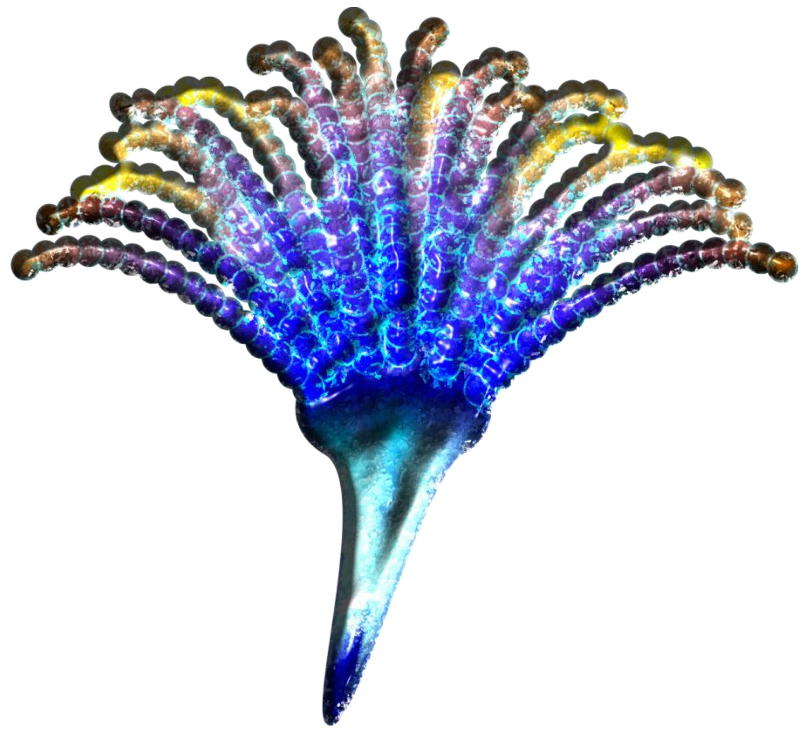
Fungi: A link between the built environment and childhood asthma

