

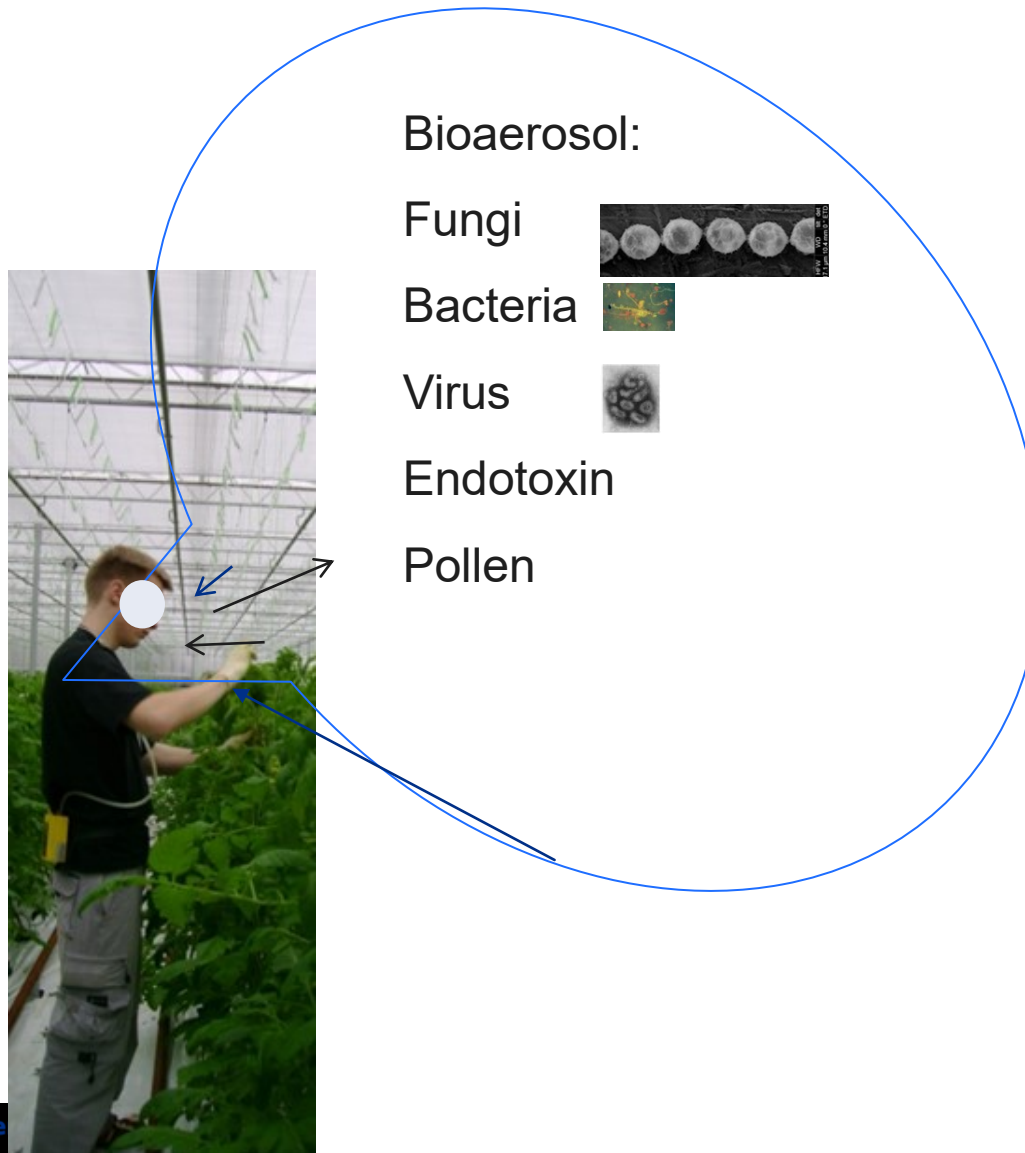
Occupational exposure and health in waste receiving and sorting plants



Anne Mette Madsen

ICOH/ European Platform of
Occupational Hygiene/AEHI webinar
October 2023

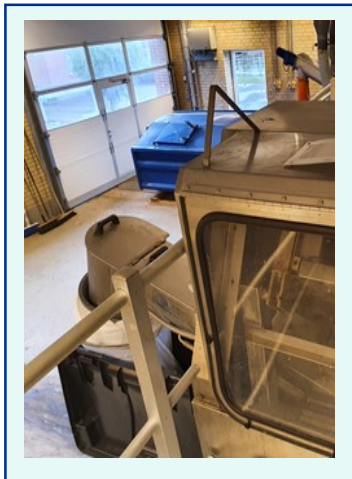
1/27



Work-related:

- Infections (pathogens)
- Allergic reactions
- ODTS
- COPD
- Inflammation
- Early signs of health effects-
inflammation, eye irritation

Species that can cause occupational infections



Norovirus
Winter vomit:
Gastrointestinal
Class 2



Staphylococcus aureus/
MRSA causes:
Soft tissue infections,
e.g. Pneumonia, ulcers
Class 2



Aspergillus niger:
Nail infection
Class 2



Sporothrix schenckii:
Rose growers' disease - a skin
infection - break in the skin + with, for
example, potting soil
Class 2



Aspergillus fumigatus:
Aspergillosis
(lung- infection)
Class 2

Two Year Follow-Up of a Garbage Collector with Allergic Bronchopulmonary Aspergillosis (ABPA)

Henning Allmers,* Hermann Huber, and Xaver Baur

Allergic bronchopulmonary aspergillosis as an occupational disease - special risk in waste management

Alexandra Maria Preissner, Volker Hoff
European Respiratory Journal 2017; 50: PA1228. DOI: 10.1183/13993003.congr-2017.PA1228

