

Methodologies for the Monitoring and Characterization of Bioaerosols: the role of lake emissions to atmosphere

Célia M. Antunes

ICT, IIFA & DQUI, ECT

2nd Alqueva Summer School on Atmospheric and Inland Water Sciences
Alqueva, 19 – 21 June 2018



Bioaerosols...

- Bioaerosols: background and definitions
- Types of Bioaerosols
- Transport mechanisms
- Biogeochemical and health impacts
- Sampling methods
- Characterization of bioaerosols
- Future developments

Bioaerosols

Google search results for "bioaerosols". The search bar shows "bioaerosols". The results page indicates "Cerca de 192 000 resultados (0,30 segundos)". The first result is a link to Wikipedia: "Bioaerosol - Wikipedia". The second result is "Bioaerosols in the Earth system: Climate, health, and ecosystem ...". The third result is "Bioaerosol - an overview | ScienceDirect Topics". The fourth result is "Bioaerosols » Section 1". A green line points from the text "Cerca de 192 000 resultados" to a teal speech bubble containing the text "192,000 hits".

bioaerosols

Tudo Imagens Notícias Vídeos Mapas Mais Definições Ferramentas

Cerca de 192 000 resultados (0,30 segundos)

Bioaerosol - Wikipedia <https://en.wikipedia.org/wiki/Bioaerosol> ▾ Traduzir esta página

Bioaerosols (short for biological aerosols) are a subcategory of particles released from terrestrial and marine ecosystems into the atmosphere. They consist of ...

[Background](#) · [Types of bioaerosols](#) · [Collection](#) · [Transport mechanisms](#)

Bioaerosols in the Earth system: Climate, health, and ecosystem ...

<https://www.sciencedirect.com/science/article/pii/S0169809516301995>
de J Fröhlich-Nowoisky - 2016 - Citado por 79 - Artigos relacionados
15/12/2016 - Primary biological aerosols (PBA), in short **bioaerosols**, are a subset of atmospheric particles, which are directly released from the biosphere ...

Bioaerosol - an overview | ScienceDirect Topics

<https://www.sciencedirect.com/topics/agricultural-and-environmental-sciences/bioaerosol> ▾ Traduzir esta página

Bioaerosols or organic dust are usually defined as aerosols of microbial, plant or animal origin (Douwes et al., 2003). They comprise airborne bacteria, fungi, ...

Bioaerosols » Section 1

<https://aerosol.ees.ufl.edu/bioaerosol/section01.html> ▾ Traduzir esta página

Bioaerosols are airborne particles that are biological in origin. Bioaerosols can be formed from nearly

192,000 hits



Review

Evaluation of exposure–response relationships for health effects of microbial bioaerosols – A systematic review



Sandra M. Walser^{a,*}, Doris G. Gerstner^a, Bernhard Brenner^a, Jürgen Bünger^b, Thomas Eikmann^c, Barbara Janssen^a, Stefanie Kolb^a, Annette Kolk^d, Dennis Nowak^e, Monika Raulf^b, Helmut Sagunski^f, Nadja Sedlmaier^g, Roland Suchenwirth^h, Gerhard Wiesmüllerⁱ, Klaus-Michael Wollin^h, Irene Tesseraux^j, Caroline F.W. Herr^a

^a Bavarian Institute, ^b Institute, ^c Institute, ^d Institute, ^e Institute, ^f Hamburg, ^g IfU – Bay. Government, ^h Health Department, ⁱ State Institute

JOURNAL OF ENVIRONMENTAL SCIENCES 51 (2017) 234–247



Available online at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/jes

JES
JOURNAL OF
ENVIRONMENTAL
SCIENCES
www.jesc.ac.cn

ARTICLE

Review

Molecular approaches for the detection and monitoring of microbial communities in bioaerosols: A review

Keunje Yoo^{1,5}, Tae Kwon Lee², Eun Joo Choi³, Jihoon Yang⁵, Sudheer Kumar Shukla⁴, Sang-il Hwang⁵, Joonhong Park^{1,*}

1. Department of Civil and Environmental Engineering, Yonsei University, Seoul 03722, South Korea

2. Department of Environmental Engineering, Yonsei University, Wonju 26493, South Korea

3. Department of Systems Biology, Yonsei University, Seoul 03722, South Korea

4. Department of Built and Natural Environment, Caledonian College of Engineering, Sultanate of Oman

5. Division of Natural Resources Conservation, Korea Environment Institute, Sejong-si 30147, South Korea

ARTICLE INFO

Article history:

Received 27 April 2016

ABSTRACT

Bioaerosols significantly affect atmospheric processes while they undergo long-range vertical and horizontal transport and influence atmospheric chemistry and physics and