Karen Dannemiller

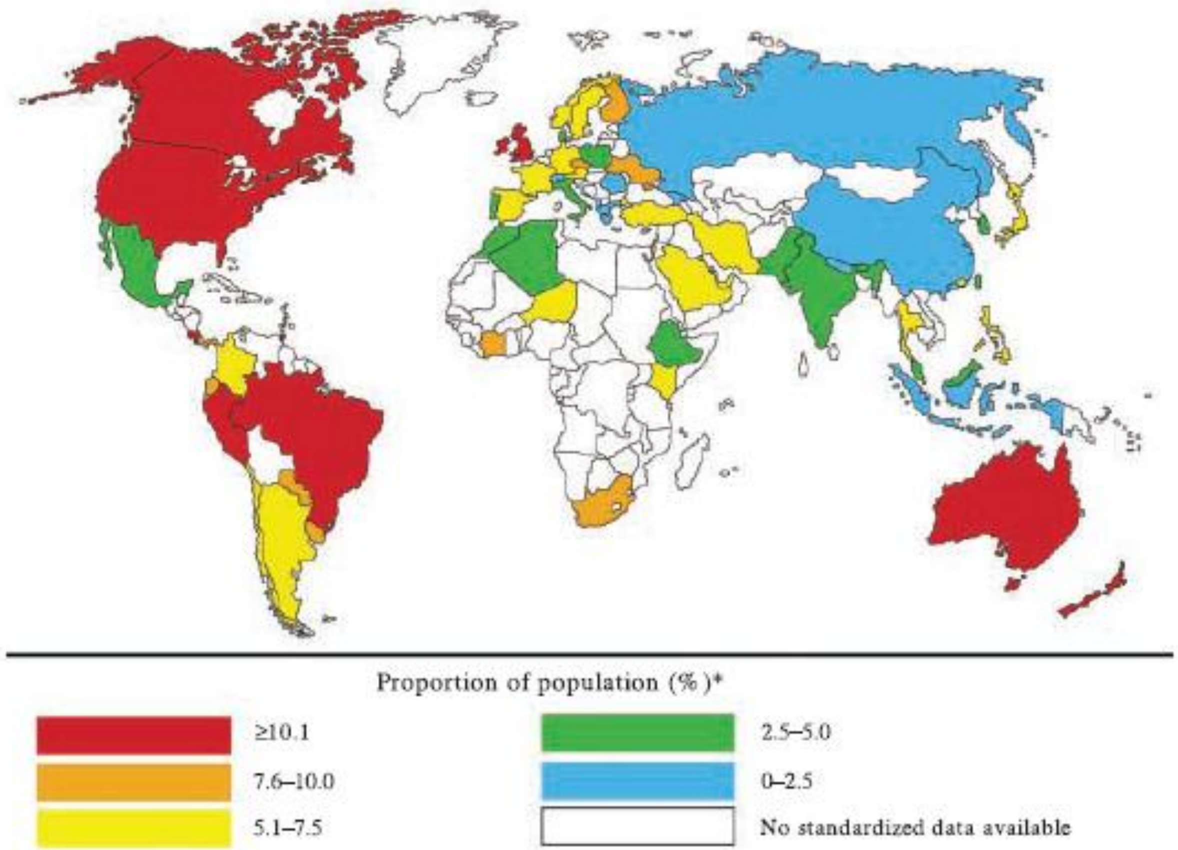
Jordan Peccia



Fungal Workshop

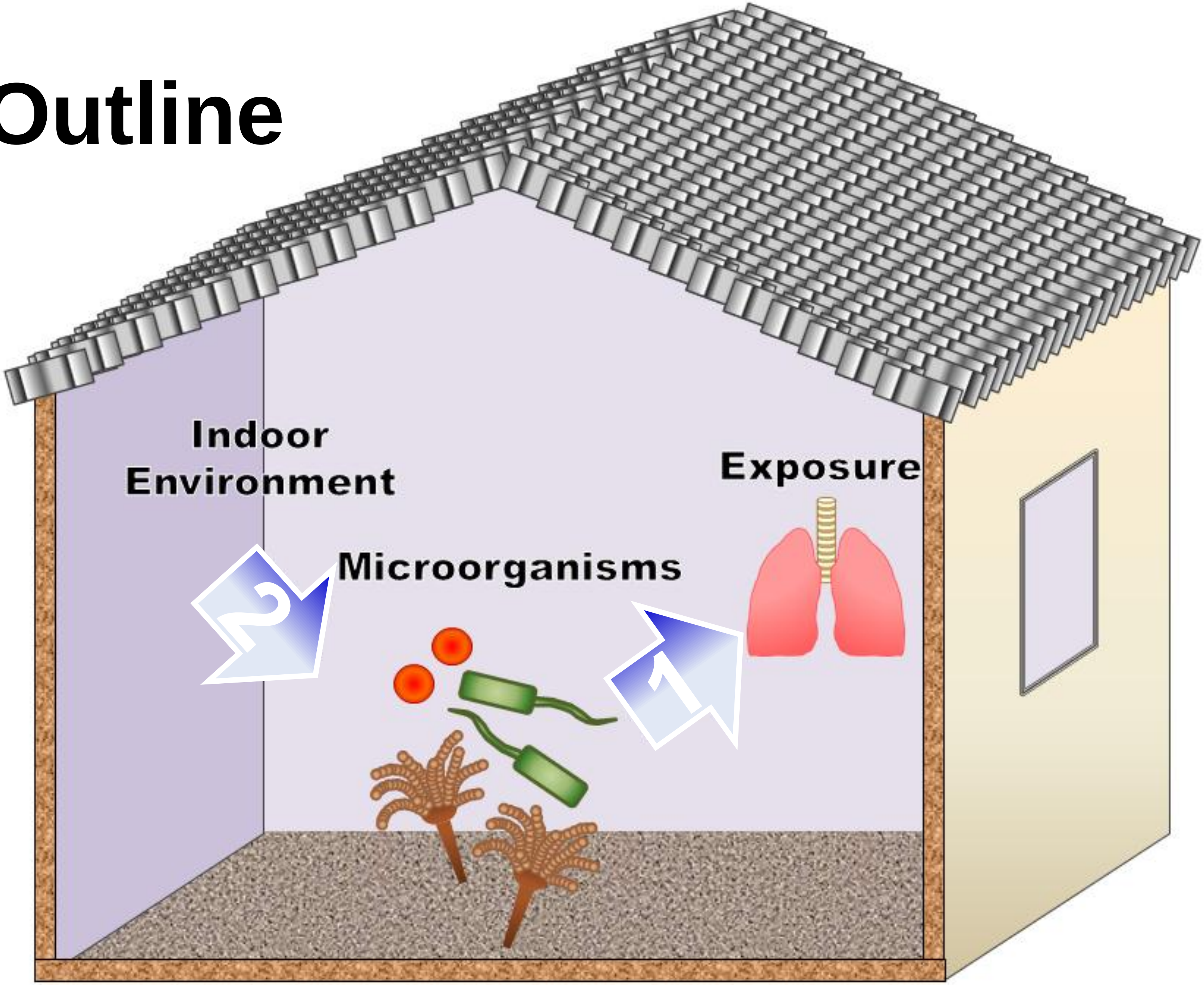
September 23, 2014

Asthma is associated with urbanization and improved development



Masoli, et al. *Allergy*. 2004. 59. 469-478.
Pope, et al., *Indoor Allergens* 1993

Outline



What fungal community features are associated with asthma?

Hygiene hypothesis?

Detrimental taxa?

Asthma development: CHAMACOS birth cohort study

Mark J. Mendell, Janet M. Macher, Kazukiyo Kumagai

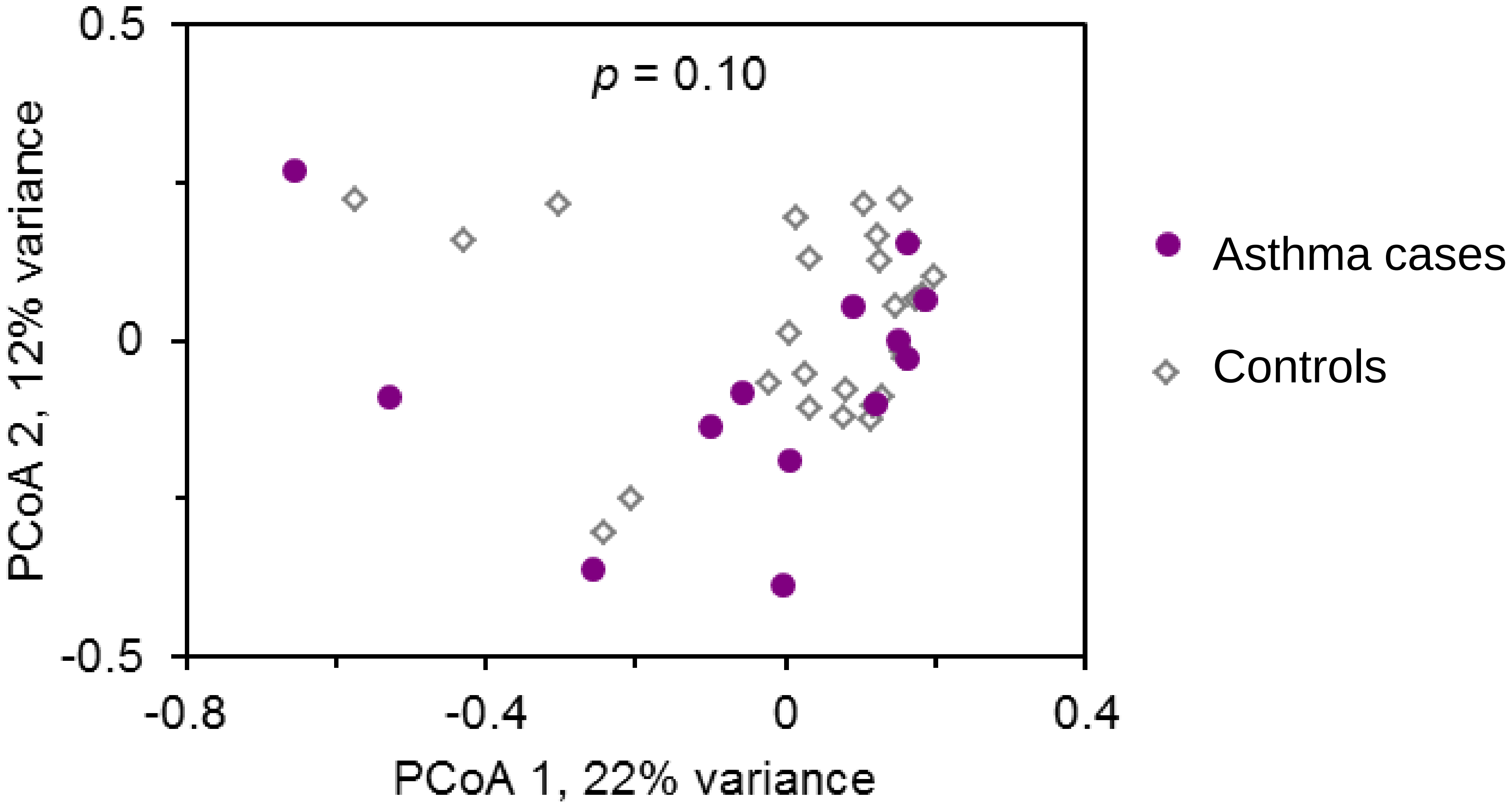
Asa Bradman, Nina Holland, Kim Harley, Brenda Eskenazi

