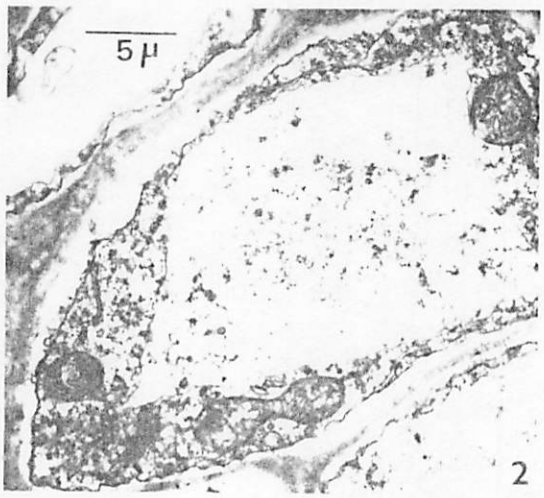

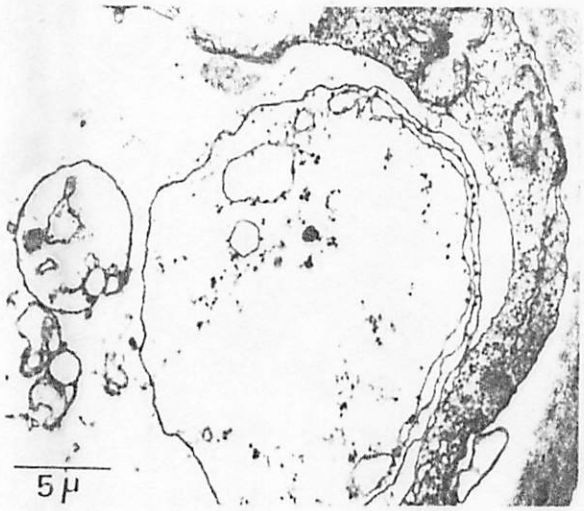

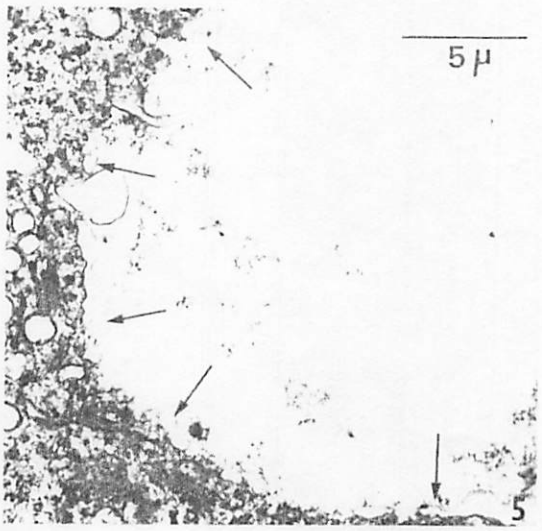

Figs. 1-3. Illustrate autophagic activity by the vacuole.

Fig. 4. Shows acid phosphatase localization within mitochondria, the extracellular space and in the wall.

Fig. 5. Tonoplast dissolution with formation of vesicles (arrows) at the vacuole/cytoplasm interface is illustrated.