

On water and indoor fungi

Fungal workshop Berkeley USA

September 23 2014

Olaf Adan



TU/e Technische Universiteit
Eindhoven
University of Technology

Where innovation starts

Transport in Permeable Media-Applied Physics



- 17 PhD students+ 3 Post-docs
- 2-4 Master students
- Staff: 1 Professor, 1 Associate professor, 1 Assistant professor
3 Industrial Research fellows (AkzoNobel, Canon-Oce, TNO)
- 2 Technical assistents
- 1 Secretary

Unique infrastructure *Darcy Lab*



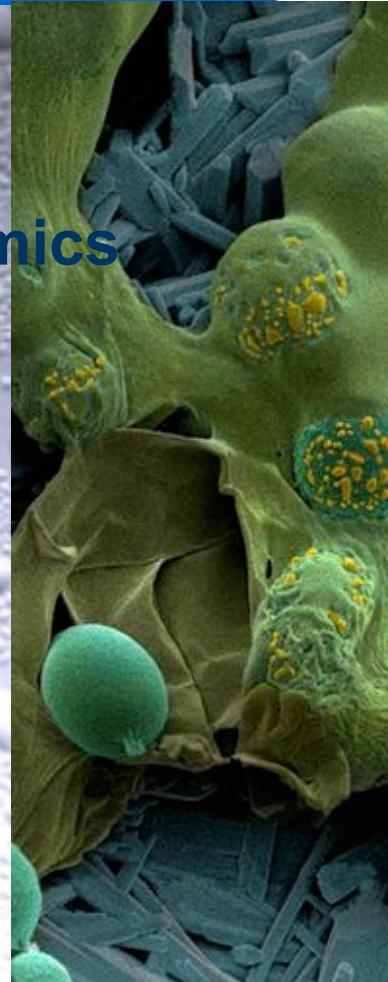
Outline

- Water in the air: introducing humidity dynamics
- Water in the substrate
- Humidity dynamics revisited

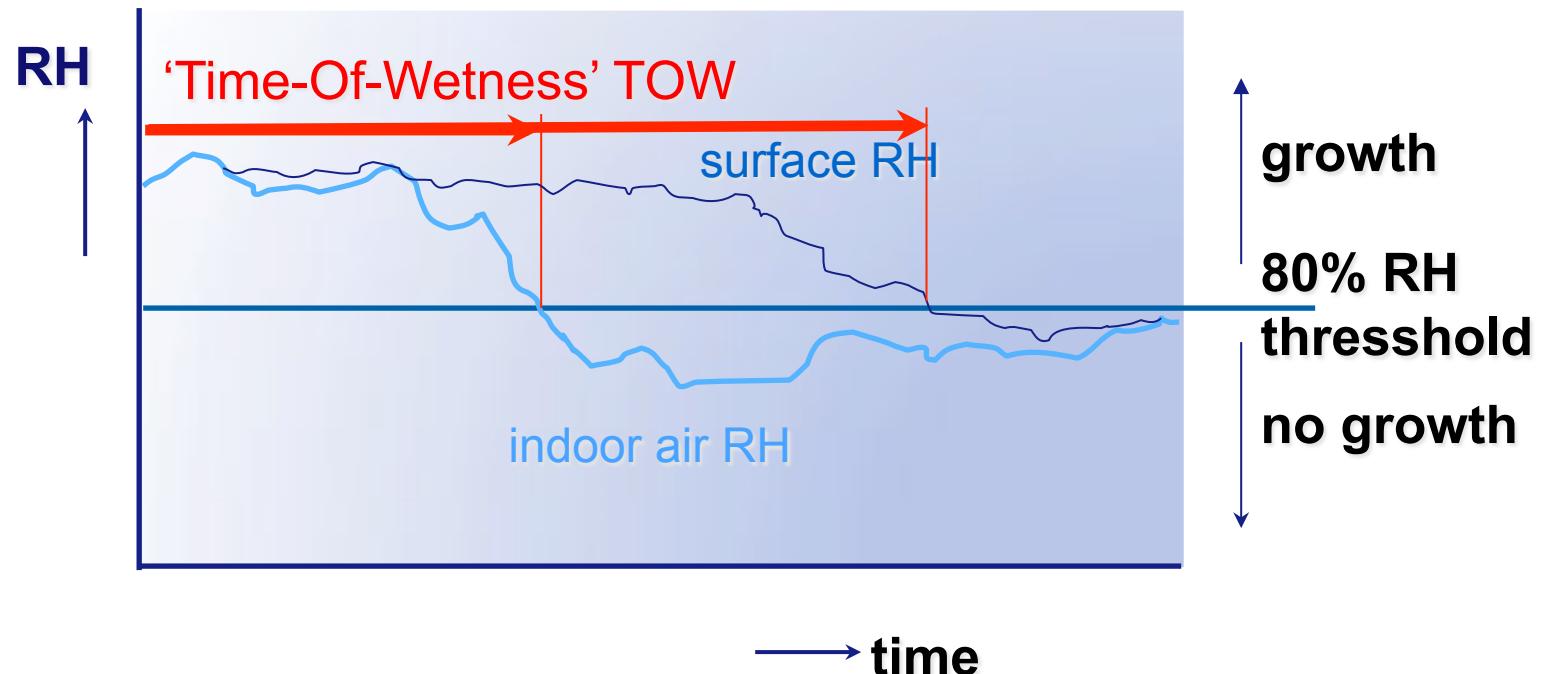


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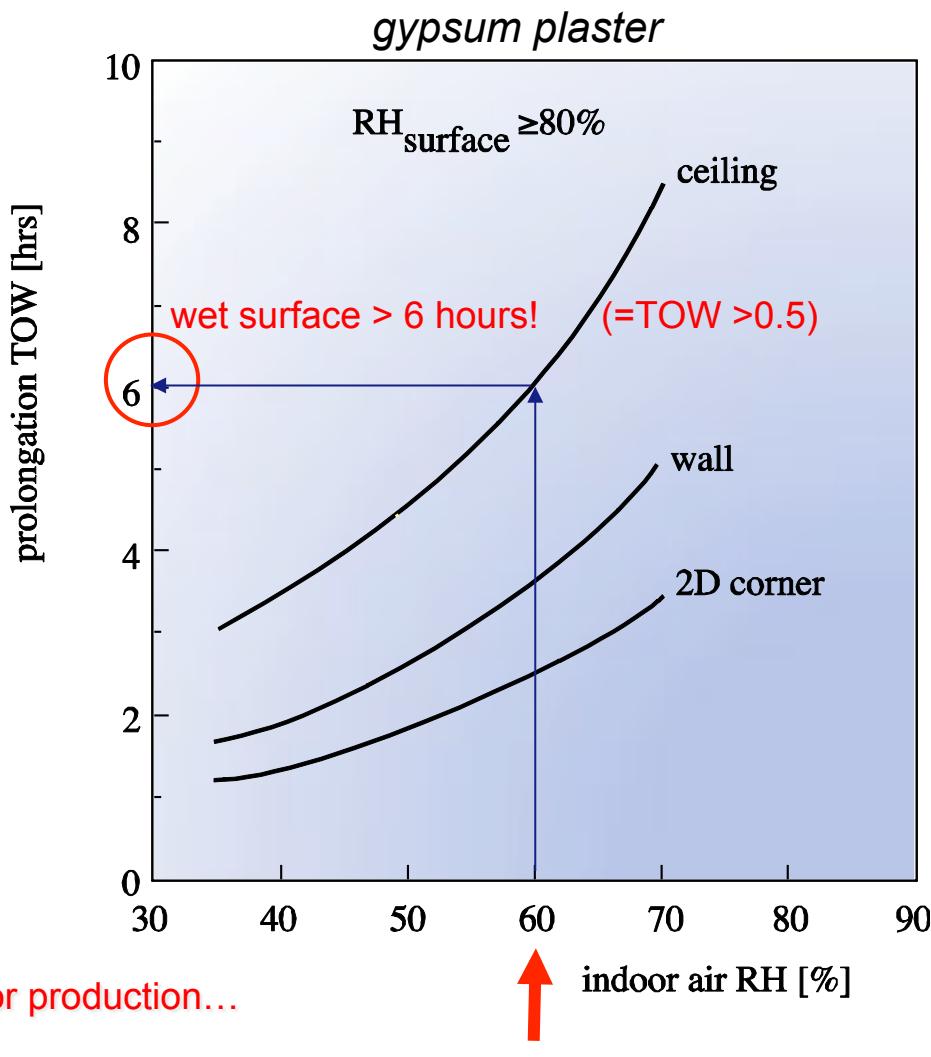
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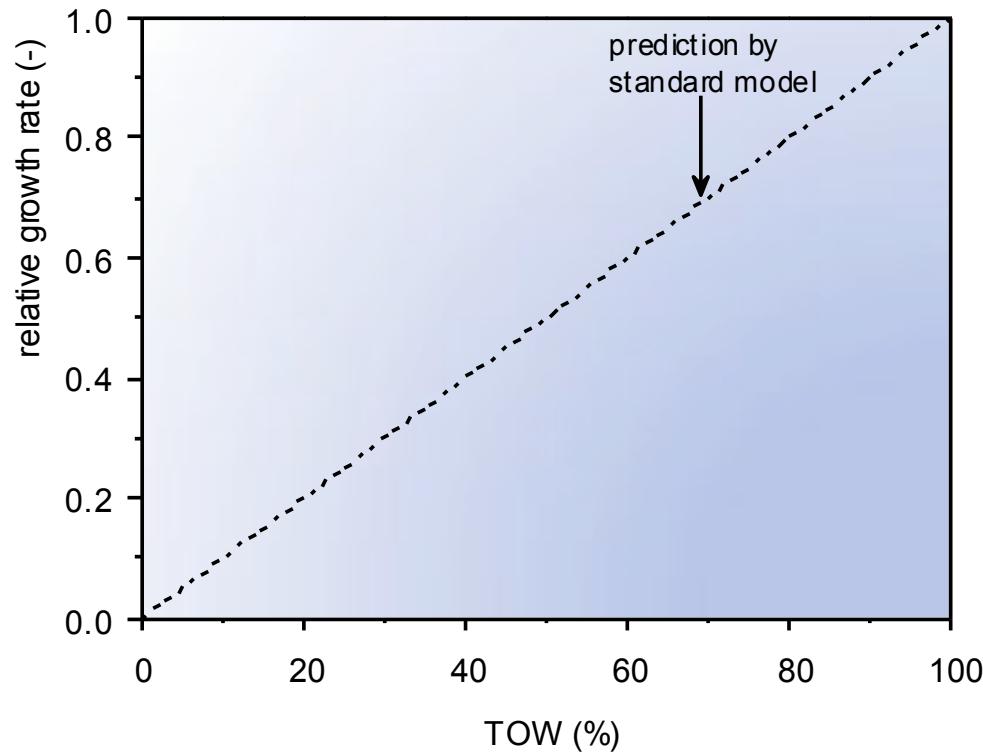
Time-Of-Wetness (TOW)