Karen Dannemiller, Jordan Peccia

For more information on CHAMACOS, see Eskenazi, et al., 2003. *J. Childrens Health* 1, 3–27. or Harley et al. *Thorax* 2009;64:353-358

- Prospective study
  - Dust at age 12 months
  - Asthma at age 7 years
- Nested case-control
  - All 13 asthma cases
  - 28 controls

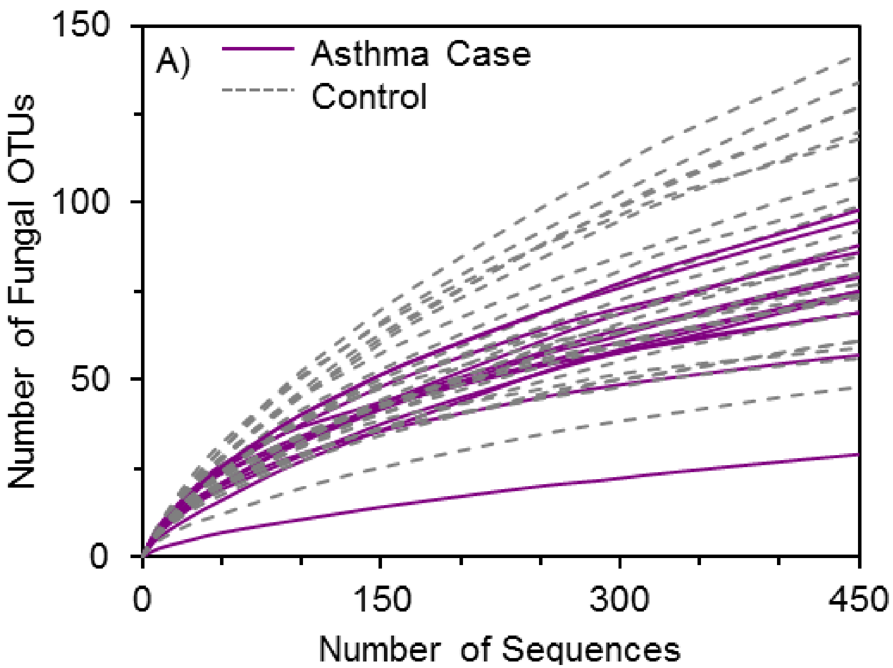
No taxa were positively associated with asthma development

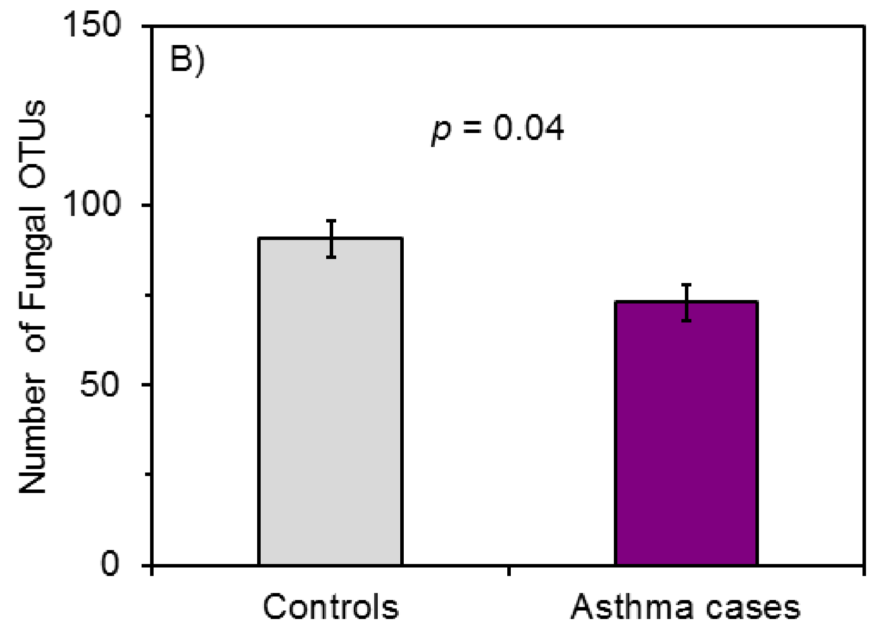


Dannemiller et al. 2014. *Indoor Air*

Low fungal diversity is associated with asthma development

Odds ratio: 4.8 (1.04-22.1)

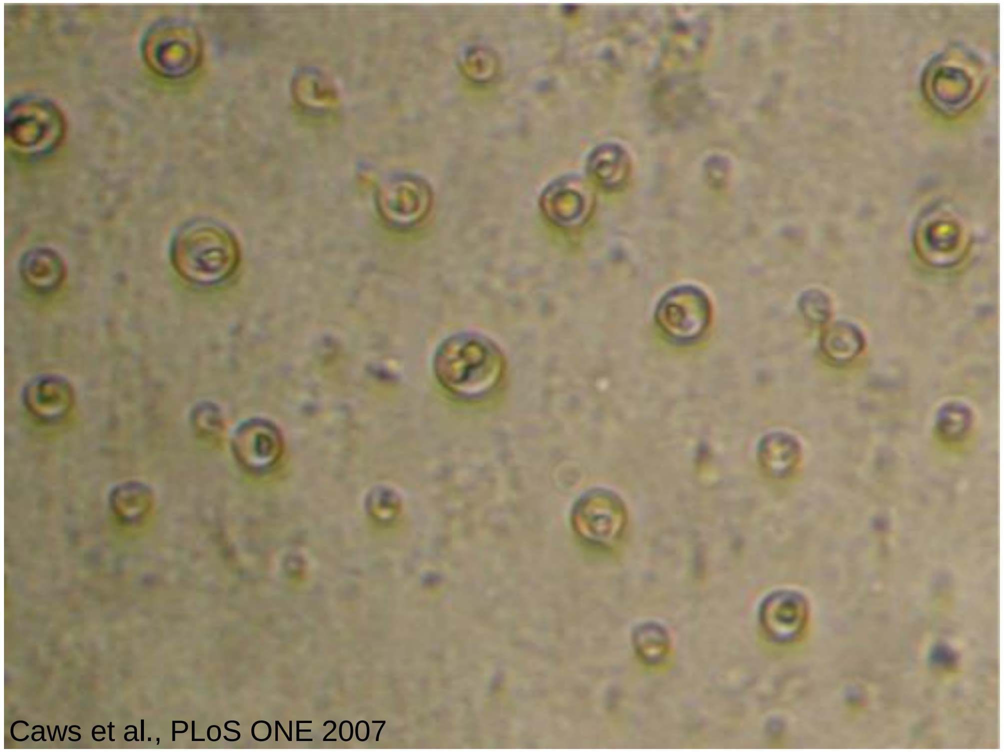




Dannemiller et al. 2014. *Indoor Air*

Diversity within *Cryptococcus* is associated with asthma development

Odds ratio: 21.0 (2.16-205)



