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FUNGAL DISEASES IN PLANT PROPAGATION

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A number of plant disease problems can be encountered in plant propagation but two of the most important, "damping off" and "root rot", can be used to illustrate some of the main principles of avoiding disease.

Consideration of disease can be based on what is sometimes called "The Disease Triangle" (Figure 1). It is self evident that to have disease there must be a *host* and a *pathogen* but the mere presence of these two does not necessarily mean that a disease problem will result. There are few, if any, fungi encountered in nursery propagation which are so virulent and so infectious that their presence is a virtual guarantee of disease. The influence of the third element of this triangle, the *environment*, is vitally important in determining the outcome and whether or not disease results.

This Disease Triangle represents the three important elements in the natural situation but in crop production generally, and in nursery production in particular, there is another important factor which influences all three and the interaction between them. This is Man or Management (Figure 2). Management can be used to affect these factors to push the outcome in the desired direction, toward good plant growth and low levels of disease.

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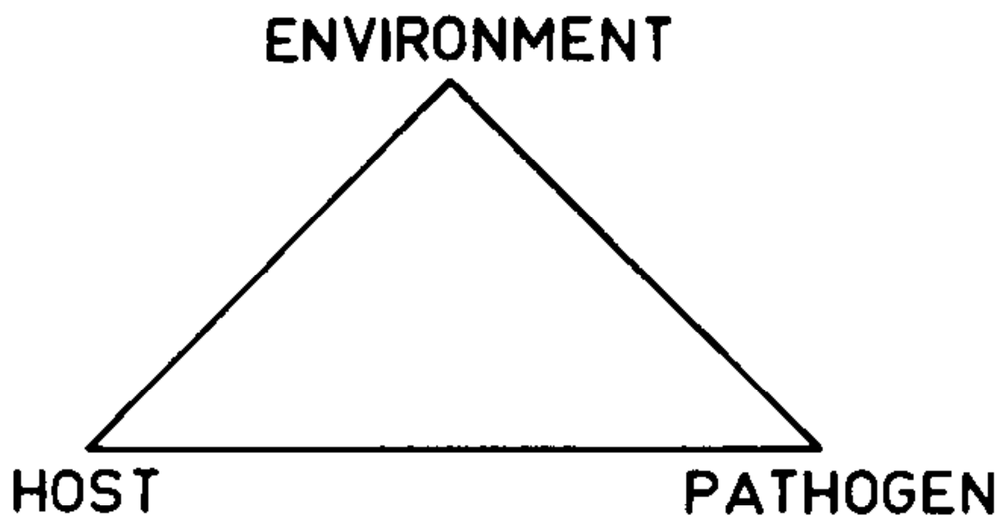

Figure 1. The Disease Triangle.

