TEXTBOOK OF FUNGI

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Preface

Fungi are classified within their own kingdom - The Kingdom Fungi, while some are in The Kingdom Protista. A fungus is neither a plant nor an animal. It is similar to a plant, but it has no chlorophyll and cannot make its own food like a plant can through photosynthesis. They get their food by absorbing nutrients from their surroundings.

Fungi that are pathogens are usually plant pathogenic Fungi. There are comparatively few species that are pathogenic to animals, especially mammals. According to Hawksworth (1992), there are approximate a little 1.5 million described species of fungi. A little more than 400 of these species are known to cause disease in animals, and far fewer of these species will specifically cause disease in people. Many of the latter will only be superficial types of diseases that are more of a cosmetic than a health problem.

Fungi, singular, fungus, is a group of eukaryotic, non-phototrophic organisms with rigid cell walls, that includes mushrooms, molds and yeasts. This definition has some words in it that probably need definitions of their own. Eukaryotic simply means that fungal cells have a nucleus, like plant and animal cells, which distinguishes them from the Bacteria and Archaea. Non-phototrophic means that they can't use light for energy because they lack chlorophyll, distinguishing them from plants. The cell walls of fungi are unique in that they contain large amounts of chitin, a structural component only found in the cell walls of fungi. The chitin makes the cells walls rigid.

This book blends information on classical fundamental aspects with recent development in fungal systematics. The textbook of fungi presents information on the morphology, life cycle and their economic uses in human life. Special attempt has been made on the biological activities of the microbial products.

– *Author*

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Chapter 1

Introduction

Many species produce metabolites that are major sources of pharmacologically active drugs. Particularly important are the antibiotics, including the penicillins, a structurally related group of β-lactam antibiotics that are synthesized from small peptides. Although naturally occurring penicillins such as penicillin G (produced by Penicillium chrysogenum) have a relatively narrow spectrum of biological activity, a wide range of other penicillins can be produced by chemical modification of the natural penicillins.

Modern penicillins are semisynthetic compounds, obtained initially from fermentation cultures, but then structurally altered for specific desirable properties.

Other antibiotics produced by fungi include: griseofulvin from Penicillium griseofulvin used to treat dermatophyte infections of the skin, hair and nails; cyclosporins, commonly used as an immunosuppressant during transplant surgery; and fusidic acid, used to help control infection from methicillin-resistant Staphylococcus aureus bacteria. Widespread use of these antibiotics for the treatment of bacterial diseases, such as tuberculosis, syphilis, leprosy, and many others began in the early 20th century and continues to play a major part in anti-bacterial chemotherapy.

In nature, antibiotics of fungal or bacterial origin appear to play a dual role: at high concentrations they act as chemical defense against competition with other microorganisms in species-rich

environments, such as the rhizosphere, and at low concentrations as quorum-sensing molecules for intra- or interspecies signaling.

TERM ADAPTATION OF FUNGI

The term adaptation, as used here, means the capacity of a single biotype to acquire and transmit the ability to do something that it either could not do originally or could not do well. Thus, race 19 of wheat stem rust can produce only small pustules on Marquis wheat. It would be a case of adaptation if genetically pure race 19 were grown on Marquis several successive rust generations and produced successively larger pustules until it acquired the ability to grow well on this variety, or at least better than it did originally. Likewise it would be adaptation if a single biotype of the corn smut fungus (Ustilago zeae) were grown for several successive generations on a medium containing arsenic and thus acquired the ability to tolerate several times as much arsenic as it did originally.

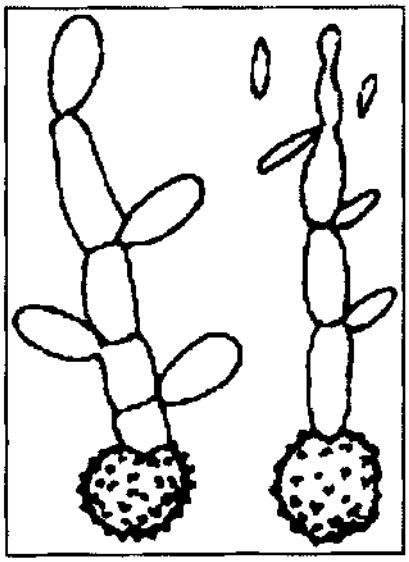

Fig. Ustilago Zeae

Between 1900 and 1910 the question of adaptation was studied by several investigators, who concluded that certain rust fungi and powdery mildews could adapt themselves quickly to resistant varieties.

Marshall Ward made many experiments with rust of bromegrasses (Puccinia dispersa) at Cambridge University, England, and published a paper on adaptive parasitism in 1903. He concluded that the brome rust could develop the ability to grow

well on a resistant species of Bromus if grown on the resistant species for one or more successive rust generations.

He also concluded that there were "bridging species" of Bromus that enabled the rust to attack very resistant varieties; for example, the rust could grow well on variety A but not on variety C.

