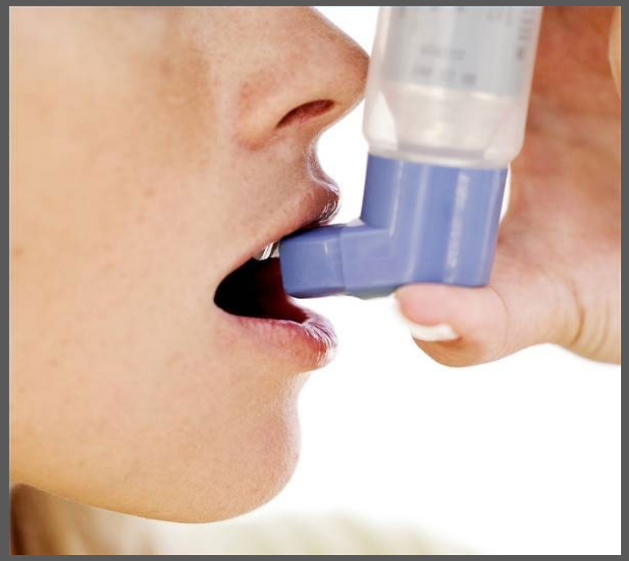
At rest, you inhale 10^4 to 10^8 microbial cells every hour outside

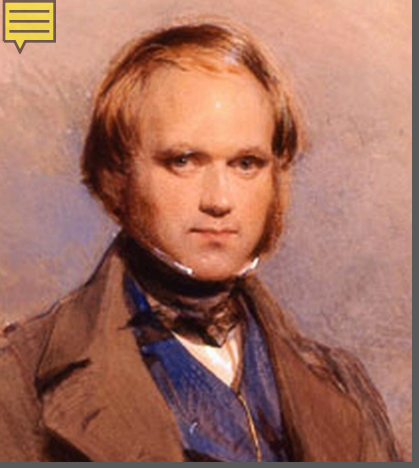
(Bowers et al. 2010. ISME Journal, Bowers et al. 2009. Appl. Environ. Micro.)

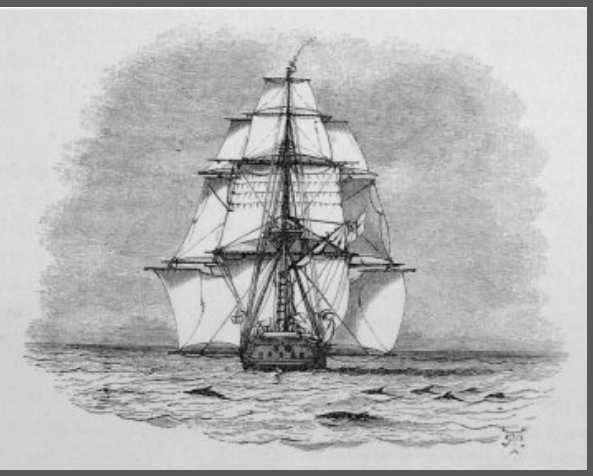


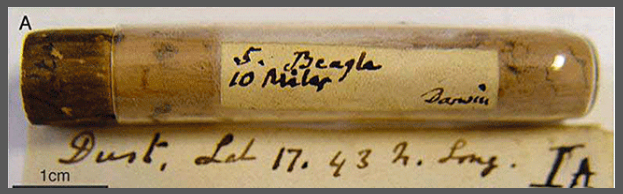
allergens and pathogens

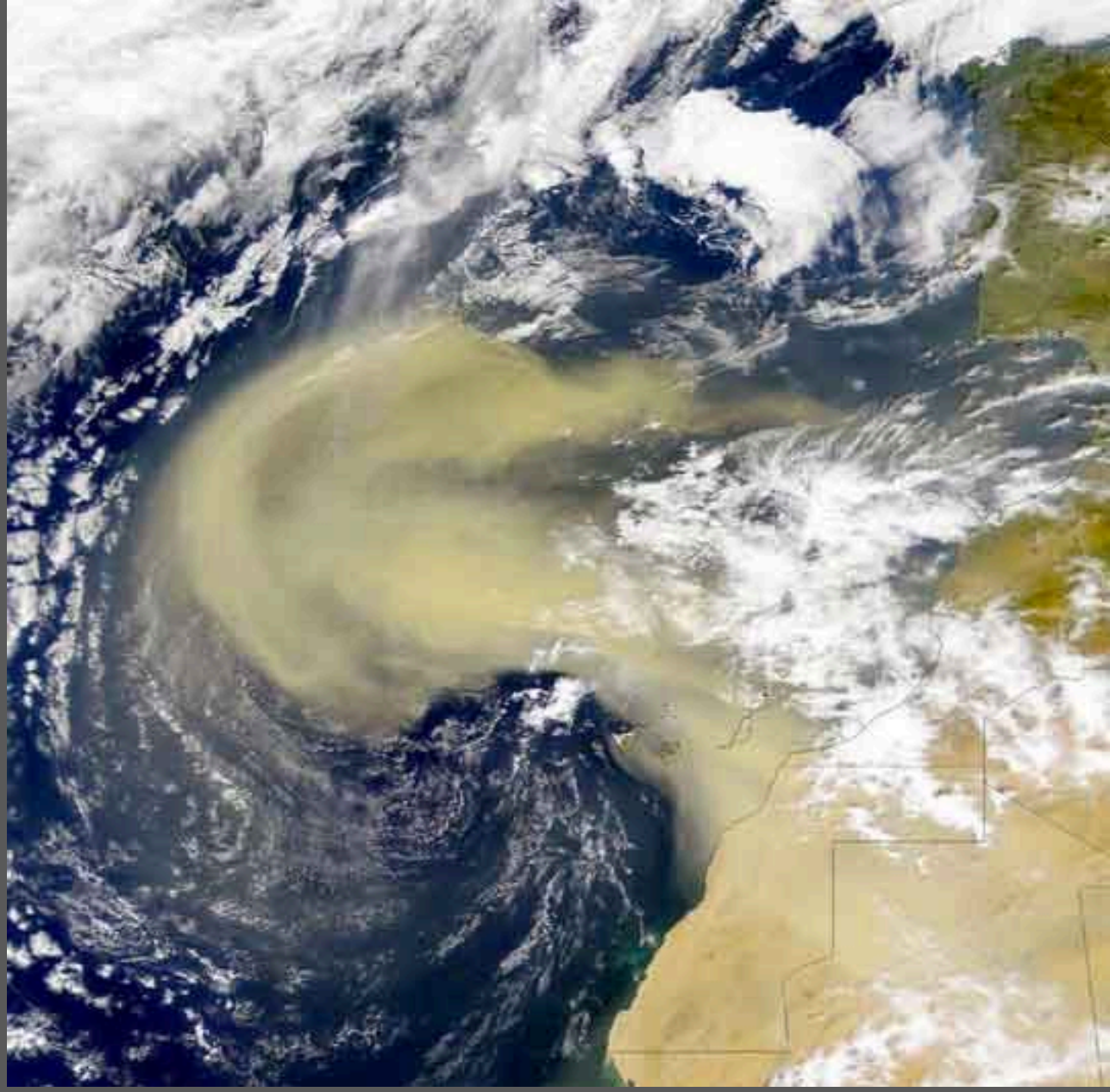
cloud condensation/ice nuclei

microbial dispersal

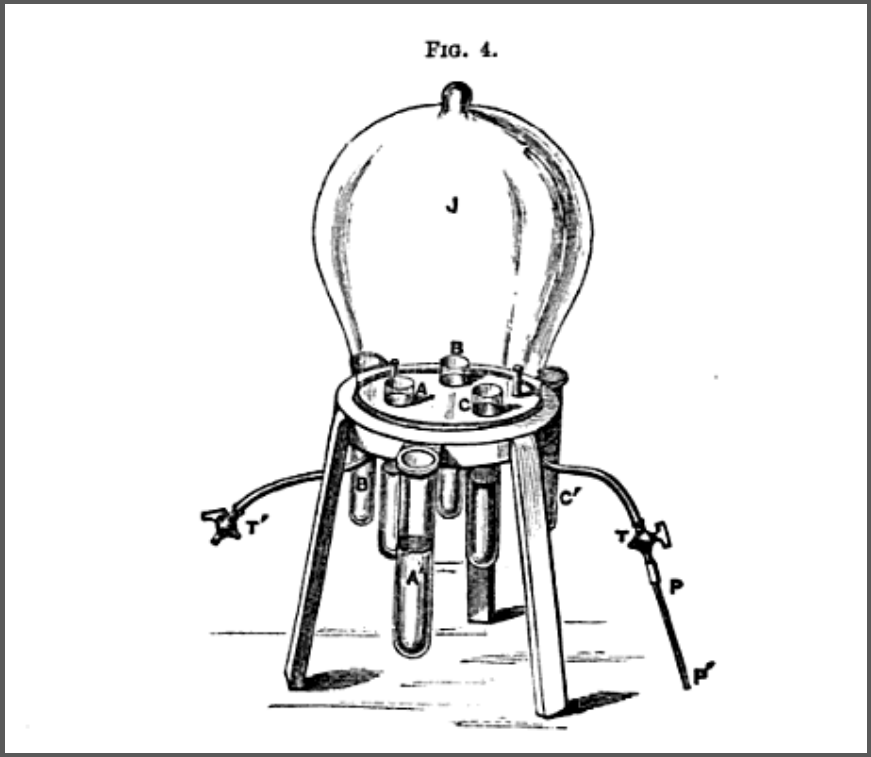




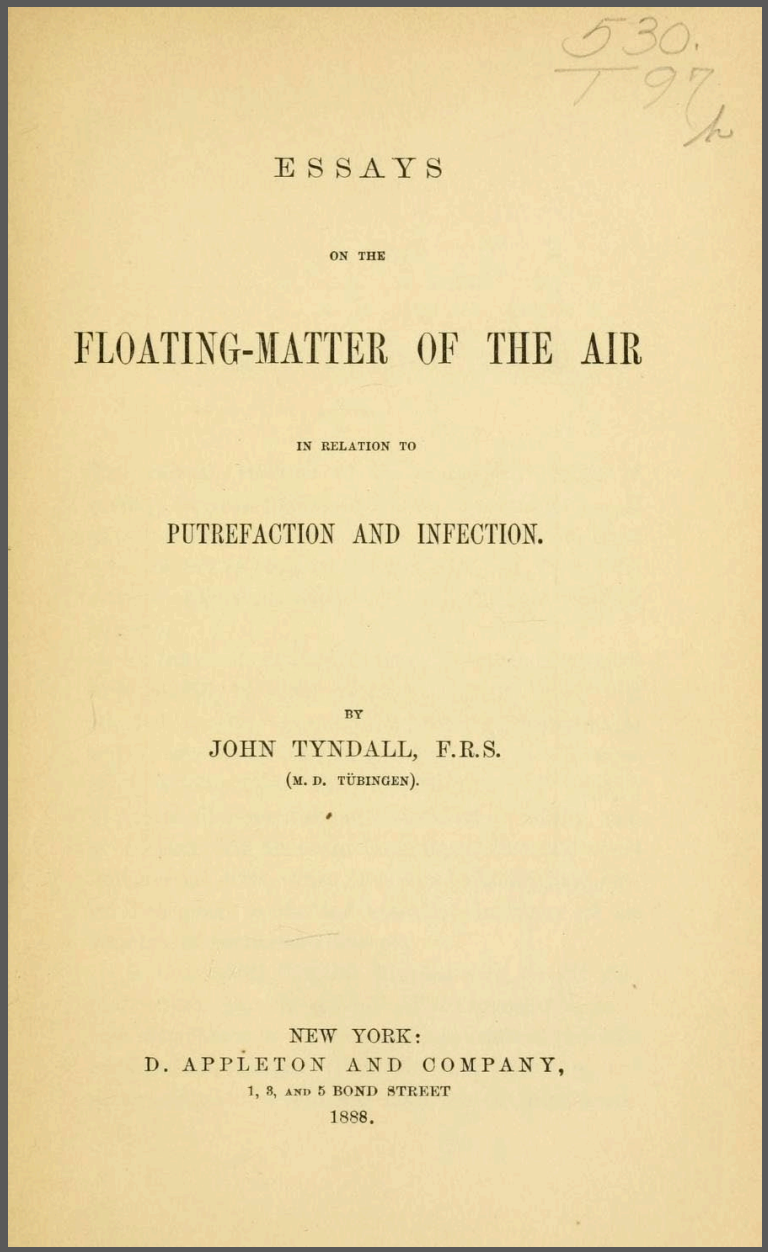




Darwin, 1832



"Thus, wherever it has been tested, the atmosphere has been found charged with the germs of Bacteria"



