



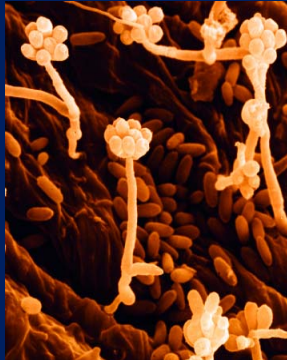
**Neuere Entwicklungen in der
Innenraum-Mykologie**
New developments in Indoor Mycology

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**Significance of
indoor molds**

- Biodeterioration of the building
- Health implications
 - Allergy
 - Pathogens (e.g. *Aspergillus fumigatus*)
 - Toxins (e.g. Black toxic mold)

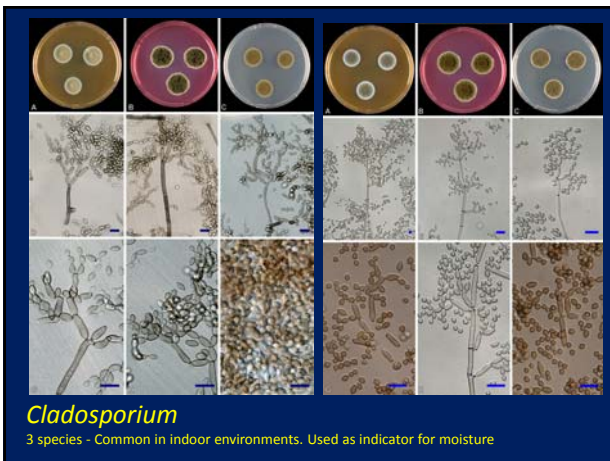


Ecology of indoor fungi
Current concepts

- The mycobiota of indoor environments is known (ca. 120 species) and is different in its composition from outdoors (phylloplane fungi)
- The mycobiota is very similar to that occurring in food
- Many species are xerotolerant or xerophilic
- Indoor fungi cause allergy and can produce toxic metabolites on building materials