Caws et al., PLoS ONE 2007

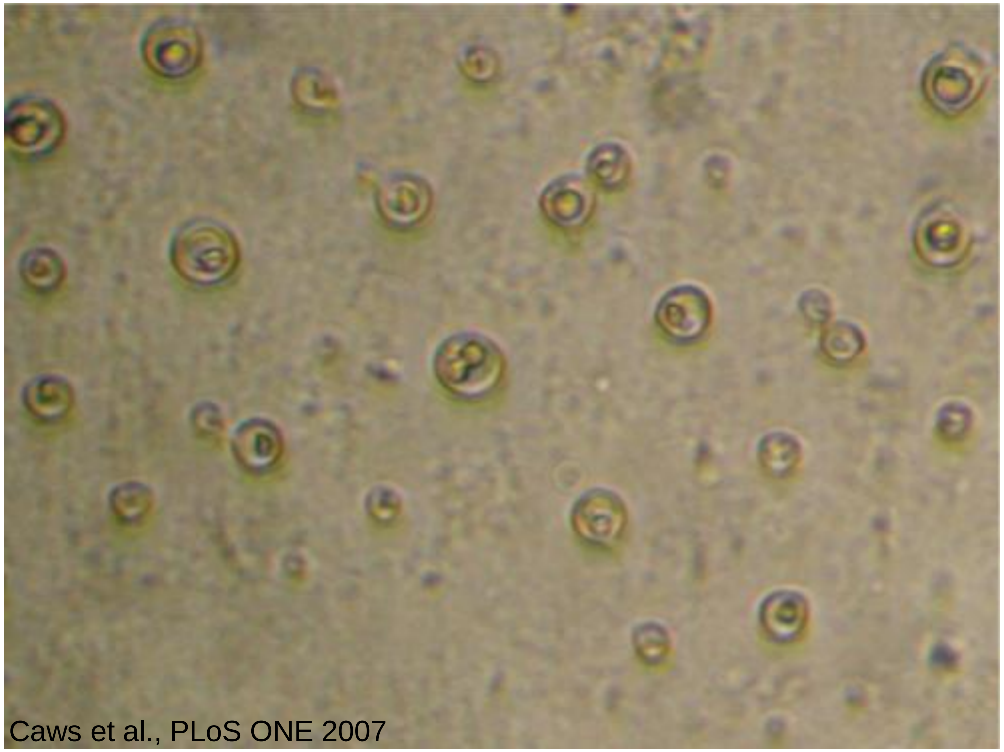
Dannemiller et al. 2014. *Indoor Air*

Asthma development conclusions

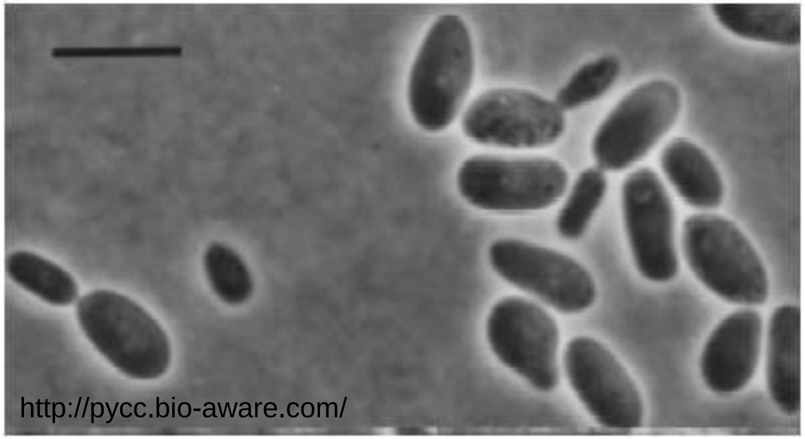
- Supports hygiene hypothesis:
  - Low fungal diversity
  - *Cryptococcus* spp. diversity