Tyndall 1882

THE SCIENTIFIC MONTHLY

JANUARY, 1935

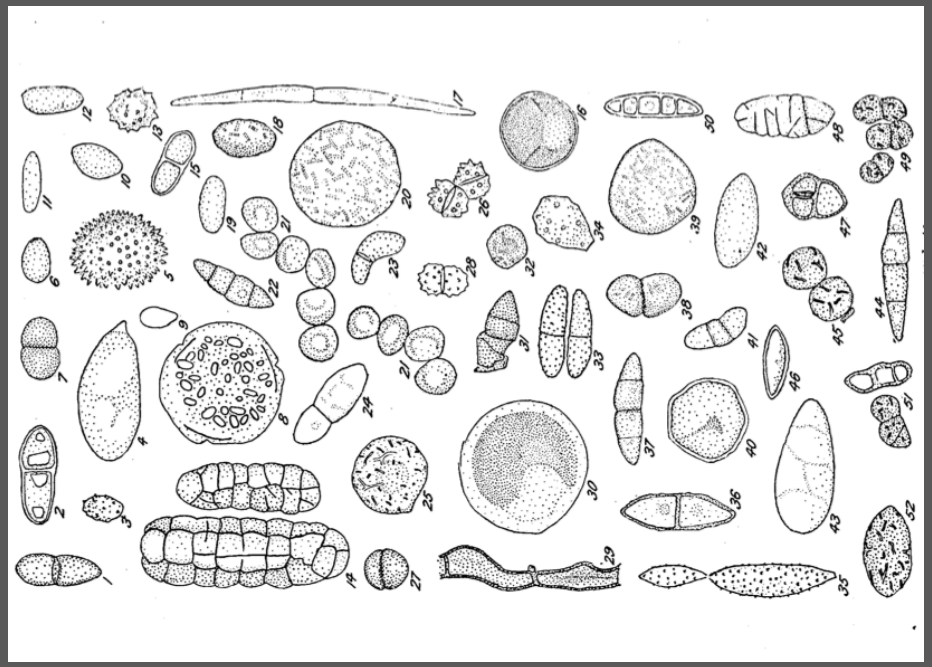
COLLECTING MICRO-ORGANISMS FROM THE ARCTIC ATMOSPHERE

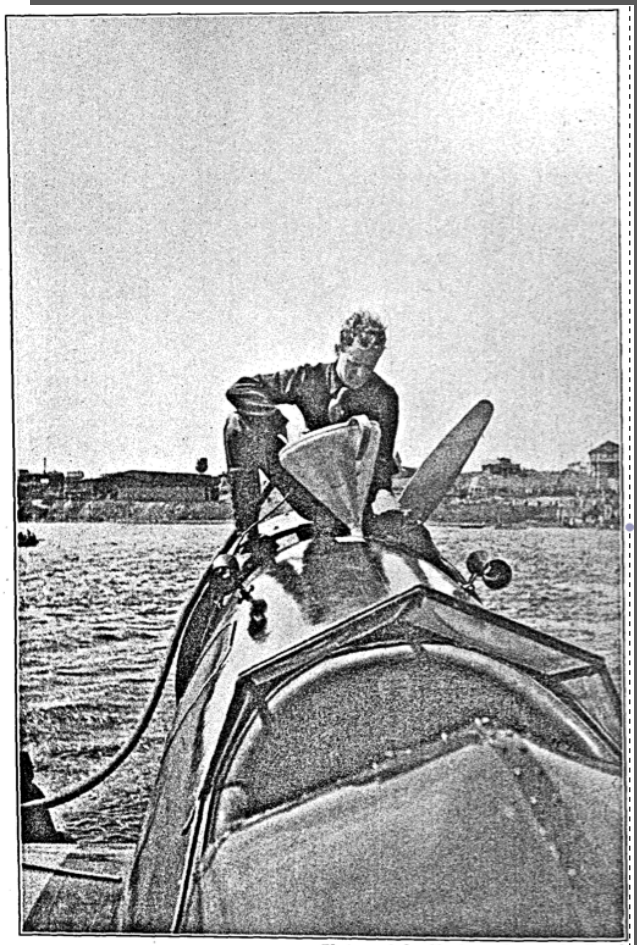
By FRED C. MEIER

COOPERATIVE INVESTIGATIONS, BUREAU OF PLANT INDUSTRY AND WEATHER BUREAU, U. S. DEPARTMENT OF AGRICULTURE

WITH FIELD NOTES AND MATERIAL

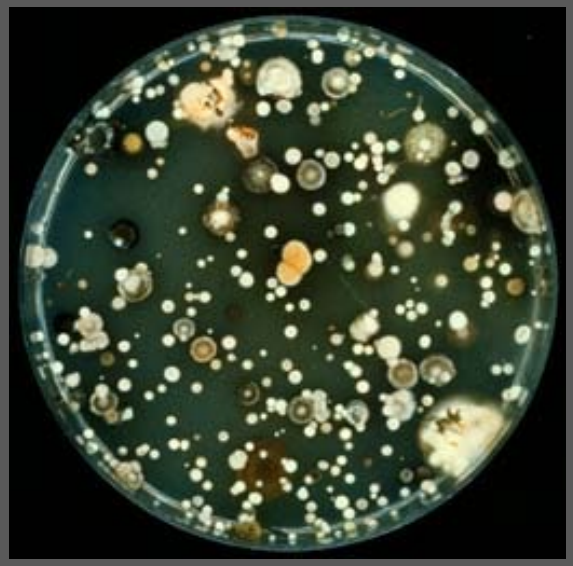
By CHARLES A. LINDBERGH



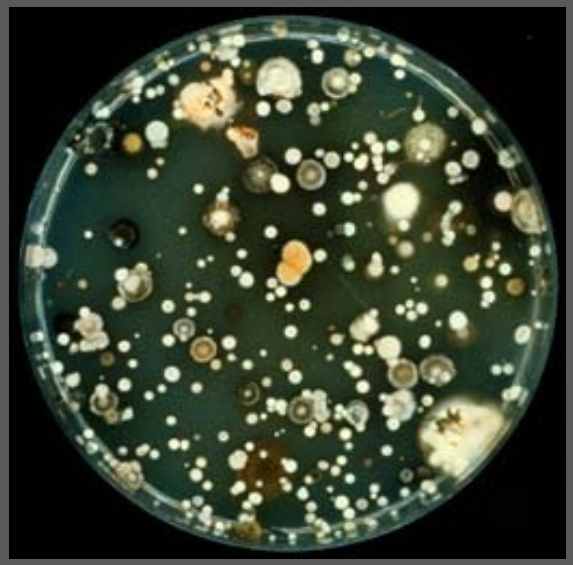


Photograph by Charles and Anne Lindbergh

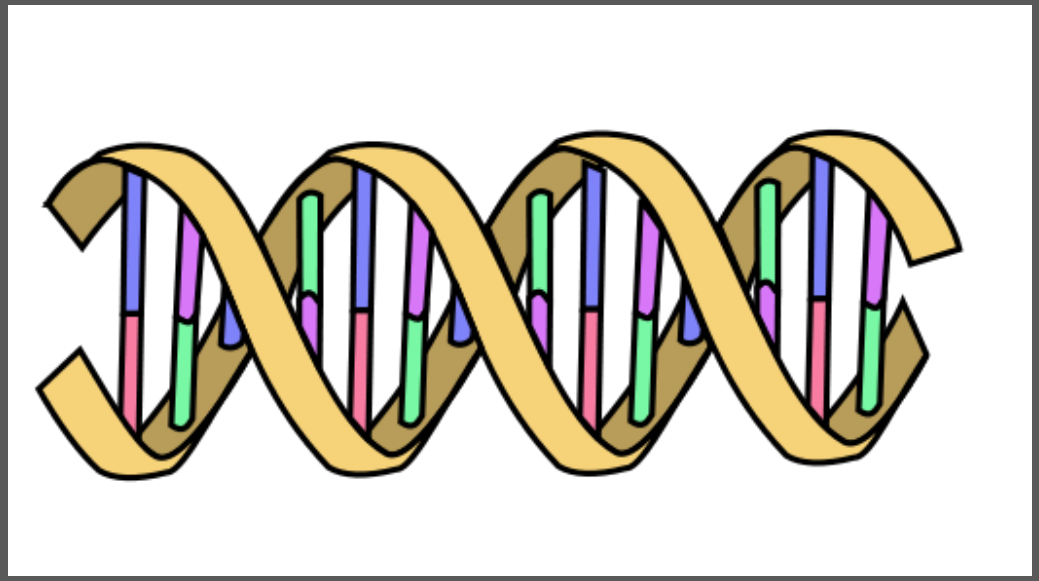
FIG. 6. REFUELING AT BOTWOOD, NEWFOUNDLAND




WF 10X
10X
40X
OMANO



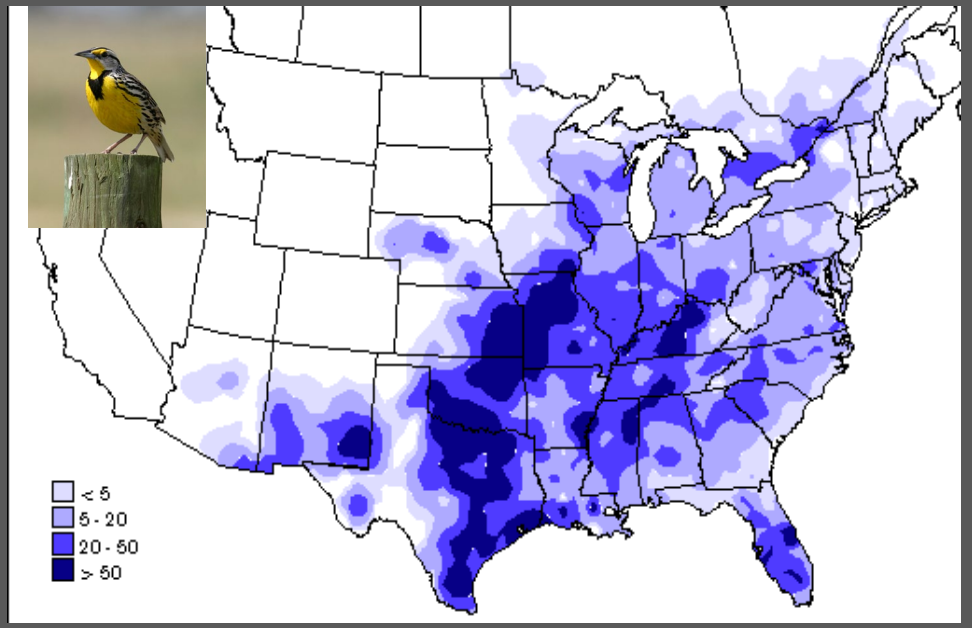

WF 10X
10X
40X
OMANO



How do the bacteria and fungi found in outdoor air vary across the continental U.S.?

How do the bacteria and fungi found in outdoor air vary across the continental U.S.?

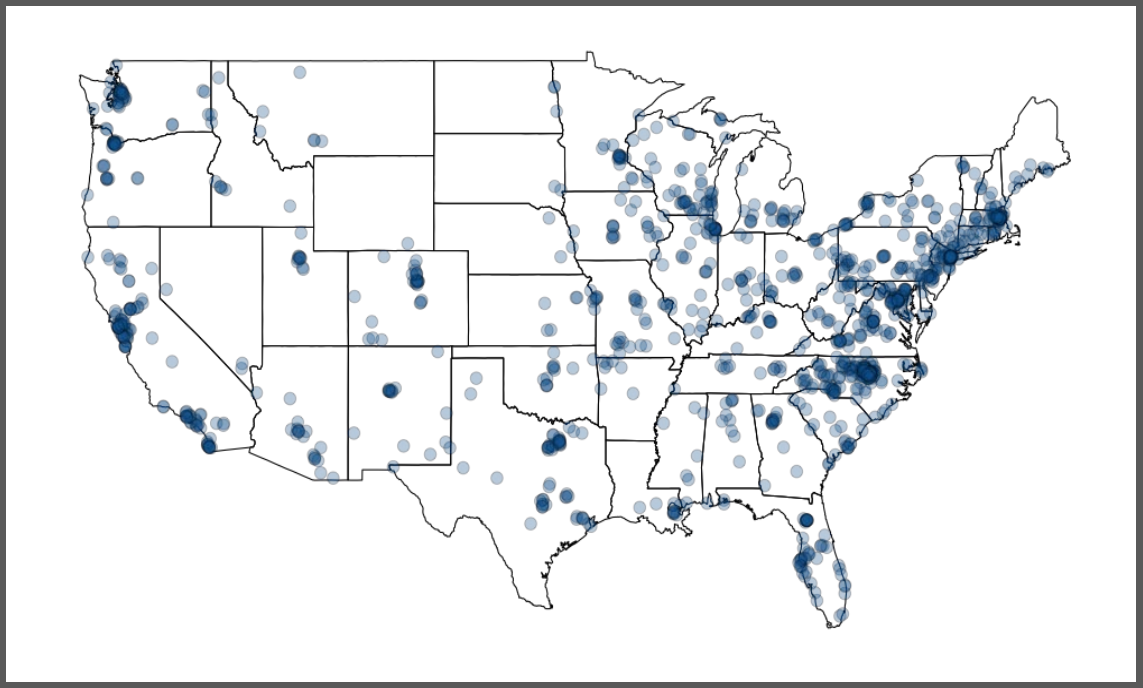
Juglans distribution
(C.S. Sargent 1884)



Eastern Meadowlark
(NPWRC, USGS)