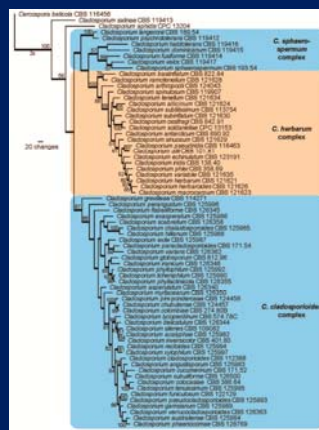


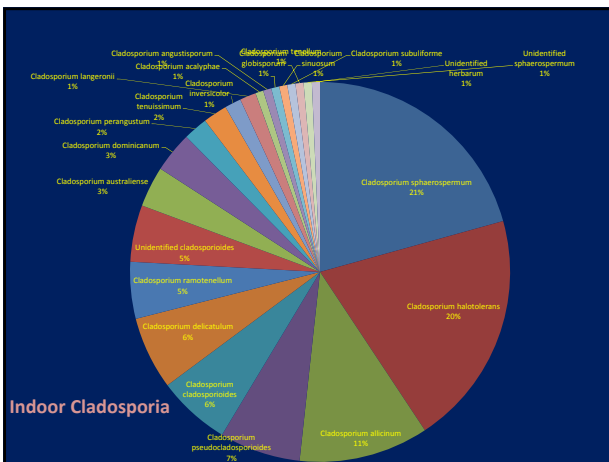


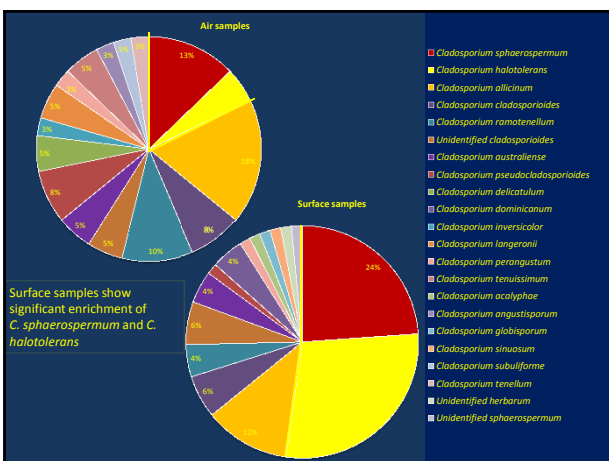


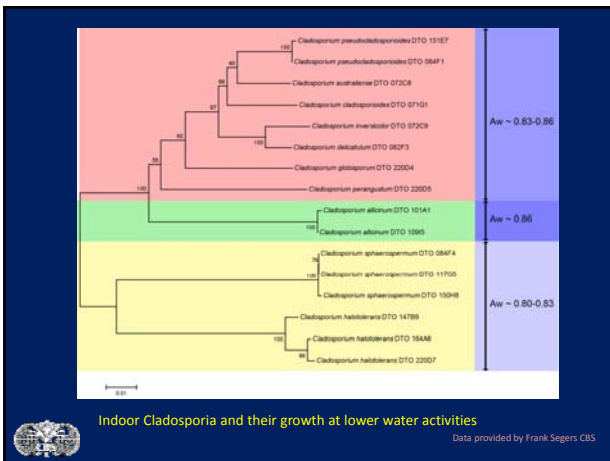
The genus *Cladosporium*

- The taxonomy of the genus *Cladosporium* based on multigene sequences
- Three main species complexes
- Bensch *et al* (Stud Mycol 2012)



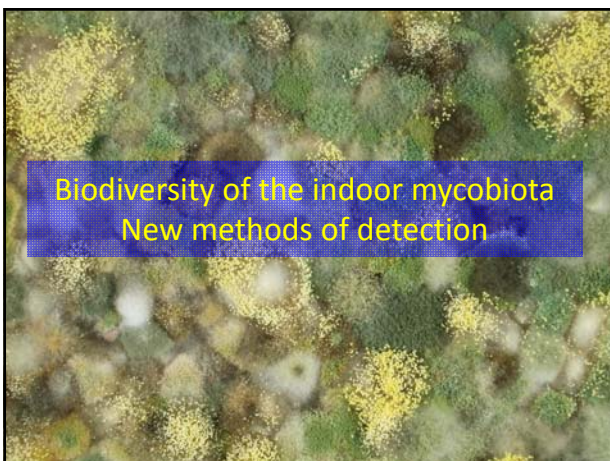






Cladosporium in indoor environments

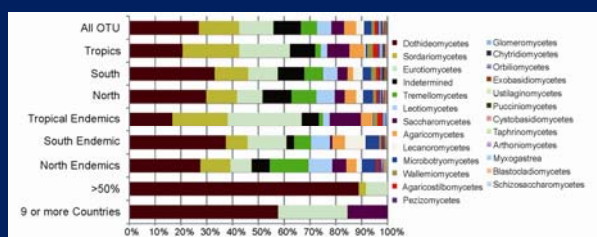
- The most common indoor *Cladosporium* species are *C. halotolerans* and *C. sphaerospermum*
- These fungi can grow at lower water activities (0.80 – 0.83) which was been previously not known
- *C. herbarum* is rare or not found indoors





Research project sponsored by the Alfred Sloan Foundation (USA)

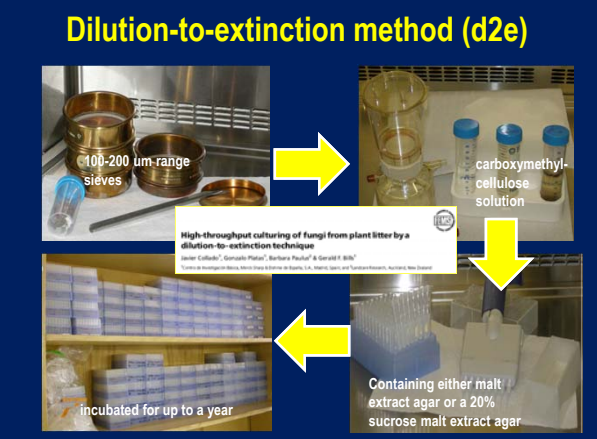
1. To develop a comprehensive, publicly accessible, on-line database of internal transcribed spacer (ITS) DNA barcodes (including voucher specimens, and DNA sequence chromatograms) for culturable fungi from human dwellings on a global scale.
2. To profile the complete fungal community, including species that cannot be cultured by standard techniques, using state-of-the-art high-throughput DNA sequencing technology.
3. To explore methods of obtaining voucher material (specimens or cultures) of 'nonculturable' fungi using novel techniques.
4. To use bioinformatics and genome mining tools to evaluate the potential of additional genetic loci that might serve as a second fungal barcode for indoor fungi and other ecological groups.
5. Help to develop standards for taxonomically categorizing environmental sequences.