Yeasts are associated with asthma development and severity

Cryptococcus



Kondoa



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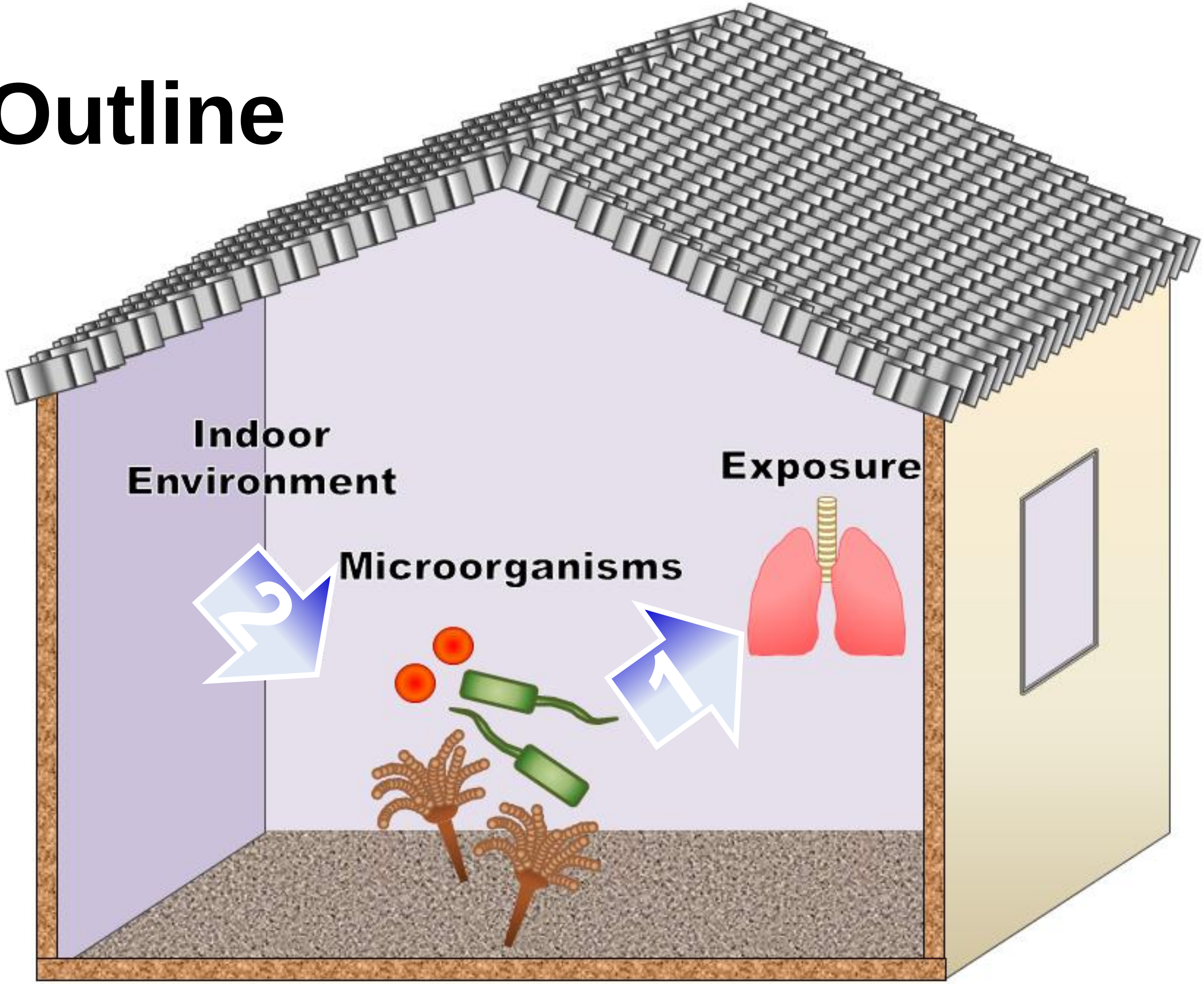


Associations with disease

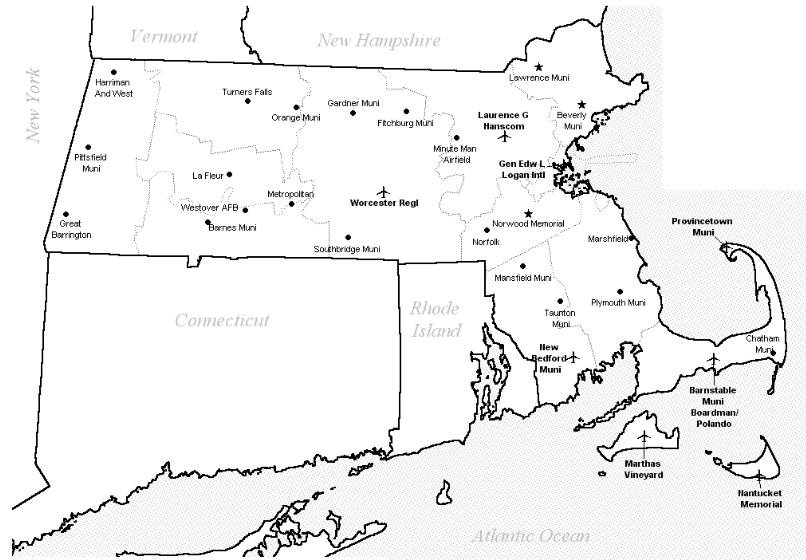
- Richness
- Community composition
- Concentration
- Allergens

- **Goal:** Engineer beneficial microbial ecologies
  - First step → how buildings affect ecology

Asthma severity

Janneane Gent,
Brian Leaderer

- STAR study in MA and CT
- Prospective study of asthma severity
- 196 children



mappery.com

Microbial communities in house dust are non-random

	C-score *p*-value	Conclusion
Fungi	<0.00001	Segregation
Bacteria	<0.00001	Segregation

