PART I

CHAPTER I

INTRODUCTION TO FUNGI

It is well known that the yields of the common farm crops show enormous variations which may be due to a number of causes, e.g. kind of soil, variety of seed, management and climate. Often, however, very different yields may be obtained when the above conditions are almost identical, and in these cases it is usual to attribute the loss of crop to a "disease." Diseases of plants then may be looked upon as causes which prevent normal growth.

It is usual to classify plant diseases into two groups:

(1) Those caused by unsuitable surroundings, such as unfavourable conditions of soil, or of weather.

(2) Those caused by living agencies.

It is this second group, the diseases caused by fungi and insects, with which we are here concerned.

The two groups are not however strictly separable, for we often find plants weakened by some condition of their surroundings marked out for attack by a living agency.

The mangolds at the Rothamsted Experimental Station often suffer from leaf spot caused by a fungus known as *Uromyces betae*, but not all the plots are

equally susceptible to the disease. The plots which have received the largest quantities of nitrogenous manures but no potash suffer most. Except for the manuring all the plots are under similar conditions. Variations in food supply therefore seem to be important in that they cause varying susceptibility to disease.

The fungi belong to the lowest group of the plant kingdom and, as we shall see later on, cause a large number of plant diseases. They differ from ordinary green plants in that they do not contain any of the green colouring matter so characteristic of the latter. It is this substance, known to botanists as "chlorophyll," which enables green plants to take from the air certain food materials that they are unable to obtain from the soluble substances in the soil. A fungus is unable to live in this way on the constituents of air and soil, but requires its food to be manufactured for it, and so it takes advantage of the food materials made by other plants. Some live on the decaying remains of plants and animals, e.g. toadstools live on leaf mould and also on manure heaps; others can only take their food from living plants, or in a few cases from animals. Those living on dead materials are known as *Saprophytes* and those on living plants as *Parasites*. There is no definite boundary line between these two classes: some members are capable of living as parasites at one period of their life and as saprophytes at other periods when the living food supply is not at hand.

Among cultivated plants are forms which differ very considerably in appearance and this naturally is found in other groups of plants. It is difficult to see any resemblance between the mushroom which we eat and the smut that blackens corn, or the yeast used by

brewers, or the mould that grows on jam or decaying fruit, and yet all these belong to the group of fungi. The best method of studying fungi is to grow them. The following experiment shows an easy way of doing this: allow a piece of bread to stand exposed to the air for a few hours. Then moisten it, and place it on a piece of damp blotting paper under a glass or bell

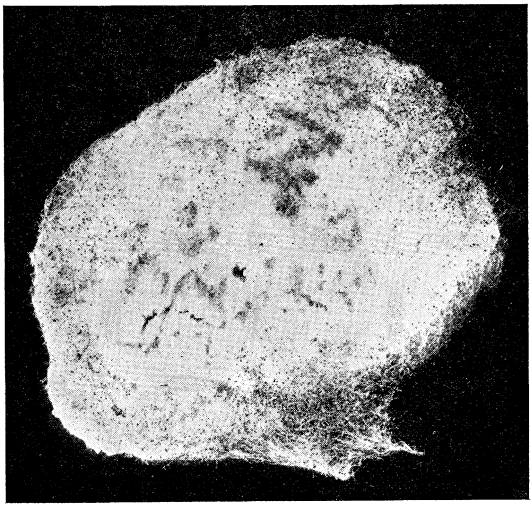


Fig. 1. Mucor growing on bread.

jar in a warm room. In a few days the surface becomes covered with white tufts having a velvety appearance. Under the microscope these appear as a number of white interlacing threads which are part of a fungus plant and collectively known as its *mycelium*. If one of these mycelial threads known as a *hypha* is carefully examined it is seen to consist of a tube-like structure

containing a somewhat granular substance which is the living portion or *protoplasm* of the fungus. Some of the tubes have no dividing walls but others are divided by cross walls into compartments called *cells*,

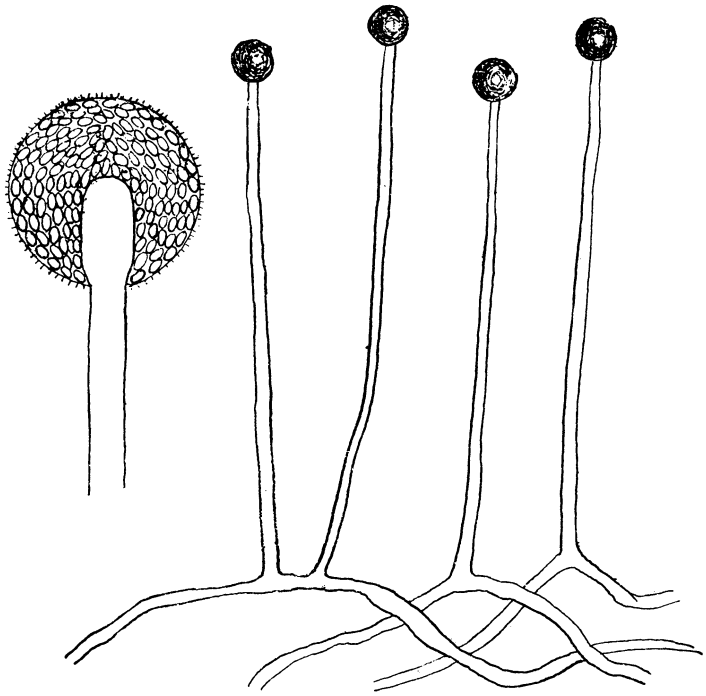


Fig. 2. Spore bearing cases of Mucor. (Magnified.)

