

sufficient length show clamp connections. Sometimes they penetrate no further than the epidermis; at other times the subepidermal cells and even the outermost cortical cells are affected also. Entry into a subepidermal cell is effected by hyphae forcing their way along the middle lamella and entering probably through a weakened pit. The hypha grows towards the nucleus which becomes enlarged, then evanescent and finally together with the cytoplasm disappears completely. The hyphae themselves collapse and disappear. Often the penetrated wall is considerably altered, appearing much thicker than previously and, as well as being suberised, giving a slight reaction for lignin. In some cases suberised, cellulosic sheaths which were secreted around the entering hyphae persist as papillose outgrowths (röhrentüpfel) projecting into the cell cavity. In isolated cells where the hyphae have penetrated to the outermost cortex all the walls of the subepidermal cells are thickened. Occasionally röhrentüpfel occur also on the radial walls of the epidermis. The thickened walls and röhrentüpfel appear to seal off areas damaged by the fungus.

The Second Type of Infection

This occurs where the tuber lies alongside a young manuka root on which the fungus is well established. Hyphae are densely aggregated between the surfaces of the root and rhizome. Some of the hyphae enter the epidermal cells of the tuber and form a dense coil within each cell over a band some 10 cells wide (Fig. 2). They grow into the cortex through a single passage cell of the subepidermal layer in which a similar, tight coil develops and in some cases röhrentüpfel also. Once within the cortex the hyphae spread tangentially in a zone some 3 cells deep, filling each cell with a tight coil of uniform diameter as they proceed (Fig. 2). The nucleus of each infected cell enlarges, becomes slightly lobed in outline with a conspicuous nucleolus, then becomes evanescent and disappears, leaving a gap in the position it formerly occupied. The cytoplasm disappears also. A single layer of cells on the inner side of the cortex functions as the main digestive layer (Fig. 2). Although not predetermined, the region soon becomes conspicuous by enlargement of the cells in a radial direction and by the course of the infection. The digestive cells are infected by hyphae growing radially inwards from the cortex and not by hyphae travelling tangentially. The entering hyphae branch into many fine threads which become greatly coiled along their length and expanded at their tips as they grow towards the nucleus (Fig. 3). Starch gradually disappears from the cell commencing at the periphery. The enlarged nucleus becomes grossly deformed by constricting into 4 or more portions held together by narrow, isthmus-like regions. Fungal cytoplasm released into the host cell appears as numerous spherical bodies (ptyosomes) which gradually shrink in size as they are slowly absorbed until they disappear completely. In the last stages of absorption the cytoplasm of the digestive cell becomes coarsely granular. The coiled remains of the hyphal walls persist for a time together with a lignified basal sheath at the point of entry. The penetrated wall itself becomes lignified. Gradually the nucleus reassumes a more spherical shape though still enlarged, then eventually loses its stainability and together with the cytoplasm disappears. Usually one or two layers of cells on the inner side of the main digestive cells are also affected by the fungus. Hyphae forcing their way along the middle lamella enter the cells as a fine, coiling, unbranched thread which grows towards the nucleus. Starch gradually disappears from the cells. The nucleus enlarges, sometimes becoming lobed, loses its staining properties, and then disappears together with the cytoplasm and the hyphal thread.

Eventually the whole region of invaded cells below the protective layer collapses, leaving a cavity in the tuber. The protective layer, now unsupported