



Fig. 1. a) *Cladobotryum* spp. hyphae and spores; b) cobweb-like white mycelium on the surface of diseased white button mushrooms; c) conidia (spores) and d) the apex and base of a conidiophore and the formation of a conidium at the apex.

Common Name: Cobweb disease

Disease: Cobweb disease

Classification: K: Fungi P: Ascomycota C: Sordariomycetes O: Hypocreales F: Hypocreaceae

Historically, the soil habiting fungus *Cladobotryum dendroides* (Teleomorph- *Hypomyces rosellus*) is the main causal agent of cobweb disease of the cultivated mushroom *Agaricus bisporus*. However, there are several *Cladobotryum* species that cause cobweb disease in commercially cultivated white button mushroom and other economically and wild edible mushrooms. The *Cladobotryum protrusum* genome is the first complete genome to be sequenced in the genus *Cladobotryum* (39.09 Mb).

Biology and Ecology:

The genus forms verticillated hyphae where at the end of which three or four conidiogenous cells (phialides) are located. Conidia, unicellular in origin, usually show from 1 to 3 septa. Each conidium is generated from the apex of the conidiogenous cells via basipetal succession. As teleomorphs, some species form red-coloured perithecia and/or colonies in culture due to the chinonic pigment, aurofusarin.

The source of primary infection is usually from casing contamination. White, fluffy mycelium over the mushroom beds and infected carpophores are characteristics of cobweb disease outbreaks leading to the discolouration and rotting of infected mushrooms.

Symptoms of cobweb on button mushroom includes; brown spotting on the cap of the mushroom which rapidly evolves to engulfing the entire mushroom in a cobweb-like mycelium, inciting decay. *Cladobotryum* spores are mainly spread aerially.

Impact:

The main impact of cobweb disease in the mushroom industry is yield loss, with early infections leading to devastating yield losses. Other impacts also include quality loss due to spotting occurring on the mushroom caps post-harvest.

Distribution:

It is found in all mushroom-growing countries worldwide.

Host Range:

Apart from white button mushroom, many economically cultivated mushrooms are also infected by this genus. They include *Pleurotus eryngii* and oyster culinary-medicinal mushroom (*Pleurotus ostreatus*, *Flammulina velutipes* (Enokitake mushroom), *Ganoderma lucidum* (reishi mushroom), *Coprinus comatus* (shaggy mane) and *Hypsizygus marmoreus* (white beech mushroom). In Spain, one species was found to infect shiitake mushroom (*Lentinula edodes*).

Management options:

Correct *Cladobotryum* spp. identification is based on: (1) morphology: screening for aurofusarin and camphor odour producers, registering conidia and phialide size as well as taxonomic characters and (2) molecular and phylogenetic analysis. *C. dendroides* have shown increasingly resistant to methylbenzimidazole carbamate (MBC) fungicides.

Currently, routine application of the fungicide, prochloraz-Mn, in the casing soil is used. Infections are managed by covering the area with damp tissue and salting the entire area. Lowering the relative humidity and temperature to 85% and 17 °C, respectively. At crop termination, *Cladobotryum* spores are killed at 45 °C for 30 minutes under steam.

Further Reading: Back et al. (2012) Mycobiology. 2012;40(3):189–194; Carrasco et al. (2017). Spanish Journal of Agricultural Research 15 (2) e10R01; Gea et al (2018) Plant Dis 102:1030; Grogan HM, Gaze RH.(2000) Mycol. Res. 104: 357-364 ; Grogan H & Gaze R (2008) Factsheet 10/08 Mushrooms; Põldmaa K. (2011). Studies in mycology, 68, 1–34. <https://doi.org/10.3114/sim.2011.68.01>; McKay et al..(1998) Mycological Research 102 (6): 671-676; Sossah et al. (2019) Genes (Basel), 10(2), 124. doi: 10.3390/genes10020124; List of *Cladobotryum* spp. record. Index Fungorum. [(accessed on 30 March 2020)]; Available online: <http://www.indexfungorum.org/Names/Names.asp>;

Key Contacts: Meghann Thai, email: meghann.thai@sydney.edu.au; Dr Francine Perrine-Walker, email: marie.perrine-walker@sydney.edu.au