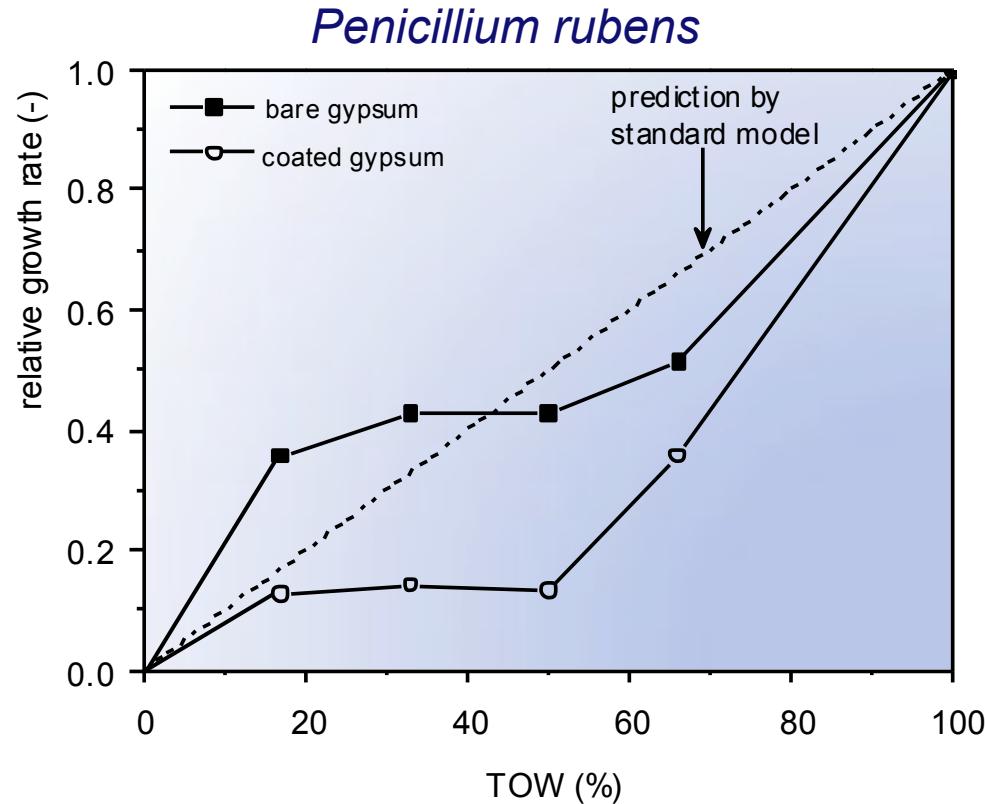
TOW as function of RH



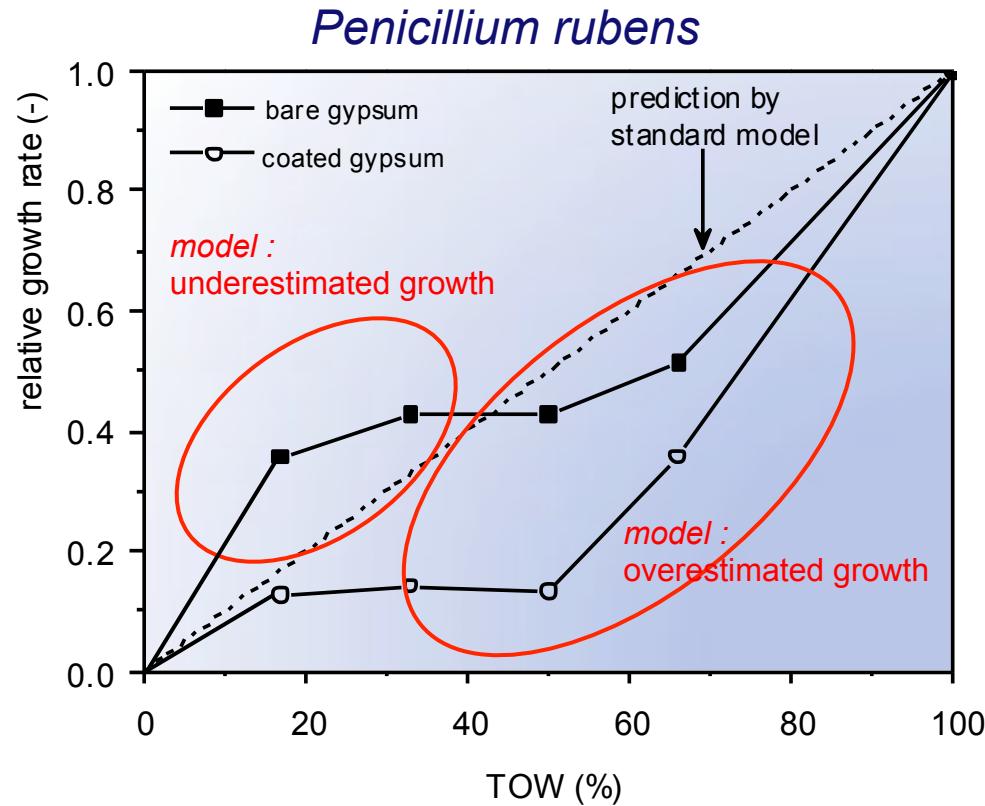
Growth as function of TOW



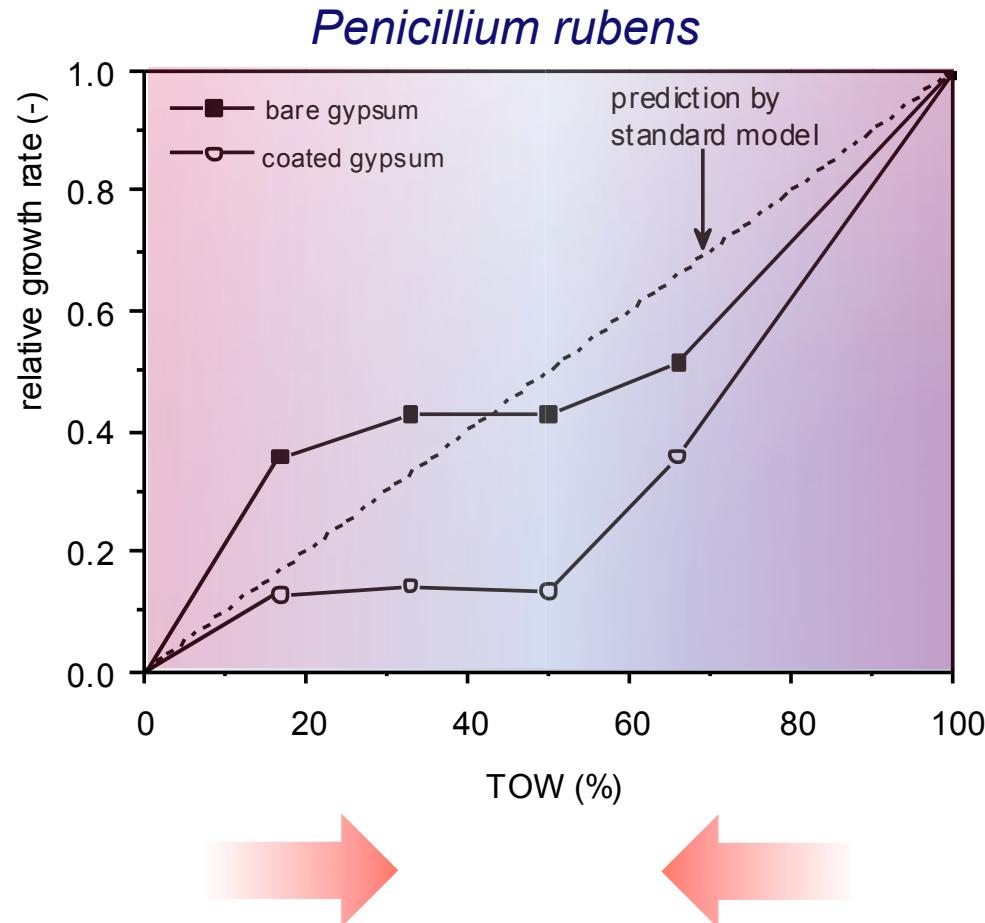
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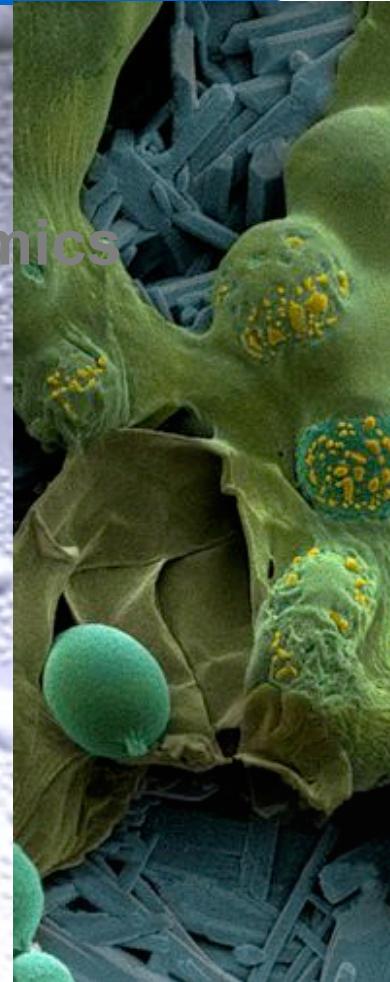


Growth as function of TOW

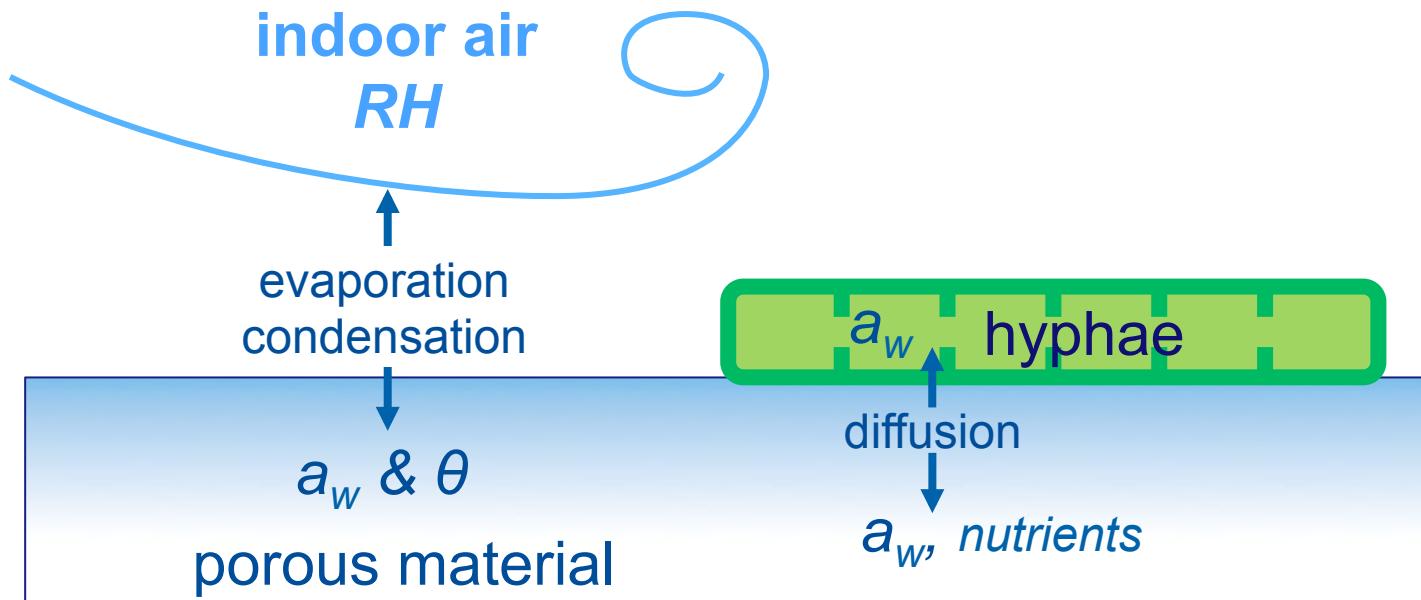


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Complexity of the water-fungus relation



