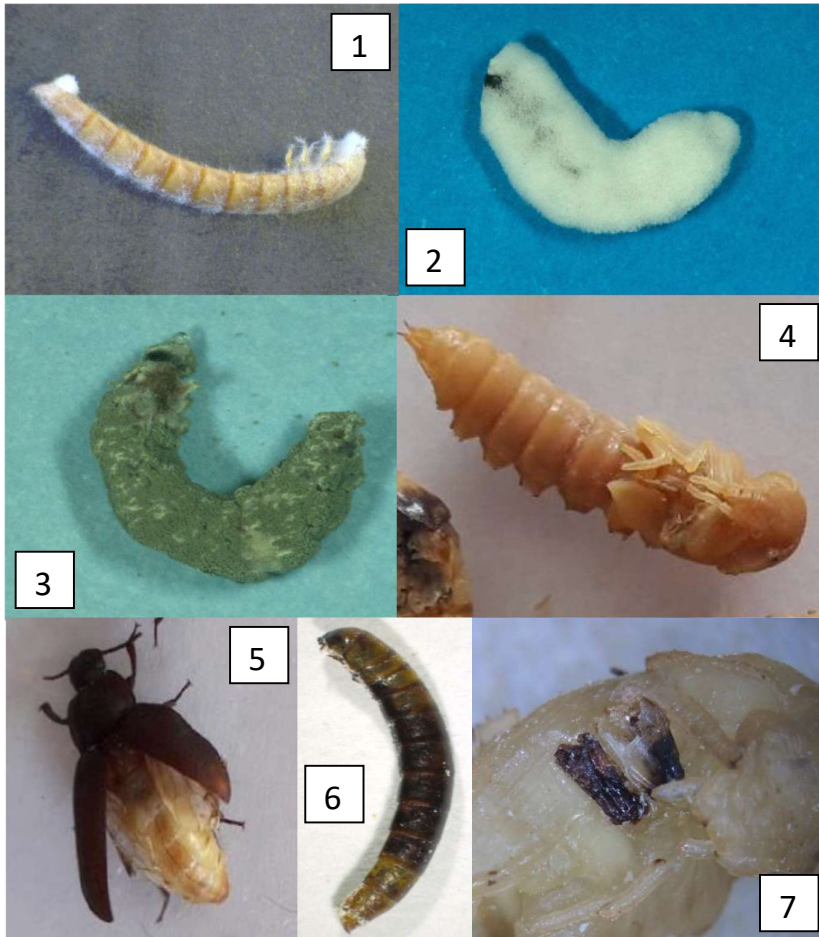


## Diseases and disorders in mealworm *Tenebrio molitor*



1) First outgrowth of fungus from larva. Often fungus infections are caused by genera *Beauveria* and *Metarhizium*.

2) Extensive outgrowth and sporulation, all whitish. The fungus is *Beauveria bassiana*, having white spores.

3) In this case, the causal agent is the fungus *Metarhizium brunneum*, having green spores in dense layers.

4) Pupa (pinkish) killed by the bacterium *Serratia marcescens*.

5) Adult with swollen abdomen, possibly infected by a bacterium or by another microorganism.

6) A larva (turned dark in colour) killed by an unknown bacterium.

7) Melanization (dark spots) in larva are often caused by injuries, for example biting.

To diagnose fungal infections, allow dead larvae with early symptoms (1) to stay in humid chamber (moist filter paper added) up to two weeks. Often extensive outgrowth will be observed (2 and 3). First diagnosis is based on color of fungus and other visible symptoms, later to be accompanied by spore morphology and PCR. For bacteria, it might be difficult to distinguish between true infections caused by an insect pathogen (4) or caused by opportunistic bacteria (5 and 6). Due to few prominent morphological characters like color and swelling of host often microscopy and PCR is needed to identify bacteria. Other microorganisms like insect viruses and protozoa can also infect mealworms, although little is known about their effects on the host. Fungal growth on dead insects can be due to mold fungi. Malfunctions, discoloration and death of *Tenebrio* may also be due to other reasons than infections (7). A main reason for insect pathogens to occur and spread is a lack of cleaning and insufficient removal of dead insects. Also, a stressed population may be more susceptible to opportunistic bacterial infections. Management: Check carefully for dead insects, remove cadavers immediately. Note external symptoms, including potential symptoms on living individuals. Immediate cleaning using standard washing and sterilizing liquids of all equipment is needed, potentially UV light as well. Smaller cohorts of insects should be kept in quarantine to avoid further spread.

Prepared by University of Copenhagen, November 2019. University of Copenhagen: all photos, except 4 and 5 (Delphine Calas-List, Entomo Farm), and 7 (Lucas Hartmann)

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