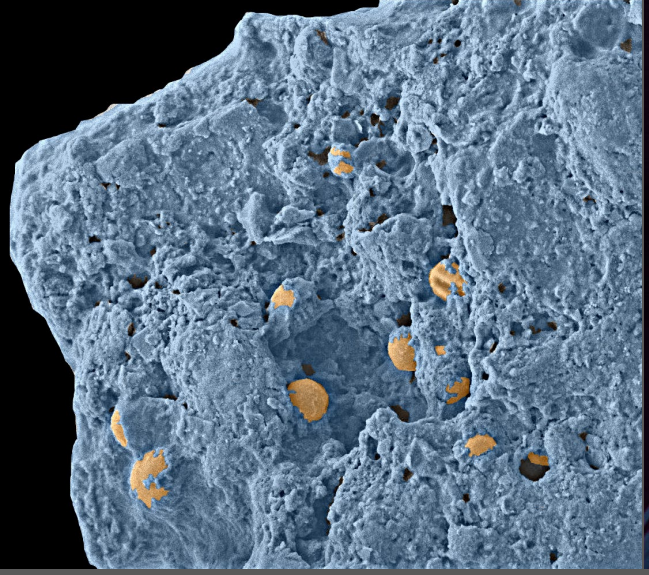
Outer door trim as passive aerosol collector

1,500 samples collected

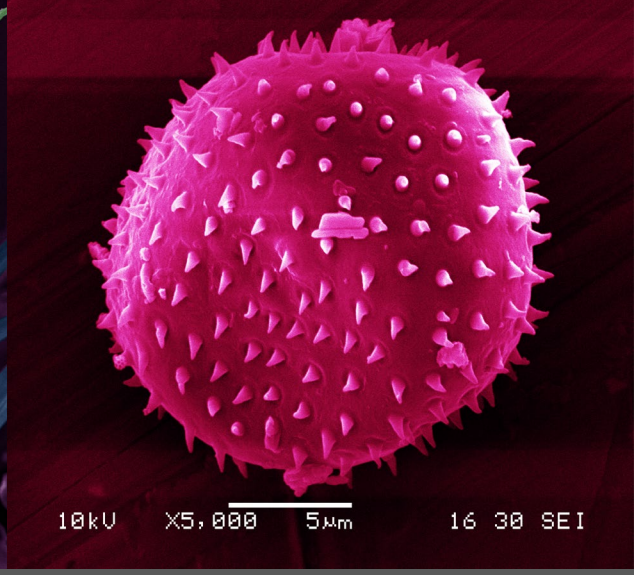


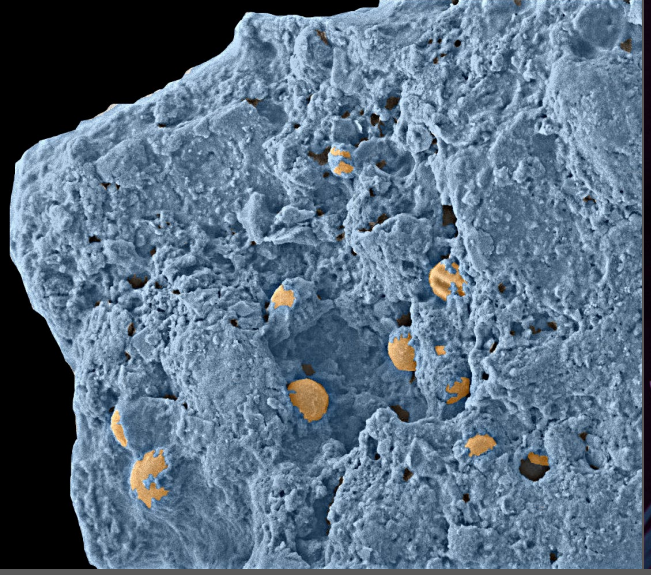
Barberán et al. 2015. PNAS

Holly Menninger

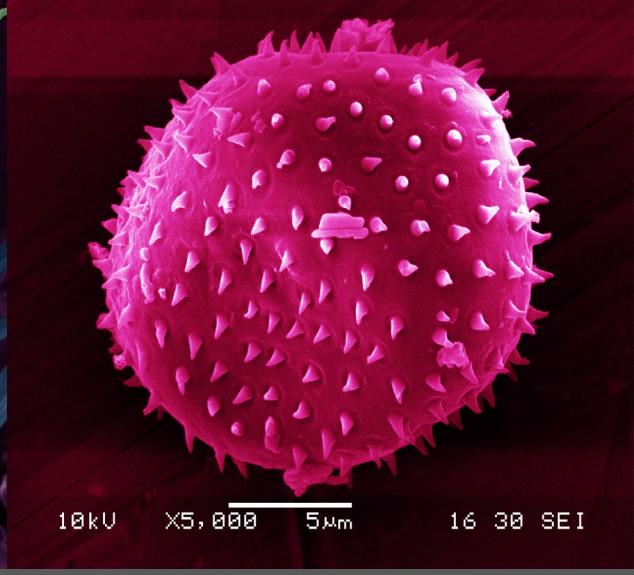



10kV X1,600 10µm 14 30 SEI

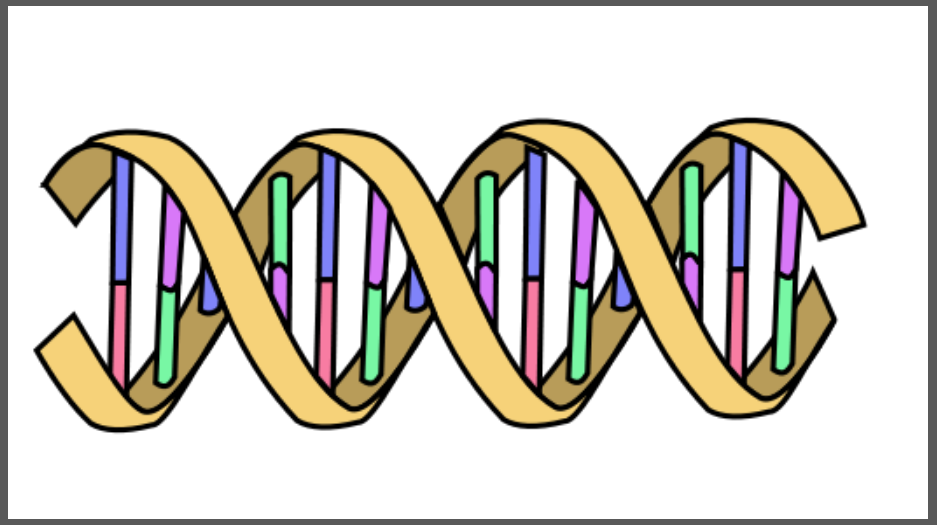

10kV X5,000 5µm 16 30 SEI

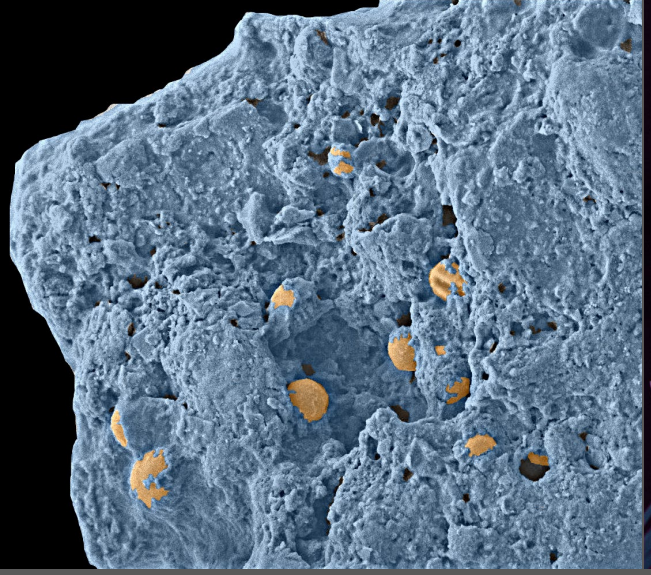



10kV X1,600 10µm 14 30 SEI


10kV X5,000 5µm 16 30 SEI


MiSeq
illumina



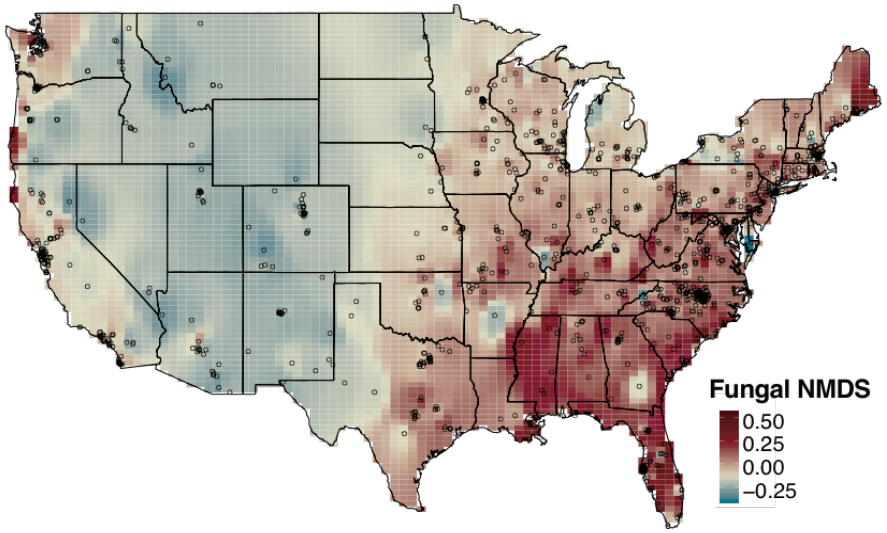


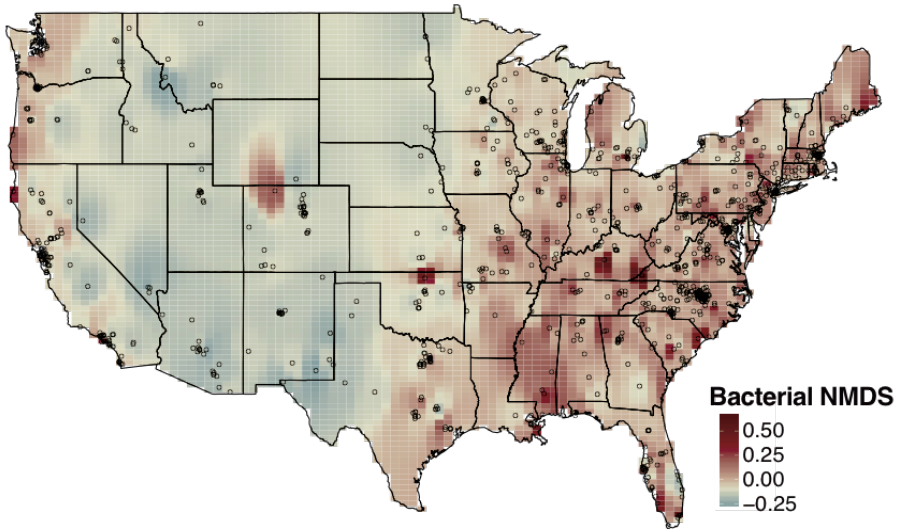
1,400 fungal and 4,700 bacterial 'species' per sample (mean)

