

In-depth understanding of the conditions under which pathogens live and develop is a prerequisite for effective crop protection. The DVD series "The Biology of Fungal Pathogens" grants easy access to this knowledge. Through an exciting blend of vivid animations and real images, with informative commentaries, these videos provide a fascinating insight into the life cycles of major pathogens. The series is an outstanding example of communication in modern science.

Editors-in-Chief and Scientific Advisors:
Prof. Dr. Joseph-Alexander Verreet, Dr. Holger Klink
Department of Plant Pathology,
Christian-Albrechts University, Kiel
Hermann-Rodewald-Str. 9, D-24118 Kiel, Germany
Phone: +49.431.880.2996 or +49.431.880.4586
Fax: +49.431.880.1583
E-mail: javerreet@phytomed.uni-kiel.de
or: hklink@phytomed.uni-kiel.de

Scientific Advisor (Eyespot Disease):
Prof. Dr. Pedro W. Crous
Centraalbureau voor Schimmelcultures
Uppsalalaan 8, 3584 CT Utrecht, The Netherlands
Phone: +31.30.2122.643
E-Mail: crous@cbs.knaw.nl

Video Production and Design:
STUMM-FILM Dr. Rolf Stumm Medien GmbH
Martin-Luther-Str. 55, D-71636 Ludwigsburg, Germany
E-mail: info@stummfilm.de – www.stummfilm.de

Reordering Address:
The American Phytopathological Society
3340 Pilot Knob Road
St. Paul, Minnesota 55121
United States of America
Phone: +1.651.454.7250; Fax: +1.651.454.0766
Web Site: www.apsnet.org

Target groups:
Students, farmers, technical
advisors, teachers

© 2006
Institut für Phytopathologie
der Christian-Albrechts-
Universität Kiel &
STUMM-FILM Dr. Rolf Stumm
Medien GmbH, Ludwigsburg

All rights reserved.
Reprinting in whole or in
part is prohibited.

Vol. 4: Fungal Pathogens and Diseases of Cereals (4)



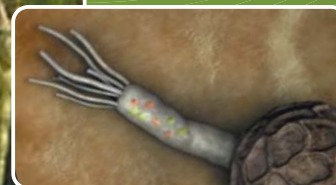
4.1

Eyespot Disease of Small Grains



4.2

Bunt and Smut Diseases of Cereals



Plant pathology is a discipline devoted to maintaining plant health and, by so doing, helping to ensure economically and ecologically sound production of foodstuffs in sufficient quantities and of high quality. This places great demands on the effectiveness of research. It also presupposes in-depth understanding of many aspects of both abiotic and biotic pathogens (e.g., fungi, bacteria, viruses, animal pests) and of plant protection.

Teaching is therefore of great importance. One especially interesting aspect of it is the transfer of knowledge of the sometimes very complex biological relationships in the life cycles of pathogenic organisms – host-parasite relationships which run their course under prevailing plant cultivation and environmental conditions.

The DVD series "The Biology of Fungal Pathogens" employs state-of-the-art visualization methods to illustrate the life cycles of various fungal pathogens. The combination of vivid 3D computer animations with real images results in a realistic overall picture that helps the viewer to understand the bio-ecological aspects of host-parasite relationships. This new information medium addresses both specialist and lay audiences. The target groups include teachers and students at many types of educational institutions, university lecturers, students of agronomy, biology, ecology and their related disciplines, as well as governmental and non-governmental advisory bodies and, last but not least, farmers.

Thanks are due to Dr. Pedro W. Crous of Centraalbureau voor Schimmeltculturen, Utrecht, The Netherlands, who contributed his expert knowledge to the movie on eyespot disease of small grains.

We are deeply indebted to Dr. Rose C. Gergerich, Editor-in-Chief of APS Press, University of Arkansas, and the APS Press staff for their editorial assistance and their commitment, which helped bring this project to a successful conclusion.

We owe a special debt of thanks to Syngenta Agro GmbH (Germany), to Akzo Nobel, and to Stiftung Schleswig-Holsteinische Landschaft for their generous support of this project.