Exposure to Airborne Noroviruses and Other Bioaerosol Components at a Wastewater Treatment Plant in Denmark

Katrine Uhrbrand · Anna Charlotte Schultz ·
Anne Mette Madsen

Outbreak of Sporotrichosis among Tree Nursery Workers

Rana Hajjeh, Sharon McDonnell,* Susan Reef,*
Carmelo Licitra, Michael Hankins, Bill Toth,
Arvind Padhye, Leo Kaufman, Lester Pasarell,
Chester Cooper, Lori Hutwagner, Richard Hopkins,
and Michael McNeil

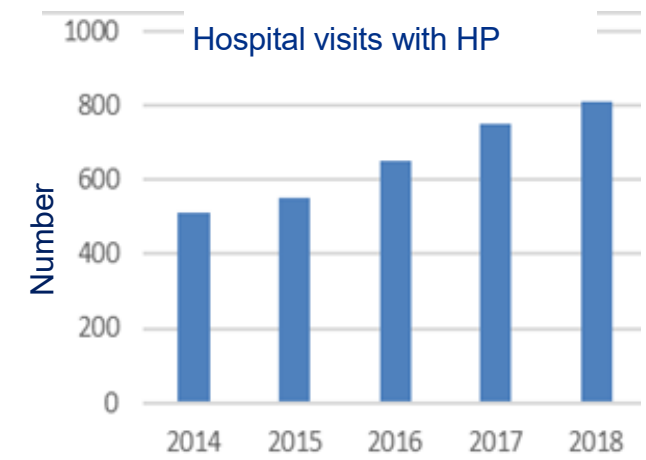
Division of Bacterial and
Infectious Diseases, and
Program Office, Centers for
Georgia; Orlando Region
Florida Department of Health
Florida; Department of F

Science of The Total Environment
Volume 761, 20 September 2020, 149702

Occupational exposure to fungi on
recyclable paper pots and growing media
and associated health effects - A review of
the literature

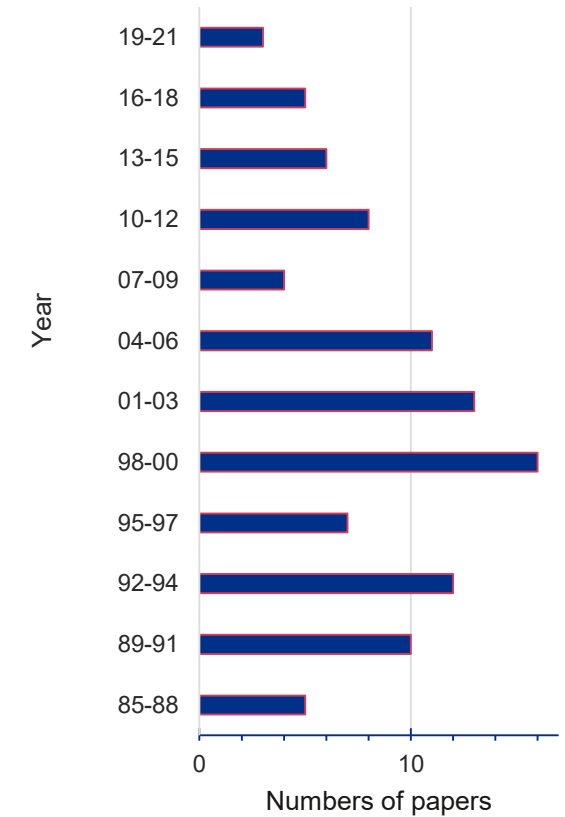
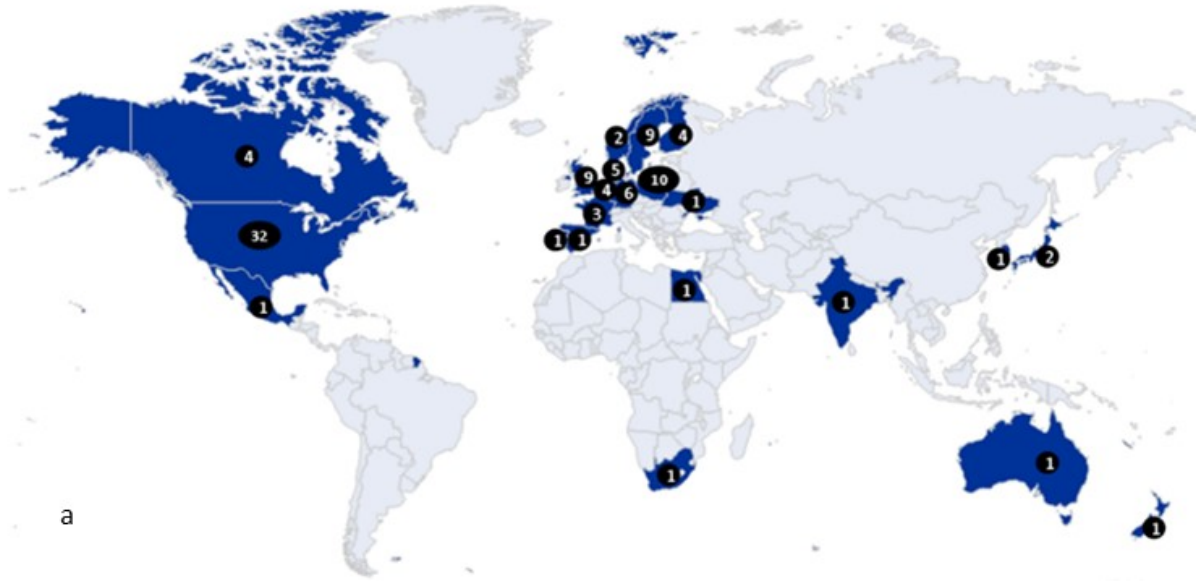
Allergic alveolitis