88% of fungal and 94% of bacterial taxa were found in <10 samples

Barberán et al. 2015. PNAS

Predictable geographic patterns in community composition



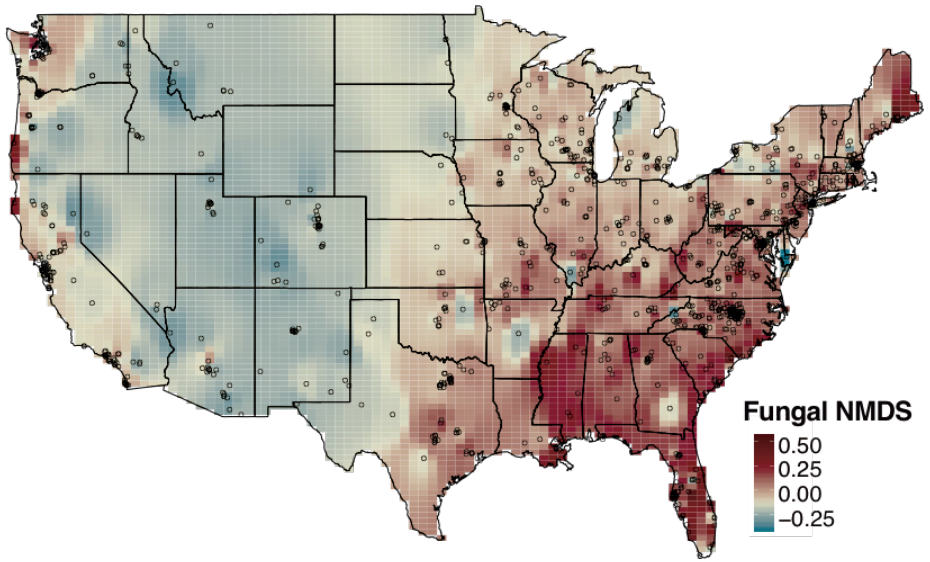


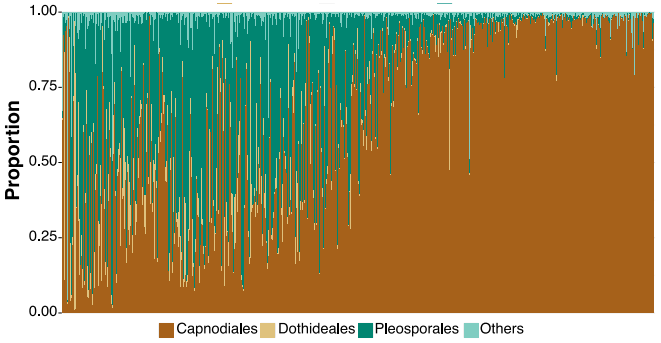
Barberán et al. 2015. PNAS

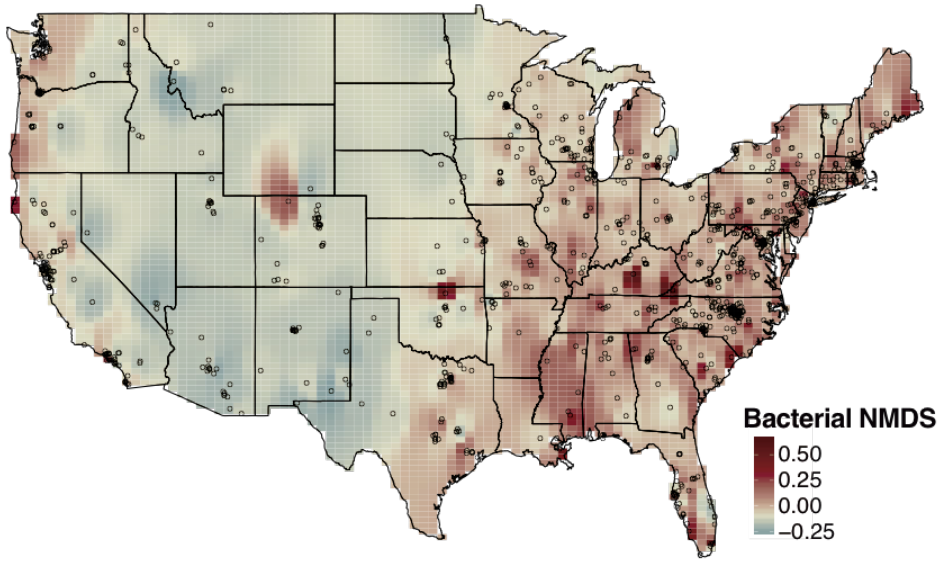
Fungi: $r_M = 0.29$, $p<0.01$

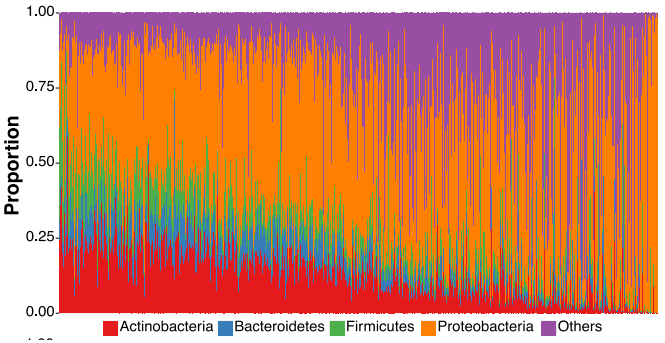
Bacteria: $r_M = 0.13$, $p<0.01$

Predictable geographic patterns in community composition



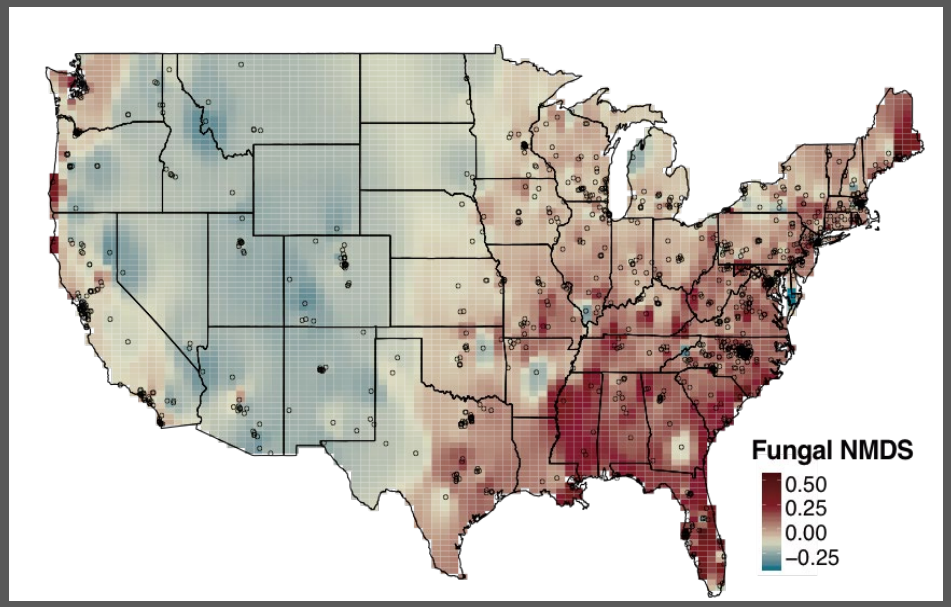




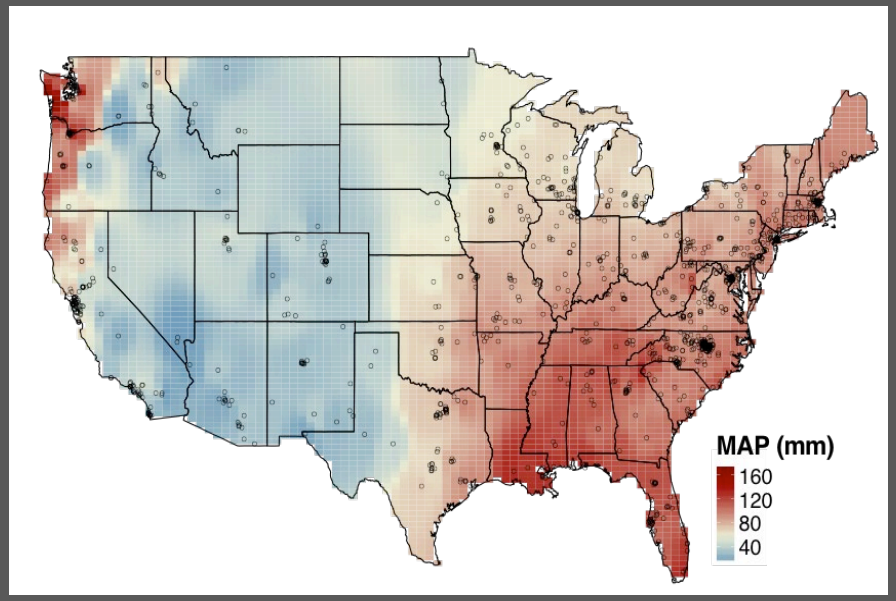


Barberán et al. 2015. PNAS

Dust-associated microbial communities are structured by **climate** and **soil**