the length of which varies with the fungus under observation. Further examination of the tufts on the bread shows that all the threads do not belong to the same fungus. Some of them carry tiny balls, at first white and later on turning black, each being borne on

a long stalk (see Fig. 2). This fungus is known as a *Mucor*. Other threads give rise to a greyish powder, which under the microscope is seen to consist of numerous egg-shaped bodies like bunches of grapes. These are the seeds or, as they are usually termed, the *spores* of the fungus known as a *Botrytis* (see Fig. 3). We may also find a fungus bearing light-blue spores

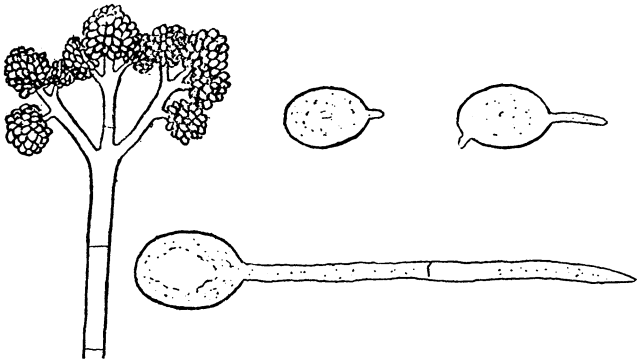


Fig. 3. Spores of Botrytis borne like bunches of grapes and some of the spores germinating. (Magnified.)

borne in chains at the ends of branches which join to form a single stalk. This fungus is a *Penicillium* (see Fig. 4).

Spores of any of these fungi placed under suitable conditions give rise to the same kind of fungus plant or mycelium as that on which they were borne. The following is a means of studying the growth of spores. Take a *Ward's Tube* (see Fig. 5) and fix the base of the chamber to a glass slide by means of paraffin wax; put in a small quantity of water. Take some of the spores of the Botrytis fungus on a brush and put them

Fig. 4 *a*. Spores of Penicillium as seen under the microscope.

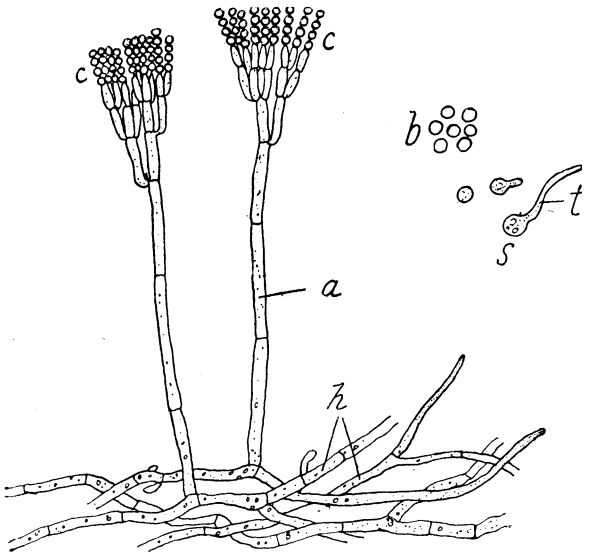


Fig. 4 *b*. (*a*) Erect hyphae bearing conidia (*c*) in chains. (*b*) Detached conidia. (*s*) Germinating conidia. (*t*) Germ tube. (*h*) Mycelium. (Magnified.) (After Percival.)

into a small drop of water on a coverslip large enough to cover the top of the chamber; smear the top with vaseline and place on it the inverted coverslip. The spores are now in a hanging drop in a moist chamber and can be watched under the microscope. After about 12 to 24 hours the oval spores send out small projections which continue to grow; later on cross walls are formed (see Fig. 3).

In water growth ceases as soon as the food in the spore is used up. If, however, a food solution is used for a hanging drop instead of the water, the tube continues to grow, branches and gives rise to the

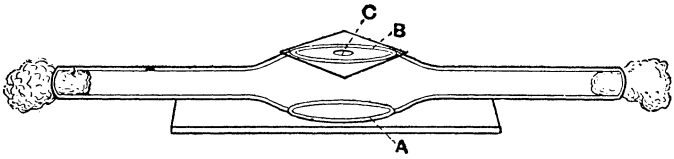


Fig. 5. A Ward's tube. *A*, paraffin wax; *B*, vaseline; *C*, the hanging drop.

same kind of mycelium as that on which the spore was borne.

