

Lecture 4: Human exposome + indoor particles

“Americans on average spend 90% indoors”

Local particles in the air we breathe

Surface inversion = thick dry warm atmospheric layer above the PBL

Concept of the Human Exposome (Trimble & Finch 2018)

Rise of inflammogen particles

EPA Report 2022 + EPA Air Now: PM_{2.5} focus

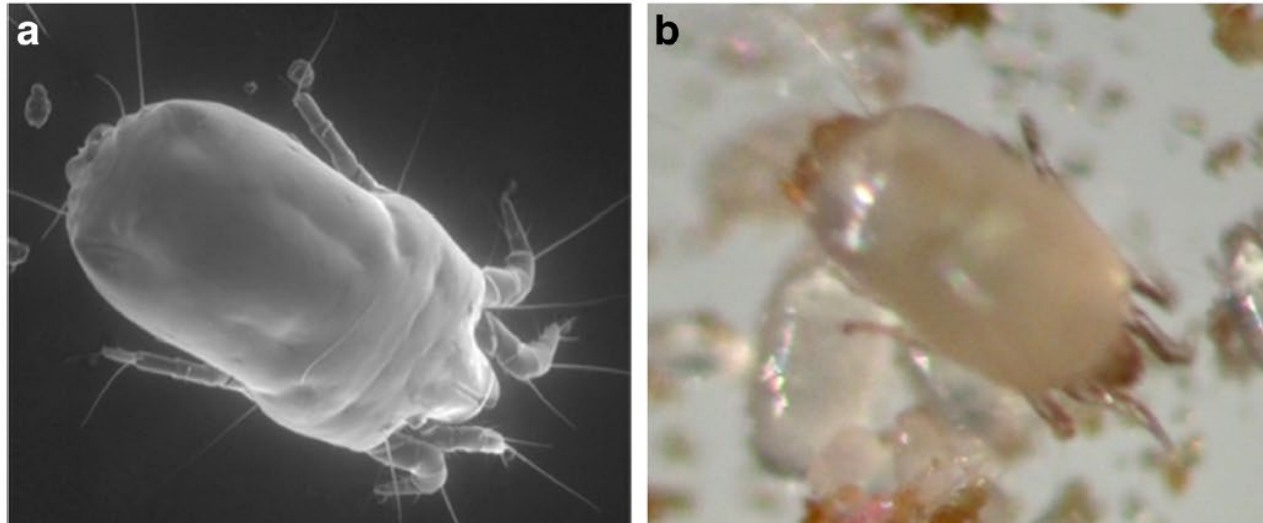
Global, regional, local and personal indoor in a single breathe

Location, location, location. Air particle content does not stay the same

Particle content varies with latitude, season, topography, pollutant sources, altitude, humidity, temperature, furnishings

Lecture 5 Indoor Particles

Fig. 2 *D. pteronyssinus* mite seen under **a** electron microscopy and **b** light microscopy. (Photos © Mission: Allergy, Inc. Used with permission)



Tovey et al. 1981

Nature Vol. 289 12 February 1981

Miller 2019

Dust mite fecal pellets as #1 source asthma in U.S. indoor spaces

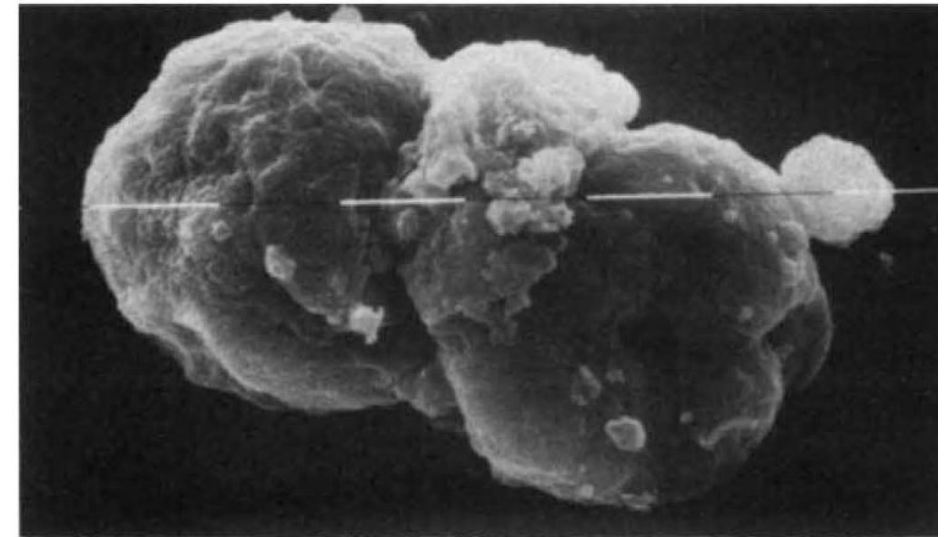


Fig. 1 Electron scanning micrograph of two mite faecal balls. Mite faeces range from 10 to 40 μm in diameter with a mean of $22 \pm 6 \mu\text{m}$ s.d. For a similar species it has been reported⁹ that the faeces are produced by compacting three to five foodballs covered in a peritrophic membrane. Scale bar, 10 μm . 2

Lecture 5 Indoor Mold is another major health hazard



Source: <https://www.alldryus.com/mold/is-it-dangerous-to-live-in-house-with-black-mold/>