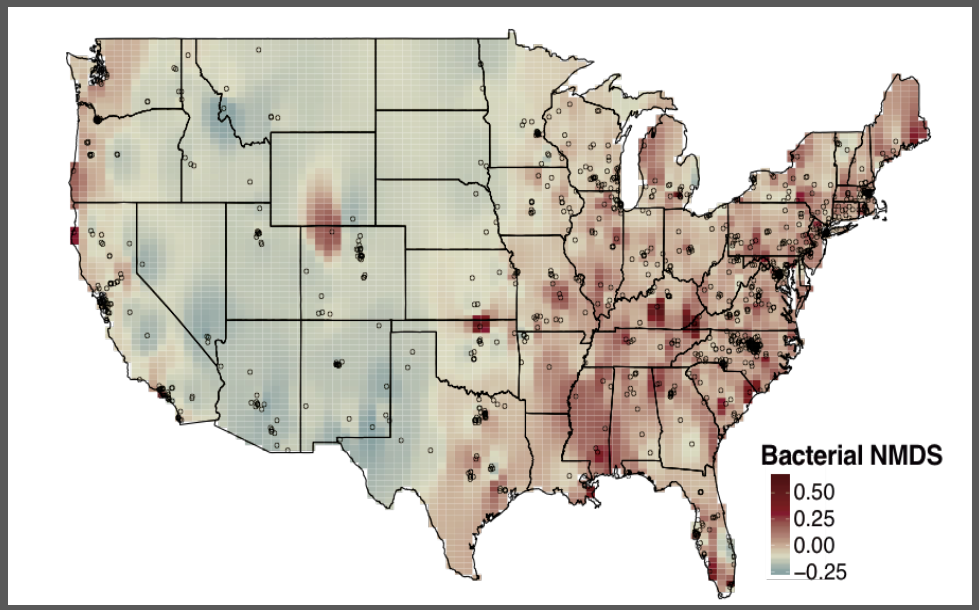
Fungi

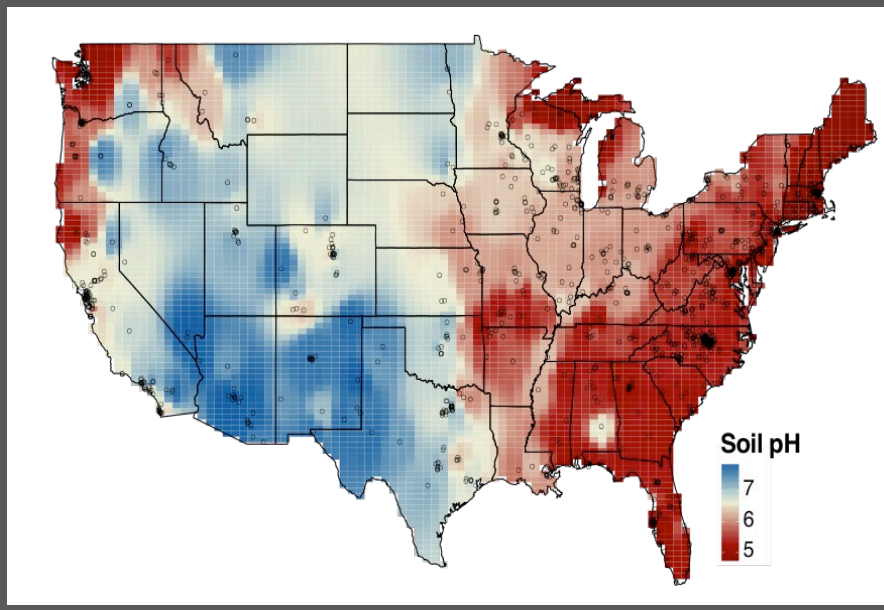


Mean Annual Precipitation

Barberán et al. 2015. PNAS

Dust-associated microbial communities are structured by **climate** and **soil**

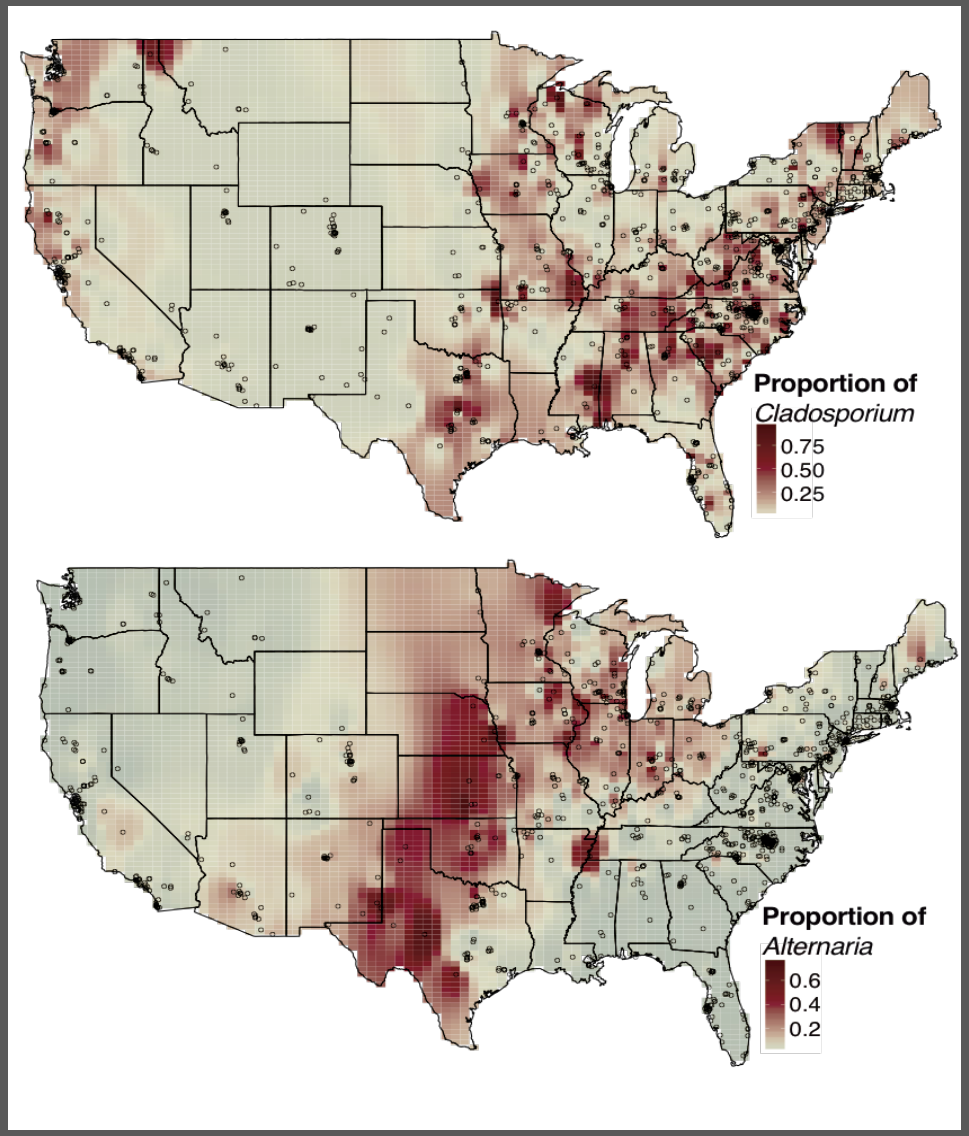




Bacteria **Soil pH**

Barberán et al. 2015. PNAS

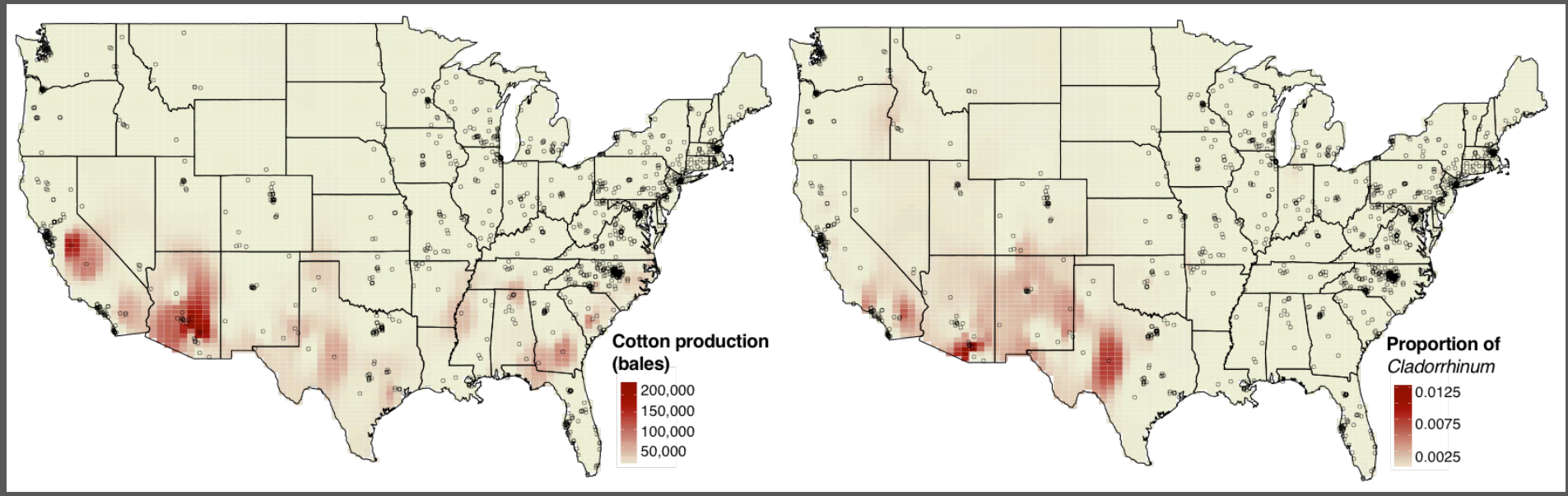
Geographic distributions of allergenic fungi



Cladosporium

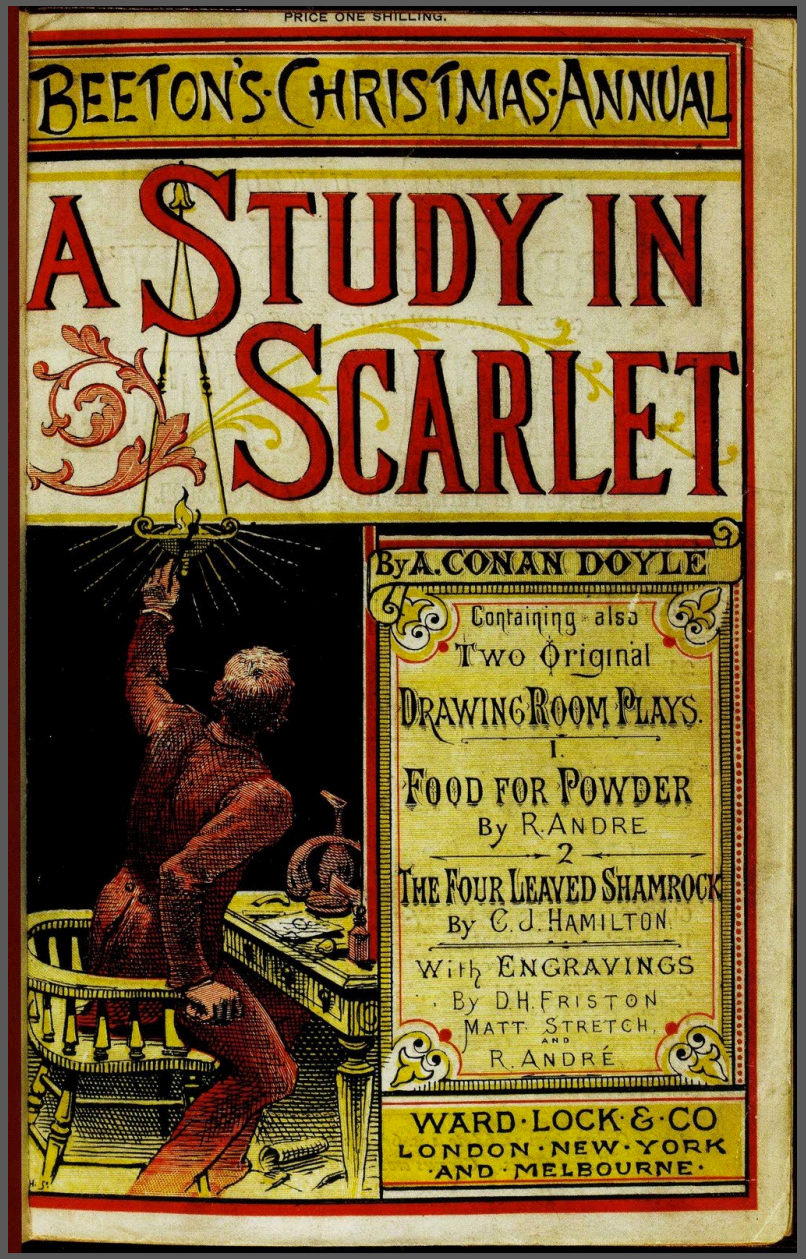
Alternaria

Crop plant-fungus co-occurrence

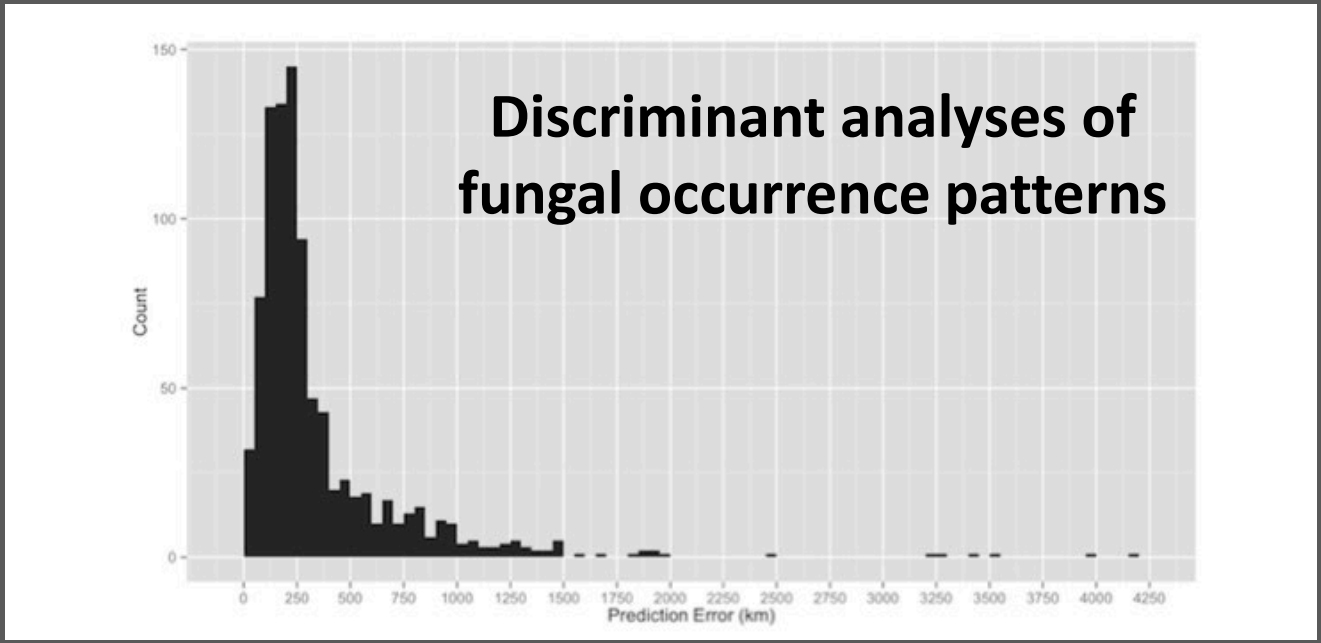


Cotton production

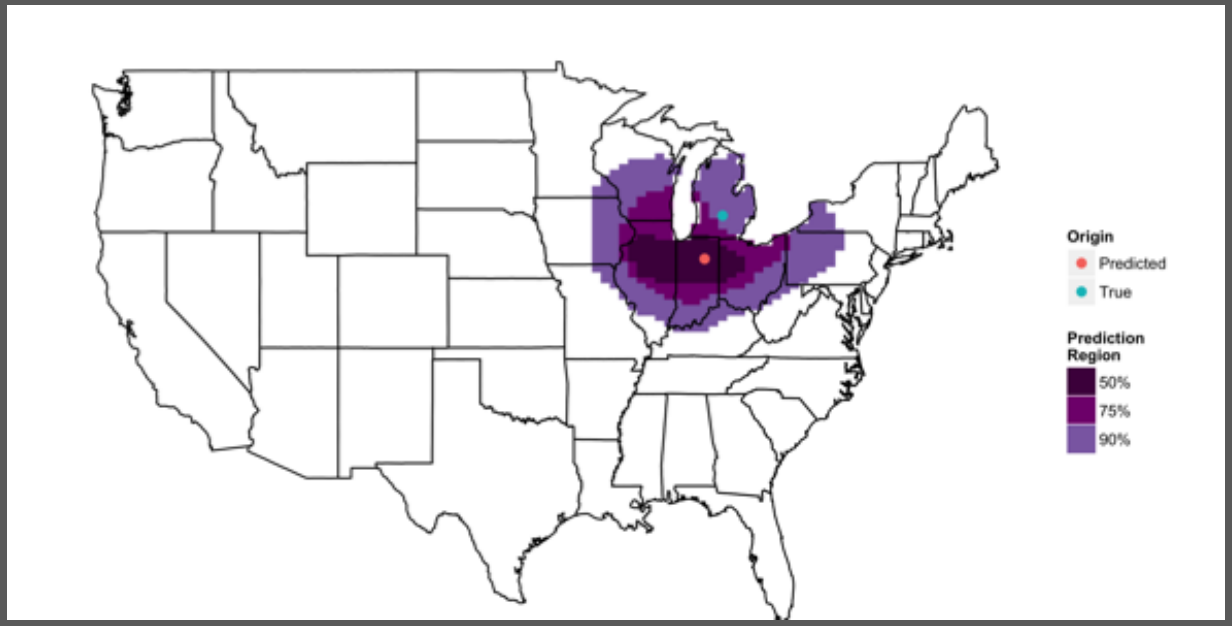
Cladorrhinum



Can we use microbial analyses to identify the geographic origin of dust samples?