Joseph-Alexander Verreet

Holger Klink

DVD Series "The Biology of Fungal Pathogens"

Vol. 4: Fungal Pathogens and Diseases of Cereals (4)

4.1 Eyespot Disease of Small Grains (13:00 min)

Where small grains are grown continuously and the climate is cool and moist, eyespot disease, also called strawbreaker foot rot, is a significant yield-limiting disease. This infection of the stem base is caused by fungi of the genus *Helgardia* (formerly *Pseudocercospora*):

- *Helgardia herpotrichoides* = *Pseudocercospora herpotrichoides* (W-type)
(teleomorph *Oculimacula yallundae*)

- *Helgardia acuformis* = *Pseudocercospora acuformis* (R-type)
(teleomorph *Oculimacula acuformis*)

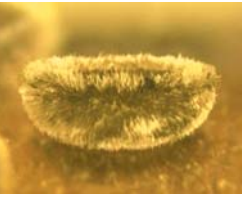
Both species differ in terms of morphology and growth characteristics. This movie depicts the life cycles of both species using three-dimensional computer animations blended with real images. Particularly, the modes of infection as well as epidemiological spread of the disease are shown. Finally, methods for successful disease management are explained.

4.2 Bunt and Smut Diseases of Cereals (10:00 min)

Common bunt of wheat caused by *Tilletia caries* and loose smut of barley caused by *Ustilago nuda* are cereal diseases that have been increasingly forgotten as a result of modern seed treatments. However, when untreated seed is used, infection by these damaging fungal pathogens can lead to substantial losses in yield and seed quality. Using *Tilletia caries* and *Ustilago nuda* as examples, this movie illustrates the life cycles of bunt and smut fungi with extensive detail, thus leading to a better understanding of the development and epidemiological spread of these fascinating fungi. All stages of the life cycles are explained using photo-like three-dimensional computer animations, macro images, and real-image video sequences.

Glossary*

Anamorph: asexual stage of fungi (see teleomorph).



Apothecium, pl. **apothecia:** open, cuplike or saucerlike, ascus-bearing fungal fruiting body, often supported on a stalk.

Appressorium, pl. **appressoria:** swollen, flattened portion of a fungal filament that adheres to the surface of a host plant, providing anchorage for invasion by a fungus.

Ascomycetes: a group of fungi that reproduces sexually by formation of ascospores borne in a saclike structure called an ascus.

Ascospore: sexual spore borne in an ascus.

Ascus, pl. **asci:** saclike structure of ascomycetes containing sexual ascospores (typically eight) and usually borne in a fungal fruiting body.

Asexual stage, syn. **anamorph:** conidial spore stage of fungi that is often responsible for epidemic spread of pathogens in the field.

Assimilate: photosynthetic product of plants (mainly sugars, amino acids) produced in green plant parts and used to form plant biomass; basic source of nutrition for many parasitic fungi.



Bunt ball **Bunt ball:** smut sorus filled with teliospores that replaces a cereal or grass kernel but is covered by plant tissue at maturity.

Chromosome: the structure that contains the genes of an organism; in eukaryotes, chromosomes are in the nucleus; in bacteria, the chromosome is usually a single circle of DNA.

Coleoptile: the sheath enclosing the stem of a seedling.

Common bunt of wheat: “stinking smut of wheat”, a fungal disease caused by *Tilletia caries*.

Conidiophore: simple or branched hypha on which conidia are produced.

Conidium, pl. **conidia:** asexually formed non-motile fungal spore transported by wind or water; immediately capable of germination.

Conjugation: the temporary contact of fungal (or bacterial) cells during which genetic material is transferred.

Cotyledon: seed leaf, one in monocots and two in dicots; primary embryonic leaf within the seed.

Crop rotation: organization of the chronological sequence of crops on one land area. Growing the same crop too frequently on the same land (i.e. monoculture) can lead to an accumulation of pathogens adapted to this crop in the soil and in plant residues, which consequently can lead to massive infection. In order to avoid this accumulation, rotation of dissimilar crop plants is practiced.

Cultivar, syn. **variety:** a plant type within a species, resulting from deliberate manipulation, which has recognizable characteristics.

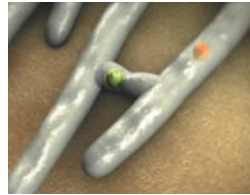
Cuticle: outermost layer of a plant consisting of wax.

Diagnosis: identification of the cause of a disease based on symptoms, pathogen-specific structures, and results of laboratory tests.

Dikaryotic: having two sexually compatible haploid nuclei per cell that divide simultaneously.

Diploid: having two complete sets of chromosomes (see haploid).

Disease cycle: succession of all the events and interactions among the host, pathogen and environment that occur in a disease, from initial infection of the host by a causal agent, through pathogenesis, to over-seasoning, until another infection occurs.