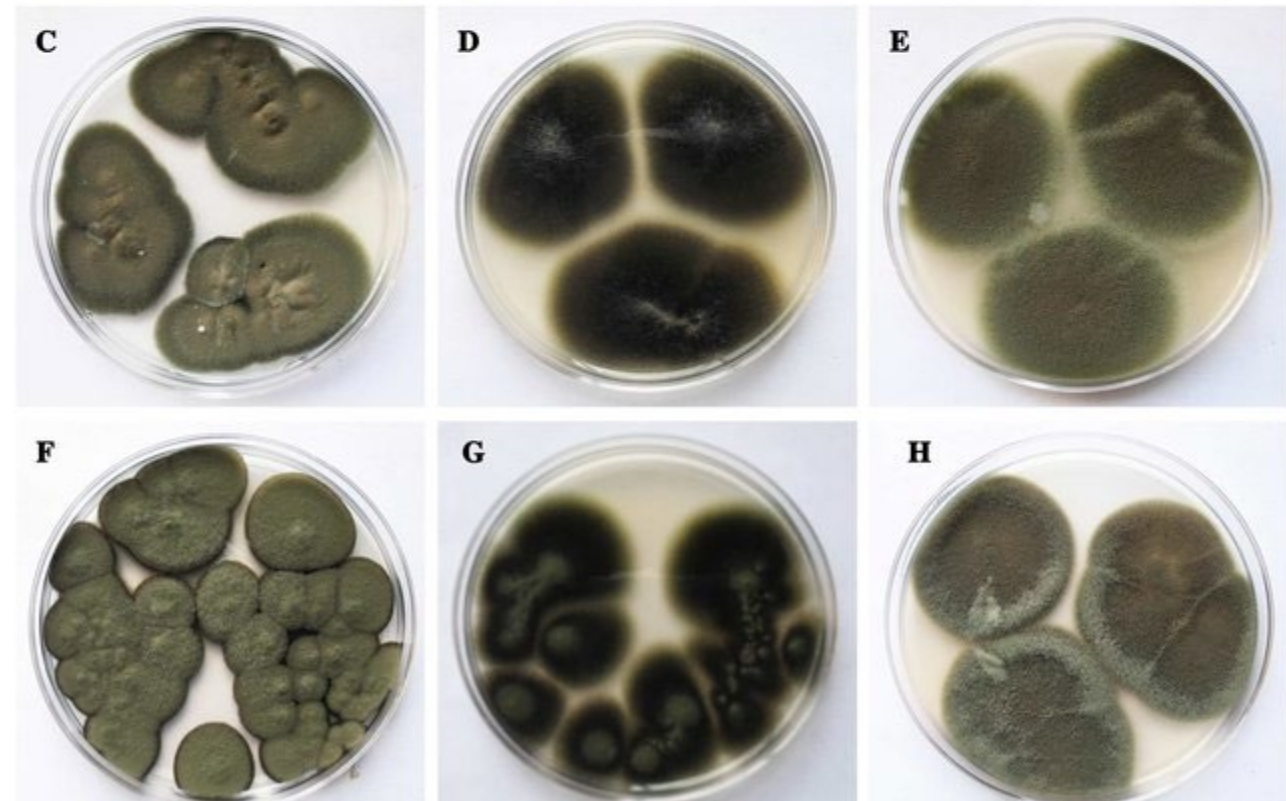
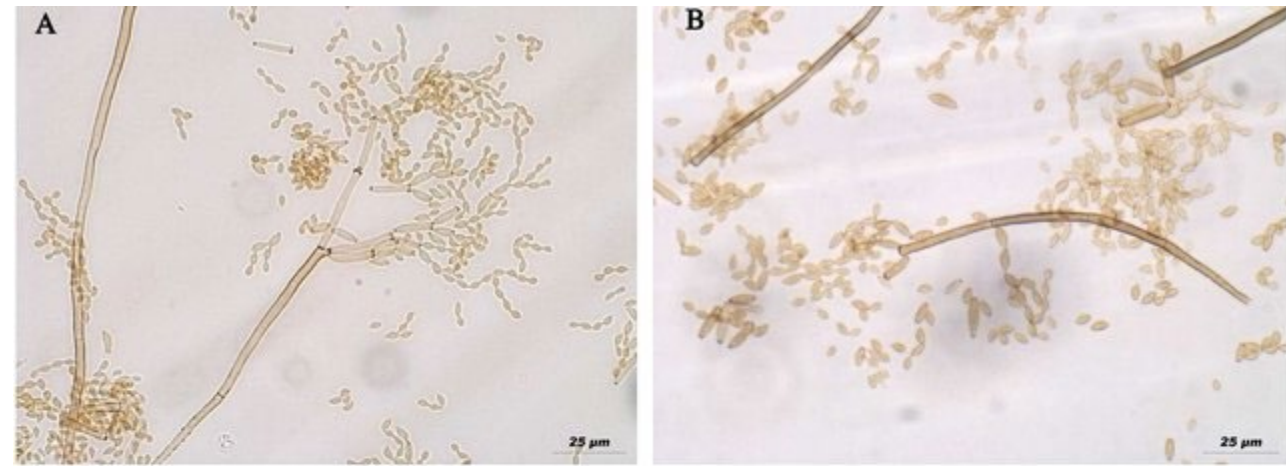
Common indoor fungal species:

Aspergillus versicolor

Pencillium melinii

Cladosporium cladosporiodes →

Stachysbotrys chartarum



Lecture 5: Indoor particles

What to do?