If, then, a variety B could be found that was intermediate immunologically between A and C, the rust could be grown on B and there it acquired the ability to infect C. Variety B, therefore, was considered a bridge or "bridging host" between the susceptible A and the resistant C.

Fig. Puccinia Dispersa

In cooperative investigations between the United States Department of Agriculture and the University of Minnesota, E. C. Stakman, F. J. Piemeisel, and M. N. Levine studied the possible adaptation of stem rust of wheat and other cereals and grasses and of powdery mildew of wheat and barley, but obtained no evidence that these fungi could adapt themselves to resistant varieties by any of the methods previously tried nor by any new methods that could be devised.

They also pointed out that differential hosts must be used to separate different biologic forms from mixtures before making experiments on adaptation; otherwise what appears to be adaptation may be merely the result of the selective effect of host plants on a mixed population of the pathogen. At that time, the now obsolete term "biologic form" was used to designate what are now called varieties of stem rust; races were just being discovered within the tritici and other "biologic forms"; and

eventually new facts led to new concepts and to changed terminology.

These results seemed to prove that stem rust and powdery mildew of cereal grains did not change by adaptation. But the rusts and powdery mildews are obligate parasites; it has not been possible to grow them on anything except living plants.

Accordingly it was desirable to study possible adaptation or changes in virulence in fungi that can grow both in living host plants and on nutrient media that is, both as parasites and as saprophytes.

The results of extensive experiments made by J. J. Christensen and C. L. Schneider at the University of Minnesota from 1946 to 1950 with Helm inthosporiun? sativum, which causes leaf spots, foot rots, and root rots of barley, wheat, and other cereals and grasses, support the view that genetically pure lines of fungi do not change their virulence easily.

The isolate of H. sativum they studied had been grown on artificial nutrient media for 28 years and had been purified by making many successive single-spore isolations. Wheat plants were inoculated with single spores; when new spores were produced, single ones were again picked and inoculated into plants with a fine needle. This process was repeated ten times in succession, and there never was any evidence of change in virulence. This extreme refinement of method was necessary because H. sativum mutates rather freely, producing many mutants that are less pathogenic and a few that are more pathogenic than the parental line.

Some of the less pathogenic lines grow very rapidly and therefore tend to overgrow the original parental line. Unless the fungus is grown under conditions that permit the recognition of mutants and their separation from the parental line, an initially pure isolate may soon comprise a diverse mixture of mutant lines, and the original line may even have been lost in the process of making periodic transfers to new tubes of nutrient media.

Obviously, then, an isolate of H. sativum derived from a single spore may change in virulence, but the change is due to the production of new biotypes resulting from mutation and not to a change in virulence of the original biotype. It would be easy to

conclude that some of the smut fungi increased in virulence for resistant varieties as a result of successive passages through those varieties if the intraspecific complexity of smut species were not known.

Many investigators, notably W. A. R. Dillon-Weston in England, tested the resistance of varieties of wheat, barley, oats, and other crop plants to various smuts. When first inoculated with a collection of smut spores (chlamydospores), very little smut develops on some varieties.

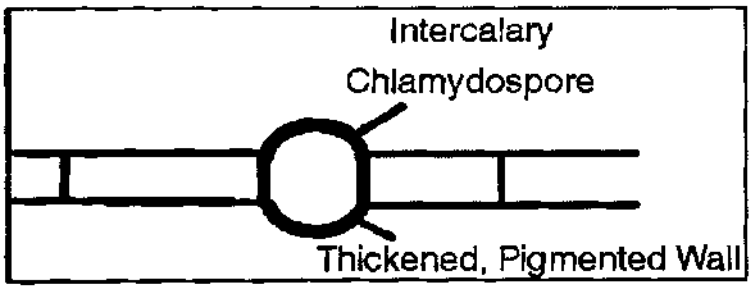

Fig. Chlamydospores

If the smut from a resistant variety is used to inoculate plants of the same variety, heavy infection may result, because unpurified collections of smut spores are likely to comprise many physiologic races that can be separated from each other by certain varieties. Assuming that three wheat varieties, A, B, and C, are inoculated with a smut collection containing races 1, 2, and 3 in the ratio of 90:9:1 and assuming that all three races infect variety A normally, that race 2 infects B but not C, and that race 3 infects C and not B, the percentages of infection theoretically should be the following:

Obviously, if plants of variety A are then inoculated with the smut produced on A, spores of all three races will again be produced. But if variety B is inoculated with spores from B, 100 per cent of them will be of race 2; and if variety C is inoculated with spores from C, 100 per cent of the spores will be of race 3, the only one in the original mixture that can attack C.

Thus, varieties B and C are biologic indicators, or differential varieties, that make it possible to find out not only which races were present in the original smut collection but also the relative percentages of each. Moreover, the apparent adaptation of the smut to varieties B and C is not adaptation at all but is due to selection of the races that can attack those varieties out of a mixture in which