Conjugation

* Many of the definitions listed are based on the Illustrated Glossary of Plant Pathology, APS Education Center (Authors: C. J. D'Arcy, D. M. Eastburn, and G. L. Schumann)

Dormancy, adj. **dormant**: a condition of suspended growth and reduced metabolism of an organism, generally induced by internal factors or environmental conditions as a mechanism of survival.



Embryo

Embryo: an organism in the early stage of development, such as a young plant in the seed.

Endosperm: nutritive tissue formed within the embryo sac of seed plants.

Environmental conditions: a wide variety of environmental factors – including soil, temperature, precipitation, relative humidity, global radiation, flora, fauna, soil management and host variety – which have a direct or indirect impact on disease development in crop plants.

Enzyme: protein that catalyzes a specific biochemical reaction, e.g., in the course of infection. Certain pathogens (fungi, oomycetes, bacteria, nematodes) produce enzymes that dissolve or break down cell walls (e.g., cutinases, cellulases, pectinases) and facilitate the penetration of host tissues.

Epidemic: development and spread of a pathogen population and/or disease in terms of the number of pathogen propagules and infections of the host.



Eyespot

Eyespot disease: “Strawbreaker foot rot”, a disease of small grains caused by fungi of the genus *Helgardia* (formerly *Pseudocercospora*): *Helgardia herpotrichoides* (teleomorph *Oculimacula yallundae*) and *Helgardia acuformis* (teleomorph *Oculimaculacae acuformis*). The disease is called eyespot because of its characteristic elliptical lesions on basal leaf sheaths and culms.

Flowering: developmental stage of plants when the sexual organs (pistil and stamens) are maturing and pollination takes place.

Fruiting body: any of various complex, spore-bearing fungal structures.

Fungicide: chemical agent that kills or inhibits the growth of fungi.

Fungus, pl. **Fungi**: chlorophyll-free organisms that cannot grow without organic substances, in particular carbohydrates, from other organisms. Fungi may possess one or several cell nuclei. The main constituent of the cell wall is chitin.

Gamete: a haploid cell or nucleus involved in sexual reproduction, during which two gametes fuse to form a zygote.

Gametangium, pl. **gametangia**: cell containing gametes or nuclei that act as gametes.

Gene: hereditary factor; discrete sections on chromosomes that are responsible for genetically inherited traits.

Genotype: genetic constitution of an individual or group; class or group of individuals sharing a specific genetic makeup.

Genus, pl. **genera**: taxonomic category that includes a group of closely related (structurally or phylogenetically) species; the genus or generic name is the first name in a Latin binomial.

Germinate, n. **germination**: begin growth (as of a seed, spore, stroma, or other reproductive body).

Germ tube: hypha resulting from an outgrowth of the spore wall and cytoplasm after germination; usually secretes mucilaginous substances which promote close contact with the plant surface.

Grain fill: period of kernel development, starting with successful pollination and ending when the kernels are physiologically mature.

Growth regulator: a chemical substance that regulates plant development and growth.

Haploid: having a single complete set of chromosomes (see diploid).

Helgardia acuformis: fungal pathogen that causes eyespot disease of small grains (teleomorph *Oculimacula acuformis*).

Helgardia herpotrichoides: fungal pathogen that causes eyespot disease of small grains (teleomorph *Oculimacula herpotrichoides*).

Host: living plant attacked by or harboring a parasite or pathogen.

Hypha, pl. hyphae: threadlike organs of fungi and oomycetes that spread through plant tissue; the totality of the hyphae = the mycelium.

Infection: entering, invasion, or penetration of a host (plant) by a pathogen in order to establish a parasitic relationship.

Infection cushion: organized mass of hyphae formed on the surface of a plant from which infective hyphae develop.

Infection hypha: penetration wedge formed below the appressorium with which the fungus mechanically penetrates the cell wall under high pressure and the simultaneous support of cell wall degrading enzymes.

Intercellular: between or among cells.

Intracellular: through or within cells.



Loose smut of barley

Leaf sheath: lower, tubular part of a grass leaf that clasps the culm.

Life cycle: cyclical succession of stages in the development of an organism.

Lodge: to fall over.

Loose smut of barley: a disease of barley caused by the fungus *Ustilago nuda*.

Meiosis, adj. meiotic: process of nuclear division in which the number of chromosomes per nucleus is halved, i.e., converting the diploid state to the haploid state (see mitosis).

Mitosis, adj. mitotic: nuclear division in which the chromosome number remains the same (see meiosis).