Monitor relative humidity with hygrometer

Example: ThermoPro TP50 Digital Hygrometer Indoor



Home Comfort C. Mendelsohn

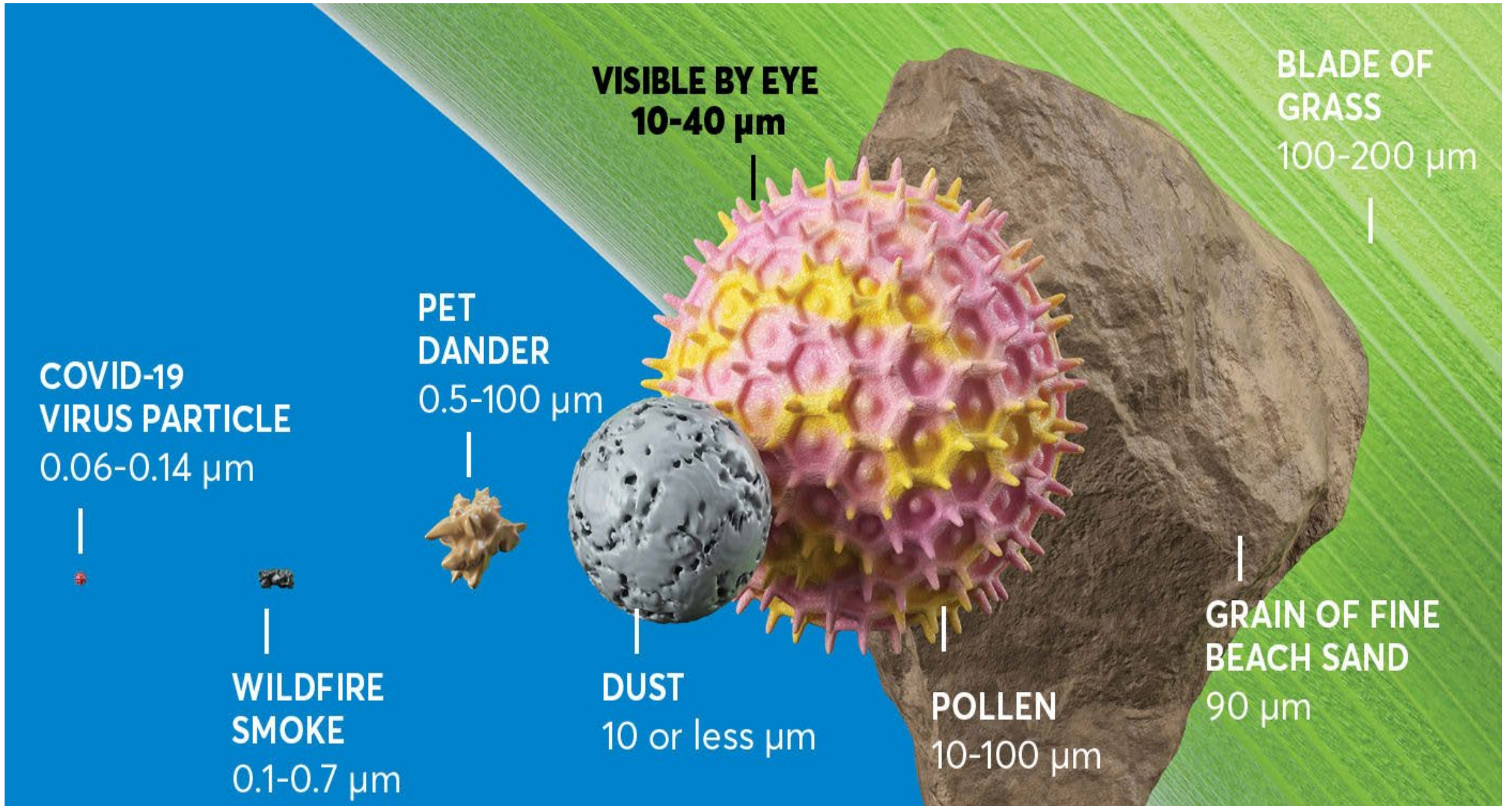
page 415 “The Air in Your Castle” Chapter

when gas cooking stoves are not vented to the outside, they cause elevated levels of carbon monoxide, nitrogen oxides, formaldehyde, and respirable particulates in the home. According to one study, the levels of carbon monoxide produced after two burners and the oven are lit for two hours are more than two and a half times greater than the EPA's maximum allowable eight-hour average concentration for outdoor air.

Natural Gas Stove Emissions Question

“Cooking with gas stoves creates nitrogen dioxide and releases additional tiny airborne particles known as PM2.5, both of which are lung irritants....Cooking and baking done with gas appliances can give off high concentrations of nitrogen dioxide.”

Source: <https://www.health.harvard.edu/blog/have-a-gas-stove-how-to-reduce-pollution-that-may-harm-health-202209072811> Accessed November 14 2023



Consumer Reports April 2023

“What Does an Air Purifier Do?

An air purifier removes allergens only while they’re floating in the air. Once they’ve settled to the ground (as is often the case with heavier particles, such as large pieces of dust and pollen), you’ll need a vacuum cleaner.

Studies of room air purifiers show that using HEPA filters—filters with very fine mesh, certified to collect 99.97 percent of particles of a certain hard-to-capture size (0.3 micrometers in diameter)—can be quite effective at removing many of the most common household irritants. These include tiny viral droplets, particulate matter (such as from cigarette smoke and burning wood), pet dander, dust, and dust mites.”