Mean prediction error = 230 km



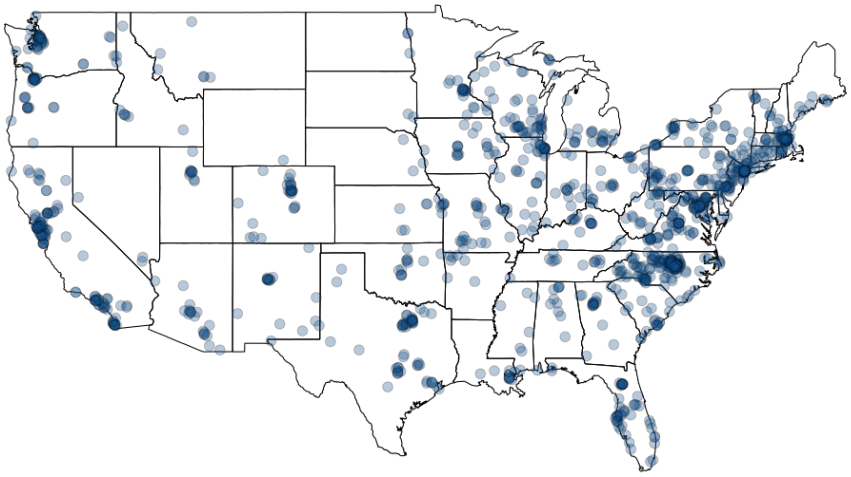
Grantham et al. 2015. PLoS One

We spend 90% of our time indoors

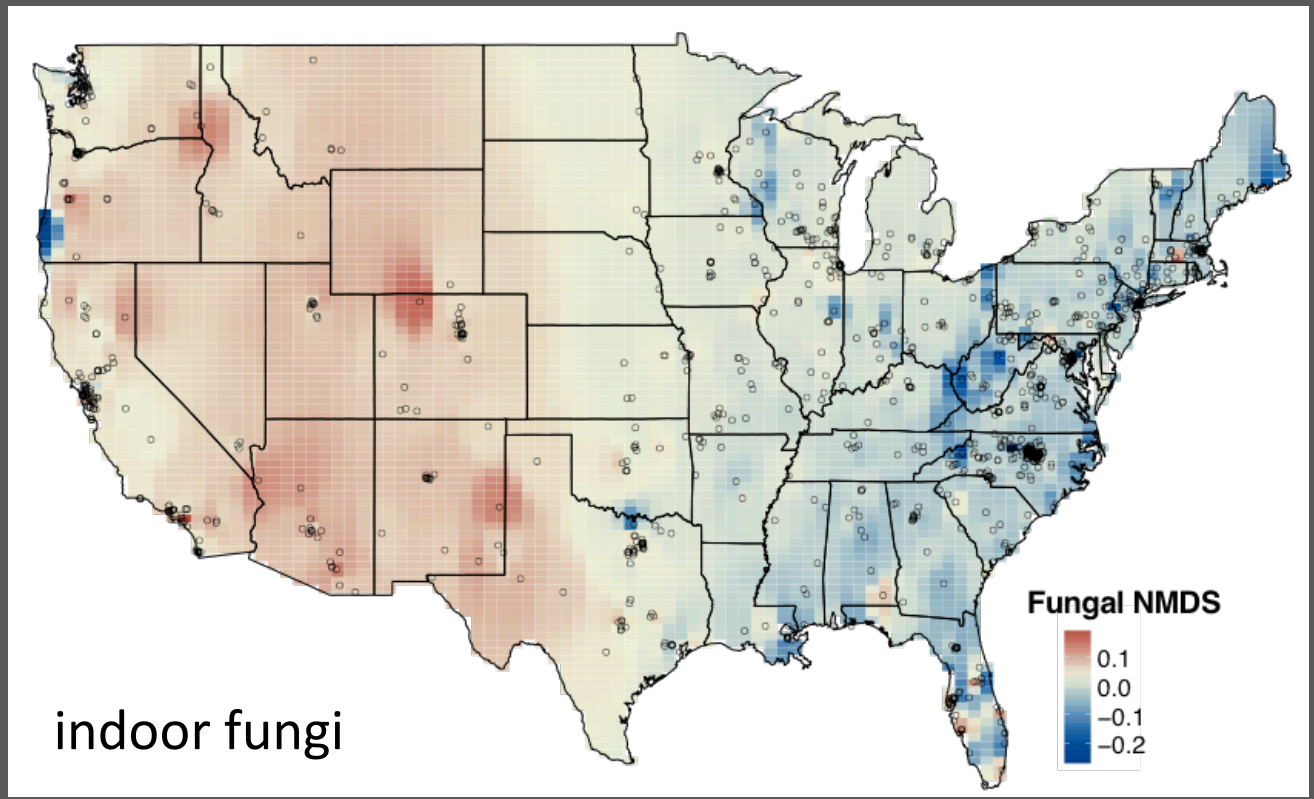
(Klepeis et al. 2001)

What about the microbes found in indoor air?

1,500 homes sampled



Where you live determines what fungi are found in your home



Barberán et al. 2015. Proc. Royal Soc. B.

Most fungi found inside your home come from outside

<10% of taxa are more common indoors

Fungi more common inside homes:

Aspergillus
Fusarium
Penicillium
Eurotium

Common household molds

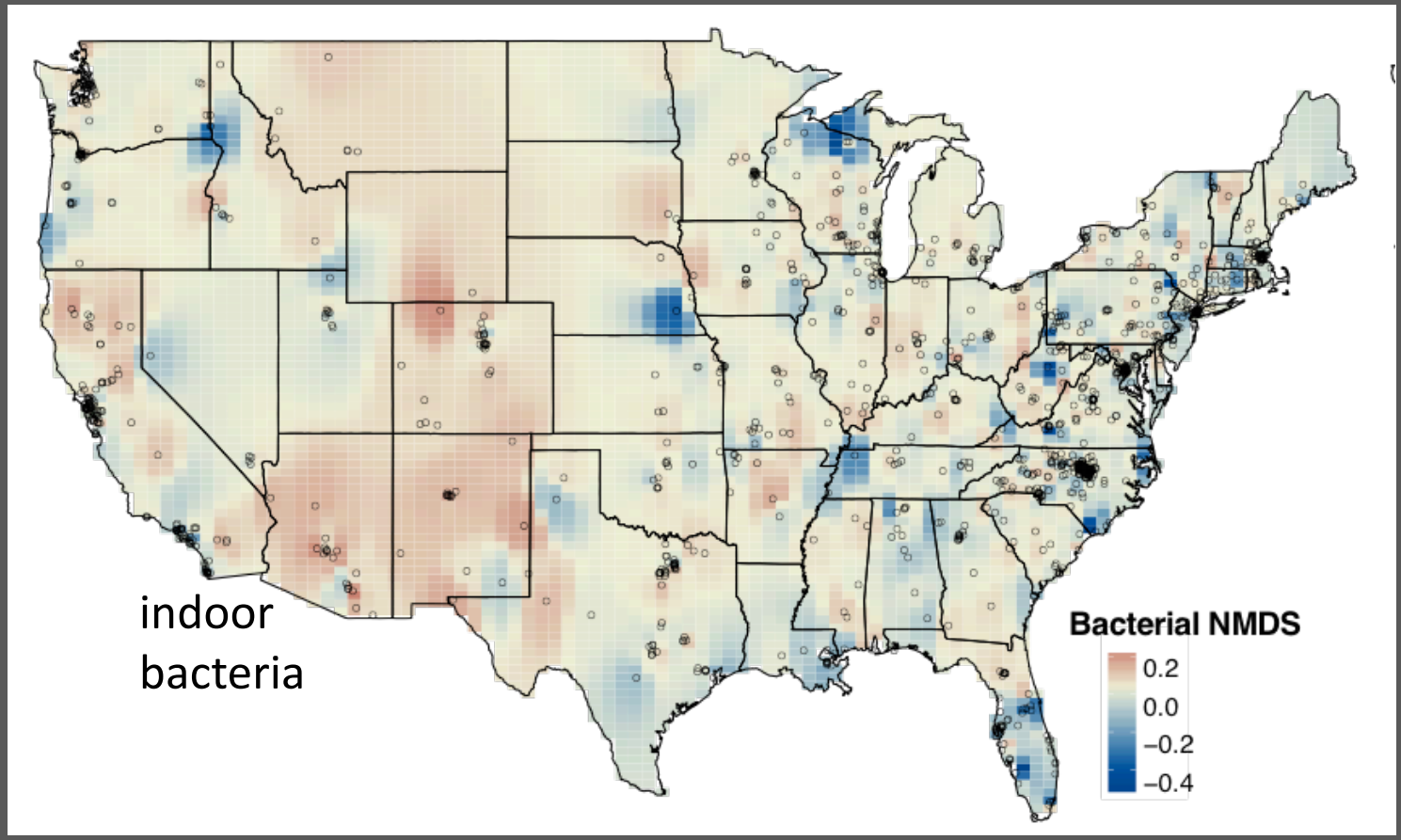
Stereum
Trametes
Schizophyllum
Chaetomium

Wood-degraders

Malassezia
Trichosporon

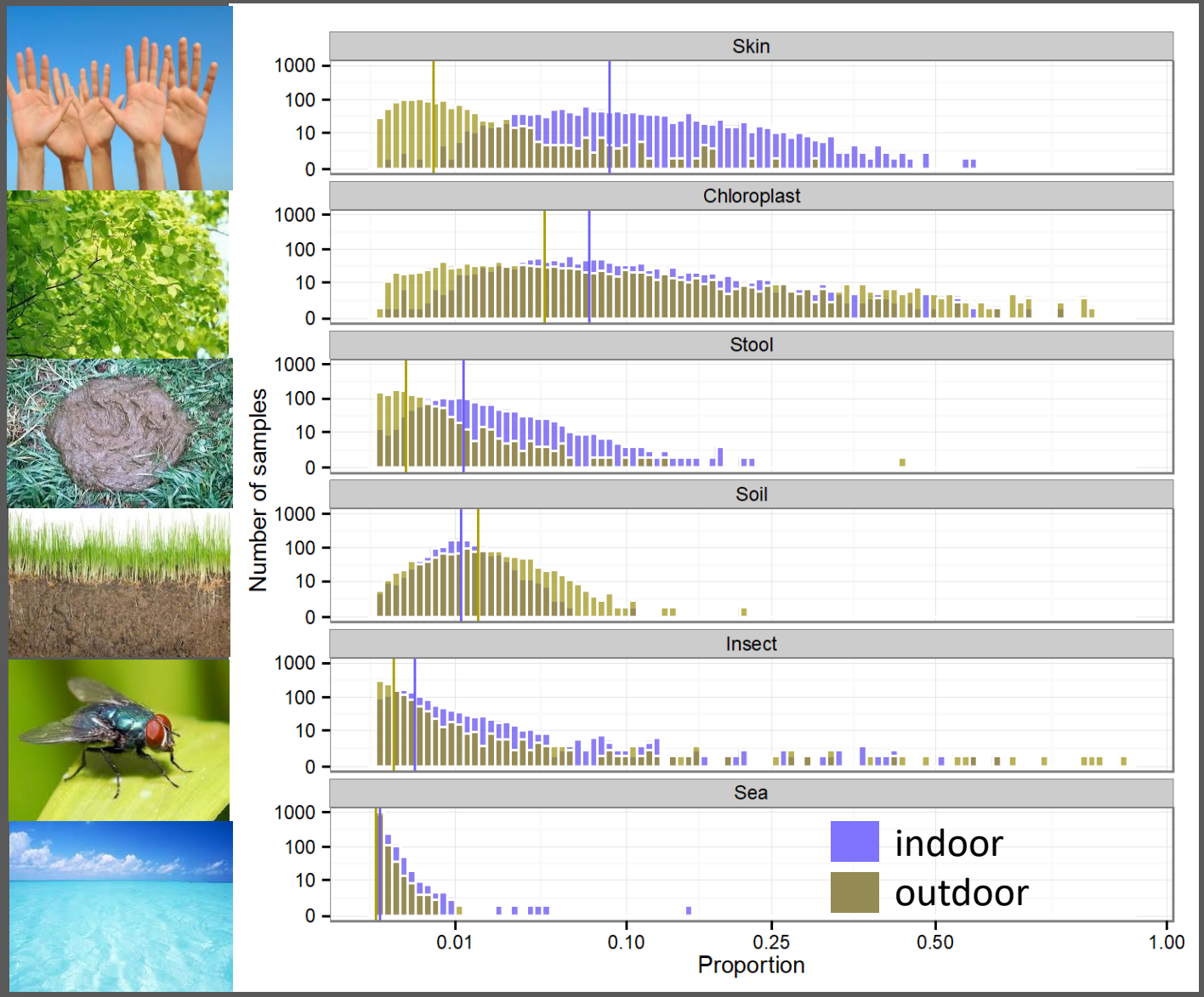
Human skin associated

Indoor bacterial communities are not predictable from climate, soil, or geography

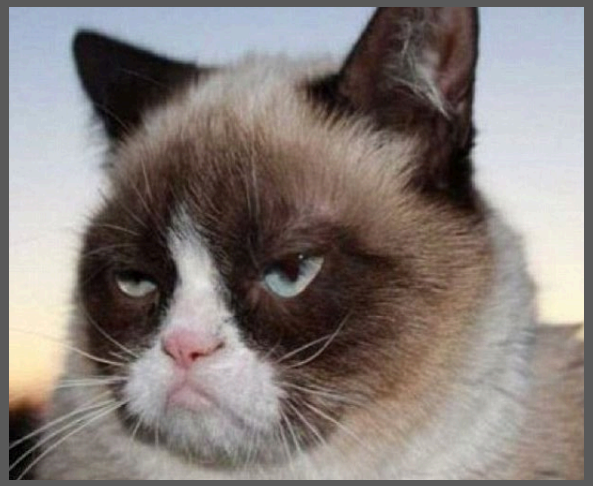


Barberán et al. 2015. Proc. Royal Soc. B.