- Also called Hypersensitive pneumonitis (HP).
- Named after the environment in which it occurs, e.g. thresher's lung, brewer's lung, cheese washer's lung, fishmeal worker's lung, coffee asthma etc.
- Lung diseases where the lung reacts to allergic inflammation.
- Often occurs after repeated exposure
- In the acute form (often with high concentrations of allergens), the symptoms appear 4-5 hours after exposure.
- Certain microorganisms, enzymes, proteins and storage mites can cause HP



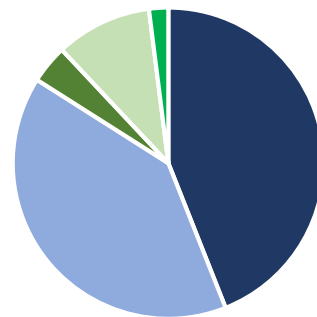
Data from lands-patientregistreret i Danmark

Allergic alveolitis or ODS

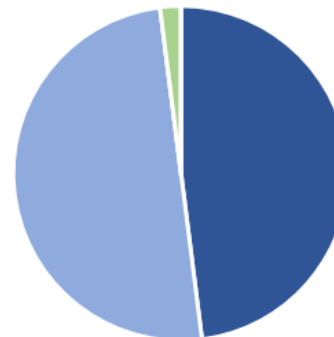


- Health
- Health and simple exposure
- Health and thorough exposure
- Simple exposure
- Thorough exposure