Consumer Reports April 2023

“[Wildfire smoke](#) is measured at 0.1 to 0.7 micron, and when inhaled, can cause a number of health problems. These include—but are not limited to—a burning sensation in the eyes, bronchitis, asthma attacks, and more serious conditions like a heart attack and stroke. According to the EPA, this smoke, often composed of vegetation, natural fuels, and synthetic materials, has been linked to premature death and trouble breathing in children.

How good are home air purifiers with HEPA filters at removing smoke? Very. CR's tests have found that the best models can effectively remove smoke particles, and the EPA has recommended air purifiers as an effective tool to combat smoke.”

Consumer Reports April 2023

Their Preferences for Air Purifier Technology?

YES Mechanical filtering system

YES Carbon activated filtering system

NOT ozone generators

NOT electrostatic

NOT UV irradiation

NOT photocatalytic oxidation

NOT photoelectrochemical oxidation

Consumer Reports April 2023 Air Purifier Models Recommended

Coway Aur Mega Pro X

Blueair Classic 604

Alen BreatheSmart 75i (>\$500 – \$850)

Blueair Blue Pure 211i (\$349)

Quiet

Less Quiet

MERV Rating	Average Particle Size Efficiency in Microns
1-4	3.0 - 10.0 less than 20%
5	3.0-10.0 greater than or equal to 20%
6	3.0-10.0 greater than or equal to 35%
7	3.0-10.0 greater than or equal to 50%
8	1.0-3.0 greater than or equal to 20% 3.0-10.0 greater than or equal to 70%
9	1.0-3.0 greater than or equal to 35% 3.0-10.0 greater than or equal to 75%
10	1.0-3.0 greater than or equal to 50% 3.0-10.0 greater than or equal to 80%
11	0.30-1.0 greater than or equal to 20% 1.0-3.0 greater than or equal to 65% 3.0-10.0 greater than or equal to 85%
12	0.30-1.0 greater than or equal to 35% 1.0-3.0 greater than or equal to 80% 3.0-10.0 greater than or equal to 90%
13	0.30-1.0 greater than or equal to 50% 1.0-3.0 greater than or equal to 85% 3.0-10.0 greater than or equal to 90%
14	0.30-1.0 greater than or equal to 75% 1.0-3.0 greater than or equal to 90% 3.0-10.0 greater than or equal to 95%
15	0.30-1.0 greater than or equal to 85% 1.0-3.0 greater than or equal to 90% 3.0-10.0 greater than or equal to 95%
16	0.30-1.0 greater than or equal to 95% 1.0-3.0 greater than or equal to 95% 3.0-10.0 greater than or equal to 95%
High efficiency Particulate Air filter HEPA*	99.97% of particles in the 0.3-micron range Particles that are larger or smaller than 0.3 microns are captured with a greater than 99.97% efficiency

MERV rating higher = better
Minimum Efficiency Reporting Values
Measures capacity for
capturing 0.3 to 10 micron sizes

HEPA pleated mechanical filter
High Efficiency Particulate Air

Lecture 5: Indoor Particles

Bacterial locations in public restrooms

**Skin-associated
bacteria on all surface**

**Gut-associated
bacteria on toilet**

**Soil-associated
bacteria on floors**
Bacteria of Public Restrooms

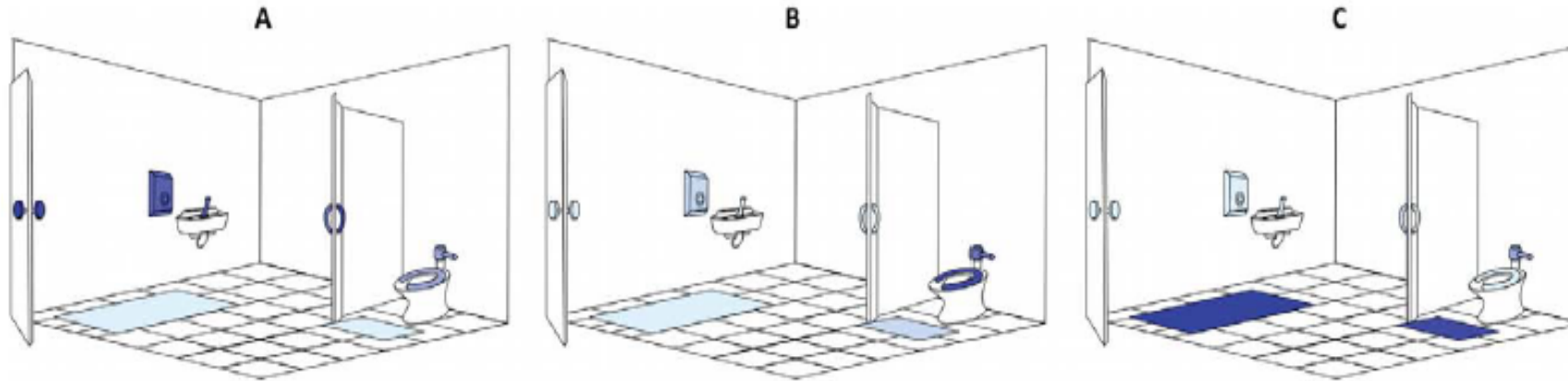


Figure 3. Cartoon illustrations of the relative abundance of discriminating taxa on public restroom surfaces. Light blue indicates low abundance while dark blue indicates high abundance of taxa. (A) Although skin-associated taxa (*Propionibacteriaceae*, *Corynebacteriaceae*, *Staphylococcaceae* and *Streptococcaceae*) were abundant on all surfaces, they were relatively more abundant on surfaces routinely touched with hands. (B) Gut-associated taxa (*Clostridiales*, *Clostridiales* group XI, *Ruminococcaceae*, *Lachnospiraceae*, *Prevotellaceae* and *Bacteroidaceae*) were most abundant on toilet surfaces. (C) Although soil-associated taxa (*Rhodobacteraceae*, *Rhizobiales*, *Microbacteriaceae* and *Nocardoidaceae*) were in low abundance on all restroom surfaces, they were relatively more abundant on the floor of the restrooms we surveyed. Figure not drawn to scale. doi:10.1371/journal.pone.0028132.g003