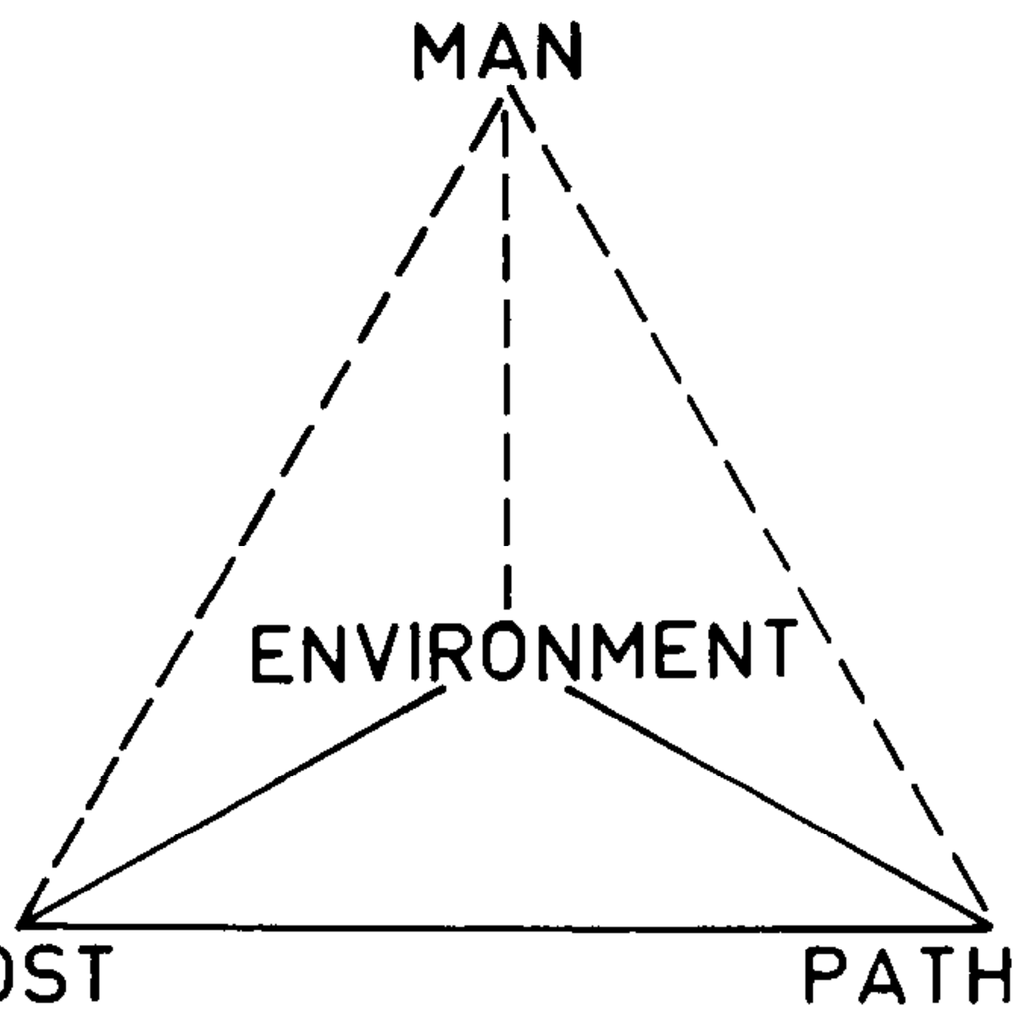

Figure 2. Man can affect each element in the Disease Triangle.

The *host* can be influenced by, for instance, the selection of species and cultivars; other things being equal, resistant cultivars will be used in preference to susceptible ones. The *pathogen* can be influenced very greatly by *hygiene*. The *environment* can be influenced in many important ways. Temperature and humidity are influenced by heating, cooling and ventilation. Soil moisture is under management control by drainage, watering regime, and choice of soil or potting mixture.

The "damping off" problem can be used to illustrate the importance of some of these factors. "Damping off" is due to attack by a fungus — usually a *Pythium* species. Those essentials of the life cycle of *Pythium* necessary to illustrate the points are represented in Figure 3. It consists of two interlinked cycles, the upper, non-sexual reproductive cycle, and the lower, sexual cycle. The common point is the hyphae or fungal threads which ramify through the plant tissue causing rotting and death (Figure 4). In the asexual cycle swellings on these hyphae (called

sporangia) germinate to form thin-walled sacs into which their contents migrate and segment to form a mass of zoospores which are released into the soil (Figure 5). These zoospores are equipped with fine whip like "paddles" or flagellae which enable them to swim in the films of water around the soil particles. After a period of free swimming they lose their flagellae, and encyst. This is followed after a rest period by germination and fresh infection of new roots and the production of hyphae to complete the cycle.