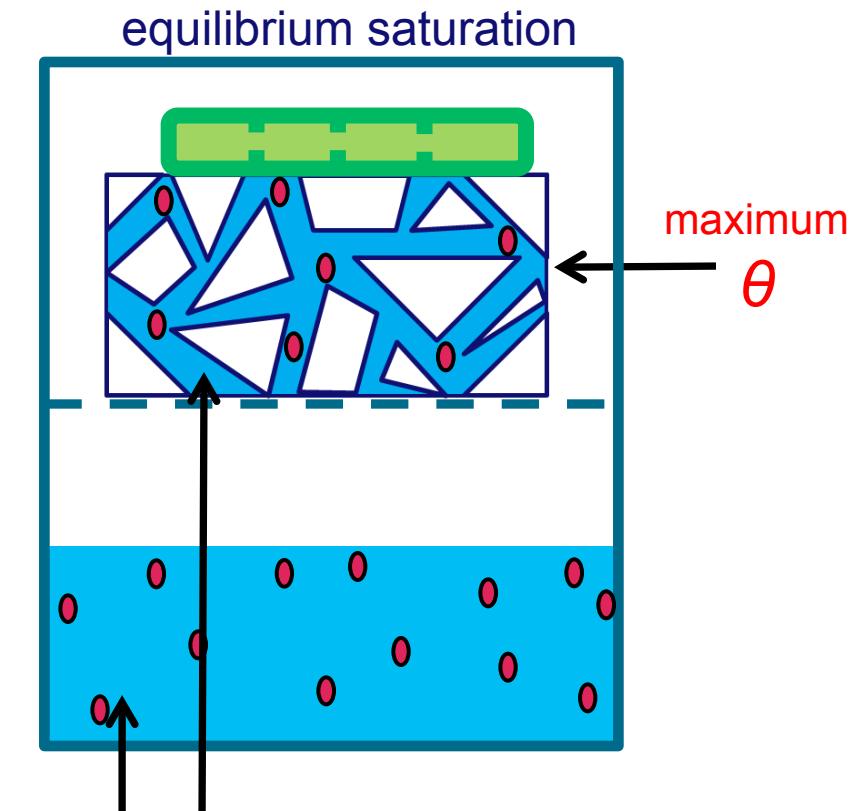
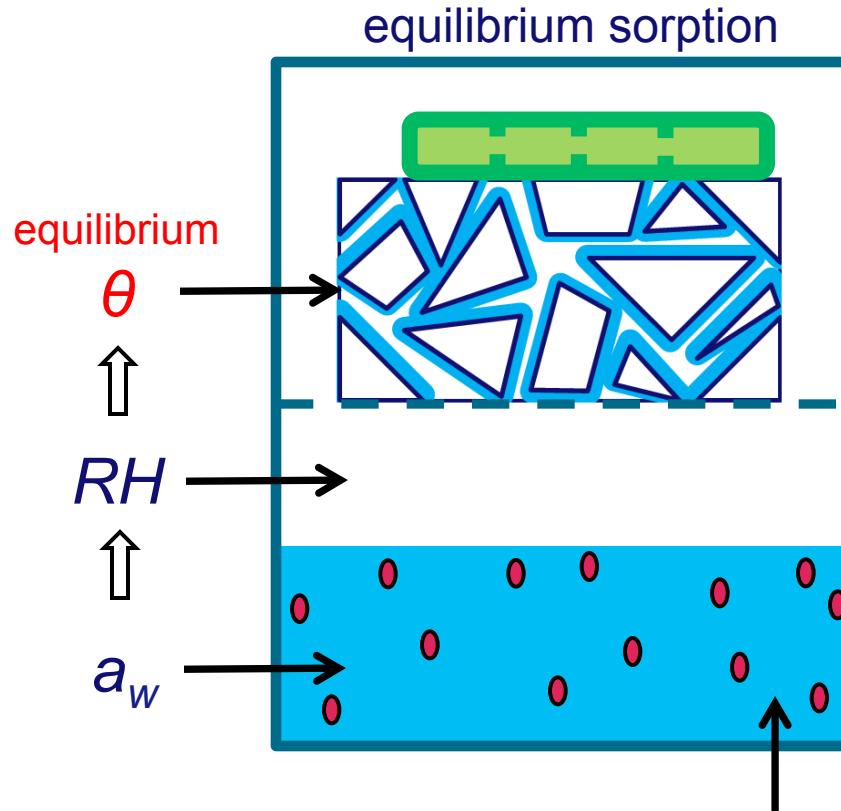
RH = relative humidity

a_w = water activity

θ = moisture content in different phases

Unraveling the a_w - θ effect

experiment: same a_w , different θ

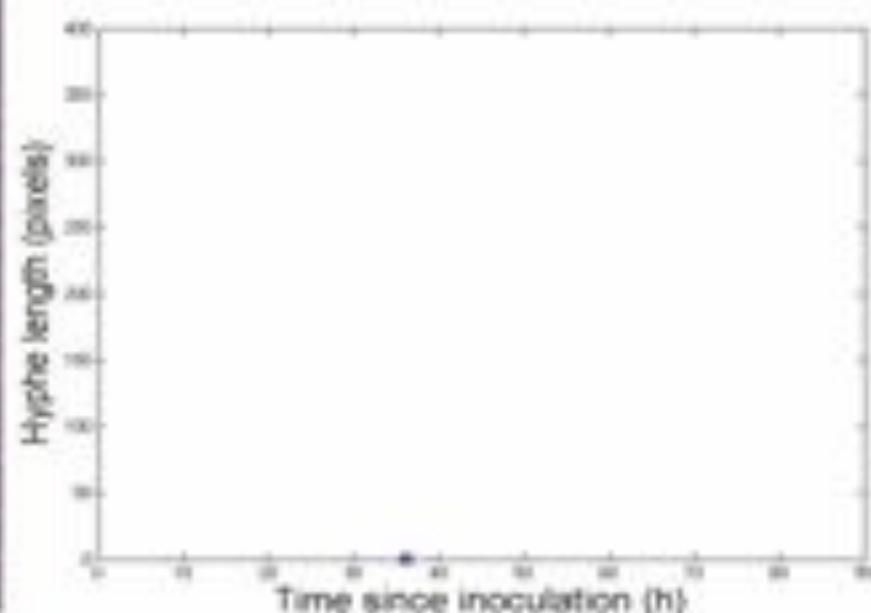
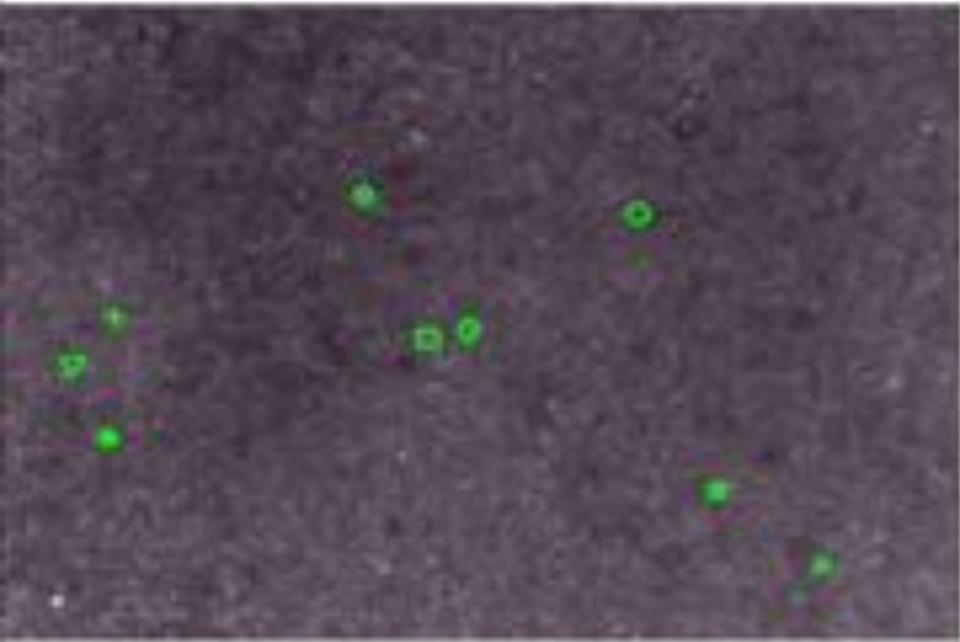


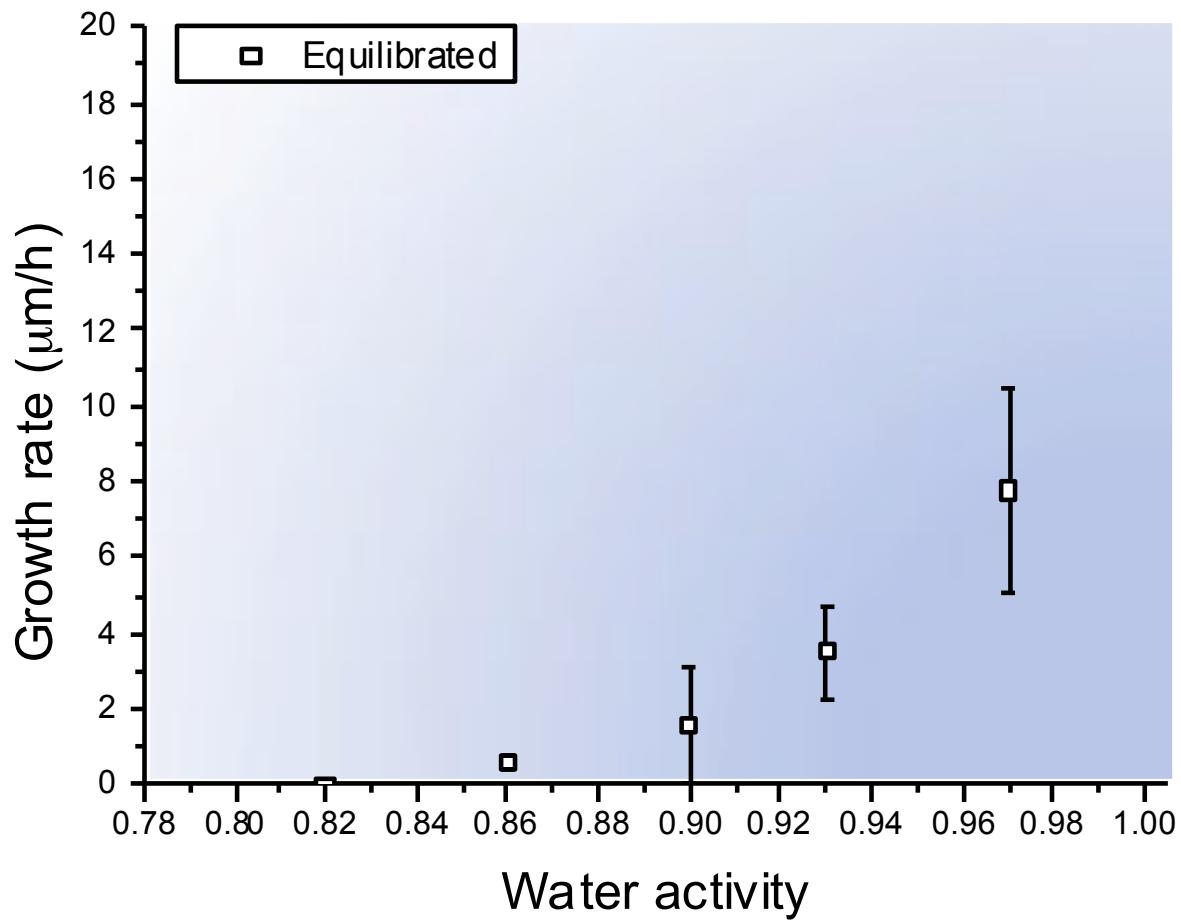
aqueous glycerol solution
(controlled a_w)

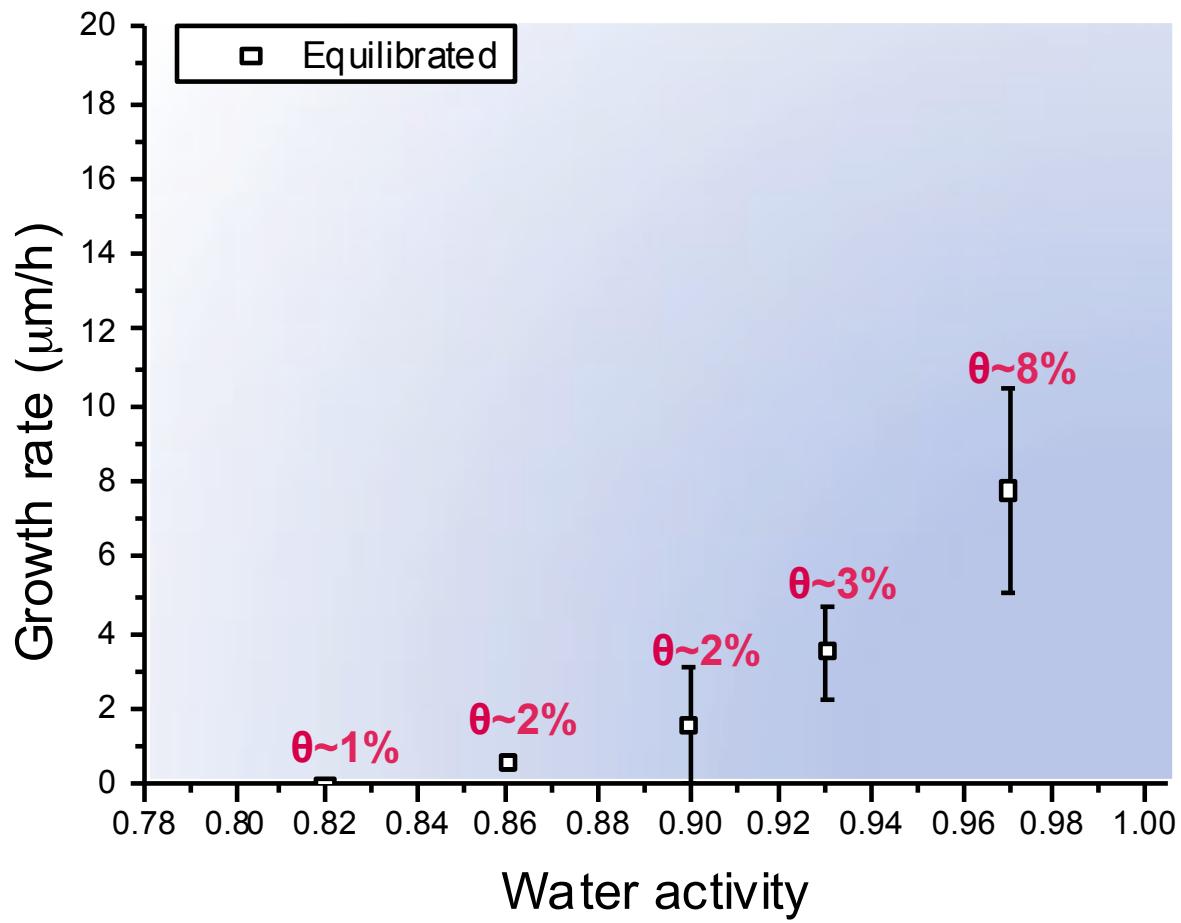
Hyphae extension as a measure for growth