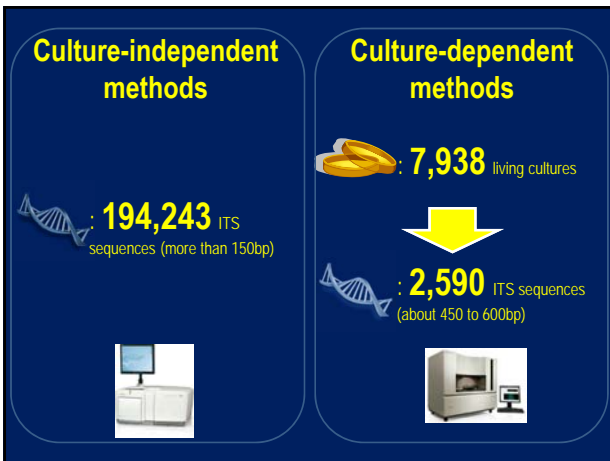
- Settled dust samples (n = 72) from buildings on six continents were collected and pyrosequenced in multiplex using 454 Titanium technology
- A high diversity of indoor fungi
- The diversity is higher in temperate zones than in the tropics
- Building function has no effect on composition of the indoor mycobiota
- The most cosmopolitan OTU's were dominated by Dothideomycete taxa

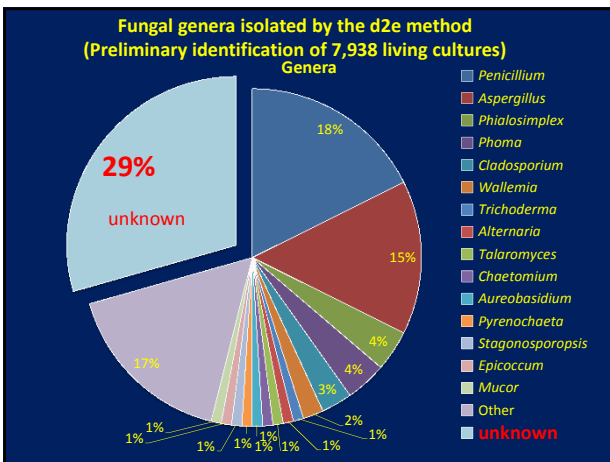
Amend AS, Selfert KA, Samson RA, Bruns TD(2010) Indoor fungal composition is geographically patterned and more diverse in temperate zones than in the tropics. PNAS 107: 13748-13753

Dilution-to-extinction method (d2e)



Author: Catherine L. Gonzalez-Pastor¹, Barbara Pevsler¹ & Gerard J. Bennett¹
 Funding: Department of Microbiology, University of Kentucky, U.S. Forest Service and National Science Foundation, Kentucky, USA

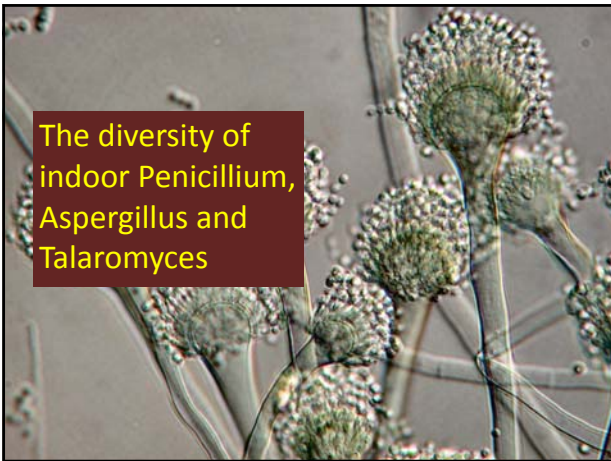


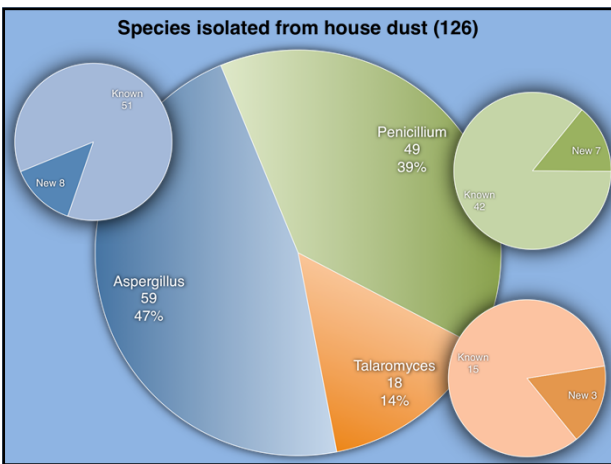


About 1/3 of the OTUs are undescribed or not sequenced and 7.5% of OTUs represent unknown or unsequenced higher taxa