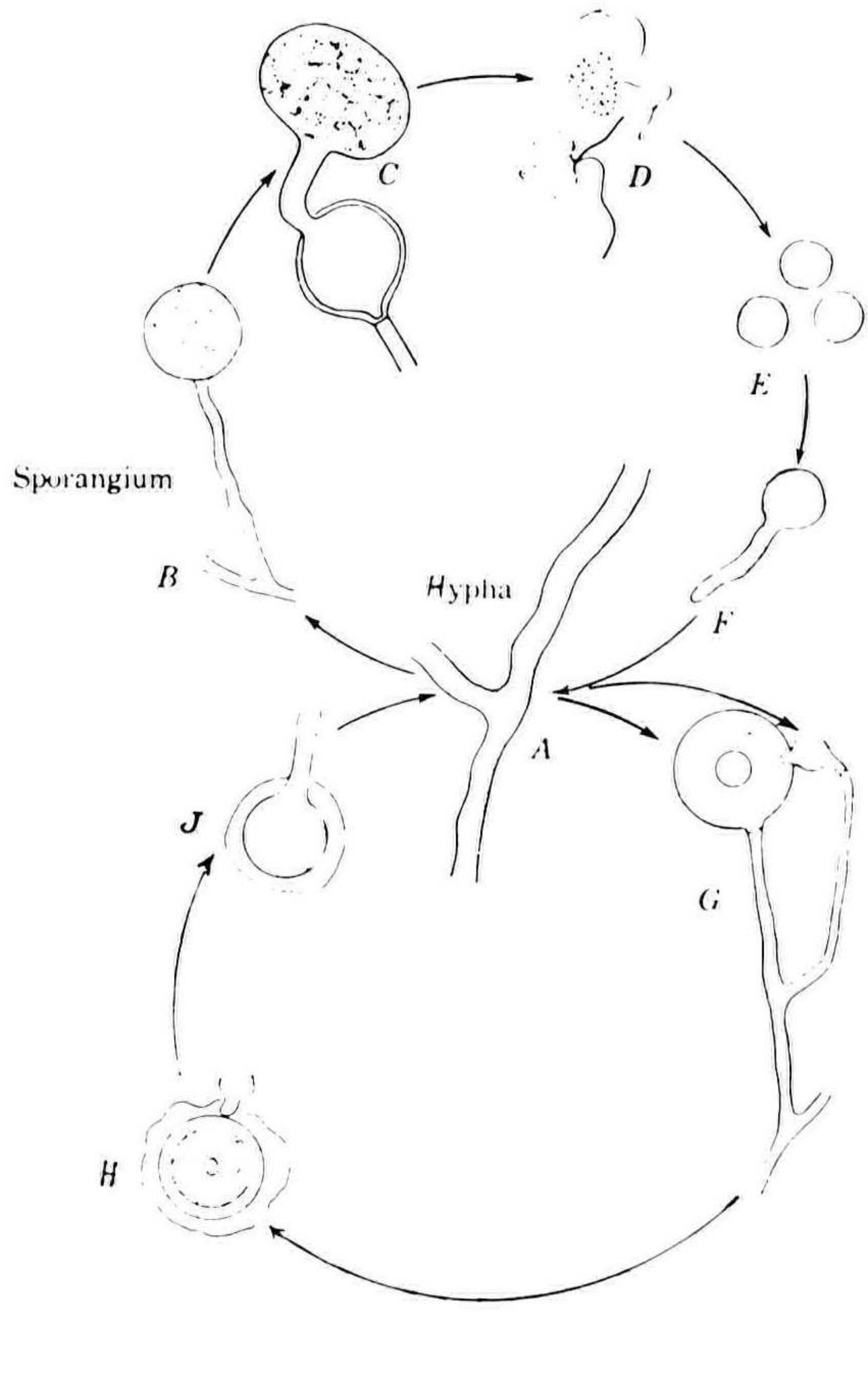

Figure 3. The life cycle of *Pythium*. Above: A to F — The non-sexual cycle. The sporangium (B), germinates to produce a vesicle (C), from which the zoospores (D) are released. After encysting (E) they germinate (F) to produce new infections.

Below: A to J — The sexual cycle. An egg cell (G) is fertilized to produce the thick-walled oospore (H) which can survive for long periods before germination (J).