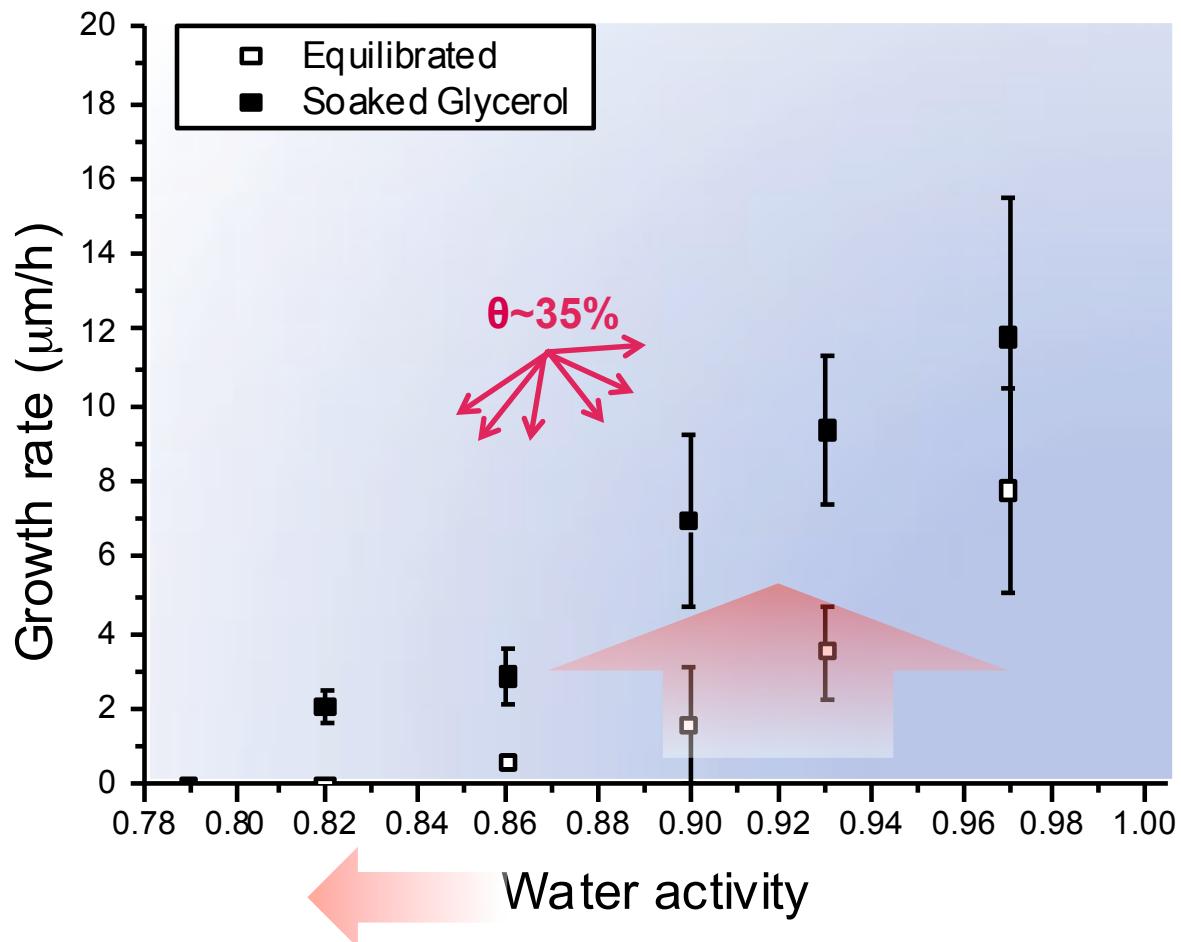
Growth on gypsum equilibrated with RH=97%

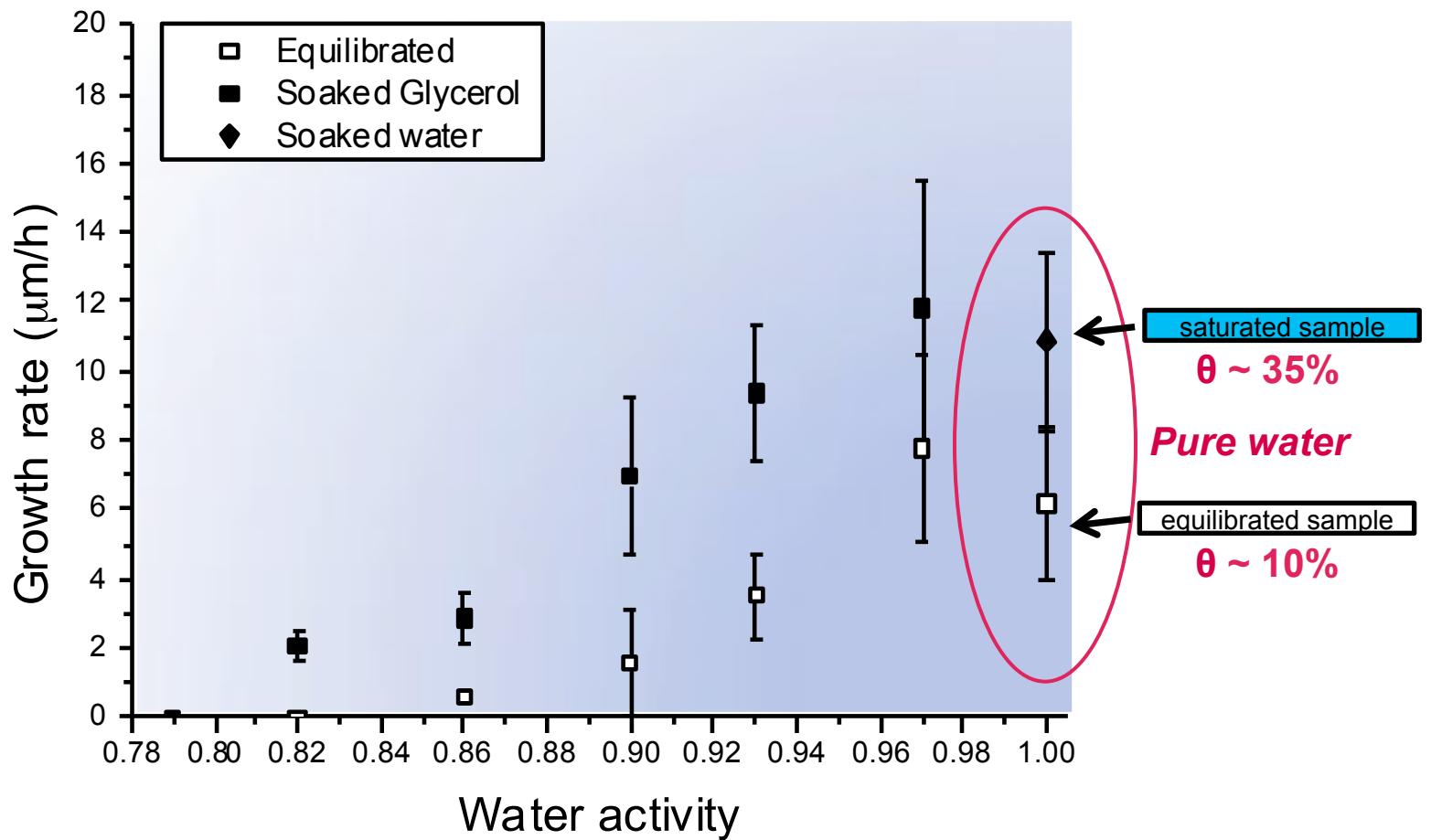
USB Microscope recordings: optical resolution $\sim 1.5\mu\text{m}$ (pixel $\sim 0.6\mu\text{m}$)

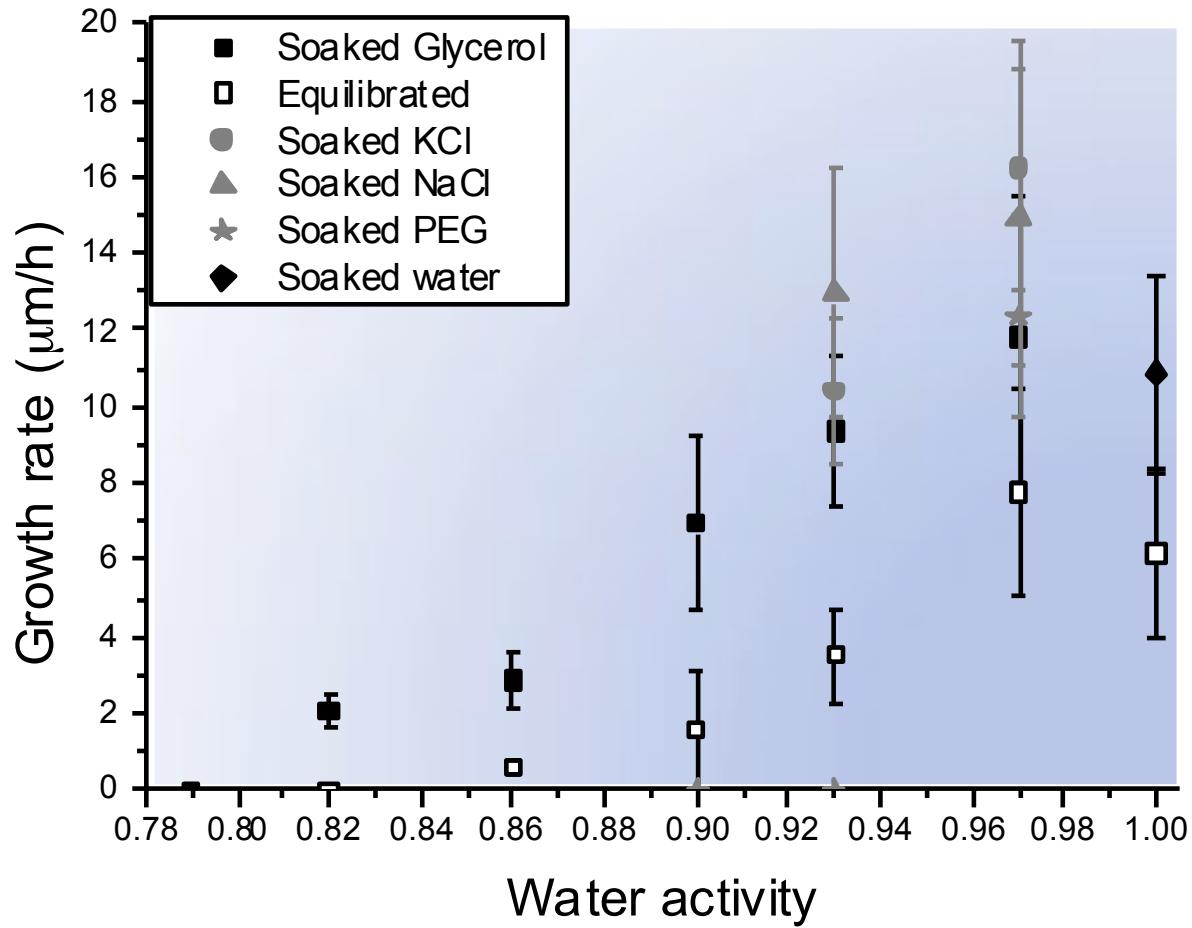












Conclusion

The effect of the moisture content θ on hyphal growth

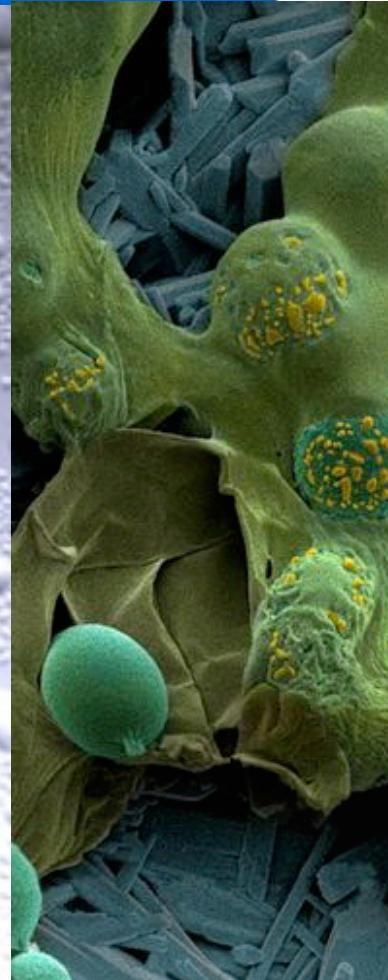
- Strong indication: θ affects growth rate, apart from a_w or compatible solutes.
- This effect is inherent to the material(-geometry):
not relevant on agar,
highly relevant on porous media

