



Aalto University
School of Engineering

Vapor as a carrier of toxicity in a health troubled building

Healthy Buildings 2015

19.5.2015

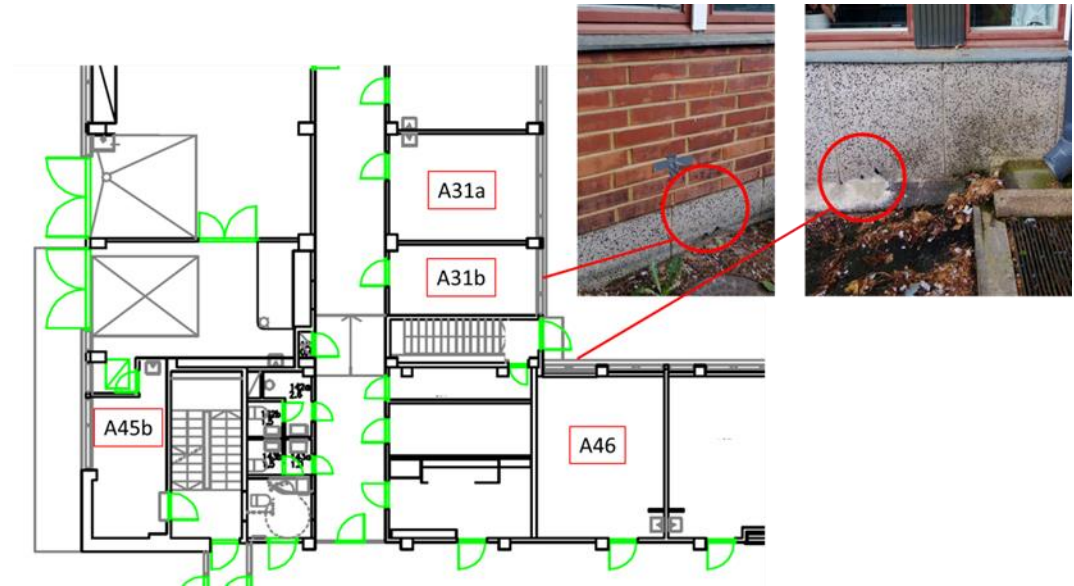
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Building with reported indoor related human illness



Finnish office building

Constructed in 1959 - 1967

Renovations made in 1997 – 2001

7 rooms were investigated

Colony tests for toxicity

Samples

- surface wiping
- settled dust collection
- 6-stage Andersen impactor
- deposition plates
- material samples

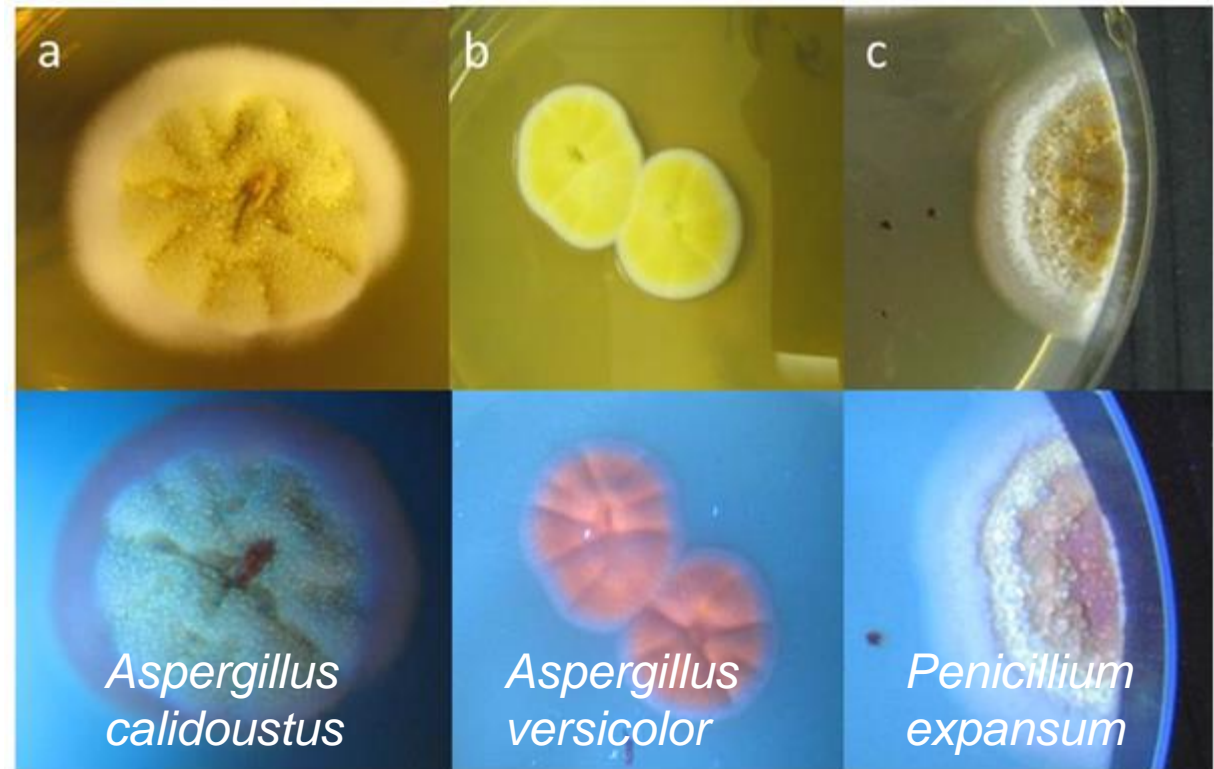
Each colonies were tested for toxicity using cell toxicological methods.

