Saprotrophs, Decomposers, litter/wood rotting fungi

Pezizomycotina and Agaricomycotina
Fungi

- Accounts for most decomposition in aerobic environments
  - 60-90% of microbial biomass in forests
  - About half of microbial biomass in grasslands

- Broad enzymatic capability
  - Cell walls (lignin, cellulose, hemicellulose)
    - Fungi are main lignin degraders
  - Cell contents (proteins, sugars, lipids)
Who are the major players in decomposition?
Leaf Skeletons: Remnant of leaves that is near completion of decomposition. Mostly the veins, which is composed of lignin, remains. Arrow points to a magnification of the area in square where a patch of the leaf surface still remains.
Wood Chip Carbon and Nitrogen
The micro-organisms that decompose wood chips require nitrogen in amounts greater than are available in the wood chips alone. If additional nitrogen is not mixed with the wood chips, the micro-organisms will get the nitrogen they need from the soil, competing with plant roots for the nitrogen available in the soil. This is why bark mulch works to keep weeds down.
Composition of wood.
Xylem tissue

SECTION OF TRUNK OF A PINE TREE

Wood is made up of annual rings, each composed of thin-walled earlywood cells and thick walled latewood cells.
Xylem cells

hyphae

excretion of digestive enzymes

digestive enzymes degrade substrate

digested food absorbed by hyphae

All images of Todd Simpson, Western Nanofabrication Facility, Western University UWO, Canada
Types of wood decay fungi

Wood-decay fungi can be grouped by their method of degrading wood, which reflects fundamental differences in enzymatic activities - the **white-rot**, **brown-rot** and **soft-rot** fungi.

**White-rot fungi**
These fungi degrade all the major wood components (cellulose, hemicelluloses and lignin) more or less simultaneously, so that the wood becomes progressively more fragile but remains white as it decays. Mostly Basidiomycota, few Ascomycota

**Brown-rot fungi (includes dry rot fungi)**
Brown-rot fungi degrade the cellulose and hemicellulose but leave the lignin more or less intact as a brown framework. Only about 6% of wood-decay fungi cause brown rots, and all these fungi are members of the Basidiomycota.

**Soft-rot fungi**
Soft-rot fungi degrade only the cellulose and hemicelluloses, and typically occur in wood of high water content and high nitrogen content. They are most commonly found in rotting window frames, wet floor boards and fence posts, etc., where nitrogen is "recruited" from soil or from atmospheric contamination. Some of these fungi are common decomposers of cellulose in soil (e.g. *Chaetomium* species) and they are the least specialized of the wood-rot fungi.
Wood Decay Fungi

- Wood-decay fungi fall into three types according to their mode of attack on the woody cell walls - soft-rot fungi, brown-rot fungi and white-rot fungi.

- Soft-rot fungi grow on wood in damp environments. They are the characteristic decay fungi of fence posts, telegraph poles, wooden window frames, the timbers of cooling towers, and wood in estuarine or marine environments.

- Secrete cellulase enzymes, little or no effect on lignin

- Several Ascomycota. Ex. Chaetomium

Kretzschmaria deusta
‘brown rot’ refers to the characteristic color of the decayed wood, because most of the cellulose and hemicelluloses are degraded, leaving the lignin more or less intact as a brown, chemically modified framework.

Brown-rot fungi are predominantly members of the Basidiomycota.

Brown-rot fungi degrade cellulose by an oxidative process, involving the production of hydrogen peroxide during the breakdown of hemicelluloses; primarily attack S2 layer.

Includes some dry-rot fungi as well.
Examples of Brown Rot Fungi

Fomitopsis pinicola

Laetiporus conifericola

Serpula lacrymans

Gleophyllum sepiarium

(dry rot)
Basidiocarp

Dry rot

Brown cubical rot
WHITE ROT

Wood Decay cont.-

- White-rot fungi are more numerous than brown-rot fungi. They include both Ascomycota, such as Xylaria spp., and Basidiomycota.
- 1, 700+ species of wood decay fungi, 6% brown rot, 94% white rot, brown rot fungi are however very common in conifer forests.
- The white-rot fungi seem to use conventional cellulase enzymes for wood decay (cellulose).
- The most remarkable feature of white-rot fungi is their ability completely to degrade lignin.
- Lignin is degraded by an oxidative process. The details of this are complex, but essentially the white-rot fungi produce only a few enzymes (lignin peroxidase, manganese peroxidase, H2O2-generating enzymes, and laccase) and these generate strong oxidants, which virtually “combust” the lignin framework.
White rot
Examples of White-Rot Fungi – cont.- Ascos -Xylaria
Crusts

Coniophora

hymenium

Phanerochaete
Hymenium on smooth underside of shelf or growing over surface of wood

*Stereum* – tough leathery texture
Examples of White rot Fungi

Pleurotus

Cyathus

Trametes

Polyporus
A blue reaction generally indicates the presence of an extracellular oxidase, it occurs when an alcoholic solution of gum guaiac is applied directly to cultures of wood-inhabiting Hymenomycetes that are associated with white rots while no (or limited) color change follows its application to cultures of species that cause brown rots.
Polypores are a group of fungi that form basidiocarps with pores or tubes (sometimes gills) on the underside. Not all polypores are closely related to each other. Polypores are also called bracket fungi, and their woody basidiocarps are called conks.

Some form annual fruiting bodies while others are perennial and grow larger year after year. Bracket fungi are typically tough and sturdy and produce their spores, called basidiospores, within the pores that typically make up the undersurface.

Tubes lined with basidia produce actively released basidiospores that are primarily dispersed by air currents.
Polyporales - hyphae structure

Polypore fungi

Basidiocarp texture may be woody or leathery due to thick walled hyphae!