Summary (*Penicillium rubens*)

- Indoor climate dynamics matter
Growth and TOW are non-linearly related
- Both water activity & substrate water content play a role in growth

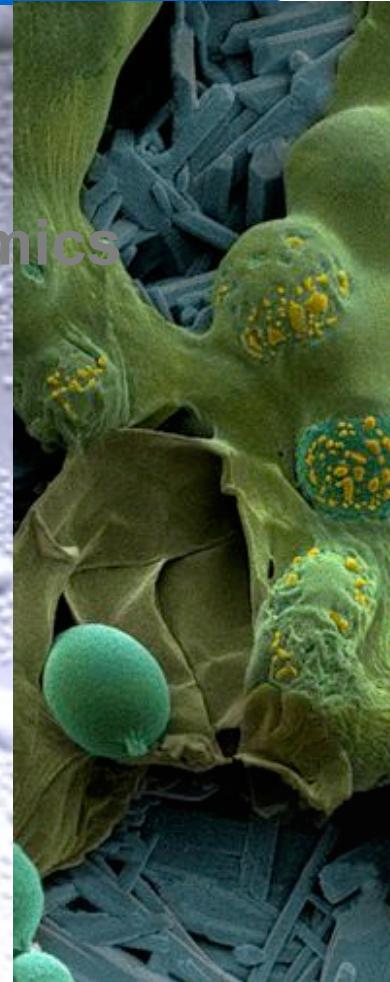
***Porous media ≠ culture media:
less water, inertia***

Culture media data cannot be extrapolated to porous substrates



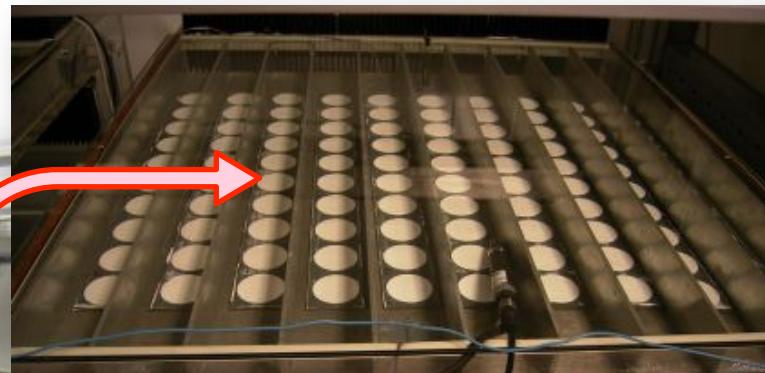
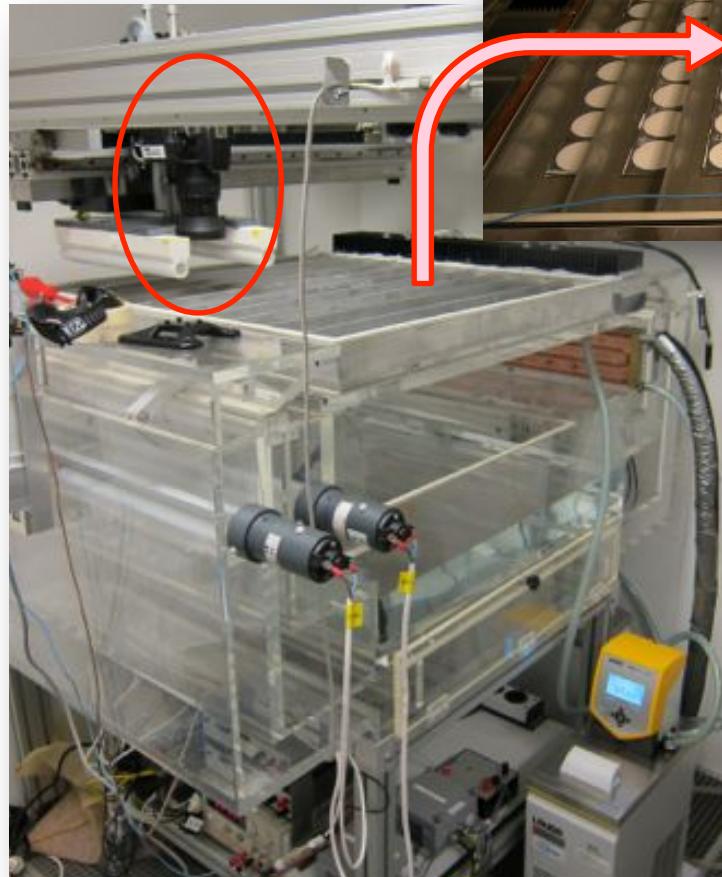
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Our FOCUS

Fungal Observatory Climate controlled aUtomized Set-up

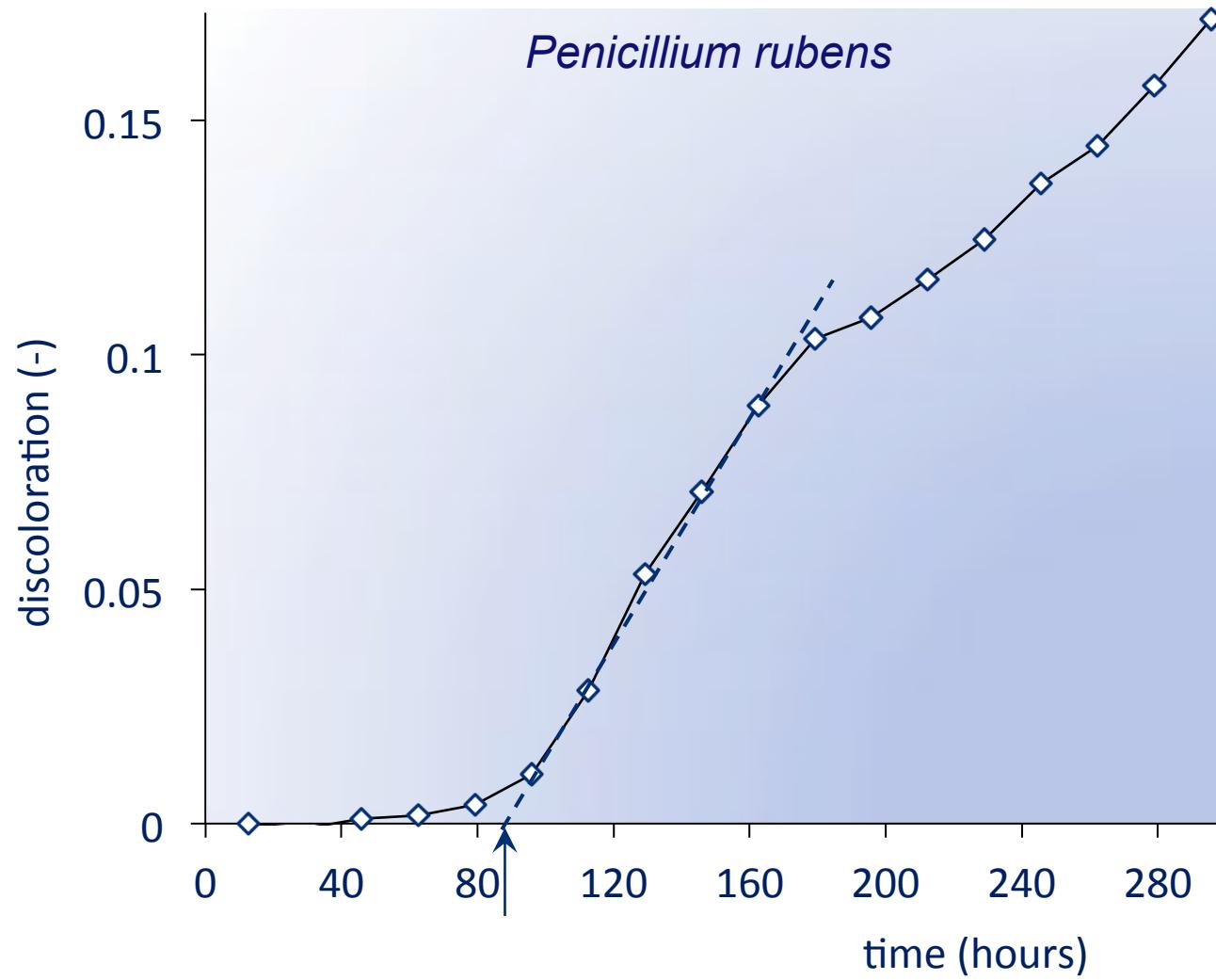


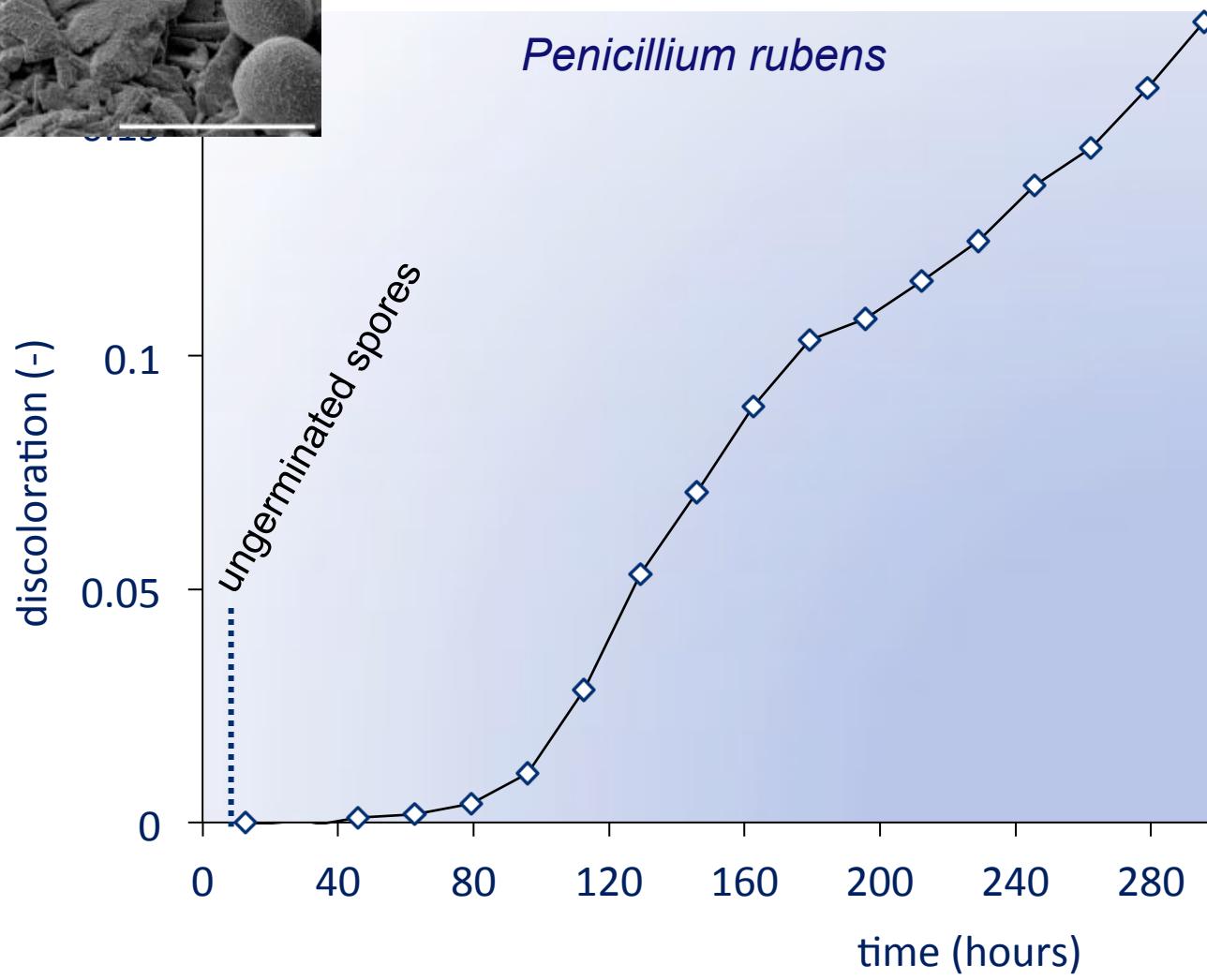
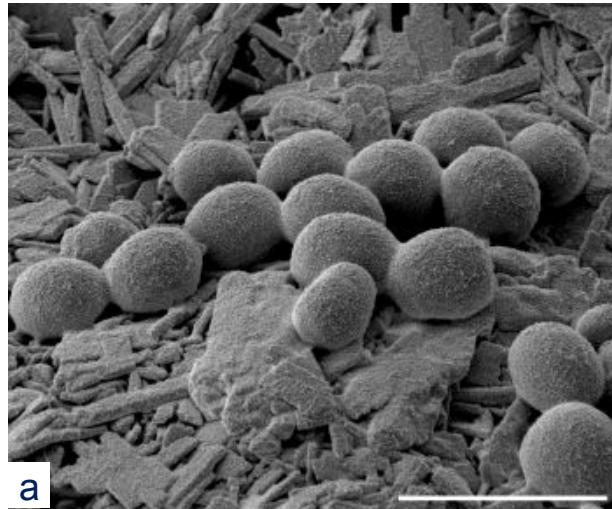
Response monitoring:
*quantified macroscopic surface
discoloration (digital analysis)*