Research papers

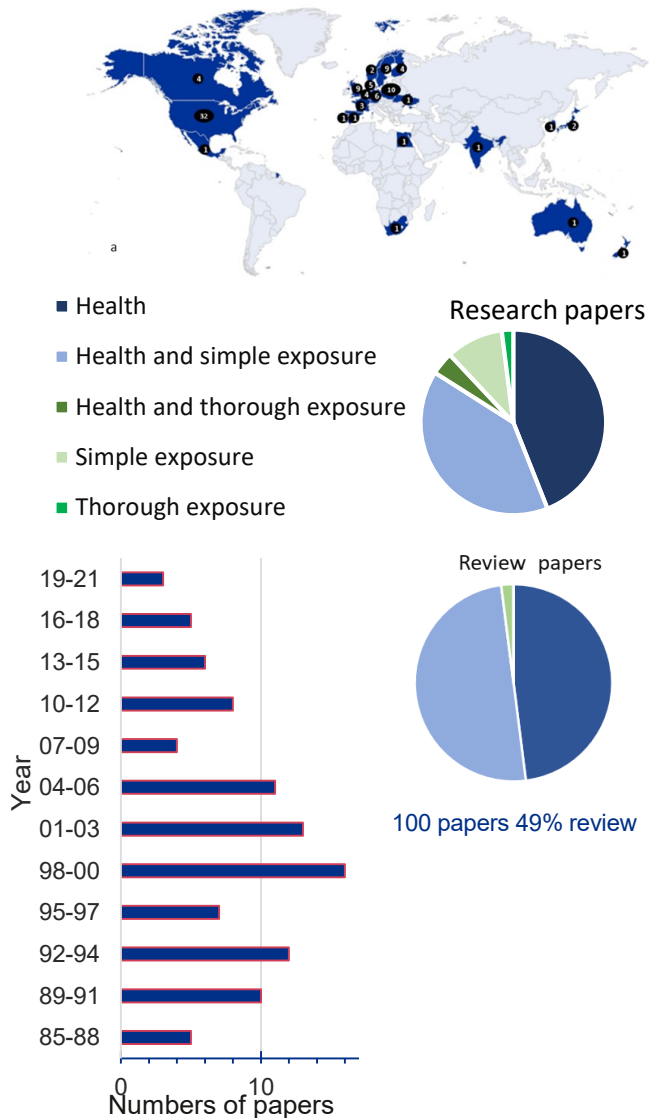


Review papers



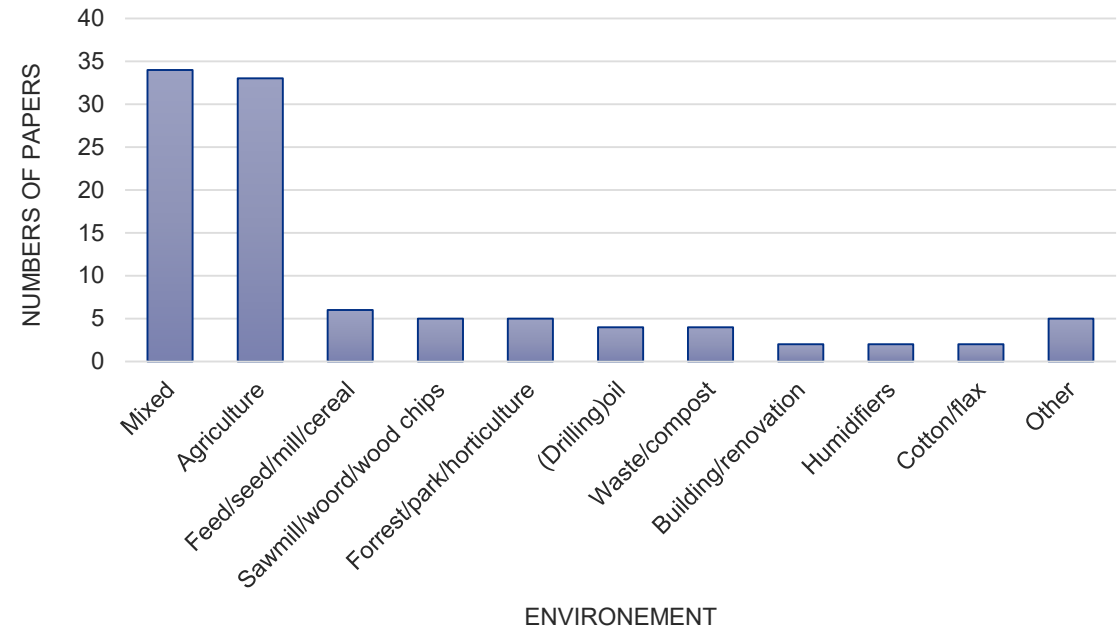
100 papers 49% review

ODTS or Allergic alveolitis

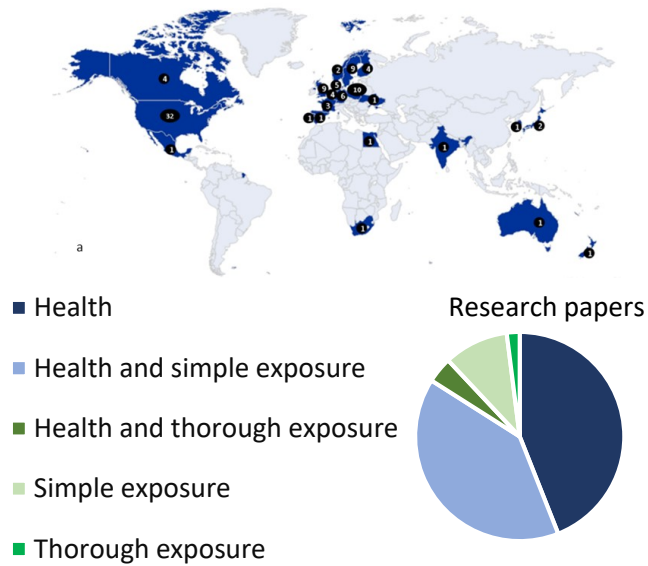


• Epidemiological studies in e.g. agriculture, questionnaire on symptoms of ODTS.

- waste,
- drilling oil,
- crab shells,
- grass seed, ←
- compost,
- tree, ←
- enzymes,
- feed,
- flour,
- wood chips, ←
- tobacco,
- forest, ←
- park,
- humidification
- fungal growth in buildings



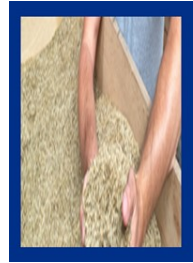
ODTS – grass seed workers



A case study with ODTS
Flu-like symptoms
Repeat the work with mask

High exposure:

- Fungi
- Bacteria
- Endotoxin
- Dust



ODTS case – grass seed workers

Bacterial genera in higher reads in exposures causing ODTS, NGS - 16S sequencing, MALDI-TOF-MS



Bacterial genera	ODTS	ODTS	Non-ODTS	Non-ODTS
<i>Acinetobacter</i>	0.44%*	0.71%	0.037%	0.010%
<i>Bacillus</i>	4.3%	13%	0.35%	0.10%
<i>Brachybacterium</i>	0.34%	0.85%	0.055%	0.097%
<i>Chromobacter</i>	0.47%	0.72%	0.037%	0.12%
<i>Cellulosimicrobium</i>	0.20%	0.22%	0.018%	bd
<i>Cupriavidus</i>	0.17%	0.44%	0.037%	0.010%
<i>Enterococcus</i>	1.4%	1.6%	0.092%	0.029%
<i>Erwinia</i>	1.7%	2.4%	0.24%	0.24%
<i>Klebsiella</i>	0.40%	0.80%	0.018%	0.029%
<i>Laceyella</i>	0.17%	0.44%	bd	0.01%
<i>Lactococcus</i>	3.3%	1.9%	0.24%	0.048%
<i>Leucobacter</i>	2.1%	1.9%	0.20%	0.06%
<i>Methylobacillus</i>	0.067%	0.18%	bd	bd
<i>Ochrobactrum</i>	3.0%	2.4%	0.26%	0.14%
<i>Olivibacter</i>	0.74%	2.2%	0.037%	0.078%
<i>Promicromonospora</i>	0.34%	0.67%	0.018%	0.010%
<i>Sphingobacterium</i>	2.5%	5.9%	0.31%	0.53%
<i>Staphylococcus</i>	4.9%	4.4%	2.0%	0.13%
<i>Stenotrophomonas</i>	0.94%	1.0%	0.15%	0.35%
<i>Streptomyces</i>	29%	20%	2.3%	0.30%
<i>Tetrathiobacter</i>	0.40%	0.16%	0.037%	0.019%
<i>Thermoactinomyces</i>	0.17%	0.96%	bd	bd
<i>Xylanimicrobium</i>	0.30%	0.26%	bd	bd
Total	57.5%	63%	6.4%	2.3%