Lecture 5: Indoor Particles

Moldy musty smells based on age of residential dwelling

Table 4 Associations between housing built year and indoor musty smell

	Musty smell (n=744)	Non-musty smell (n=4173)	OR	P value
Built year				
1990 to present	64 (6.3 %)	957 (93.5 %)	1.00	n/a
1978–1989	104 (14.0 %)	639 (86.0 %)	3.04 (1.61–5.77)	0.002
1960–1977	127 (17.4 %)	604 (82.6 %)	3.97 (2.23–7.09)	<0.001
1950–1959	80 (17.4 %)	381 (82.7 %)	3.84 (2.31–6.37)	<0.001
1940–1949	73 (23.2 %)	242 (76.8 %)	4.97 (2.73–9.05)	<0.001
Before 1940	108 (19.8 %)	437 (80.2 %)	5.27 (3.50–7.92)	<0.001

Environ Sci Pollut Res (2015) 22:14234–14240
DOI 10.1007/s11356-015-4671-8

RESEARCH ARTICLE

Indoor mildew odour in old housing was associated with adult allergic symptoms, asthma, chronic bronchitis, vision, sleep and self-rated health: USA NHANES, 2005–2006

Ivy Shiue^{1,2}

3 February 2024

Claire G. Williams, Ph.D.

CLASS REVIEW “Air We Breathe” Fall 2023

“Americans on average spend 90% indoors”

Indoor particles in the air we breathe

Lecture 5:

What about particle output from natural gas-powered cooking stove

Concept of the Human Exposome (Trimble & Finch 2018)

Rise of inflammogen particles

Global, regional, local and personal indoor

Location, location, location? Air particle content does not stay the same

Source pollutants: diesel

Nonsource pollutant: carbon dioxide which forms a blanket around the Earth

Particle content variables: latitude, season, topography, pollutant sources, altitude, humidity, temperature, furnishings