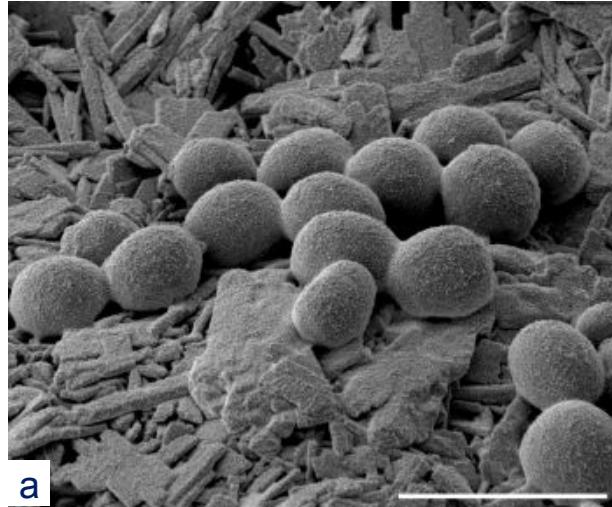


TU/e

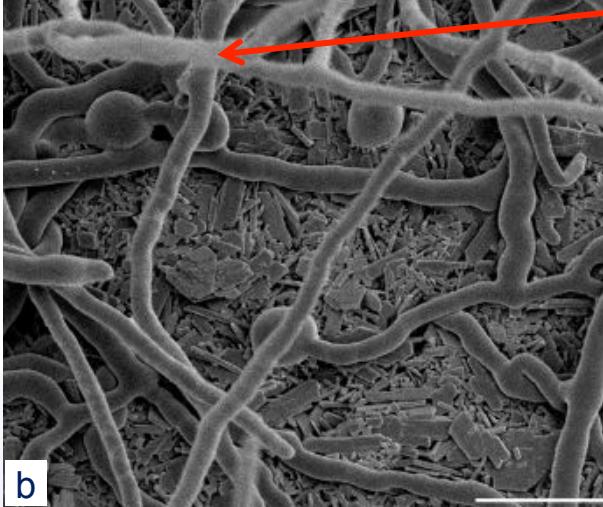
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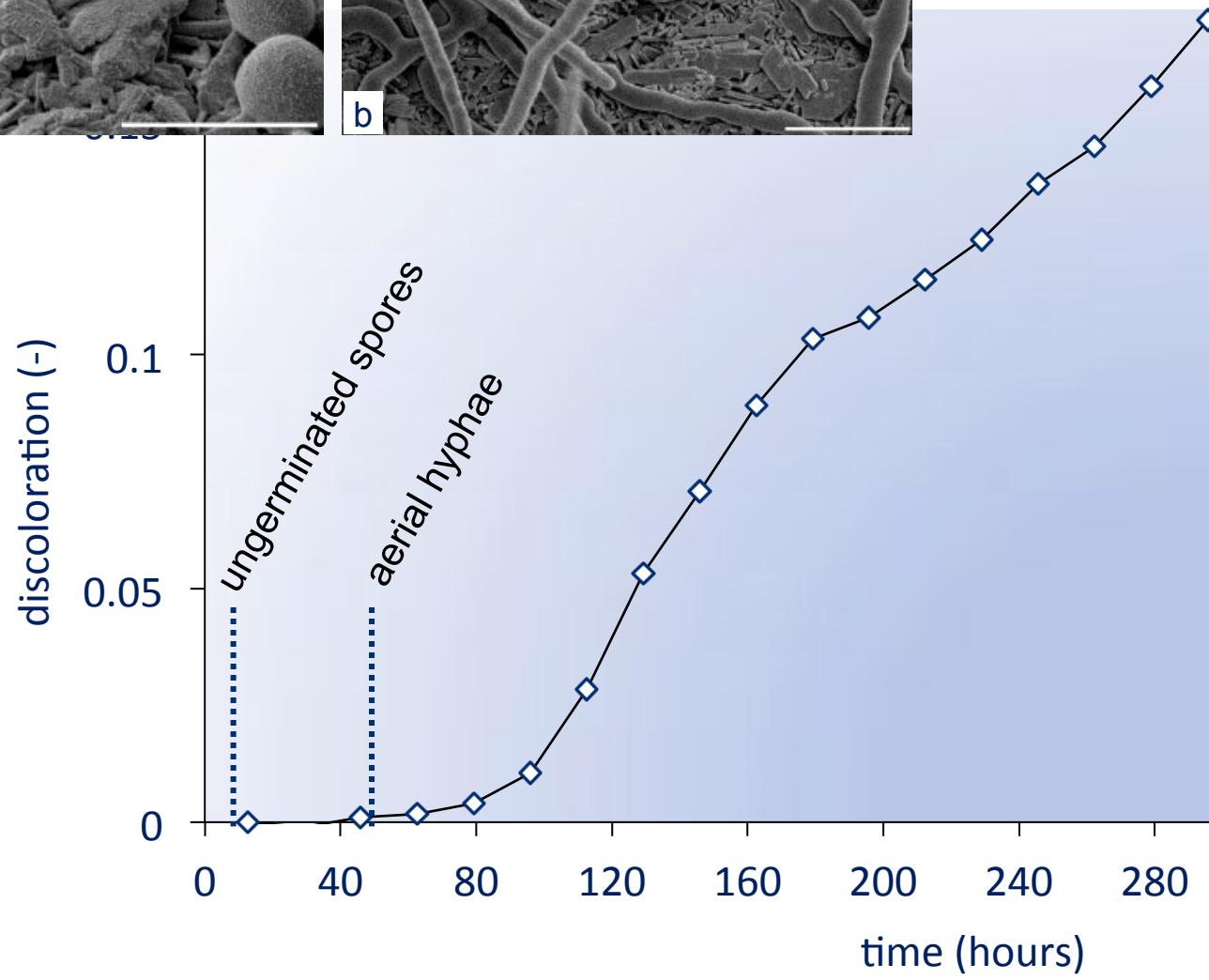


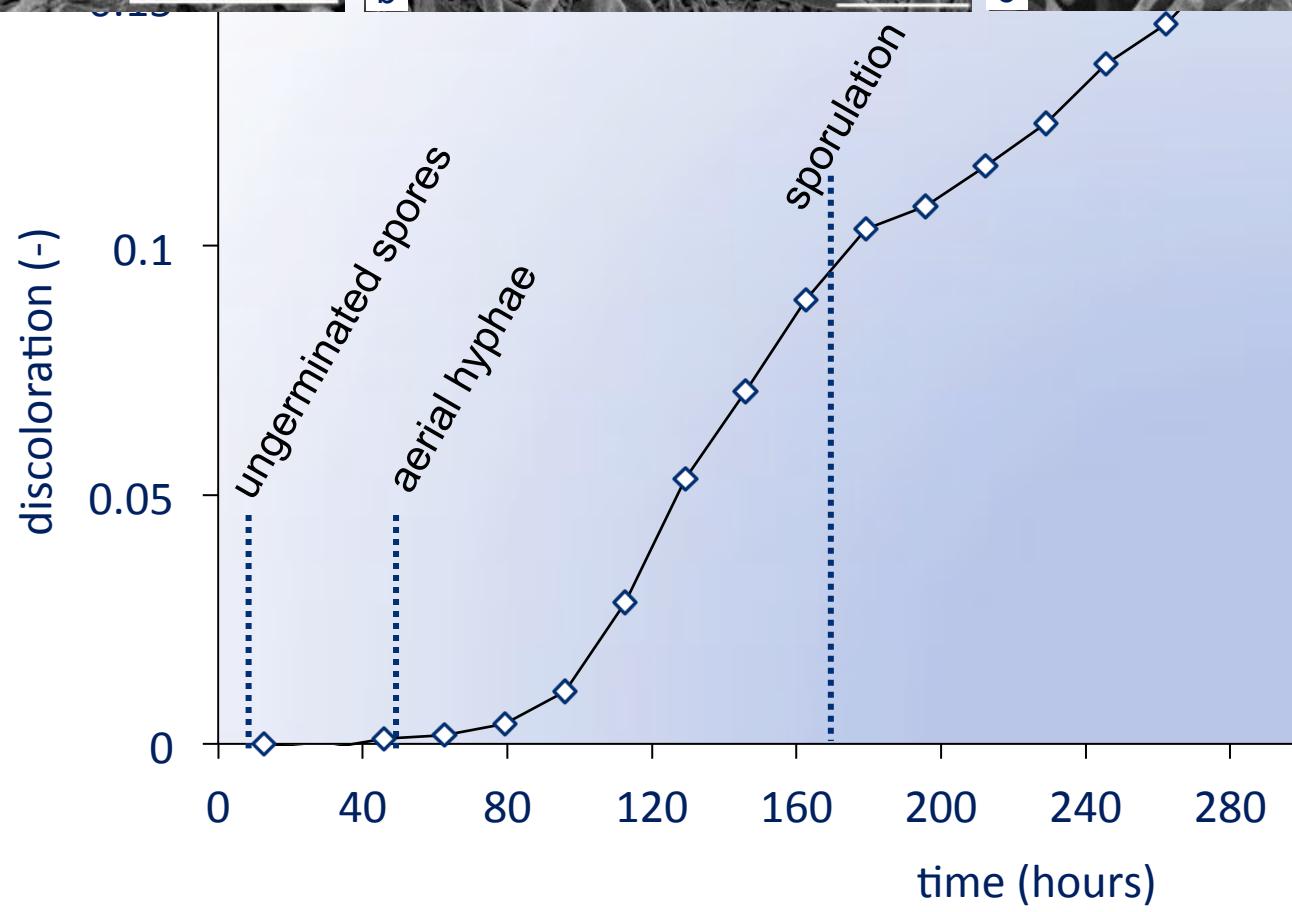
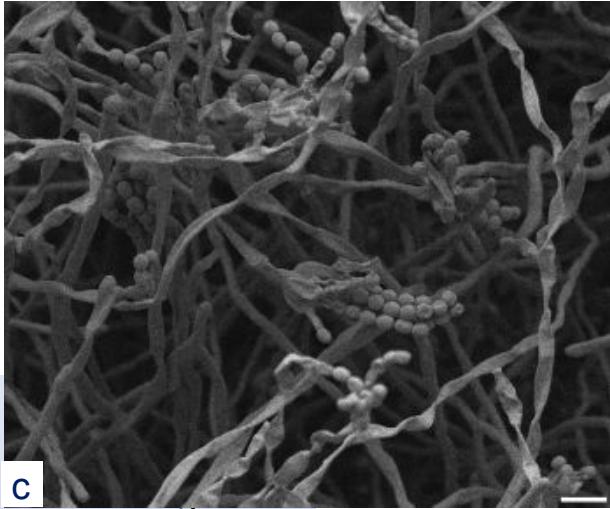
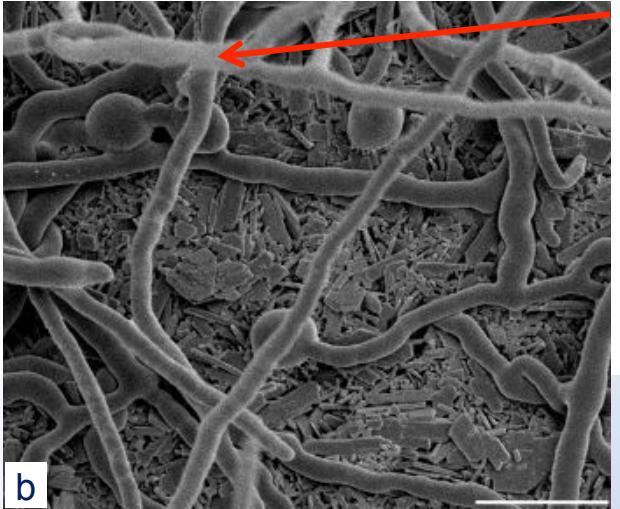
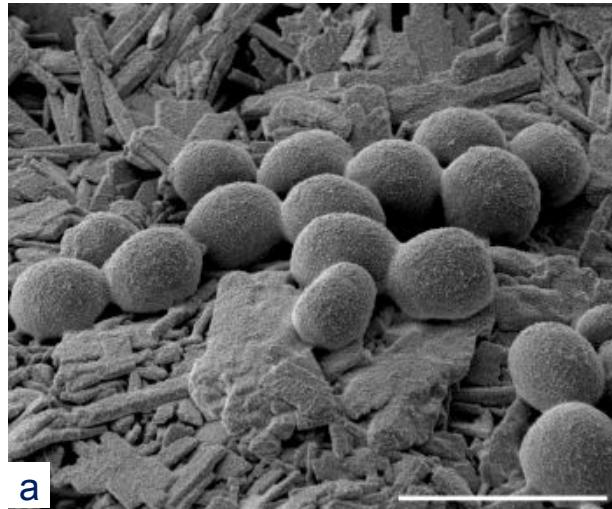


