

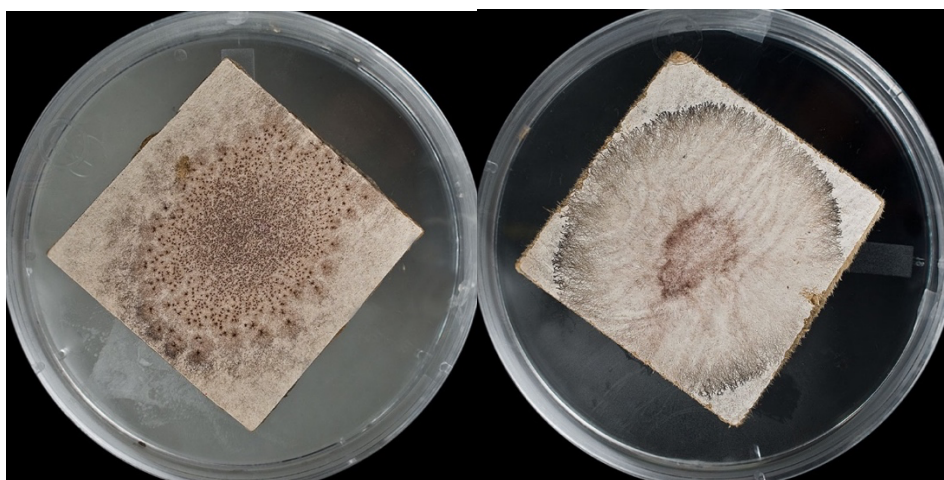
MicroPest: Aureo (*Aureobasidium pullulans*)
(Geoffrey Michael Gadd)



Aureo colonies on a damp painted wooden surface
(image "[Aureobasidium](#)" by [eyzayah](#) is licensed under [CC BY-NC 4.0](#)).

Claim to Fame: a black mould responsible for stains on bathroom tiling.

Aureo grows in many different environments, but it can especially thrive in the indoor environment where there is sufficient moisture. It can become particularly problematic in damp housing, bathrooms, showers, kitchens, etc., where the black – melanised – colonies can thrive, discolour and biodeteriorate walls and ceilings, tiling and grouting. It is often considered the prime spoilage organism of paint and painted surfaces and can also be involved in the blackening and discolouration of external painted surfaces, wood, plastic and stone in the built environment, as well as the blackening of cultural heritage such as monuments and historic buildings. The production of black melanised hyphae and other cell forms give rise to its inclusion in a loose grouping of fungi known as “black yeasts” or “black moulds”.

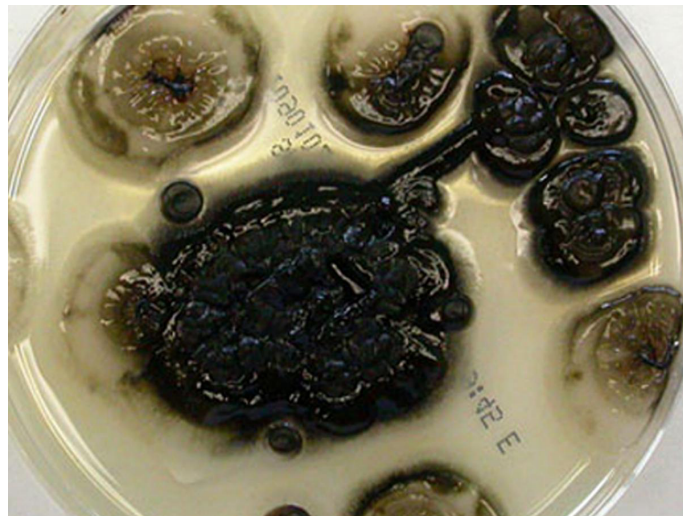


Aureo colonies on gypsum board (left) and a ceiling tile (right) (images from <https://www.inspq.qc.ca/en/moulds/fact-sheets/aureobasidium-pullulans> (Gouvernement du Québec, Institut National de Santé Publique du Québec, 2010).

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Melanin: the reason for the black colour of the fungus and the tile stains. Melanins are pigments found in organisms from all kingdoms of life. In humans, the most obvious role for melanin is in photoprotection from solar irradiation with darkening of skin resulting from exposure to sunlight, and brown or black skin a dominant human feature of humans living in hot and sunny climates. Fungal melanins have different structures and routes of formation, but have some analogous functions which aid growth and survival.

Chemically, melanins are heterogeneous polyphenols that form more complex structures with unique physicochemical properties. In fungi, there are different kinds of melanin formed by different metabolic pathways. Not all melanins are black or dark brown, some being yellow, red and brown and shades between these colours and black.



Aureobasidium pullulans colonies on a nutrient agar plate. The dark sectors show development of melanised cells, the lighter areas are predominantly yeast-like cells with filamentous branching hyphae at the colony edges (image licensed by the University of Adelaide under the Creative Commons [Attribution-NonCommercial CC BY-NC] Licence).

In fungi that are pathogenic for humans and plants, melanin aids tissue penetration and provides resistance to host defences and antifungal treatments.