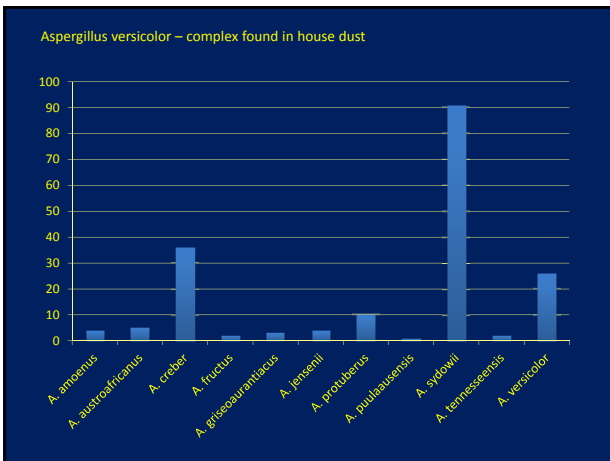
Our estimated diversity → **~1790 species**

New or unsequenced species → **~600 species**
(~135 higher level taxa)









Exometabolites in *Versicolores*

A. australfricanus: St, Or, anidiquinolones, calbistrins
A. jensenii: St, Or, calbistrins, cyclopenols, sh, versicolamides, versicotides
A. protuberus: St, Or, cottoquinazolines, cyclopenols, sh, versicolamides, versicotides
A. puulaausensis: St, Or, brevianamide M, insulicolides, sh, versicolamides
A. amoenus: St, Or, kipukasins, versicolamides
A. creber: St, ---, anidiquinolones, versicolamides
A. cujetkavicii: St, ---, brevianamide M, cottoquinazolines, epi-deoxybrevianamide E, 1,3,6,8-tetrahydroxyanthraquinone, versicolamides, versicotides
A. venenatus: St, Or, epi-deoxybrevianamide E, versicolamides
A. fructus: St, Or, antholorins, glyanthrypine, tryptoquivalins
A. subversicolor: St, Or, "unique exometabolites"
A. tennesseensis: St, Or, brevianamide M, brevianamides J,K,Q,R,T-W, cottoquinazolins
A. versicolor: St, Or
A. sydowii: ---, Or, 5'-deoxy-5'-methylamino-adenosine, butyrolactones, sydonic acids, sydowninins, WIN 64745 & 64821
A. tabacinus: ---, Or

St = sterigmatocystins, Or = Orsellins & violaceols, Sh = shamixanthone der.

Data from Jens C. Frisvad

Indoor fungi and toxin production

Indoor moulds	Growth on building material	Toxins on building materials
<i>Alternaria spp</i>	yes	No toxins found
<i>Aspergillus flavus</i>	Yes but very wet	No aflatoxins
<i>Aspergillus niger</i>	Yes but very wet	No toxins found
<i>Aspergillus versicolor</i>	yes	Sterigmatocystin but not produced at aw<0.9
<i>Aspergillus calidoustus</i>	Yes but poor growth	No toxins found
<i>Chaetomium globosum</i>	yes	Chaetomins and chaetoglobins
<i>Cladosporium spp</i>	yes	No toxins found
<i>Penicillium chrysogenum</i>	yes	No toxins found
<i>Stachybotrys chartarum</i>	Yes but wet	Trichothecenes, satratoxins
<i>Ulocladium spp</i>	Yes but wet	No toxins found

Data from Kristian Nielsen - DTU

Secondary metabolites from Eurotium species, Aspergillus calidoustus and A. insuetus common in Canadian homes with a review of their chemistry and biological activities

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A Neurotoxin A **B** Neurotoxin B **C** Fibrinolytic
D Cholesterin **E** Flavoglycoside
H Toxin **I** Neurotoxin **J** Neurotoxin F **K** Toxin

Fig 1. Secondary metabolites detected from Eurotium species (detected in the spores), minor metabolites.

Extrolites of Wallemia sebi, a very common fungus in the built environment.

Desrosiers, IC¹, MAAJIN DS, Miller, JD

Abstract

Wallemia sebi has been primarily known as a spoilage fungus of dried, salted fish and other foods that are salty or sweet. However, this fungus is also very common in house dust. The health effects of chronic exposure to mold and dampness are known to be associated with both allergens and various inflammatory compounds, including the sea salts. It has been long reported from housing and occupants have been reported to produce a number of compounds including the known compound wallemic acid. Based on an in silico analysis, wallemic acid is the primary human antigen of W. sebi is a 47 kDa excised glycoprotein and, unsurprisingly, the antigen was found in house dust.

