SCANNING ELECTRON MICROSCOPY OF SYNCYTIA INDUCED BY 
NACOBBUS ABERRANS IN TOMATO ROOTS

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The morphology of walls of syncytia induced by Nacobbus aberrans in tomato roots has been 
examined by scanning electron microscopy after digesting out the cytoplasm from the cells. A clear 
boundary exists between the gall cells which surround the syncytium and the transformed cells.
Syncytial cells are interconnected by perforations through their walls; these perforations are numerous 
and are frequently round or oval in shape. Wall ingrowths are absent. The structure of these syncytia 
is compared with those induced by other endoparasites.

The reaction of host plant tissues to infection by phytoparasitic nematodes of 
the genus Nacobbus has been much less studied than the response of host tissues 
to other endoparasitic nematodes. Using the light microscope, Schuster, Sandstedt & 
Estes (1964, 1965) described the cellular changes caused in a number of hosts by 
N. bataiformis, and Clark (1967) described the development and life history of 
N. serendipiticus on tomato, where galls containing syncytia were only found in 
association with adult female nematodes.

The ultrastructure of syncytia induced by cyst-nematodes (Heterodera spp) and 
giant cells induced by root-knot nematodes (Meloidogyne spp) has been examined 
by both transmission and scanning electron microscopy (Bird 1961; Huang & Mag-
genti 1969; Paulson & Webster 1970; Gipson, Kim & Riggs 1971; Ambrogioni & 
Syncytia induced by Rotylenchulus reniformis have been studied by transmission 
microscopy (Jones & Dropkin 1975a; Rebois, Madden & Eldridge 1975).

Using the scanning electron microscope, we have studied the wall structures of 
syncytia induced in tomato roots by N. aberrans and have compared them with 
those induced by other endoparasitic nematodes.

MATERIALS AND METHODS

Galls cut from tomato roots infected with N. aberrans were fixed either in 6% 
glutaraldehyde in 0.05M cacodylate buffer for 18 hr at 4°, rinsed in the buffer, 
then post-fixed in 1% osmium tetroxide in 0.05M veronal-acetate buffer pH 7.4 
for 3 hr at 4°; or in 3% glutaraldehyde in 0.025M phosphate buffer pH 7.2, 
rinsed in buffer and postfixed in 2% osmium tetroxide in the same buffer for

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2 hr at room temperature. Tissues were transported by airmail either in 70% ethanol after the first regime or in phosphate buffer after the second.

After rehydration of the partially dehydrated specimens the roots were split open carefully with a clean, sharp razor blade on a dental wax sheet. The cytoplasmic contents of the cells were removed by the following treatment: 1% periodic acid (2 min), wash well with distilled water, 4% KOH at 55° (30 min), wash with distilled water, 1% acetic acid (2 min), wash well with distilled water (Kinden & Brown 1975, Jones & Dropkin 1976). The specimens were then refixed in osmium, dehydrated, critical point dried from acetone, coated with gold and examined in a Hitachi HHS-2R electron microscope at 10 or 15 kV.

**OBSERVATIONS**

The appearance of cytoplasm in syncytia prepared without the digestion procedure is shown in Fig. 1. It is composed of numerous small vacuoles, and smooth, oval starch grains are also visible. The organisation of a syncytium within a gall after the cytoplasm has been removed is illustrated in Fig. 2. The structure has been described as a spindle- or crescent-shaped mass of cells which may reach 3 mm in length by 2 mm in diameter (Schuster, Sandstedt & Estes, 1965). The extensive mitotic stimulation of cells around the syncytium is evident. The tiers of cells in some regions indicate that active division of cambial cells has occurred. The outline of the syncytium is irregular, but there is a strict demarcation between cells which have been incorporated into the syncytium and those outside, which are much smaller (Figs. 2, 3, 6). During the process of incorporation of cells, expansion in all three dimensions has evidently occurred (Figs. 3, 4), with no obvious polarity. Although the individuality of the cells in the syncytium has been maintained, the cytoplasmic contents are clearly free to move through the extensive gaps in the walls between the cells (Figs. 3, 4, 7), and these gaps are well illustrated by scanning electron microscopy. They may be round, oval or irregular, and the area of any one wall which is perforated is variable (Figs. 4, 7). The perforations are similar in appearance to those in syncytia induced by cyst-nematodes (Jones & Dropkin, 1975b), but the latter are more variable in shape and may be separated by long, thin columns of wall. The rounded nature of the perforations gives the impression that wall degradation was enzymatic not mechanical. The remaining wall between perforations is very thick and it appears that considerable deposition of polysaccharides must have taken place (Figs. 4, 7). The shape and orientation of columns of wall material between some gaps suggest that the expansion of cells in the syncytium has increased the size of the original perforations (Fig. 4). If the walls are softened during wall hydrolysis, expansion and wall breakdown may occur at about the same time.

In the cells surrounding a syncytium, differentiation of vascular elements is evident. Xylem elements, frequently of abnormal shape, develop both within the mass of smaller cells many cell layers away from the syncytium (Fig. 2) and also adjacent to syncytial cells (Figs. 3, 6). Similarly groups of phloem cells, looking