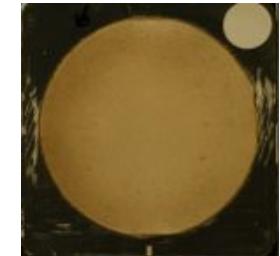
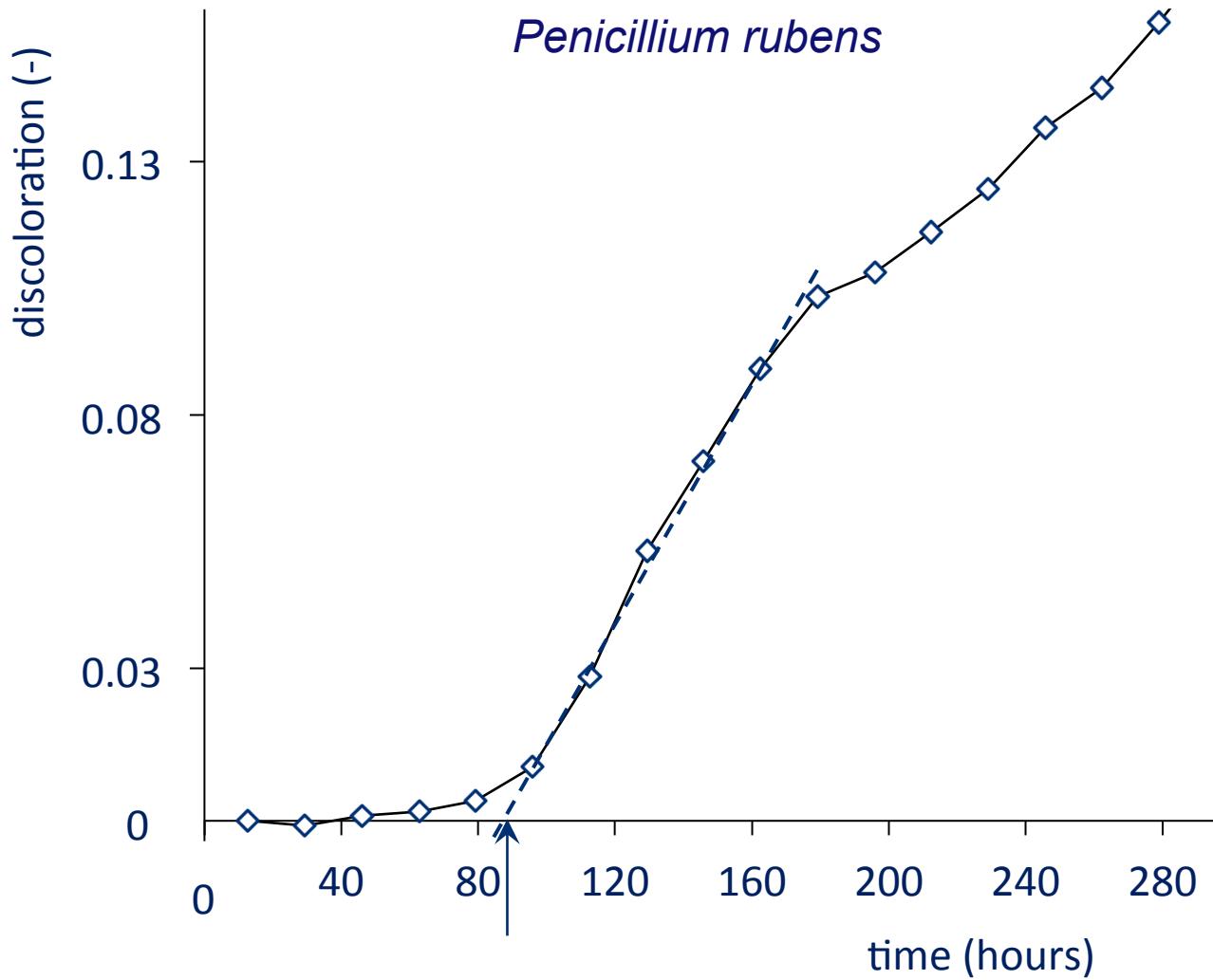
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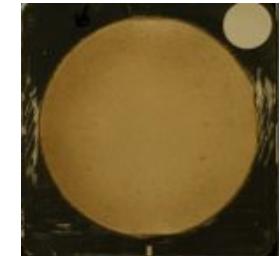
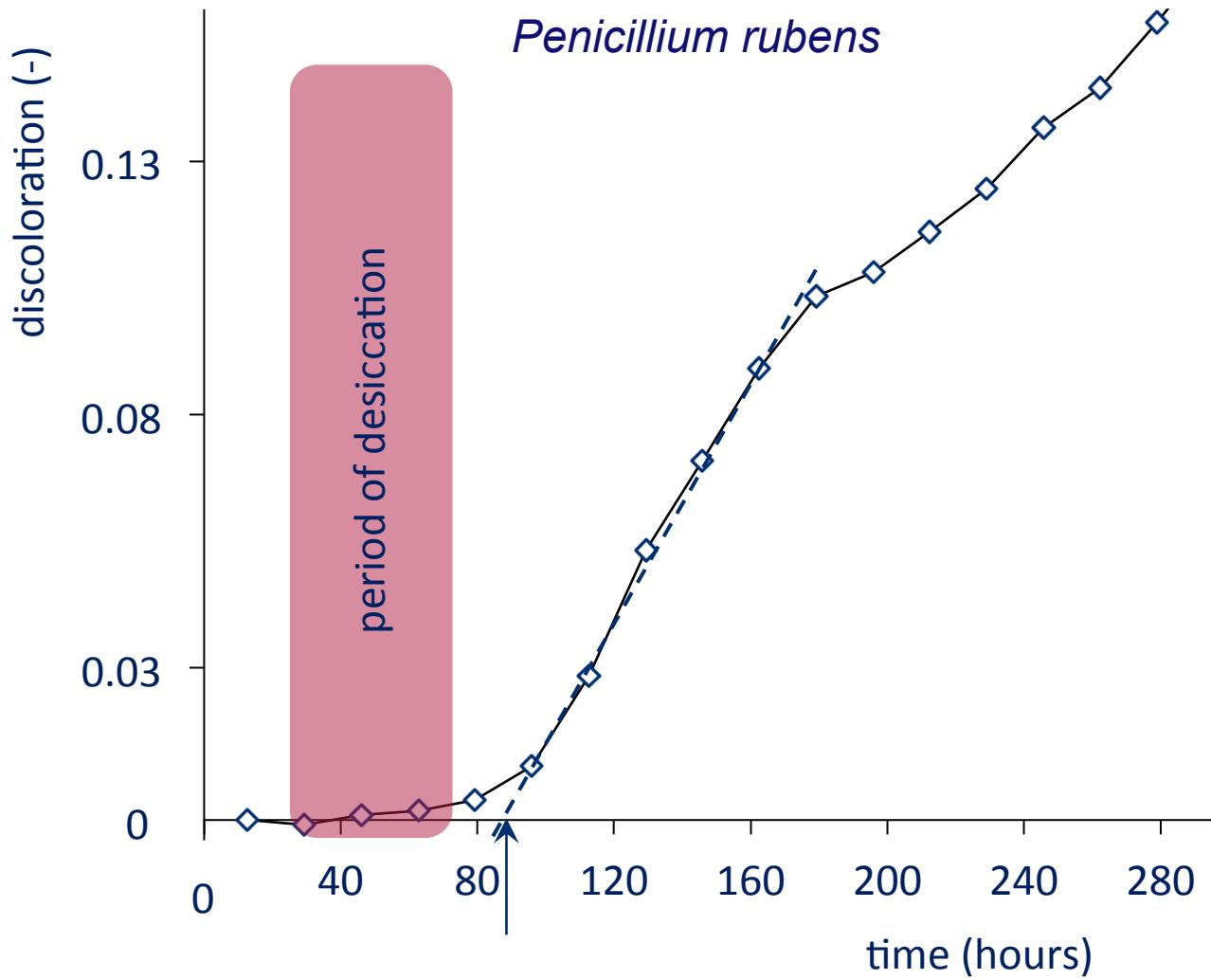