Bacterial genera	ODTS	ODTS	Non-ODTS	Non-ODTS
<i>Agrococcus</i>	bd	0.011%	0.50%	0.44%
<i>Clavibacter</i>	0.40%*	0.43%	15%	3.5%
<i>Devosia</i>	bd	bd	0.90%	0.93%
<i>Dyadobacter</i>	bd	bd	0.44%	0.82%
<i>Exiguobacterium</i>	0.10%	bd	0.49%	2.6%
<i>Flavobacterium</i>	0.067%	0.18%	1.4%	3.9%
<i>Frigoribacterium</i>	1.9%	1.3%	10.5%	9.7%
<i>Hymenobacter</i>	0.034%	0.12%	0.83%	1.0%
<i>Janthinobacterium</i>	0.034%	bd	0.11%	0.38%
<i>Kineococcus</i>	bd	0.033%	0.17%	0.16%
<i>Luteimonas</i>	0.30%	0.088%	0.35%	0.56%
<i>Methylobacterium</i>	bd	0.011%	0.40%	0.51%
<i>Mycoplana</i>	bd	bd	0.18%	0.24%
<i>Pedobacter</i>	bd	0.18%	2.9%	4.1%
<i>Planococcus</i>	bd	bd	0.018%	0.16%
<i>Planomicrobium</i>	bd	bd	0.073%	0.42%
<i>Propionibacterium</i>	0.10%	0.044%	1.1%	0.11%
<i>Rathayibacter</i>	0.20%	0.066%	1.4%	1.2%
<i>Rhodobacter</i>	bd	0.044%	0.40%	0.78%
<i>Salinibacterium</i>	bd	bd	0.17%	0.18%
<i>Sanguibacter</i>	0.24%	0.033%	0.66%	0.52%
<i>Sphingomonas</i>	0.13%	0.16%	2.9%	2.3%
<i>Streptococcus</i>	0.034%	0.011%	0.15%	0.019%
<i>Variovorax</i>	bd	0.011%	0.24%	0.81%
Total	3.5%	2.7%	41%	35%

ODTS case – grass seed workers

Fungal genera in higher reads in exposures causing ODTs, ITS- NGS sequencing



Fungal genera	ODTS	ODTS	Non-ODTS	Non-ODTS
<i>Alternaria</i>	1.6%*	0.36%	0.17%	0.067%
<i>Aspergillus</i>	13%	32%	5.8%	0.39%
<i>Lichtheimia</i>	0.39%	0.066%	bd	bd
<i>Mucor</i>	0.11%	0.026%	bd	bd
<i>Penicillium</i>	0.71%	0.90%	0.37%	0.053%
<i>Rhizomucor</i>	0.22%	0.053%	bd	bd
<i>Rhizopus</i>	64%	14%	1.5%	0.48%
<i>Sarocladium</i>	0.11%	0.36%	0.10%	0.040%
<i>Trichothecium</i>	7.6%	0.74%	0.22%	0.040%
Total	87%	49%	8.1%	1.1%

Examples of MALDI-TOF – species

Alternaria alternata

As. fumigatus, A. nidulans, A. niger, A. versicolor

Mucor sp.

P. brevicompactum, P. camemberti etc.

Rh. microspores

The fungus *Cryptostroma corticale* on maple, wood chips, paper production

Maple – used as an avenue tree, park tree and shelterbelt trees
Mild winters and dry soil provide a higher risk of exposure to the spores

Cultivation of edible fungi on wood chips

Cultivation of orchid on wood chips

Spores of *Cryptostroma corticale*

Exposure levels not known

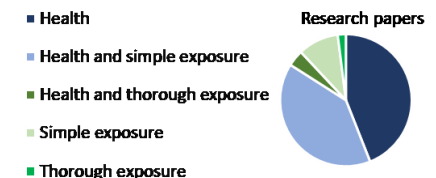
Impact of climate change on wood and woodworkers—*Cryptostroma corticale* (sooty bark disease): A risk factor for trees and exposed employees

 Sabine Kespohl^{1*}  Janett Riebesehl²  Jörg Grüner³  Monika Raulf⁴

Review

Occupational exposure to fungi on recyclable paper pots and growing media and associated health effects – A review of the literature

Anne Mette Madsen^{a,*}, Brian Crook^b



Waste workers

- Biowaste workers working environment
- Factors affecting exposure in waste plants
- Transport of microorganisms with work clothes



Waste worker cohorts

- Wastewater treatment plant workers
- Waste collection workers
- Waste receiving and pretreatment plant workers
- Waste to energy



Questionnaire

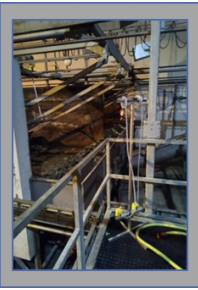
- Tasks
- Work life
- Symptoms
- Diseases



photo Anna Klitgaard



Exposure – Biowaste workers



Exposed to:

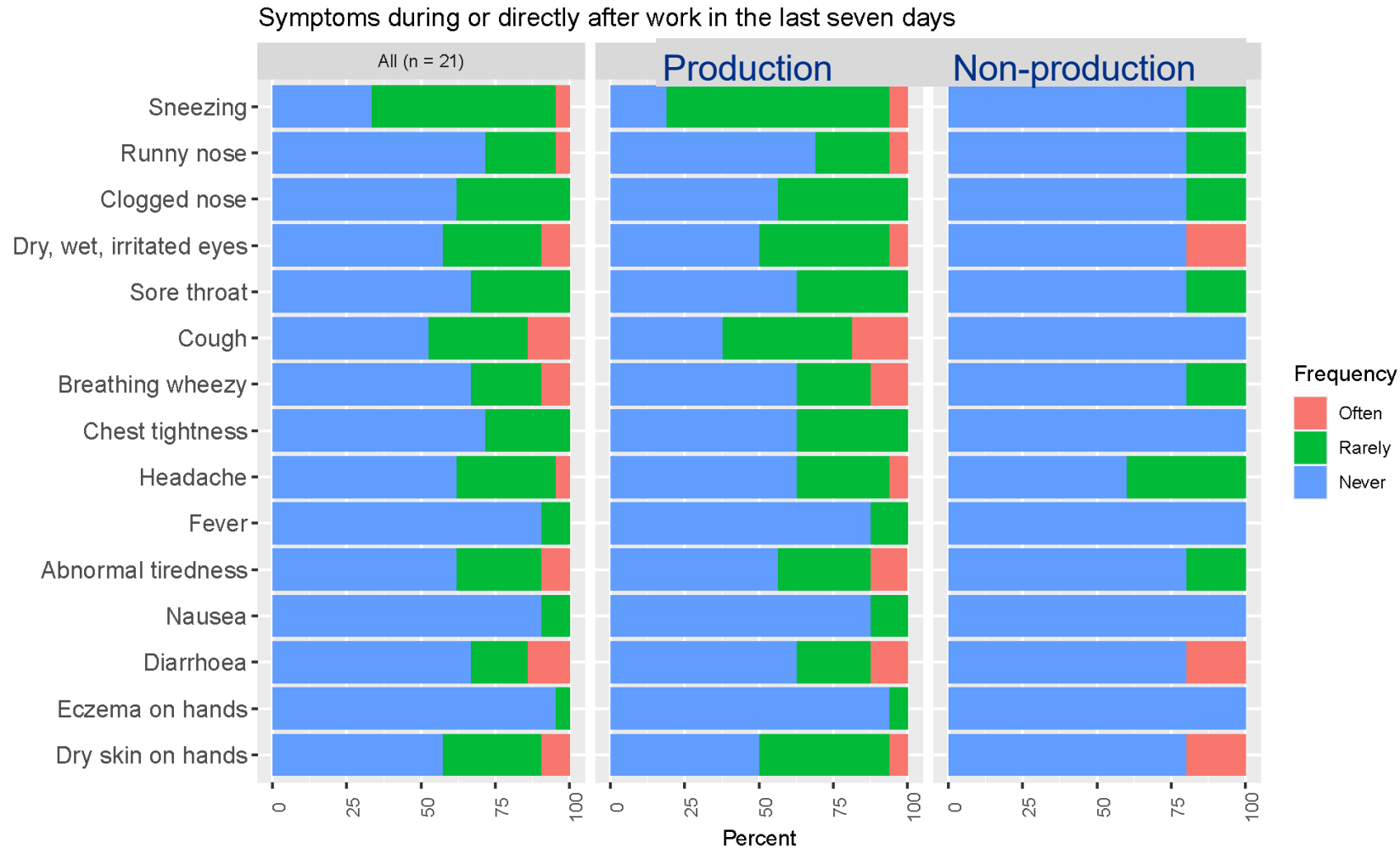
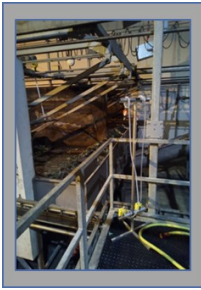
100-10 ⁵ cfu fungi/m ³	from low to high
100-10 ⁵ cfu bacteria /m ³	from low to high
10-10 ⁴ cfu anaerobic bacteria /m ³	from low to high
0.2-500 Endotoxin EU/m ³	from low to high
0.01 – 0.65 mg dust/m ³	low to mean

Outdoor references:

155 cfu fungi/m ³
40 cfu bacteria /m ³
4 cfu anaerobic bacteria /m ³
0.3 Endotoxin EU/m ³
Dust bd

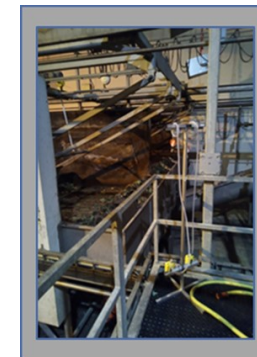
Production workers exposed to higher concentrations of all exposures than non-production workers

Biowaste pretreatment plants – exposure and health



The employees who worked with biowaste (production workers) often reported sneezing, coughing and chest tightness.

Biowaste pretreatment plants



	C-reactive protein CRP 0.07-19.1 mg/l		Serum amyloid A SAA 1.5-353 mg/l	
	P	Estimate	P	Estimate
Bacteria (25°C)	< 0.001	-0.456	< 0.001	-0.688
Anaerobic bacteria	< 0.001	0.443	< 0.001	0.906
Fungi (25°C)	0.002	0.416	0.281	0.184
Fungi (37°C)	0.966	0.005	0.075	0.272
Dust	0.835	0.090	0.014	1.242
Endotoxin	0.024	-0.273	< 0.001	-0.719
Gender				
(male/female)	0.208	-0.313	0.006	-0.772
Age	0.001	0.020	0.848	-0.001
Atopy (yes/no)	0.544	0.217	0.364	0.354

Discriminate between species

Next step

- More plants – waste types to get a better understanding of the importance of species composition
- Size distribution of airborne fungi and bacterial species – potential airway deposition – or swallowing



Accumulation of microorganisms on work clothes and potential take home exposure

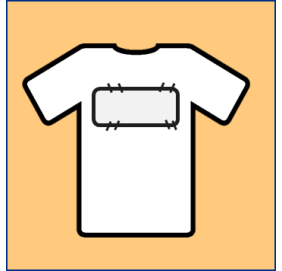
Waste collection workers

From air to work-clothes and from work-clothes to air?

- The knowledge is very limited - mainly studied for pollen
- Exposure in some work-places can be very high and may contain pathogens

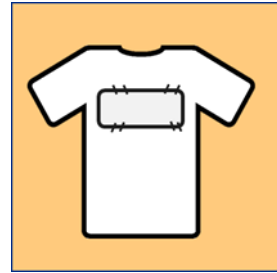
Design:

- Exposure to airborne microorganisms personal samplers for a workday (62 personal samples)
- Accumulation of microorganisms on work-clothes – see figure (62 samples)
- Microorganisms in indoor air – stationary samplers in a truck cabin (48 samples)
- Concentrations and species – laboratory analysis