Target cells for toxicological assays

- porcine spermatozoa,
- kidney tubular epithelial cells (PK-15)
- feline fetal lung cells (FL)
- murine neuroblastoma cells (MNA)

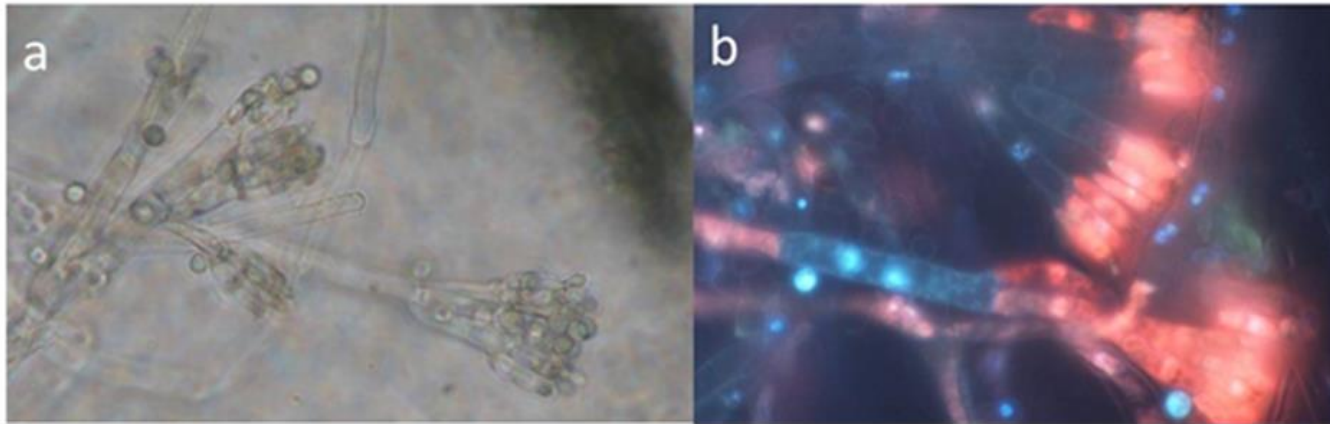


The most prevalent toxin producers found



Top row: photographed under ambient light; bottom row: illuminated at 360 nm.

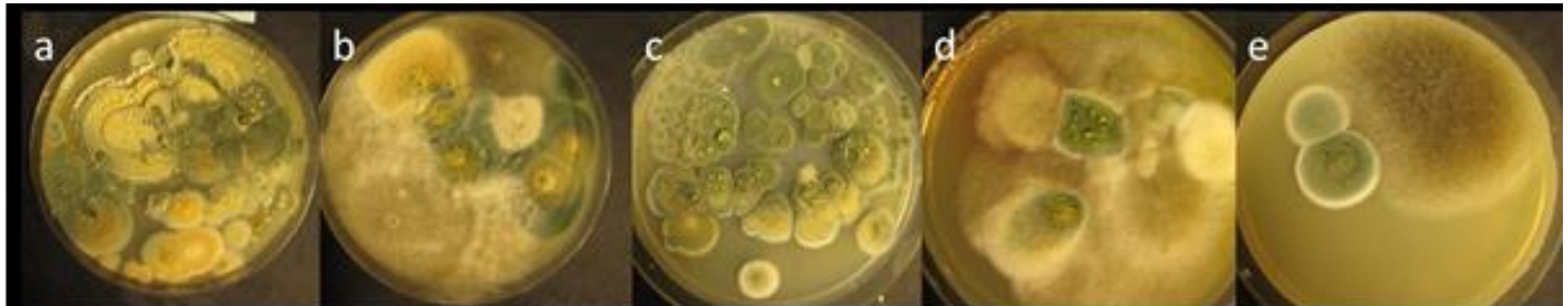
Toxin producing *P. expansum* was found as a major contaminant



- *P. expansum* was found in settled dust, building materials and on deposition plates (1 h exposed).
- All colonies identified as *P. expansum* were toxic in *in vitro* tests.

P. expansum appeared to be tolerant to high concentrations of wood preserving chemicals (arsenic, boric acid, borax) and polyguanide antimicrobials (PHMG, PHMB).