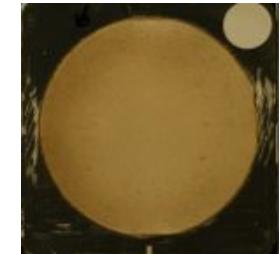
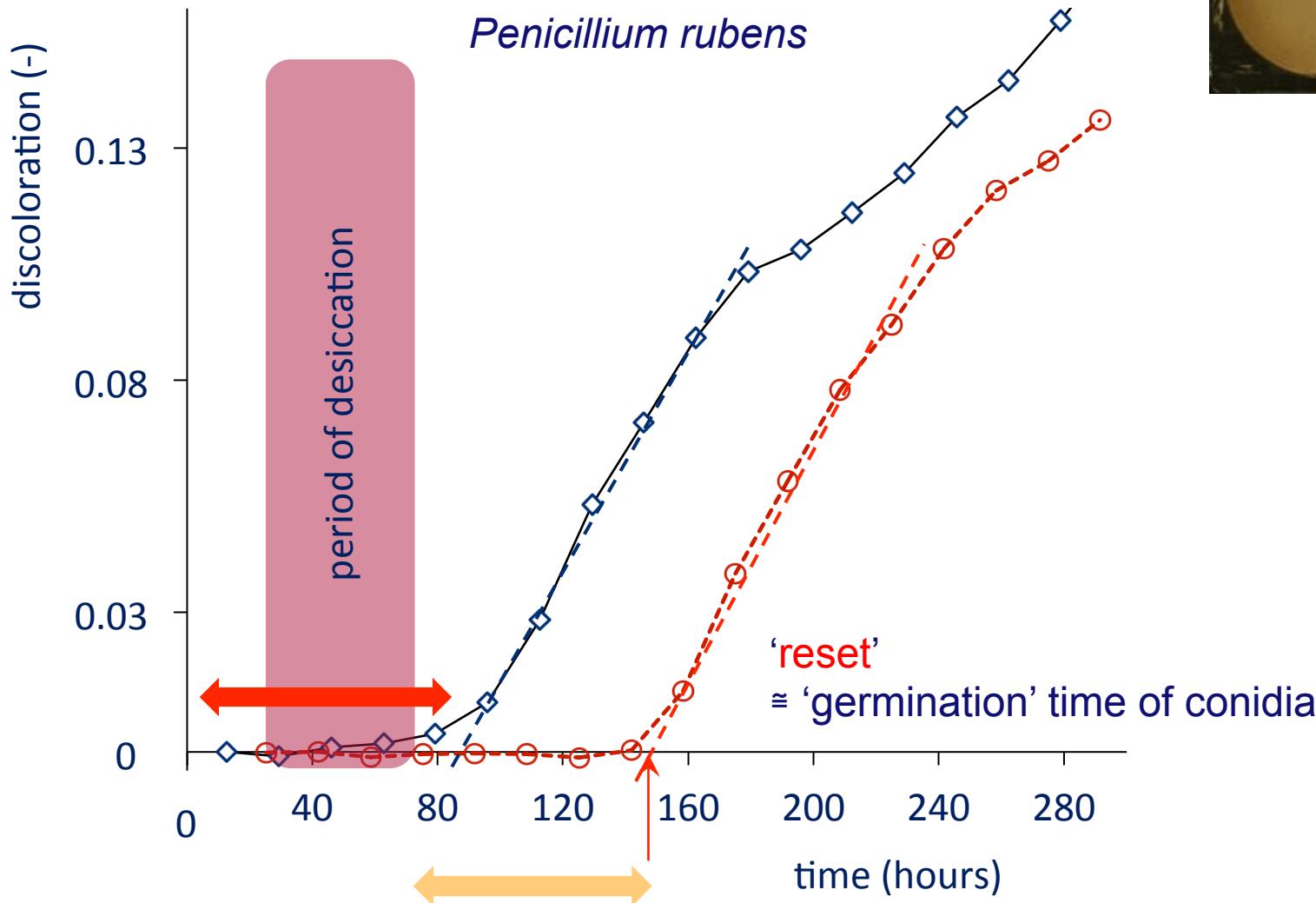
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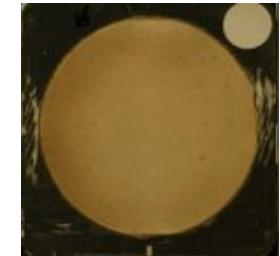
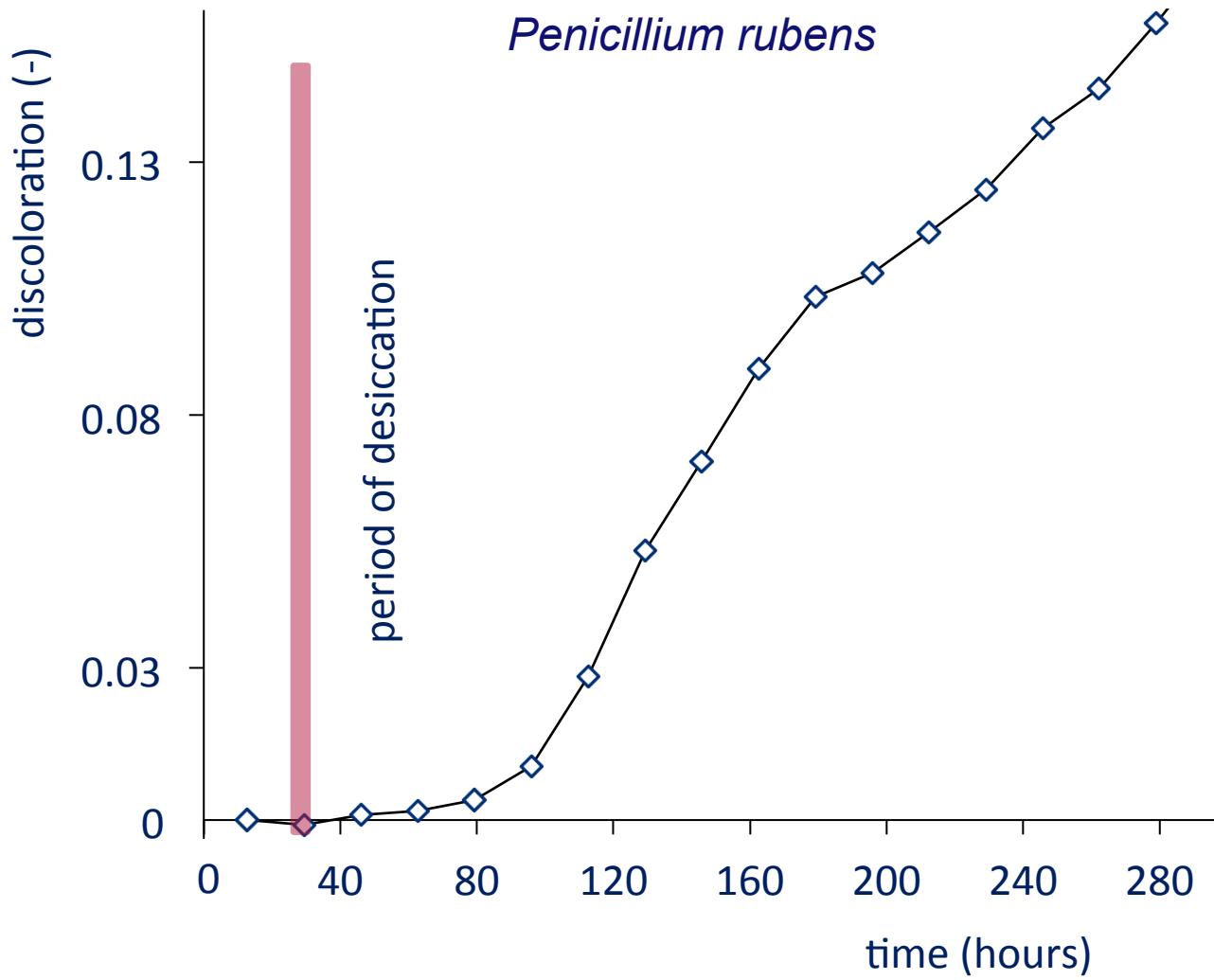


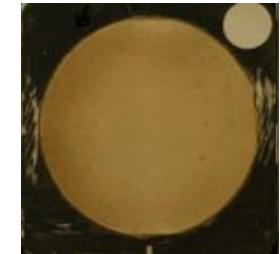
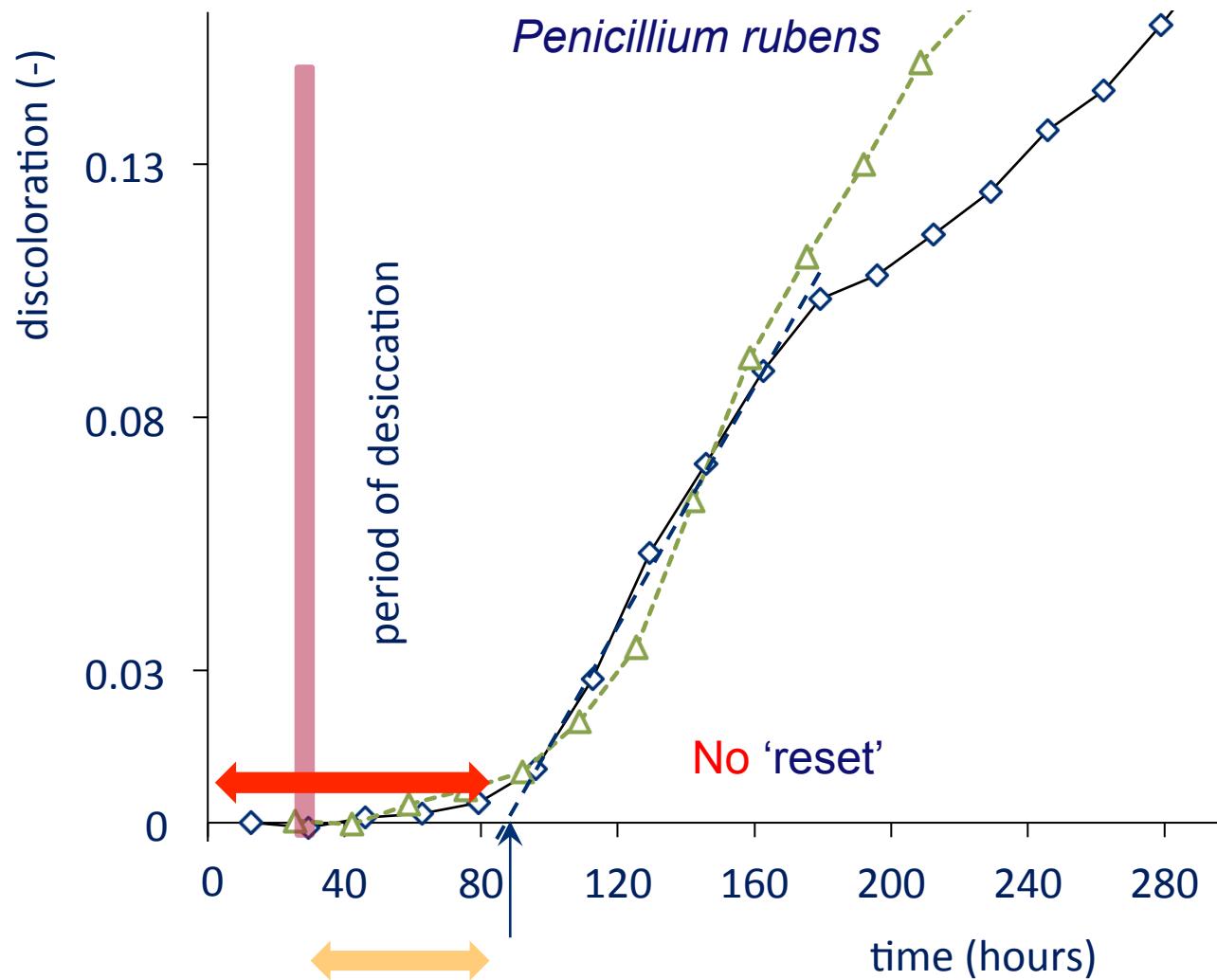








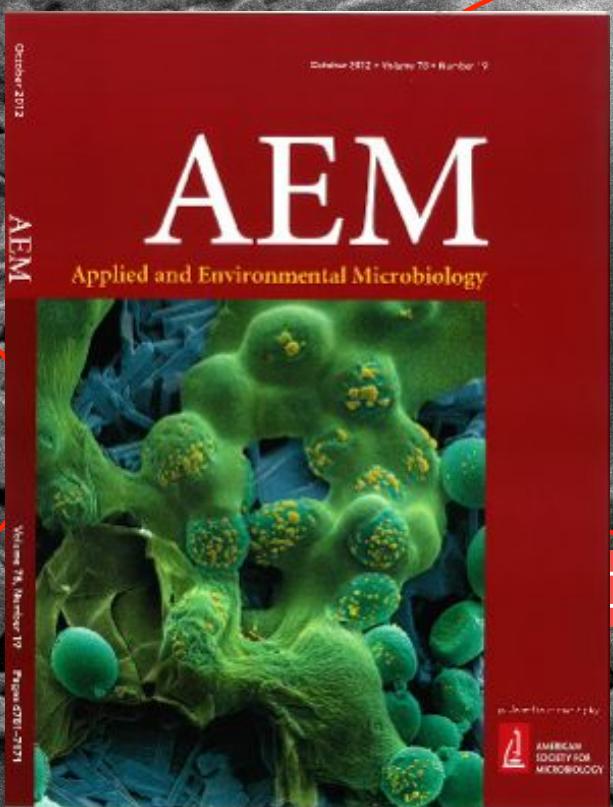




Conclusion

Colony recovery (*P. rubens*) after first desiccation

- “**full reset**” after a 48 h desiccation in initial stages
recovery: conidia, and (not) more?
- “**ignores**” a 6 h desiccation in initial stages
recovery: more than conidia

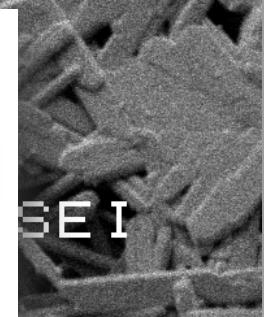


Production of an Extracellular Matrix as an Isotropic Growth Phase of *Penicillium rubens* on Gypsum

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¹Eindhoven University of Technology, Department of Applied Physics, Eindhoven, The Netherlands; ²ICL-Delft, Delft, The Netherlands; and ³CBM-Fungal Biotechnology Centre, Utrecht, The Netherlands

Indoor mold represents an important environmental concern, but a fundamental knowledge of fungal growth stages is needed to limit indoor fungal proliferation on finishing materials used in buildings. The present study focused on the succession of germination stages of the common indoor fungus *Penicillium rubens* on a gypsum substrate. This substrate is used as a model system representing porous materials that are widely used in indoor environments. Imaging with cryo-scanning electron microscopy



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