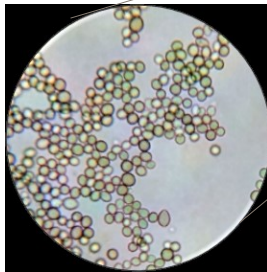


Accumulation of microorganisms on work-clothes

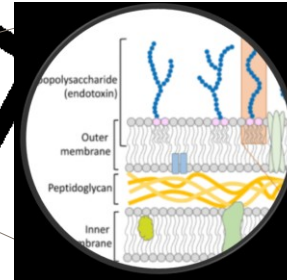
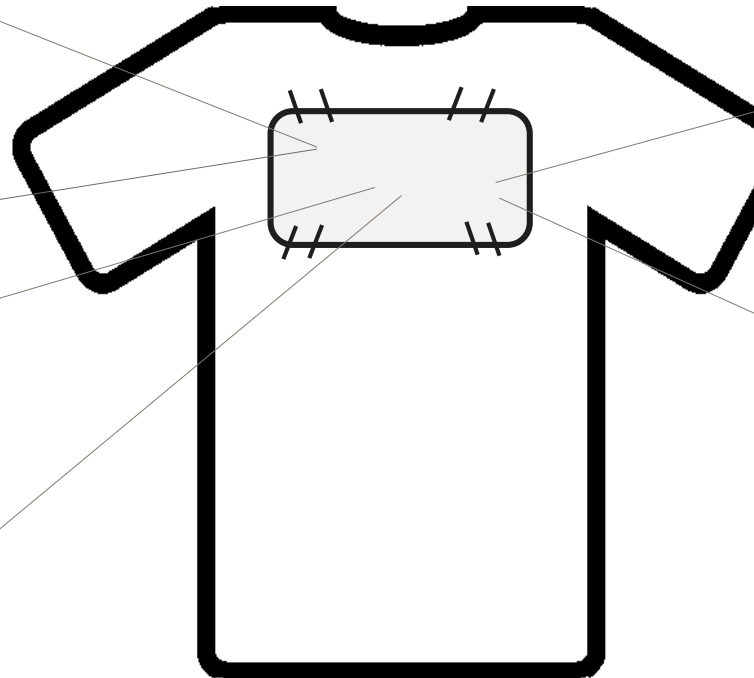
The method and accumulation on work clothes



10^7 CFU bacteria/m²
100 species

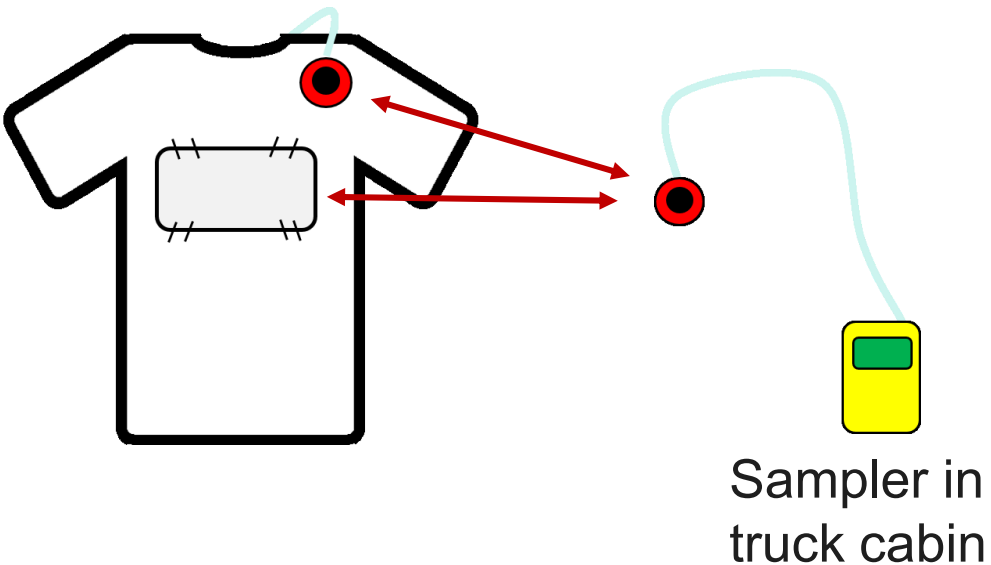


10^7 fungi CFU/m²
25 species fungi



$4.4 \cdot 10^4$ Endotoxin EU/m²

Transport and release of fungi -fungal concentration



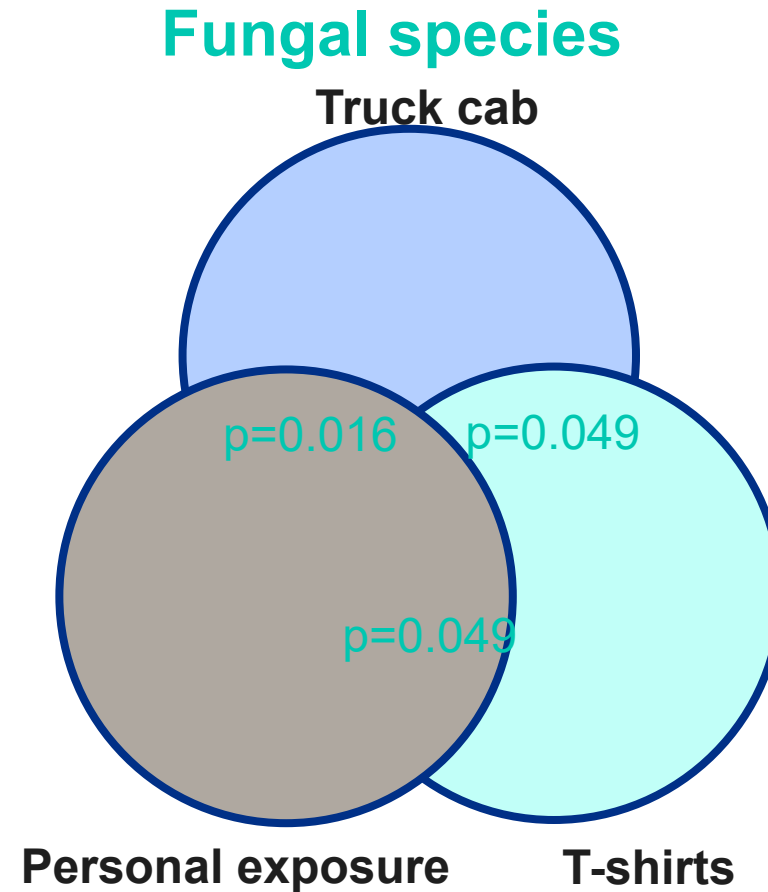
Transport and release of fungi – species composition