KEYWORDS: Wallemia sebi; Allergy; House dust; Wallemic acid

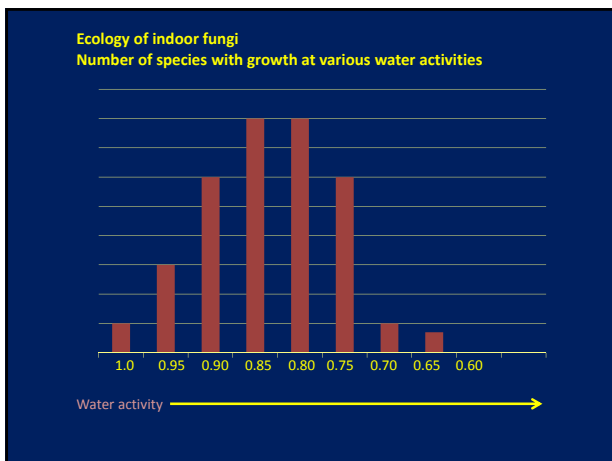
Found: "most toxic" metabolite from a very common indoor fungus

A just published article by Desrosiers et al., 'Extrolites of Wallemia sebi, a very common fungus in the built environment', in the journal Indoor Air, describes a previously unidentified metabolite of Wallemia sebi, a very common fungus in houses worldwide, although relatively more common in north temperate climates. The authors (including David Miller) write that it is well known as a contaminant of salty and sweet foods, cheeses, and workplace exposures are known to result in IgE sensitization, and some metabolites have been reported.

The article reports new work from Miller's lab that "uncovered the sequence of the primary human antigen and describes the metabolites from dense building strains including a new compound, 3-(benzylamino)pyrrolidine [3, 2'-n] piperidine-3, 2'-diol which [they] call wallemic acid." Of the eight isolated ones examined by the authors, "the percentage with antibodies to the antigen was similar to that of the most common variety of Aspergillus in house dust."

Summary

- There are many genera/species which were not expected indoors and are unknown to science
- Some fungi which occur commonly prove to be taxonomically complex and each species have special characters of growth and metabolite production
- How can we deal with all the new species and what is their significance?
- What does it mean that there are many xerophilic species
- Which species are responsible for allergy or toxins ??



- ## Summary
- There are many fungi which were not expected indoors and are unknown to science
 - Some fungi which occur commonly prove to be taxonomically complex (e.g. *Scopulariopsis*)
 - How can we deal with all the new species?
 - What does it mean that there are many xerophilic species
 - Which species are responsible for allergy or toxins (glucan) ??

Fungal fragments and undocumented conidia function as new aeroallergen sources
 Brent James Green, BSc (Hons),¹* Jason Kingsley Barrow, BSc (GIS),² and Evan Roger Terry, PhD³ (Lubbock, Australia)

Background: More than 100 genera of fungal conidia are generally regarded as sources of allergens. The contribution of other fungal genera and particularly fungal spores that are highly resistant to allergic disease is poorly understood. Objective: To attempt to identify the spectrum of allergenic fungi in the air using the Bridge biosensors which use digital arrays of 16 microarray biosensors.

Methods: Airborne fungi were cultured onto solid culture agar plates holding biosensors (12 discs with various 16 pairs). Coloured fungi were transferred to agar in a humid chamber to promote the germination of spores. It was then compared with an allergenic source and an allergen control. The results are compared to those of the allergen and other common indoor fungal particles, from dusts and carpets.

Results: All air samples contained fungi that were viable allergens and were highly resistant to detergent. Some species of mould with characteristic allergenicity of *Asp. fumigatus*, *Asp. terrestris* and *Asp. clavus* had high allergenicity and approximately 10% of all fungal material deposited allergen composed with combined fungal spores. Fungal conidia of 20 genera were present in bioaerosols in allergen sources were shown to bioaccumulate in dusts on residential surfaces as compared to 1% of the total airborne particles count.

Abstract: Much scientific evidence indicates a positive association between highly environmental and respiratory symptoms (e.g., asthma, allergy, rhinitis, sinusitis, fungal dermatitis) (1, 2, 3, 4) have been reported as a potential contributor to allergic health effects due to their biological composition (e.g., antigens, lipoteichoic acid, 1,3-β-D-glucan) as well as their small size. However, the contribution of exposure to fine fungal particles on allergic health outcomes has been poorly characterized, particularly in homes with asthmatic children. We characterized the airborne level of viable and fungal particles between homes with and without asthmatic children. **Methods:** We tested 20 homes with (n=11) and without (n=9) an asthmatic child and sampled airborne fungal fragments in 10 living areas and 10 child bedrooms, along with outdoor sampling, using the NIOSH two-stage sampler (1, 2) in place of fungal fragments analyzed by (Imofer, Amesbury) (see annex 1, 2). We used the quantitative, their exposures.