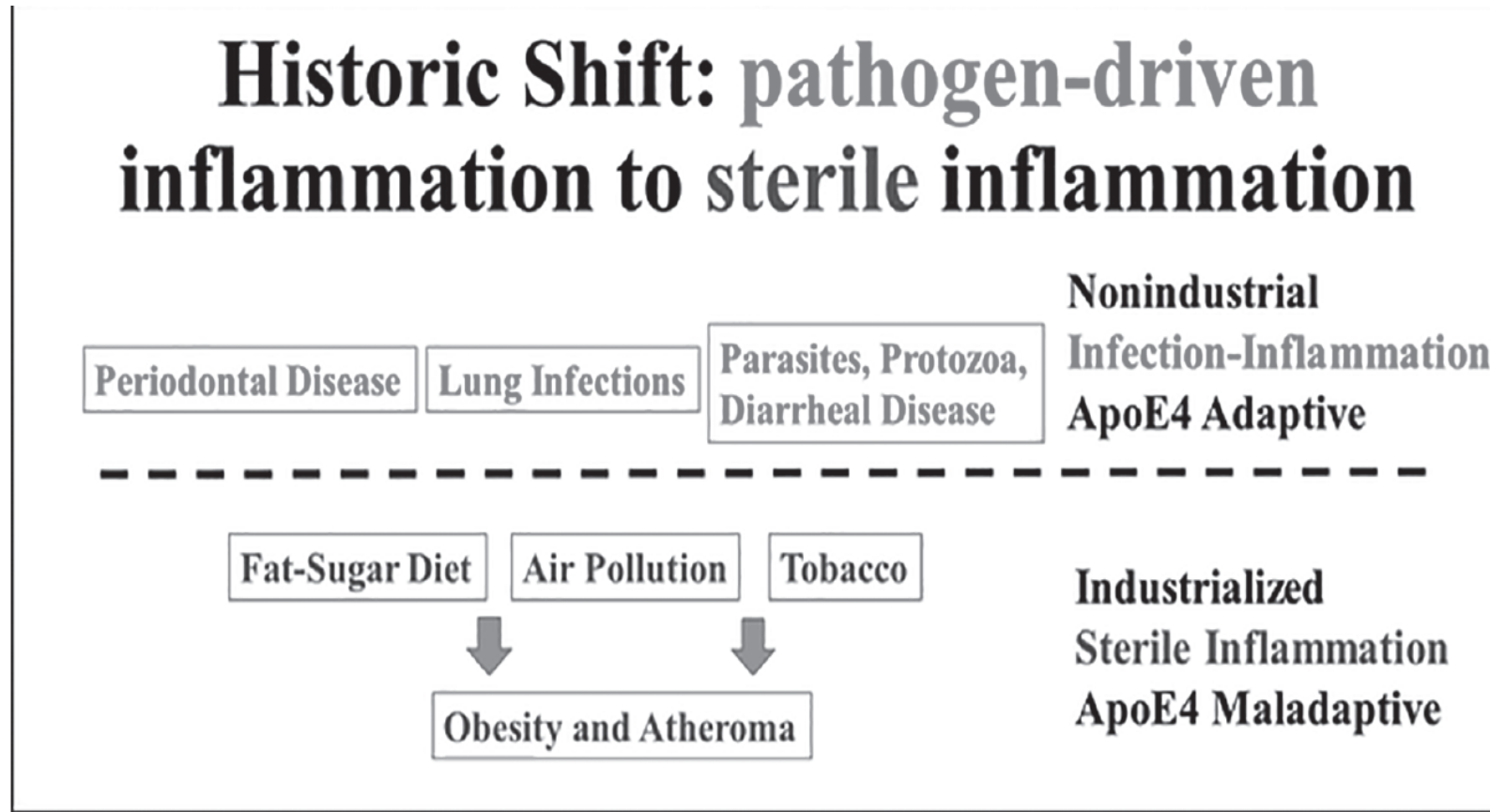


FIGURE 8. SHIFTS OF MORTALITY FROM PATHOGEN-DRIVEN INFLAMMATION TO STERILE INFLAMMOGENS DURING INDUSTRIALIZATION

Panel A: Industrialization was associated with shifts from mortality caused by infections and pathogen-driven inflammation to chronic low-grade inflammation from sterile inflammogens. Panel B: Health changes during industrialization shifted endogenous sites of inflammation: premodern sites above the dotted line included chronic infections of the mouth (periodontal disease), lung, and gastrointestinal tract.

Lecture 4: Local Particles a case of norovirus transmission



[Xiao S. et al. 2017. Int J Environ Res Public Health. 14\(12\): 1571. doi: 10.3390/ijerph14121571](#)

Poulson et al.

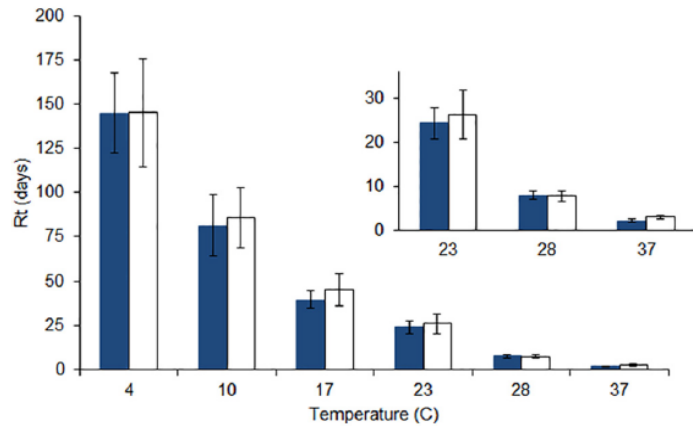


FIG 2 Mean (\pm SE) Rt values for seven pandemic (blue) and seven nonpandemic (white) viruses in distilled water at temperatures ranging from 4°C to 37°C. The pH was held constant at 7.2, and salinity was 0 ppm. No statistically significant differences were observed in the responses for pandemic and nonpandemic viruses at any temperature at an α value of 0.05.

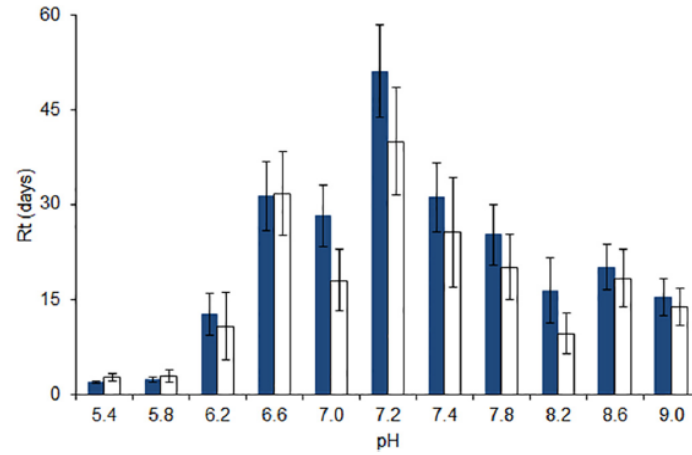


FIG 4 Mean (\pm SE) Rt values for seven pandemic (blue) and seven nonpandemic (white) viruses in distilled water at pHs ranging from 5.4 to 9.0. The temperature was held constant at 17°C, and salinity was 0 ppm. No statistically significant differences were observed in the responses for pandemic and nonpandemic viruses at any pH at an α value of 0.05.