fungus species identification

- 48 workers
- 87% of the fungal species were identified
- 60 different species

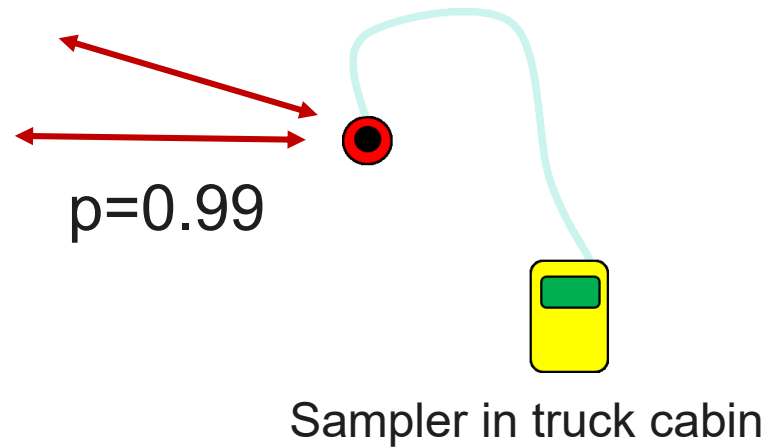
Example from one team (collecting cardboard waste):

Sample	Exp.	Exp.	T-shirt	T-shirt	Cab
<i>Aspergillus flavus</i>	6				
<i>Aspergillus fumigatus</i>	26	16			15
<i>Aspergillus glaucus</i>	119				
<i>Aspergillus niger</i>	197		8465	2365	
<i>Aspergillus versicolor</i>		178		2154	44
<i>Cladosporium herbarum</i>	237	199		2027	426
<i>Cladosporium sp</i>	513	479	13163	11593	281
<i>Penicillium brevicompactum</i>	370		4388	2091	94
<i>Penicillium camemberti</i>	641		13163	2091	236
<i>Penicillium chrysogenum</i>	128	239		2192	118
<i>Penicillium commune</i>	384	60	4388	2154	94
<i>Penicillium digitatum</i>	128	80	32278	3167	568
<i>Penicillium expansum</i>	119				
<i>Penicillium glabrum</i>	119				
<i>Penicillium italicum</i>	128				
<i>Penicillium olsonii</i>	183	60			94
<i>Penicillium roqueforti</i>				2154	
<i>Penicillium verrucosum</i>			8775		94



Transport and release of bacteria - bacterial concentration

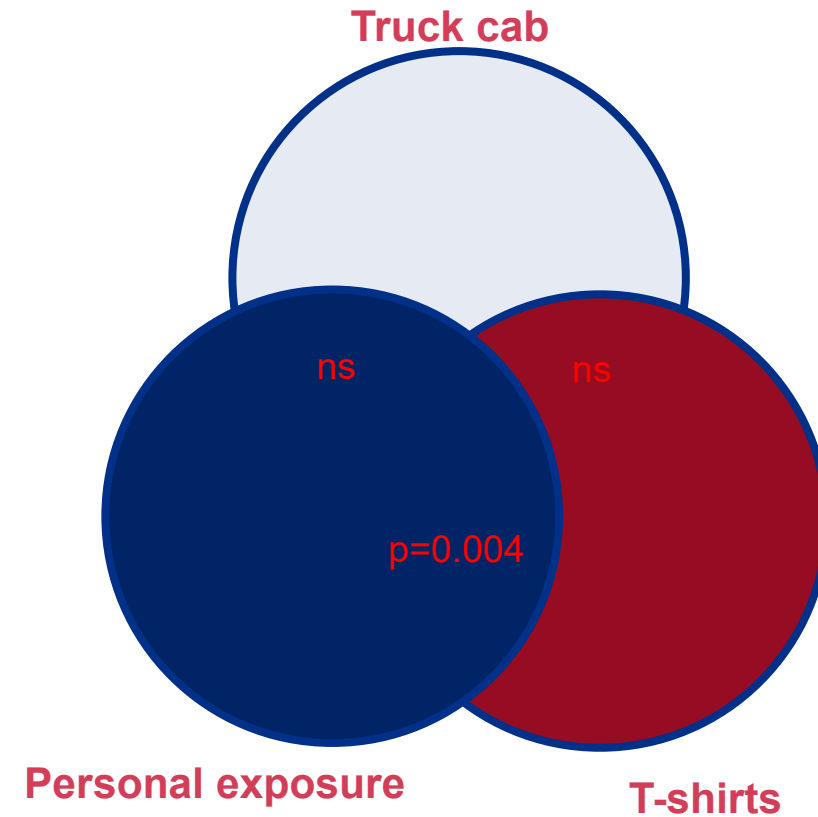
Step 2 transport of fungi



Example of a team Transport and release of bacteria – species composition



Bacterial species



Mantel tests on species composition

Concluding remarks

- Human pathogens – risk class 2 – e.g. *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Stenotrophomonas maltophilia*, *Aspergillus fumigatus*
- Don't take work clothes at home – and/or take care when it is handled
- Take care when it is handled at work
- Take off jackets before entering the cantina

Acknowledgement and thank you for the attention

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The microbiology exposure group at NRCWE-dk

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25