Bacteria found indoors are more likely to come from home occupants

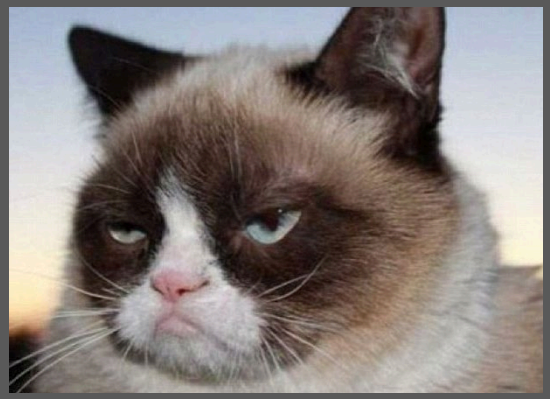


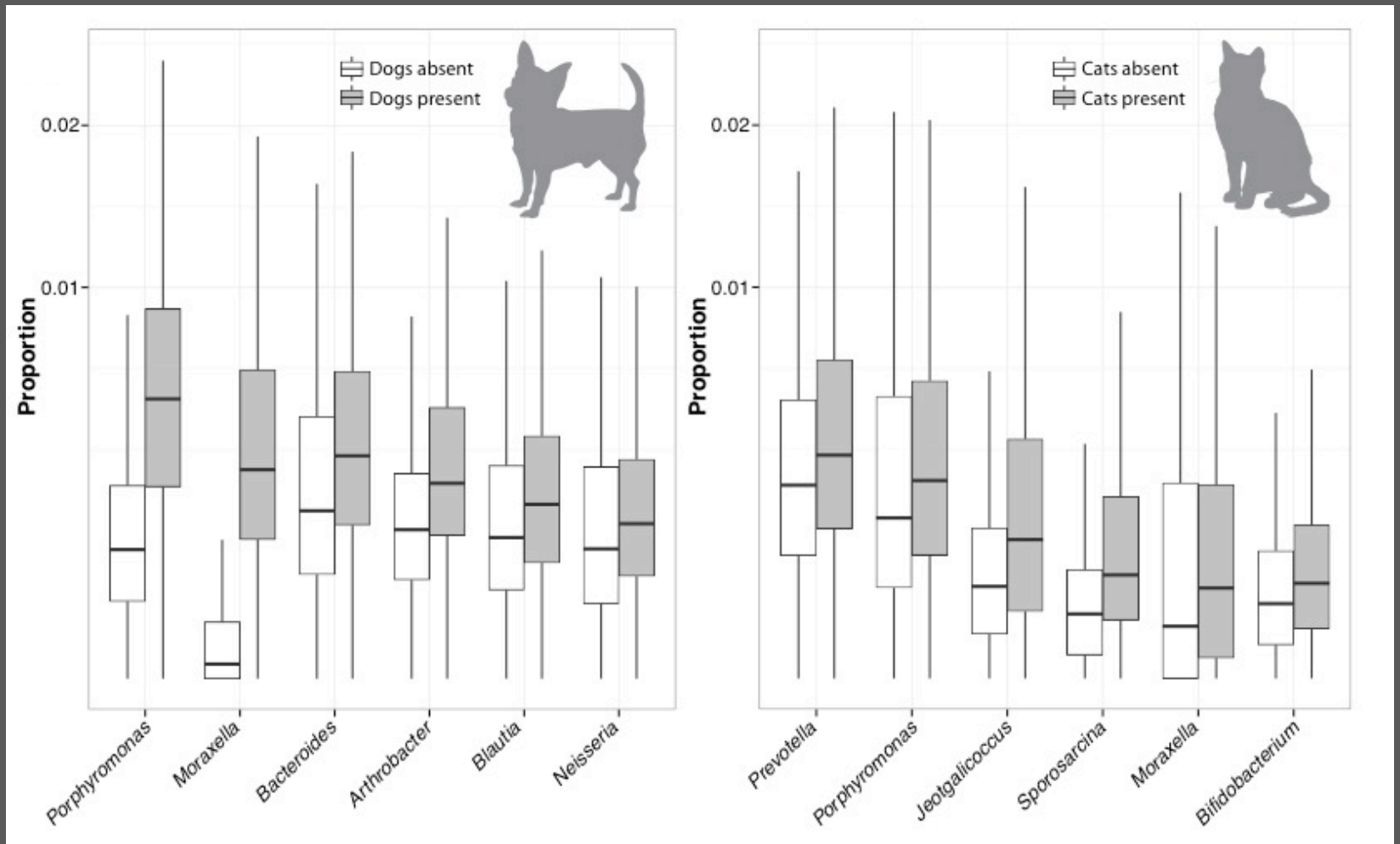
For indoor bacteria, who you live with matters more than where you live



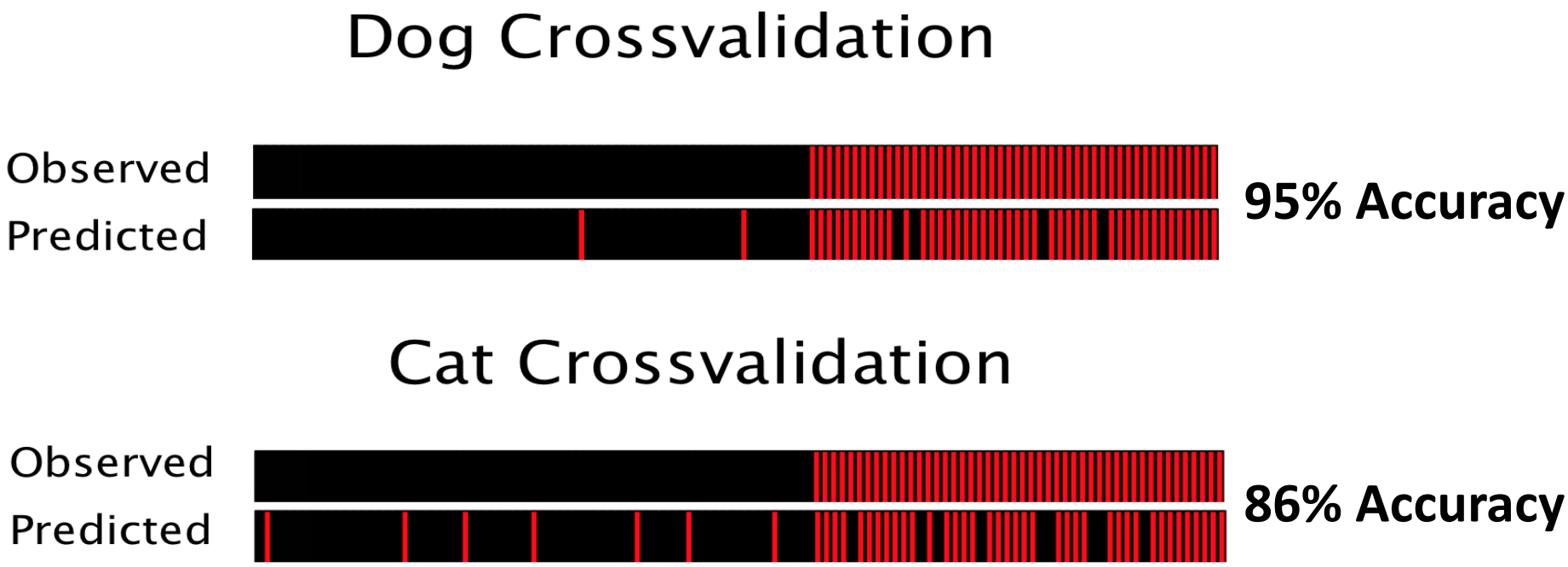
(male:female ratio)

≈40% of homes have a dog or a cat

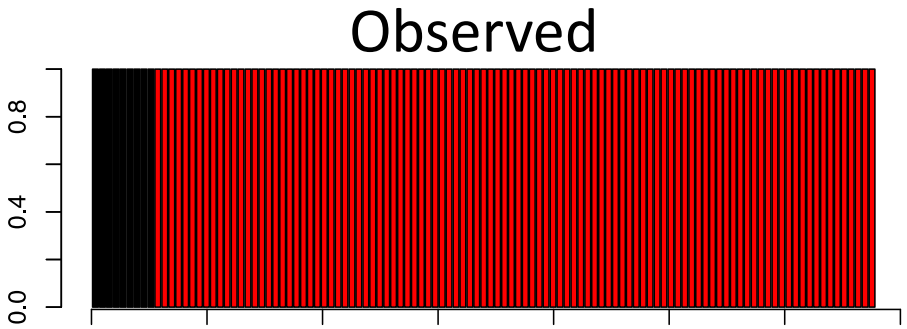




Predicting the presence of pets in home



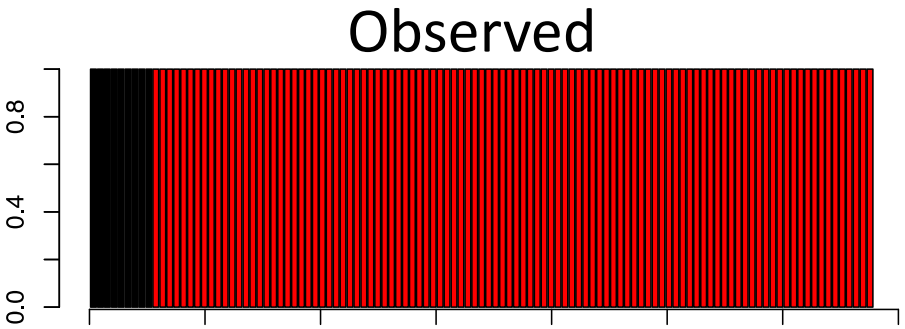
Predicting which homes have only male inhabitants