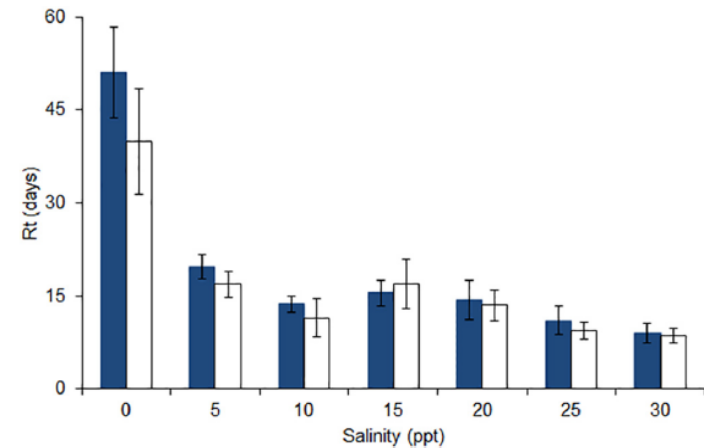
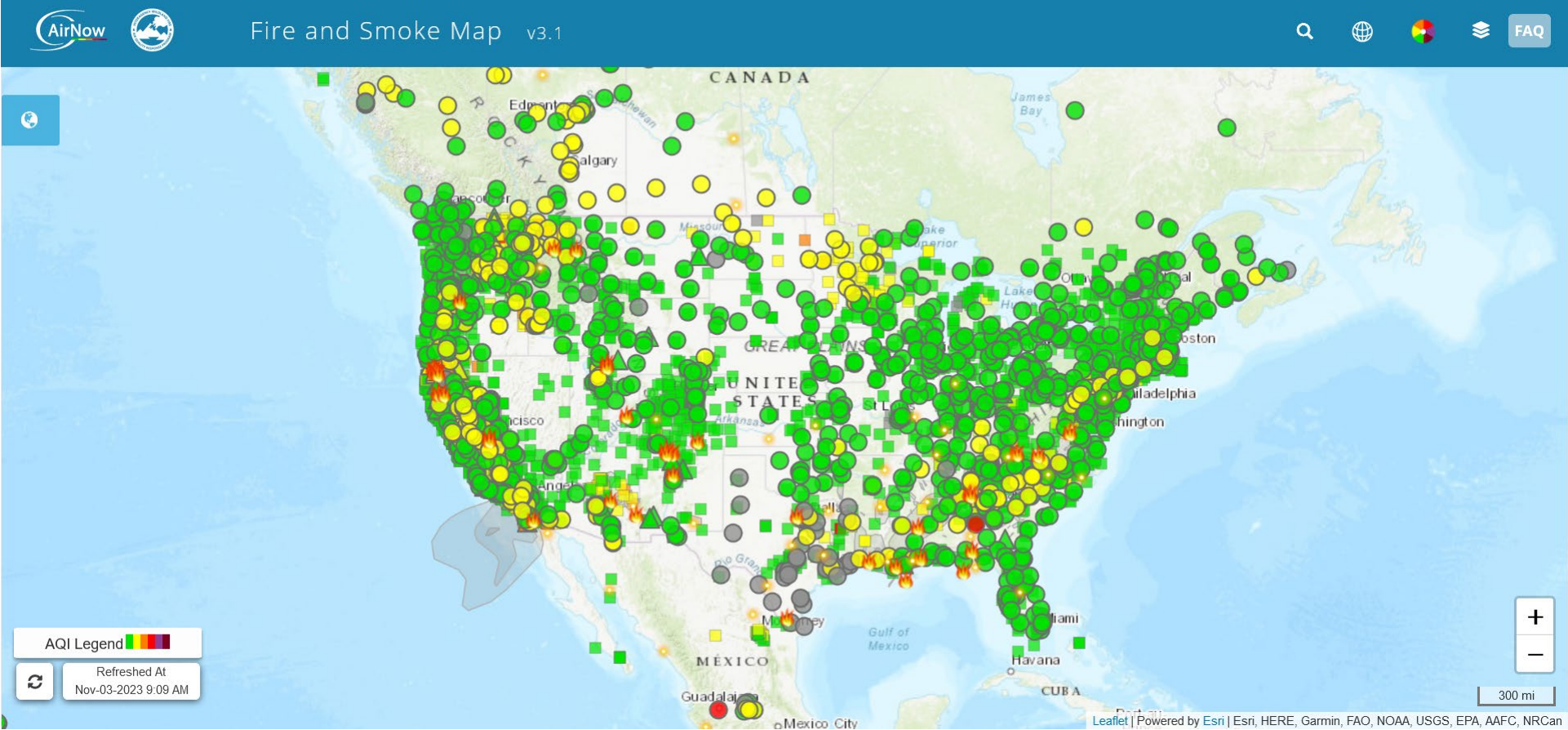


FIG 6 Mean (\pm SE) Rt values for seven pandemic (blue) and seven nonpandemic (white) viruses in distilled water at salinities ranging from 0 to 30 ppt. The temperature was held constant at 17°C, and the pH was 7.2. No statistically significant differences were observed in the responses for pandemic and nonpandemic viruses at any salinity at an α value of 0.05.

EPA's Air Now has a Fire and Smoke Map. Accessed November 3 2023 at 0911h.



<https://fire.airnow.gov/>

EPA Nonattainment Areas for Critical Pollutants October 31 2023 Wash DC in compliance

<https://www.epa.gov/green-book> Federal Register CA, PA,

**Counties Designated Nonattainment
for PM-2.5 (1997, 2006, and/or 2012 Standards)**

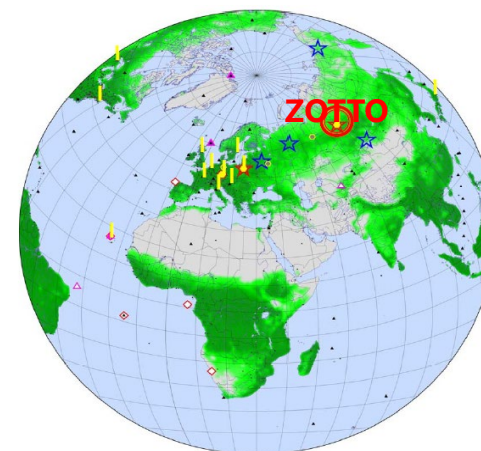


ZOTTO – continental tall tower observatory

Long-term Eurasian mid-continental observatory (>30 y)