Mass balance approaches to occupancy

Denina Hospodsky, Yale Univeristy

Naomichi Yamamoto, Seoul National University

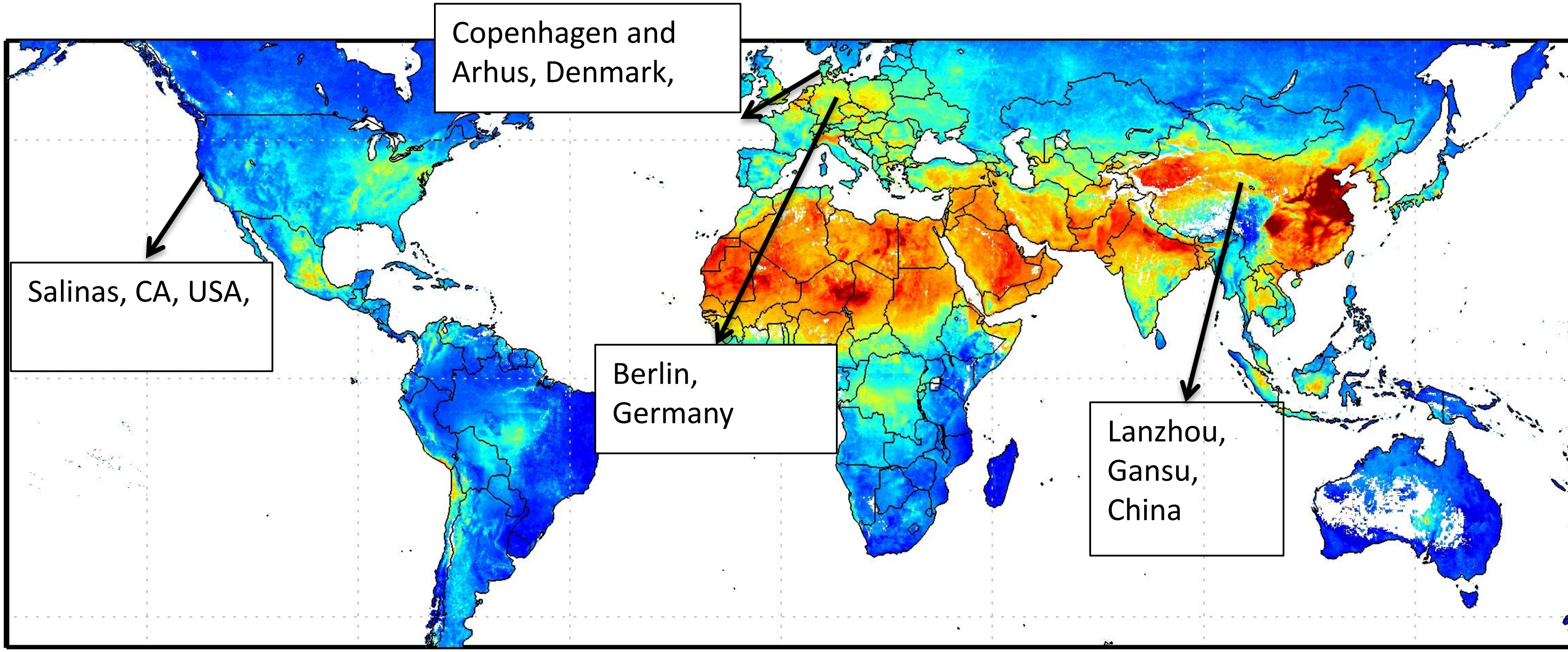
Bill Nazaroff, co-PI, UC Berkeley

Jordan Peccia, PI, Yale University

Dana Miller,
Sisira Gorthala

ALFRED P. SLOAN FOUNDATION
1934

Classroom studies in 5 cities, 4 countries



<u>Sampled occupied vs. vacant:</u>
- Indoor air
- Outdoor air
- Floor dust

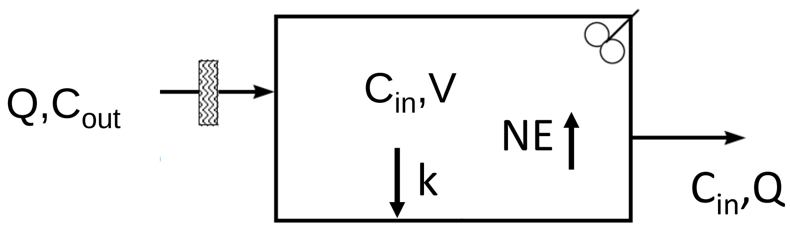
<u>Measured:</u>
- Size resolved: PM, qPCR fungi, qPCR bacteria
- Size resolved bacteria and fungi libraries
- OPC, CO_2, activity, AER (CO_2)

Emission Rates

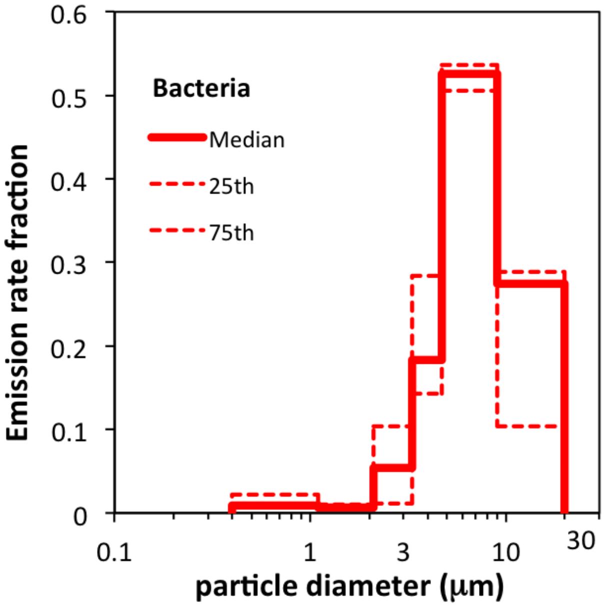
Median bacterial emissions = 12.6 million cells h^{-1} $person^{-1}$;

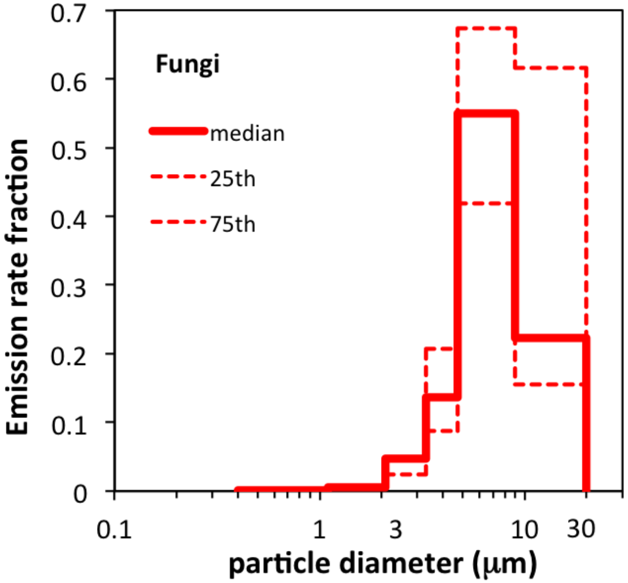
Median fungal emission rate = 6.6 million spore eq. h^{-1} $person^{-1}$

Median PM emission; rate = 21.7 mg h^{-1} $person^{-1}$.