Monoculture: continuous cultivation of the same crop on the same cultivation area.

Mutation: transmissible change in a genotype. This may result in an adaptation to changes in environmental conditions.

Mycelium, pl. mycelia: mass of hyphae constituting the body (thallus) of a fungus.

Necrosis, adj. necrotic: death of cells or tissue, usually accompanied by black or brown darkening.

Nucleus: in eukaryotes, the cell structure – surrounded by a membrane – that contains chromosomes and controls heredity.

Oculimacula acuformis: fungal pathogen that causes eyespot disease of small grains (anamorph *Helgardia acuformis*).

Oculimacula yallundae: fungal pathogen that causes eyespot disease of small grains (anamorph *Helgardia herpotrichoides*).

Parasite: organism that lives in intimate association with another organism on which it depends for its nutrition; not necessarily a pathogen.

Pathogen, adj. pathogenic: organism (e.g., bacterium, virus, fungus, oomycete, nematode) that can cause disease in another organism.

Penetration: initial invasion of a host by a pathogen.

Premature senescence: early plant death due to severe necrosis of leaves and heads prior to the normal date of maturity, induced by stress or nutrient or water deficiencies, may significantly reduce yield.

Promycelium, pl. promycelia: in rust and smut fungi, a germ tube issuing from a teliospore and bearing a sporidium.

Pseudocercospora: former botanical name of the fungal genus *Helgardia*.

Resistance, adj. resistant: a) plant: genetically determined protection against diseases; b) fungus: genetically determined protection against fungicides/host metabolites.

Resting spore: spore, often thick-walled, that can remain alive in a dormant state for some time, later germinating and capable of initiating infection.



Promycelium

Rot: softening, discoloration, and often disintegration of plant tissue as a result of fungal or bacterial infection.

Seed: ripened ovule consisting of an embryo and stored food enclosed by a seed coat.

Seed treatment: application of a biological agent, chemical substance, or physical treatment to seed, to protect the seed or plant from pathogens or to stimulate germination or plant growth.

Septum, pl. septa, adj. septate: dividing wall; in fungi, cross wall.

Sexual stage, syn. teleomorph: the fungal stage characterized by the production of ascospores, basidiospores, teliospores, or other basidium-bearing organs.

Smut: any of a number of plant diseases caused by the smut fungi; characterized by masses of dark, powdery, and sometimes odorous spores (e.g., stinking smut of wheat).



Smut spores

Smut spore: dark, thick-walled resting spore of a smut fungus; may germinate to produce a promycelium.

Sorus, pl. sori: compact fruiting structure, especially spore masses in smut and rust fungi.

Species: any one kind of life subordinate to a genus but above a race; a group of closely related individuals of the same ancestry, resembling one another in certain inherited characteristics of structure and behavior and relative stability in nature; the individuals of a species ordinarily interbreed freely and maintain themselves and their characteristics in nature.

Spore: uni- or multicellular reproductive structure of fungi; it serves for reproduction or proliferation of the species or as a dormant stage (thick-walled resting spores) for surviving unfavorable environmental conditions.

Sporidium, pl. sporidia: basidiospore formed by the rust or smut fungi.

Sporulation: the process of producing spores.

Stigma: female portion of a flower that receives pollen and on which the pollen germinates.

Stroma, pl. stromata: compact mass of fungal mycelium (with or without host tissue) that supports fruiting bodies or in which fruiting bodies are embedded.

Symptom: indication of disease by reaction of the host, e.g., leaf spot or wilt.

Teleomorph: sexual stage of fungi (see anamorph).

Teliospore: thick-walled resting spore produced by some fungi, notably smut and rust fungi, from which the basidium is produced.

Tilletia caries: fungal pathogen that causes common bunt of wheat.

Tolerance, adj. tolerant: ability of a plant to endure an infectious or non-infectious disease, adverse conditions, or chemical injury without serious damage or yield loss.

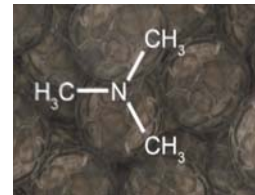
Trimethylamine: nitrogen compound causing the characteristic fish-like odor of bunt spores.

Ustilago nuda: fungal pathogen that causes loose smut of barley.

Variety, syn. cultivar: a plant type within a species, resulting from deliberate manipulation, which has recognizable characteristics.

Vascular: pertaining to fluid-conducting tissues in plants.

Yield: an aggregate of the products resulting from growth or cultivation.



Trimethylamine