Part of the global tall tower network



ЛАБОРАТОРИЯ
биогеохимических циклов
в лесных экосистемах



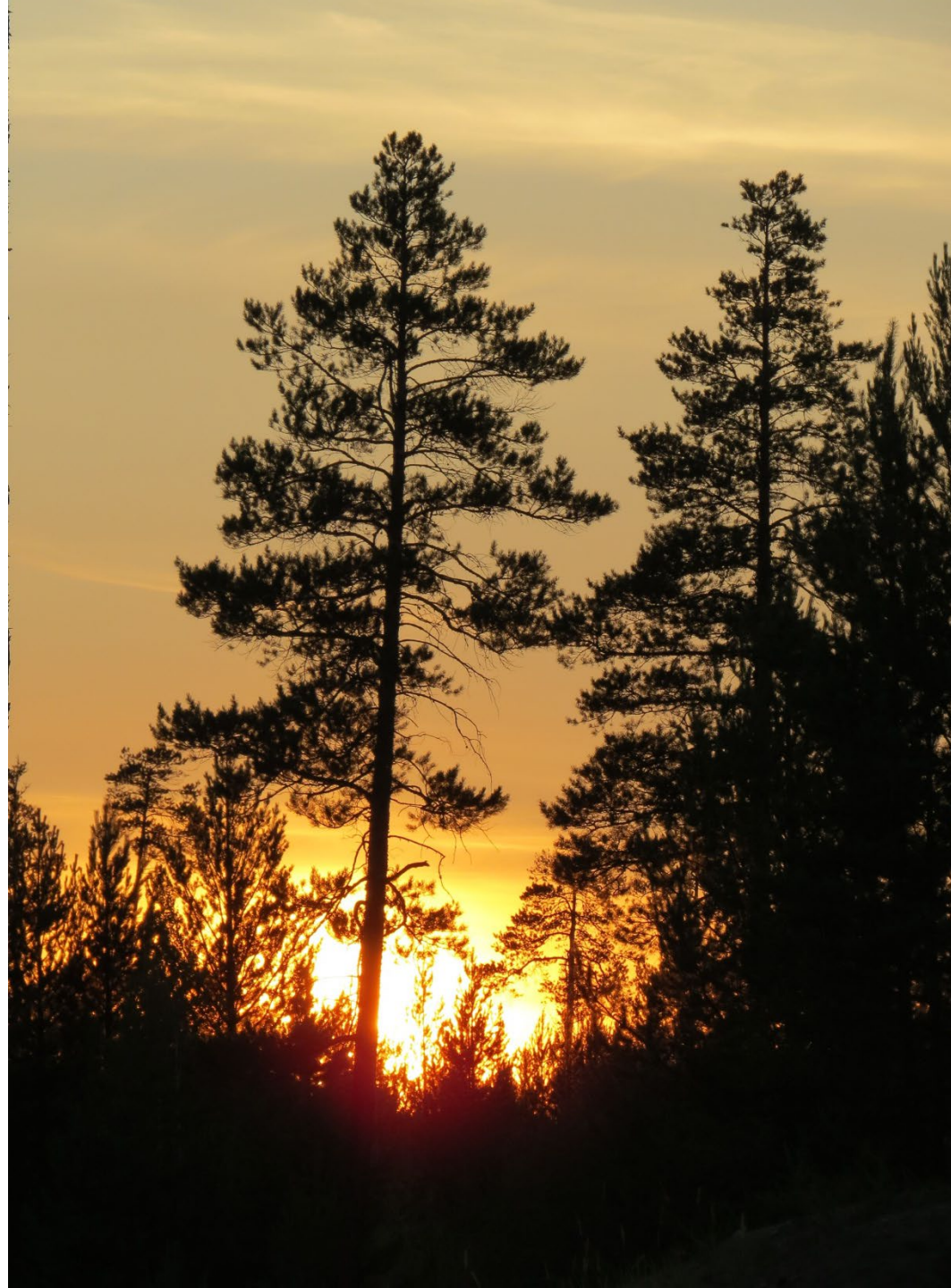


State forester
Comes for an evening
Meal with our research
Team.



**Photos by
Anastasia Makhnykina
Sukachev Institute &
Ph.D. candidate
Siberian Federal University**





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Larix spp. female strobili in Krasnoyarsk



НОВАЯ АКТИВНАЯ ФОРМУЛА



Рецепты
бабушки Агафьи

**ГУСТОЙ
ШАМПУНЬ АГАФЬИ**
ДЛЯ УКРЕПЛЕНИЯ,
СИЛЫ И РОСТА

*Настой 17 сибирских трав,
белый мед, репейное масло
и сосновая живица
на талой воде*



СLS
НЕ СОДЕРЖИТ
ПАРАБЕНОВ

ДЛЯ ТОНКИХ
И ОСЛАБЛЕННЫХ ВОЛОС



Blueberry relative
Finds its way into every dish
Sweet or savory.
Spring tonic is
“sea cabbage (brown sea algae)
Which is eaten with this berry.



Birch tapping
for sweetwater



Edible pine seeds



Central Siberian birch forests



One of our research trucks for the ZOTTO tall-tower observatory and research station. About 600 km north of Krasnoyarsk.



Pinus sylvestris
Or Scots Pine
In late spring
near
Sukachev Institute
of the Forest