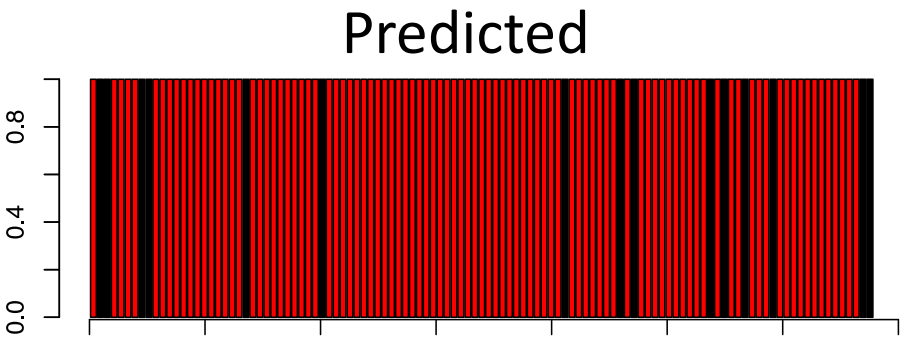


= women present in home

= no women present in home

Predicting which homes have only male inhabitants

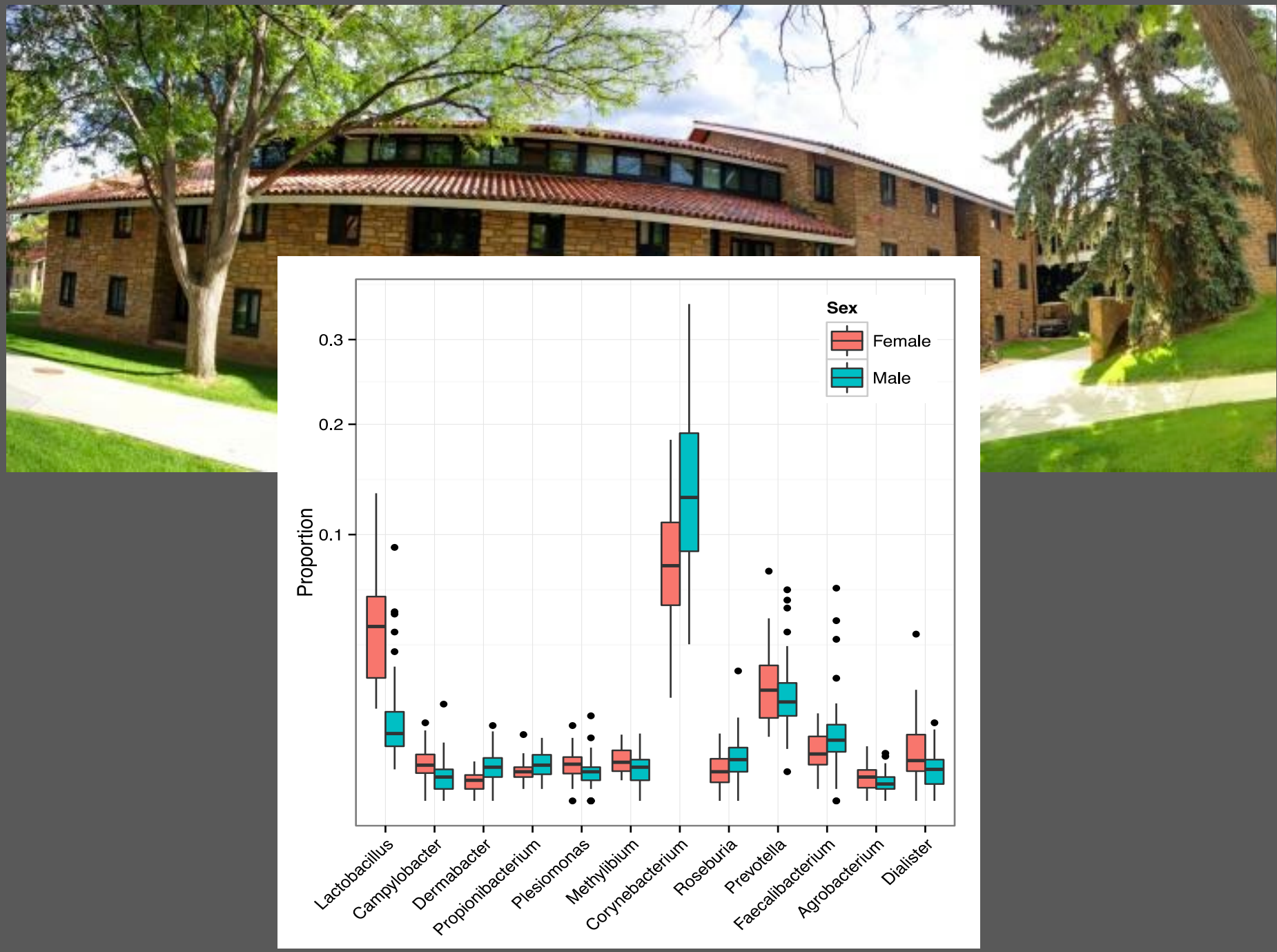


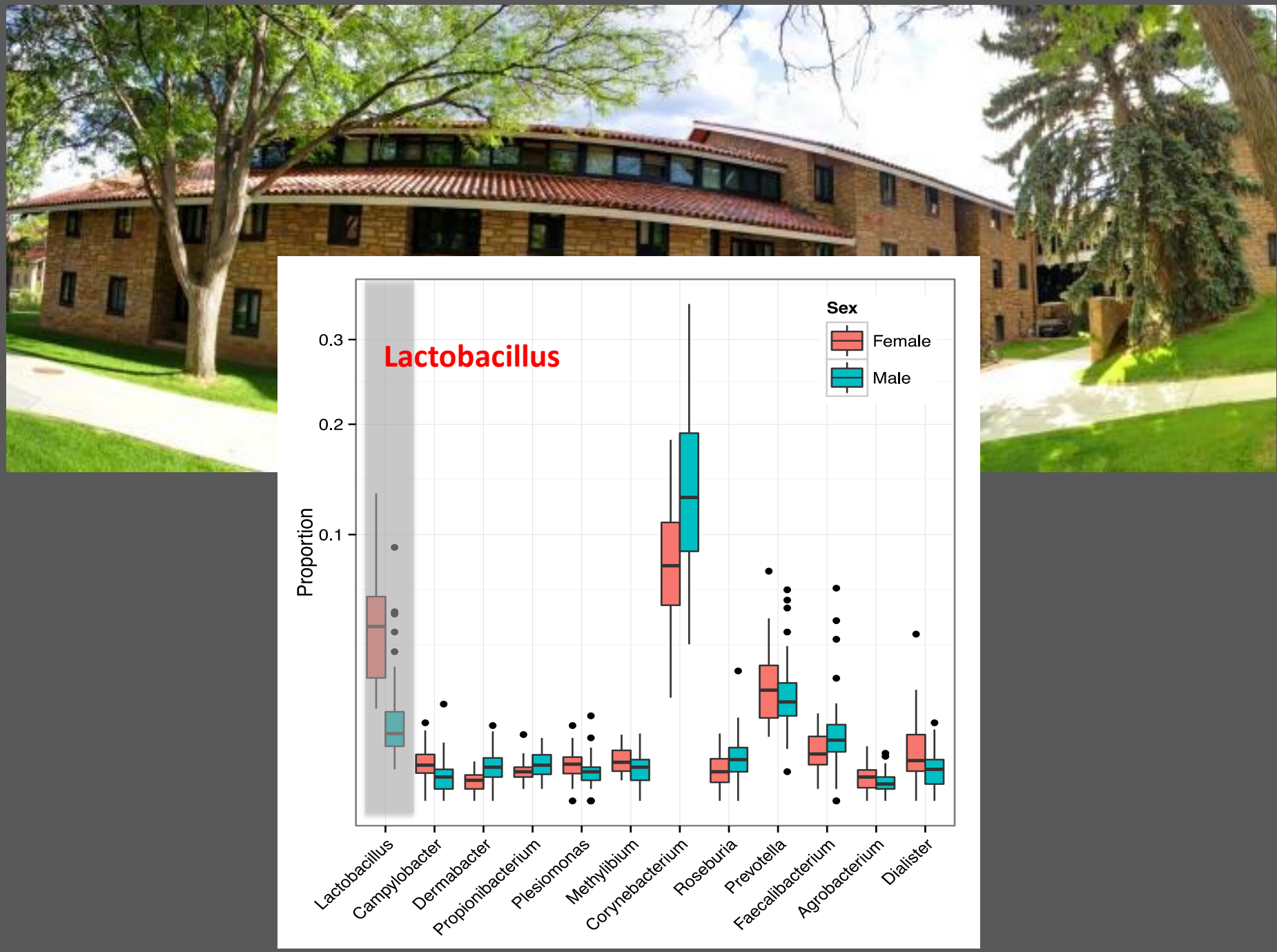


= women present in home

= no women present in home

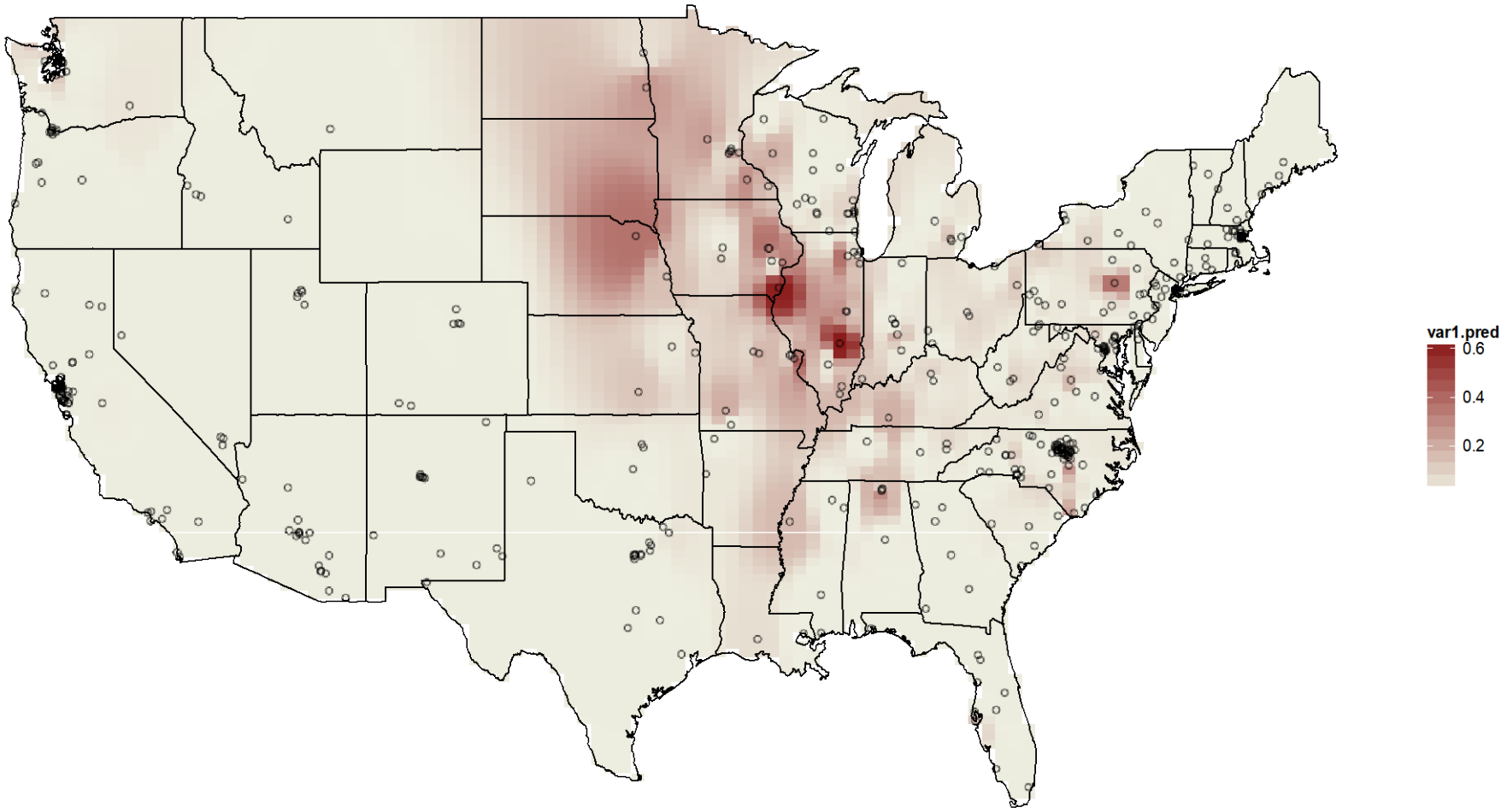
Problem: Only 6% of homes have no women living in them

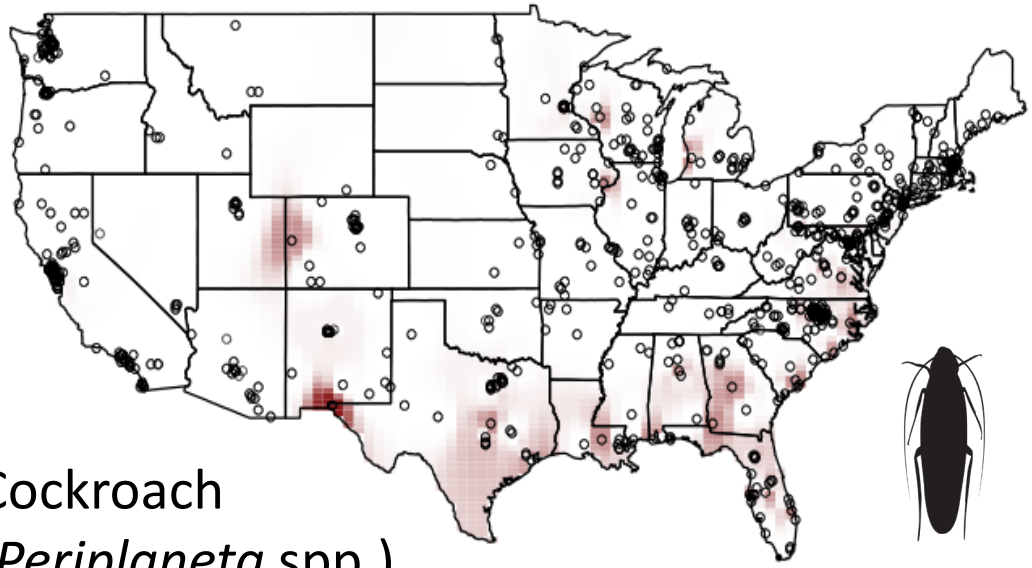

Sex
Female
Male
Proportion
0.3
0.2
0.1
Lactobacillus
Campylobacter
Dermabacter
Propionibacterium
Plesiomonas
Methylibium
Corynebacterium
Roseburia
Prevotella
Faecalibacterium
Agrobacterium
Dialister


Lactobacillus
Sex
Female
Male
Proportion
0.3
0.2
0.1
Lactobacillus
Campylobacter
Dermabacter
Propionibacterium
Plesiomonas
Methylibium
Corynebacterium
Roseburia
Prevotella
Faecalibacterium
Agrobacterium
Dialister

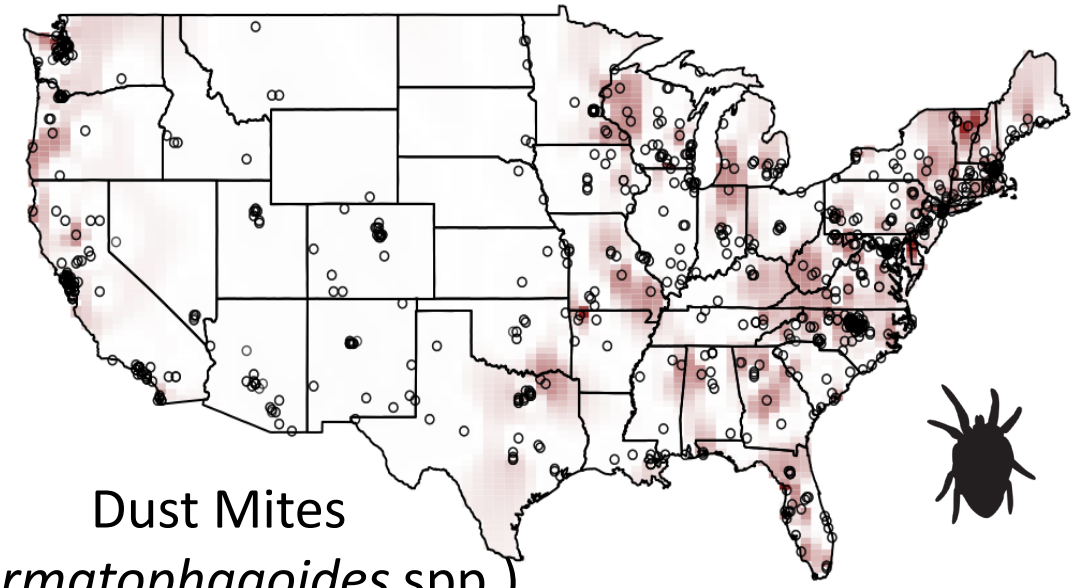

DUST

Ragweed (*Ambrosia*)





Cockroach
(*Periplaneta* spp.)



Dust Mites
(*Dermatophagoides* spp.)

Univ. of Colorado

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Jon Leff
Anne Madden
Shelly Miller
Jamie Morton



North Carolina State Univ.

Rob Dunn
Neal Grantham
Eric Laber
Holly Menninger
Brian Reich
Krishna Pacifici


Univ. of California – San Francisco

Josh Ladau
Katie Pollard

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