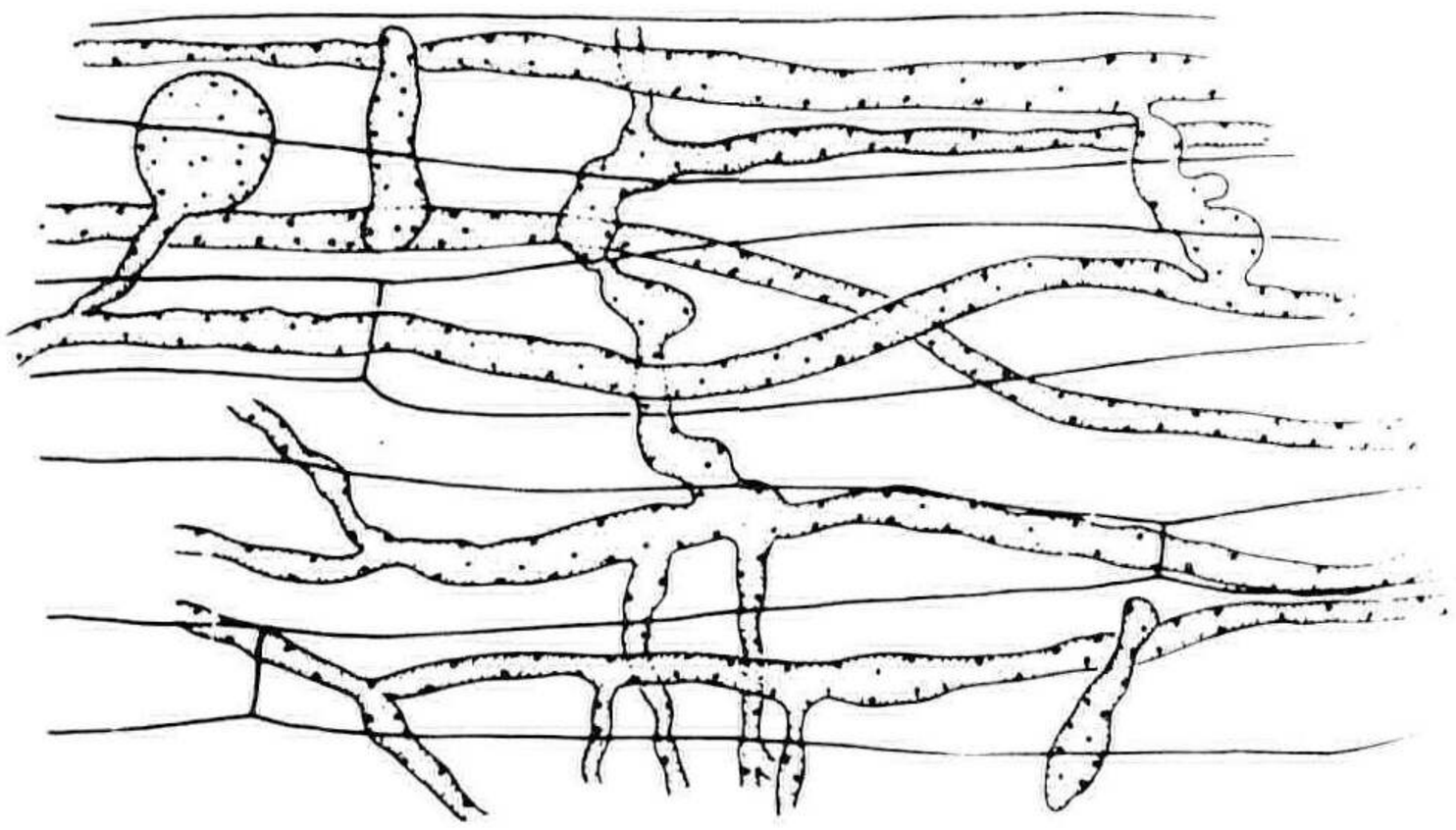

Figure 4. The hyphae or fungal threads of *Pythium* ramifying through plant tissue.

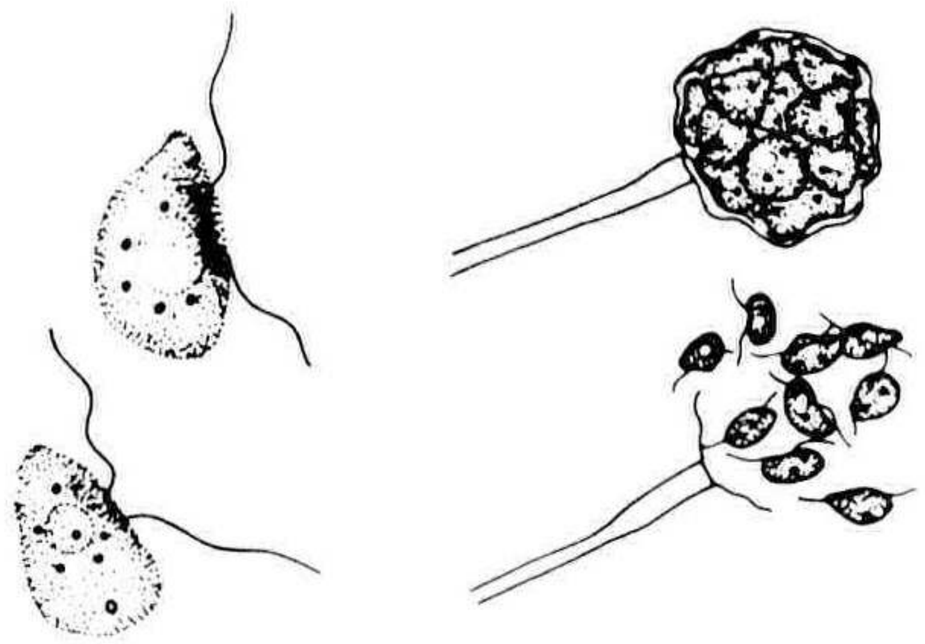

Figure 5. Production and release of the flagellate zoospores of *Pythium*.

In the context of nursery management of the environment the important aspect of this life cycle is the production of the specialized swimming spores which enable the fungus to spread rapidly and infect new roots and new seedlings. This process is greatly favored by wet soil conditions and the aim of management must be to ensure adequate soil moisture for plants while avoiding excess water which will be unduly favorable to the fungus.