Melanins also provide mechanical strength to fungal structures and enable certain fungi to tolerate a wide-range of fluctuating and stressful environmental conditions, such as low and high temperature and pH extremes, desiccation, gamma, X-ray, and ultra-violet radiation, as well as toxic metal pollutants, toxic reactive oxygen species, high salinity, predation by invertebrates, and enzymic attack. Aureo is a *polyextremophile*, tolerating diverse environmental stressors. As a consequence, melanised fungi are pervasive on natural and human-engineered surfaces, outside and indoors, and survive experimental conditions that simulate outer space. A substantial proportion of melanised fungal species, including Aureo, were found at nuclear test sites in the USA and at Chernobyl.

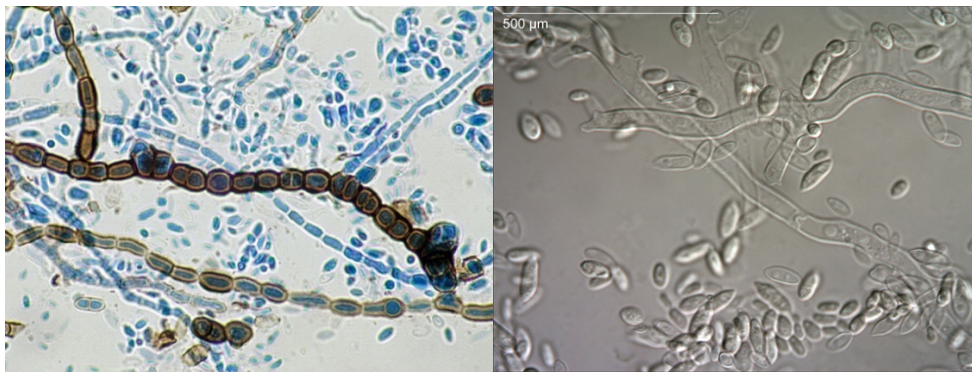
Also as a consequence, it is very difficult to eliminate Aureo from stained tiles in the bathroom: it resists bleach and detergents and the many products that have been developed to combat the problem of staining by Aureo. The only solution seems to be repeated cleaning, repainting, retiling etc., or maintaining a relentless dry ventilated atmosphere, which is often not possible and economically challenging.

Aureo is a mighty awful MicroPest!

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Flexible morphology. Aureo is a polymorphic fungus, which means it can exist in different morphological or cellular forms, and also interchange between them in response to environmental conditions or stress. These morphological interchanges are integral to the environmental success of Aureo, the yeast-like cells enabling dispersion, the hyphae enabling colonization, spread and penetration of the growth substrate. Colonial integrity and biofilm development on surfaces are also assisted by the production of large amounts of the extracellular polysaccharide, pullulan. The yeast-like cells can independently reproduce by budding, just like normal budding yeasts, or be budded off from branching true filamentous hyphae (the yeast-like cells can also be termed conidia, blastoconidia or blastospores).

Both yeast-like cells and hyphae can develop swollen cell forms and thickened melanised cell walls, which can be termed chlamydospores or arthroconidia, the latter term for when the melanised hyphae fragment into individual melanised cells.



Some of the morphological forms exhibited by Aureo: (left) yeast-like cells, and hyphae fragmenting and forming dark melanised chlamydospores (right) yeast-like cells and non-melanised hyphae (Left: Image licensed by the University of Adelaide under the Creative Commons [Attribution-NonCommercial CC BY-NC] Licence. Right: "[Aureobasidium pullulans](#)" by [cooperj](#) is licensed under [CC BY 4.0](#)).

Aureo in nature. Aureo is an environmentally ubiquitous fungus found in many kinds of habitat ranging from soil, rock and mineral surfaces, plant surfaces, and on exterior and interior surfaces in the built environment, including cultural heritage. It is saprophytic but can grow in nutrient-deficient locations, and those with fluctuating moisture levels. Aureo is also a ubiquitous plant inhabitant, especially of leaf surfaces, where it may be a dominant microorganism, and is also an endophyte, living within plant buds and leaves. The sycamore (*Acer pseudoplatanus*) is an excellent host for both surface- and internally-located Aureo.

The importance of Aureo to us

As a ubiquitous spoilage organism within and on human dwellings and built structures, Aureo will continue to irritate and baffle households for years to come. While Aureo itself is not considered a health risk, the conditions that enable it to proliferate are also suitable for many other fungi that can infect damp housing, many of which, such as several species of *Cladosporium*, *Penicillium*, and *Aspergillus*, can cause significant health problems through spore inhalation and allergenic reactions.

The Future

Regarding the significance of Aureo as a spoilage organism, it is unknown what the consequences of climate change might be in exacerbating or limiting deleterious effects, or the development of more energy-efficient and insulated housing, or increased use of plastics in building construction, such as window frames, which can be readily colonized. Since good

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ventilation accompanied by good heating is the only proven remedy for fungi in damp housing, this will obviously provide food for thought as energy costs increase.