A method now in common use for the study of fungi consists in making cultures of them in such substances as plant extracts, meat extracts, gelatin, or agar-agar (prepared from sea-weed) or a mixture of some of these. The medium is freed from living organisms by means of heat and then infected with fungus spores or pieces of mycelium. Saprophytes and many parasites grow and form spores; some parasites, however, such as rusts, will not grow in this way. The experiment is usually carried out in tubes stopped with cotton wool or in Petri dishes (see Fig. 6).

In neither case can foreign organisms enter the culture. It is thus possible to grow a fungus free from all other organisms. If at first the culture is not pure a few spores of the required fungus may be transferred to a sterile medium and a pure culture so obtained. The mushroom fungus resembles those already examined in consisting of a mycelium and a part which bears the spores. The spawn contains a

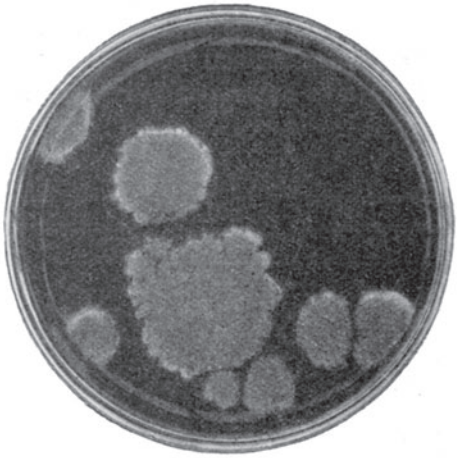


Fig. 6. Colonies of a fungus growing on gelatin in a Petri dish.

dense growth of hyphae which take up food from decaying matter and then produce the fructification known as a mushroom.

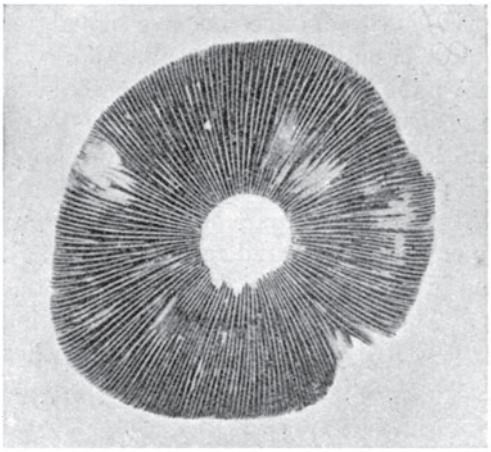
If some of the white strands (i.e. mycelium) from mushroom spawn are placed in decaying manure or rich soil containing much organic matter, and kept moist and at a suitable temperature, mushrooms will be formed. If however the soil contains very little

organic matter, no mushrooms will form. This is because the mushroom does not live like a green plant, but requires organic matter for its food.

Remove the stalk of a ripe mushroom and place it with the coloured part downwards on a piece of white paper and leave it for some time. Then tap it gently and lift it; on the paper will be found a print similar to the gills or coloured part of the mushroom which is found to consist of coloured spores (see Fig. 7). These are borne in pairs on some of the cells on the sides of the gills. The mushroom is the spore-bearing part of the fungus and it can be produced from these spores as well as from spawn. Toadstools similarly bear spores.

So far we have been growing the fungi on dead materials and dealing only with saprophytes. Parasitic fungi can be obtained by growing plants under suitable conditions for fungus attacks. Sow cress seed in a pot of soil, keep the soil very wet and in a fairly warm atmosphere. The young seedlings soon wilt and die. Examination of the surface of the soil shows a ramifying growth of mycelium, some of which has entered the plant. Here, then, we have a case of a fungus capable of injuring a plant and therefore a parasite, but it is also capable of living on the soil as a saprophyte. There are many others besides this one capable of living either as saprophytes or parasites. Some however can live only as saprophytes, e.g. Penicillium, and others only as parasites, e.g. rusts.

In a previous experiment we simply moistened a piece of bread, and on leaving it found that fungi began to grow. How did these get on the bread? The following experiment affords an answer. Take a piece



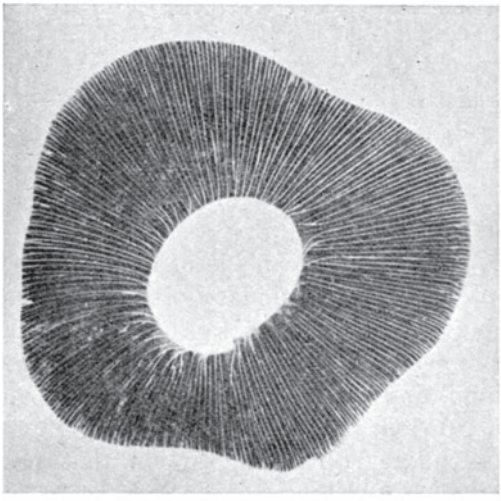


Fig. 7. Spore prints of common toadstools.