Unfortunately this is not the complete answer since while there is enough water for plants to grow there will be enough for slow spread. It is therefore much better for the soil to be free of the fungus in the first place. In Figure 3 the lower circle shows the sexual cycle of the fungus. The important feature of this cycle in the context of avoiding disease in the soil, is the very thick walled "egg spore" or oospore (Figure 6). These spores are produced in large numbers and are capable of long survival in soil irrespective of conditions. When conditions are favorable they germinate to produce hyphae and the asexual cycle of zoospore production occurs with consequent disease risk in plants.

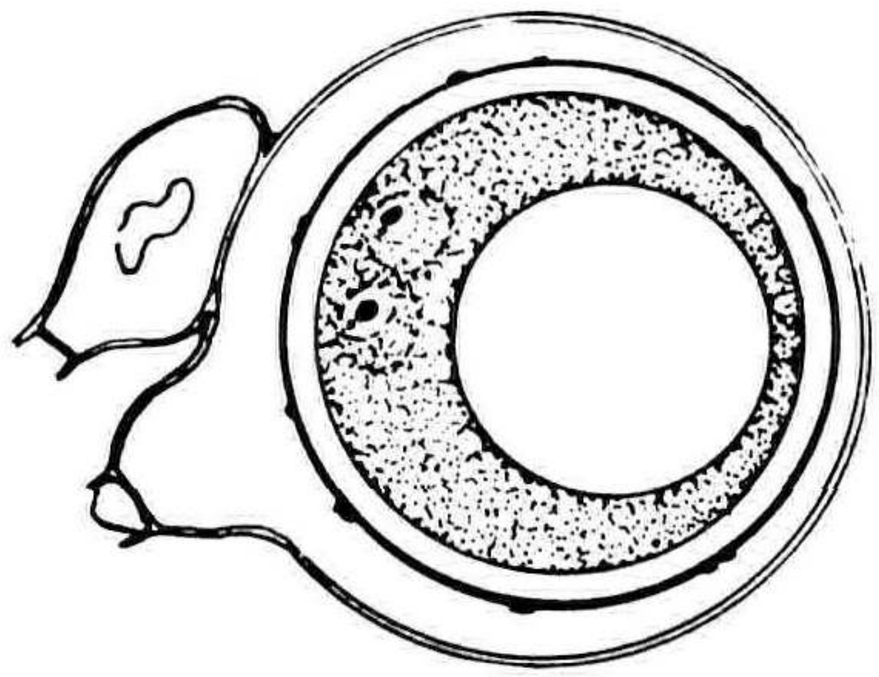

Figure 6. A thick walled resistant oospore of *Pythium*.

The answer to protection of young plants from this risk lies in soil pasteurization followed by hygiene. These two features, soil pasteurization and hygiene go hand-in-hand — soil pasteurization without hygiene is useless; hygiene without soil pasteurization may be little better.

The choice of methods for soil pasteurization is a wide one and some possibilities with their advantages and disadvantages are shown in Table 1.

Once soil is pasteurized by one of these means the reintroduction of contamination must be guarded against by the practice of rigorous hygiene. The tools, containers, working and growing surfaces used in conjunction with pasteurized soil must all be themselves clean and sterilized.

Any contaminated soil from these or any other sources will serve to reintroduce infection and quickly undo the benefits of pasteurization.

The two aspects of the life cycle of *Pythium* which are important in the above considerations i.e. the swimming zoospores and the thick-walled resistant oospores, also occur in the life cycle of *Phytophthora cinnamomi* the fungus which has caused much concern in nursery propagation, particularly of many native species in Australia in recent years. The key to its control

Table 1. Methods of Soil Pasteurization.

		Advantages and Disadvantages
Heat	Dry Heat	Difficult to apply and likely to ruin soil structure
	Steam	Very effective but expensive and some danger to operators. Any recontamination spreads quickly. Induction of toxicities e.g. ammonia and manganese is common.
	Steam/air	Equally effective, less expensive, safer. Retains antagonistic fungi and bacteria which restrict spread of recontaminants. No toxicity problems.
Chemicals e.g. Methylbromide Chloropicrin Dazomet Methyl isocyanate Formalin		Less extensive capital outlay required but restricted range of action, very careful soil preparation required; very temperature-dependent for effectiveness and dissipation of phytotoxic chemicals. Toxicities are quite common. Varying degrees of danger.

is management to eliminate the long lived oospores from the soil by pasteurization; to prevent recontamination from implements, containers and growing surfaces; and to maintain moderate soil moisture levels which favor the plant without being excessively favorable to the spread of zoospores.