Fall out plates, exposure time 1 h, on MEA with supplements



Arsenic As_2O_3
200 ppm

Borax
500 ppm

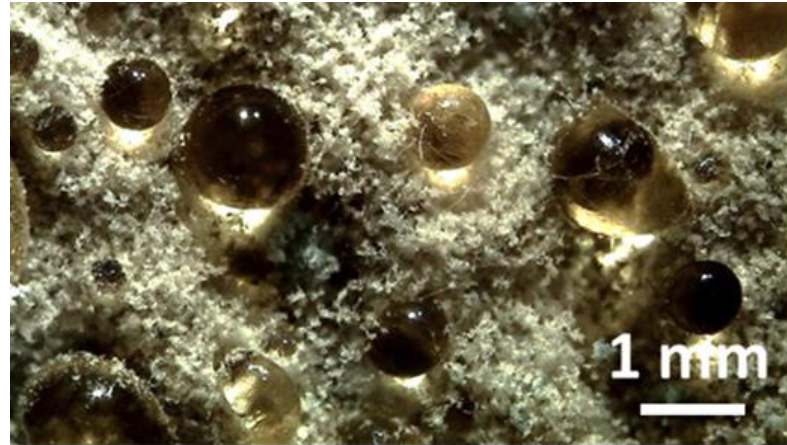
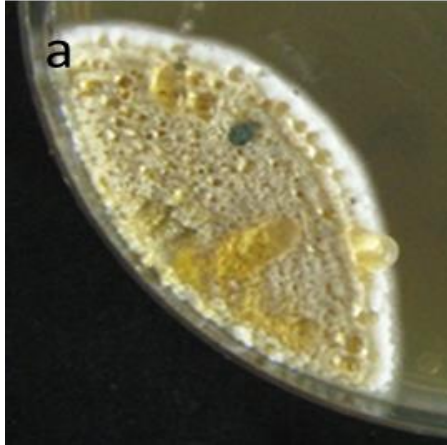
PHMB
500 ppm

Boric acid H_3BO_3
2000ppm

PHMG
500 ppm

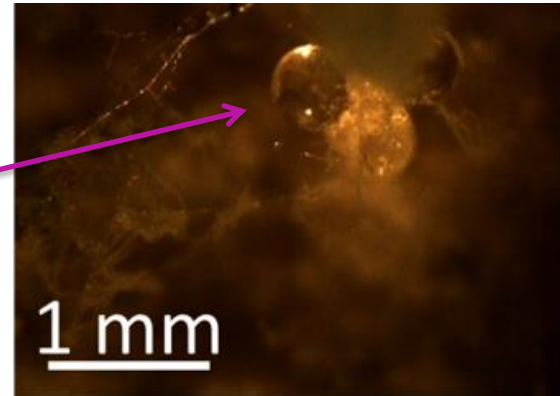
Using biocidal antimicrobials may offer selective advantage for *P. expansum* and is likely to be ineffective in remediating buildings already colonized by this fungus.

P. Expansum indoor isolate produced guttation droplets



The droplets of *P. Expansum* RcP61 growing on MEA (above)

And growing on gypsum board



Toxicity of guttation droplets of *P. expansum* strain RcP61

Exposed cells (exposure time)	Highest toxic dilution ^a	Toxic endpoint
Boar spermatozoa (1 h)	>1000	Motility inhibition ^b
Porcine kidney tubular epithelial cells (PK-15, 2 d)	10240	Cell death ^c
Murine neuronal cells, neuroblastoma (MNA, 2 d)	5120	Cell death ^c
Feline fetal lung cells (FFL, 2 d)	10240	Cell death ^c

^a First dilution 20 × , subsequent dilutions with step = 2 ×

^b Microscopy, computer based endpoint reading

^c Propidium iodide staining

Toxins communesin A, B, D and chaetoglobosin were identified from these exudates by LC-MS/MS.

Toxins transfer

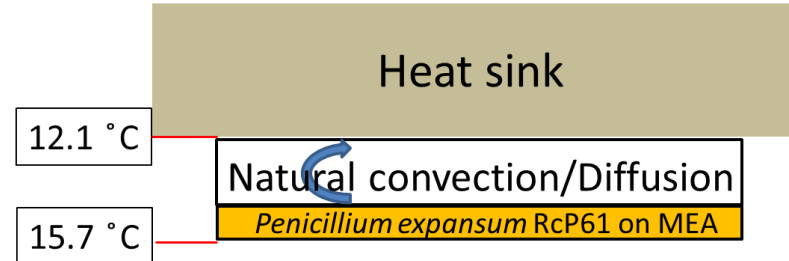
Experimental set-up:
Cooled upper lid of Petri dish

Condensed was collected and analyzed (LC-MS)

Communesin A and B and chaetoglobosin was identified from condense.

The toxins were transferred through the air space.

Surface temperatures measured:



CONCLUSIONS

- 1) **Toxin producing *P. expansum* was found as a major contaminant in a health troubled public building.**
- 2) **This fungus appeared to be tolerant to high concentrations (500 - 2000 ppm) of wood preserving chemicals (arsenic, boric acid, borax) and polyguanide antimicrobials (PHMG, PHMB).**
- 3) ***P. expansum* indoor isolate was shown to emit its toxins communesins A, B, D and chaetoglobosin as exudate droplets from which the toxins mobilized into the air.**