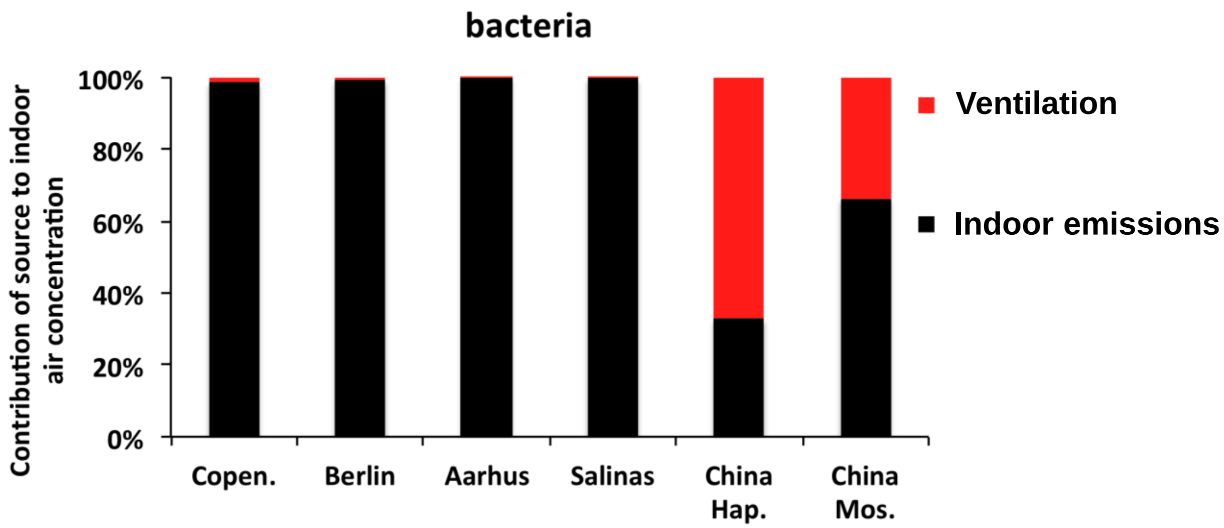


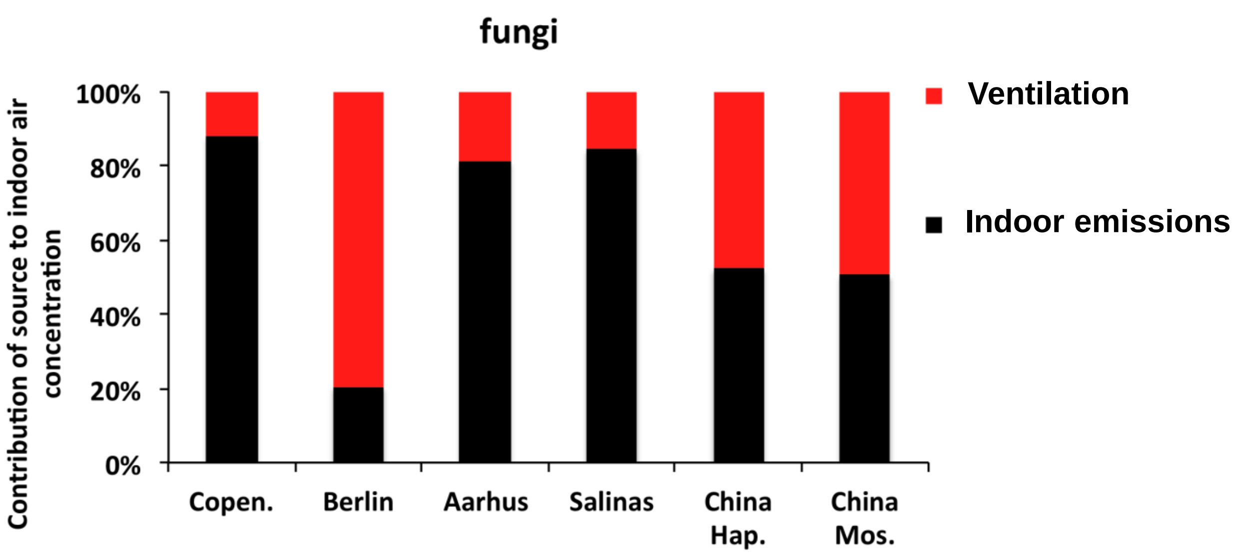
$$QC_{out} + NE = QC_{in} + kVC_{in}$$



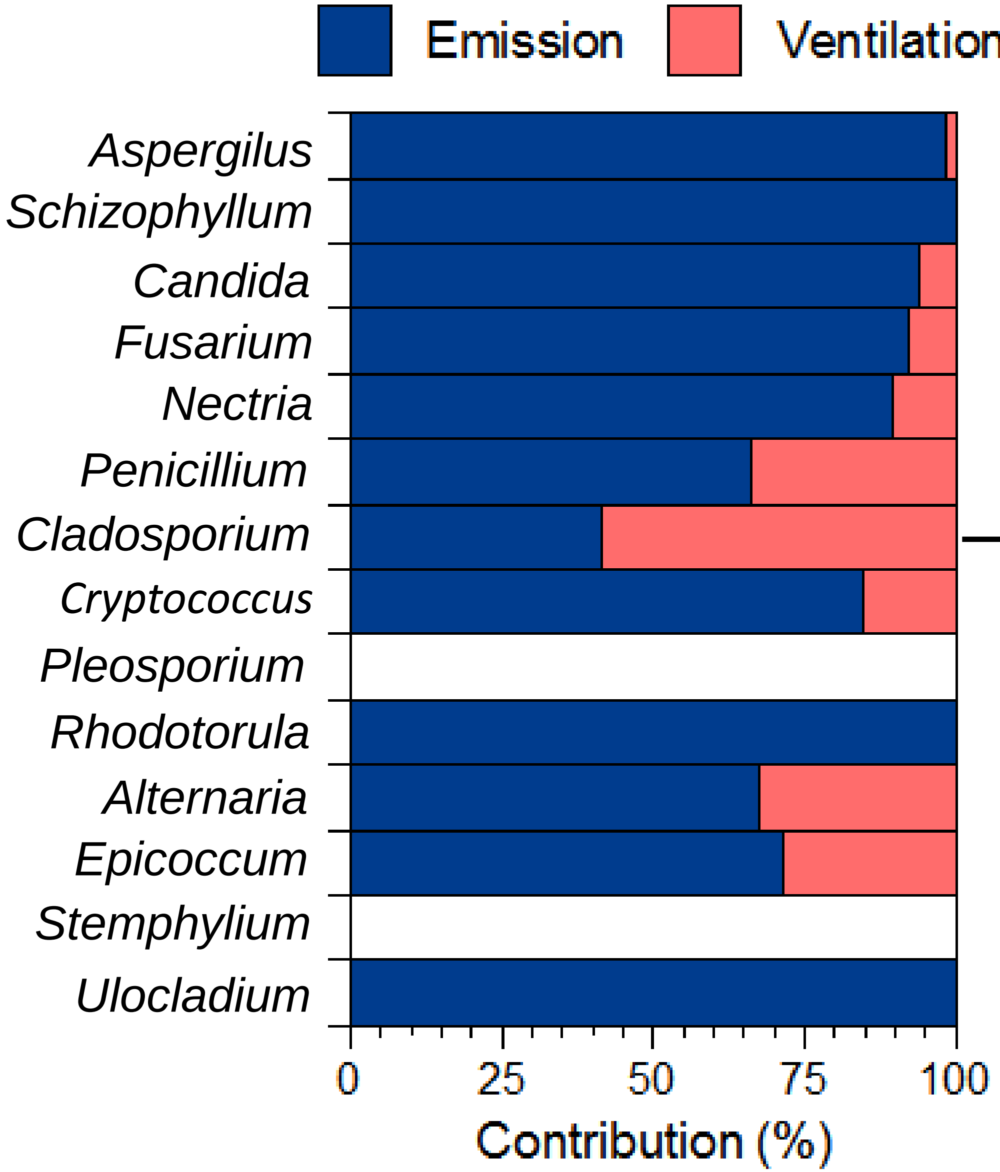


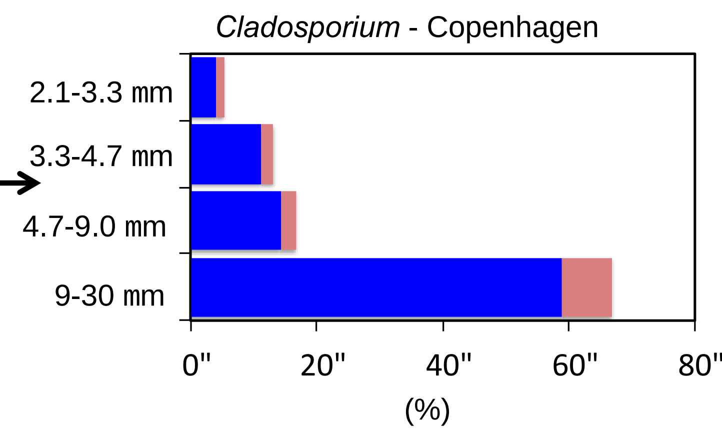
Indoor sources dominate, even for fungi





Typical indoor microbiome: Fungi



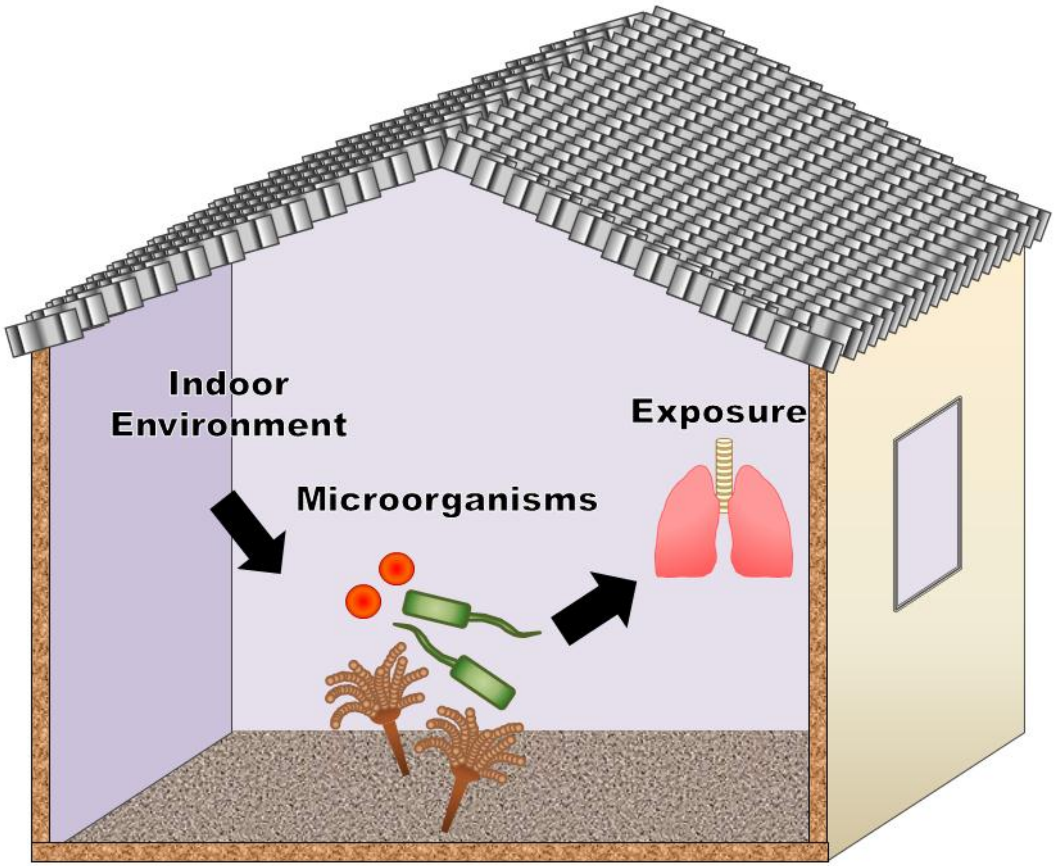


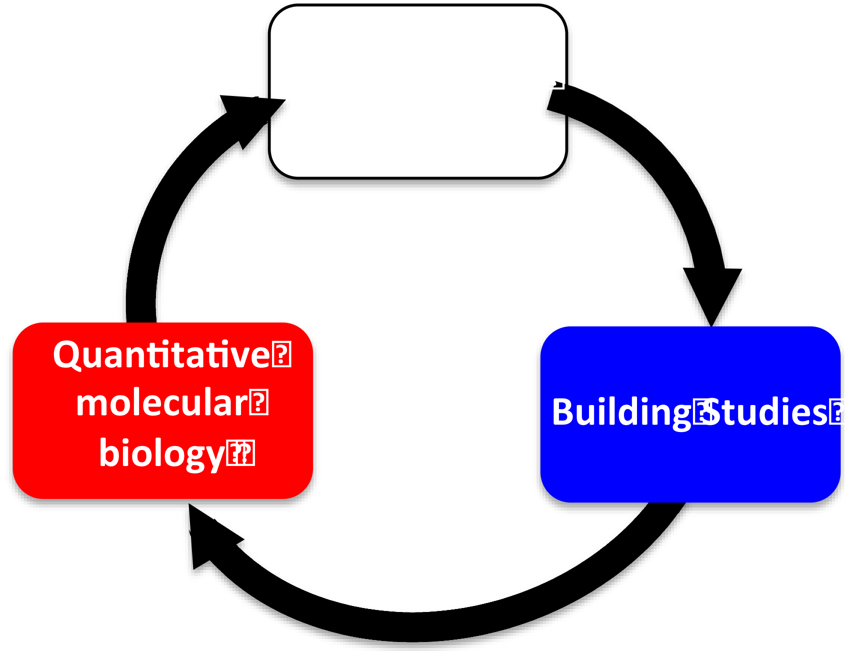
Human occupancy/activity produces emissions

- House dust → air exposure
- Human activity/occupancy produces emissions
  - Emissions > Ventilation for fungal aerosol population
- Mass balance methods for determining ratios for different taxa/different contributions
  - Specifically allergenic taxa

- **By combining building science and molecular measurements, we can determine the sources of specific, medically relevant taxa in buildings with improved benefits for modeling and designing interventions**

Microbial exposures and health in buildings





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WHERE DISCOVERIES BEGIN

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Peccia lab:

Denina Hospodsky, Naomichi Yamamoto

IAQ group, California Dept of Public Health

CHAMACOS group at UC Berkeley

CPPEE group at Yale

Study participants & their families

Questions?