

of the finest roots of diameter 0.1 to 0.2 mm lying closely appressed to the tubers and even encircling them. Older rhizomes die away in the autumn, and only those of 2 to 3 seasons persist through the winter, some as vegetative tubers and others with the flower-primordia for next season already present. The tubers lack roots but carry the ragged remnants of scale leaves. Regions of fungal infection are visible as concave, circular marks 2 to 3 mm in diameter or as larger, brown, roughened patches up to 10 mm in length. With a lens it can be seen that in places slender brown hyphae form an open network over the surface of the rhizomes and extend on to the fine roots lying alongside.

COLLECTION AND TREATMENT OF MATERIAL

Most of the material was collected in mid-December and early May from the Lake Manapouri site. Here a water-retentive, organic-matter layer, some 70 mm deep, composed of decaying manuka leaves and mosses and penetrated by fine manuka roots is readily lifted from an underlying, morainic gravel or sandy-clay zone. The tubers of *Gastrodia minor* occur at the base of the organic horizon and are readily excavated from the soil.

Immediately following their removal some of the rhizomes and the manuka roots alongside were killed and fixed in formalin-acetic-alcohol. Later these were embedded in paraffin and sectioned at thicknesses of 8μ to 20μ . For general anatomical study safranin and Delafield's haematoxylin, safranin and fast green, or chrysoidin and fast green proved satisfactory stains. Other rhizomes and roots were brought back to the laboratory and either potted up in the glasshouse or used in an attempt to identify and isolate the fungus as described below.

For comparison of the root structure of manuka in other soils, material was collected from a terrace site in the Manawatu, where the soil type is Tokomaru silt loam with a heavy textured subsoil, and this root material was later sectioned and stained. Also, plants were grown from seed in sterilised potting soil in a glasshouse.

ANATOMY OF THE *Gastrodia* RHIZOME

A transverse section of the rhizome shows the following structure. On the outside is a protective region of suberised cells, consisting of an epidermis of flattened, pavement-like cells and a subepidermal layer of isodiametric cells. The layer immediately below may be suberised also. There is a cortex some 3 cells deep, a few of the cells containing a deposit of calcium oxalate in the form of a bundle of raphides and the rest storing small starch grains. A wide, central zone has vascular bundles scattered throughout the ground tissue of thin-walled cells packed with large, compound, starch grains.

THE FUNGAL INFECTION OF THE RHIZOME

There are two types of fungal infection. The first affects the epidermal cells, sometimes the subepidermal cells, and occasionally the outermost cortical cells also. The second affects deeper cells of the tuber.

The First Type of Infection

On the surface of the tubers there are septate hyphae of diameter 6μ , showing clamp connections and having rather thick, brown walls when old (Fig. 8). Usually the hyphae occur singly, but in the confined space of the axils of the scale leaves they may entwine in a loose strand. Infection takes place by a hypha, after first attaching itself, forcing its way along the middle lamella of a radial wall, or occasionally penetrating the outer wall directly, then entering the cell and destroying its contents. Inside the cells the hyphae are usually thin-walled and of diameter 2– 2.5μ , but in a few cells there are brown, thick-walled hyphae of diameter 4μ . They lie in a band or loose coil within the cell cavity, and if of