Bioaerosols – hot topic

Atmospheric Research 182 (2016) 346–376



Contents lists available at ScienceDirect

Atmospheric Research

journal homepage: www.elsevier.com/locate/atmosres



Invited review article

Bioaerosols in the Earth system: Climate, health, and ecosystem interactions

Janine Fröhlich-Nowoisky^{a,*}, Christopher J. Kampf^{a,b}, Bettina Weber^a, J. Alex Huffman^c, Christopher Pöhlker^a, Meinrat O. Andreae^a, Naama Lang-Yona^a, Susannah M. Burrows^d, Sachin S. Gunthe^e, Wolfgang Elbert^a, Hang Su^a, Peter Hoor^f, Eckhard Thines^g, Thorsten Hoffmann^b, Viviane R. Després^h, Ulrich Pöschl^{a,*}

^a Multiphase Chemistry and Biogeochemistry Departments, Max Planck Institute for Chemistry, Mainz, Germany

^b Institute of Inorganic and Analytical Chemistry, Johannes Gutenberg University, Mainz, Germany

^c Department of Chemistry and Biochemistry, University of Denver, Denver, CO, USA

^d Atmospheric Science and Global Change Division, Pacific Northwest National Laboratory, Richland, WA, USA

^e Department of Civil Engineering, IIT Madras, Chennai, India

^f Institute for Atmospheric Physics, Johannes Gutenberg University, Mainz, Germany

^g Institute of Microbiology and Wine Research, Johannes Gutenberg University, Mainz, Germany

^h Institute of General Botany, Johannes Gutenberg University, Mainz, Germany

ARTICLE INFO

Article history:

Received 23 February 2016

Received in revised form 14 July 2016

Accepted 19 July 2016

Available online 9 August 2016

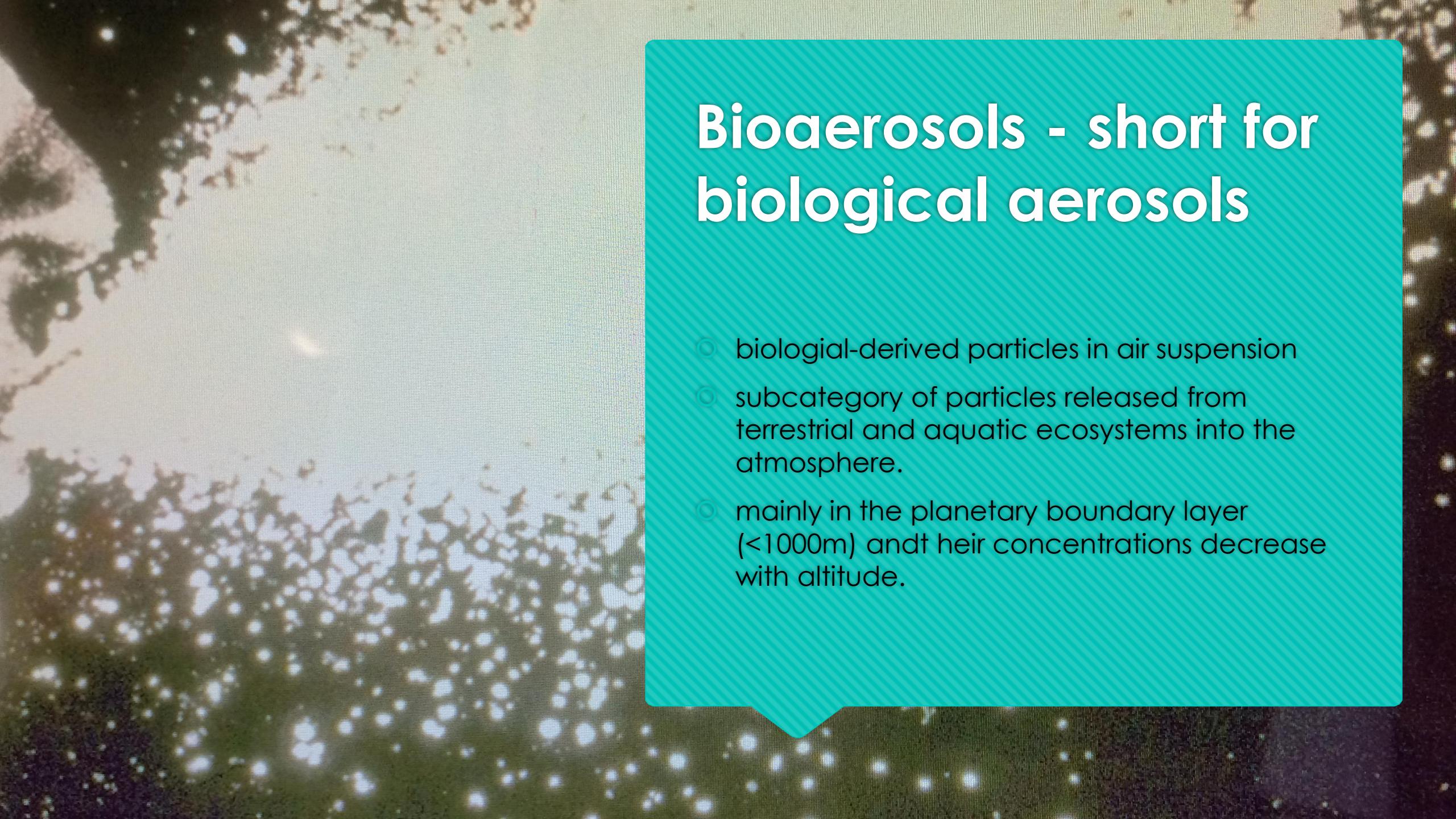
Keywords:

Bioaerosol

Biological ice nuclei

ABSTRACT

Aerosols of biological origin play a vital role in the Earth system, particularly in the interactions between atmosphere, biosphere, climate, and public health. Airborne bacteria, fungal spores, pollen, and other bioparticles are essential for the reproduction and spread of organisms across various ecosystems, and they can cause or enhance human, animal, and plant diseases. Moreover, they can serve as nuclei for cloud droplets, ice crystals, and precipitation, thus influencing the hydrological cycle and climate. The sources, abundance, composition, and effects of biological aerosols and the atmospheric microbiome are, however, not yet well characterized and constitute a large gap in the scientific understanding of the interaction and co-evolution of life and climate in the Earth system. This review presents an overview of the state of bioaerosol research, highlights recent advances,

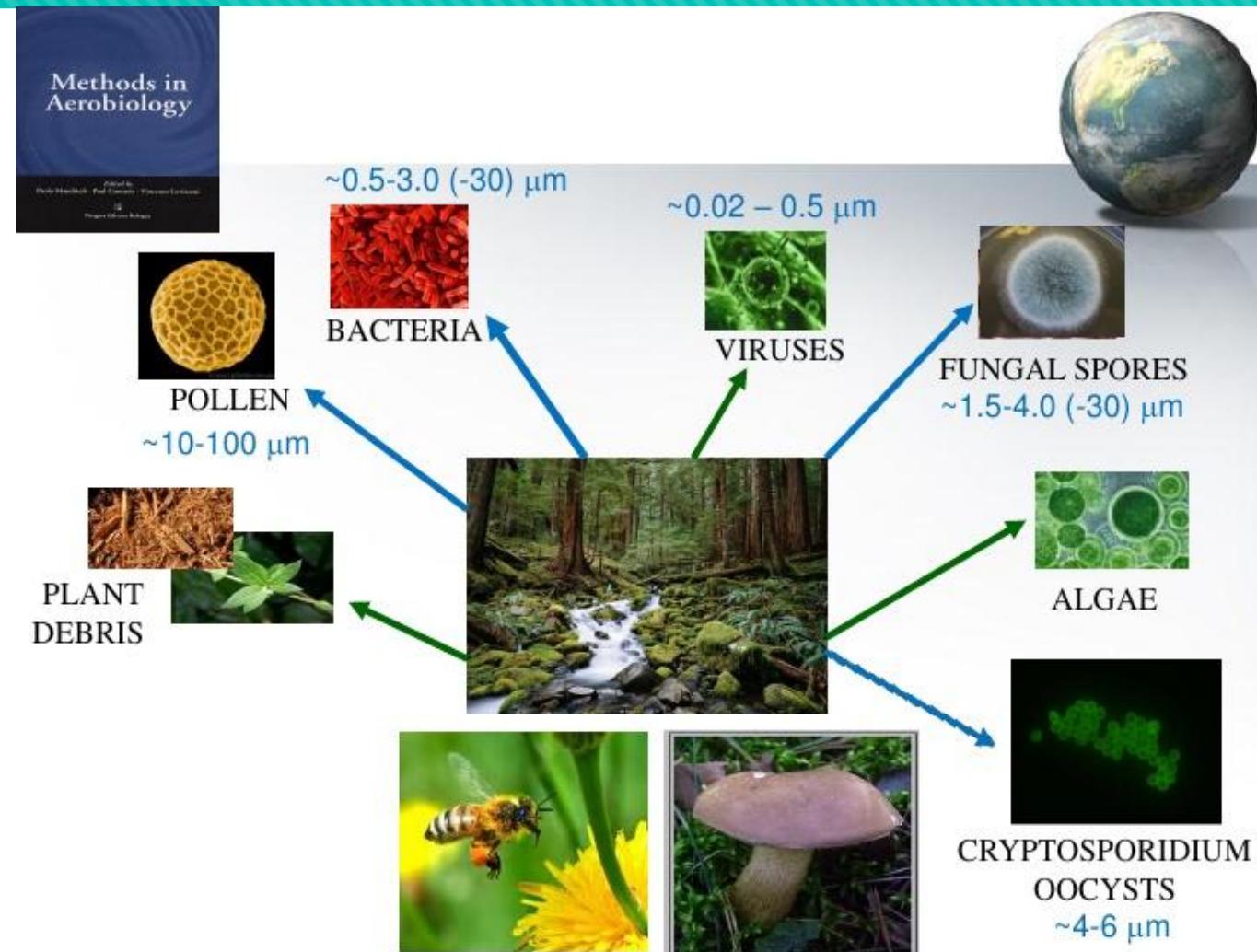


Bioaerosols - short for biological aerosols

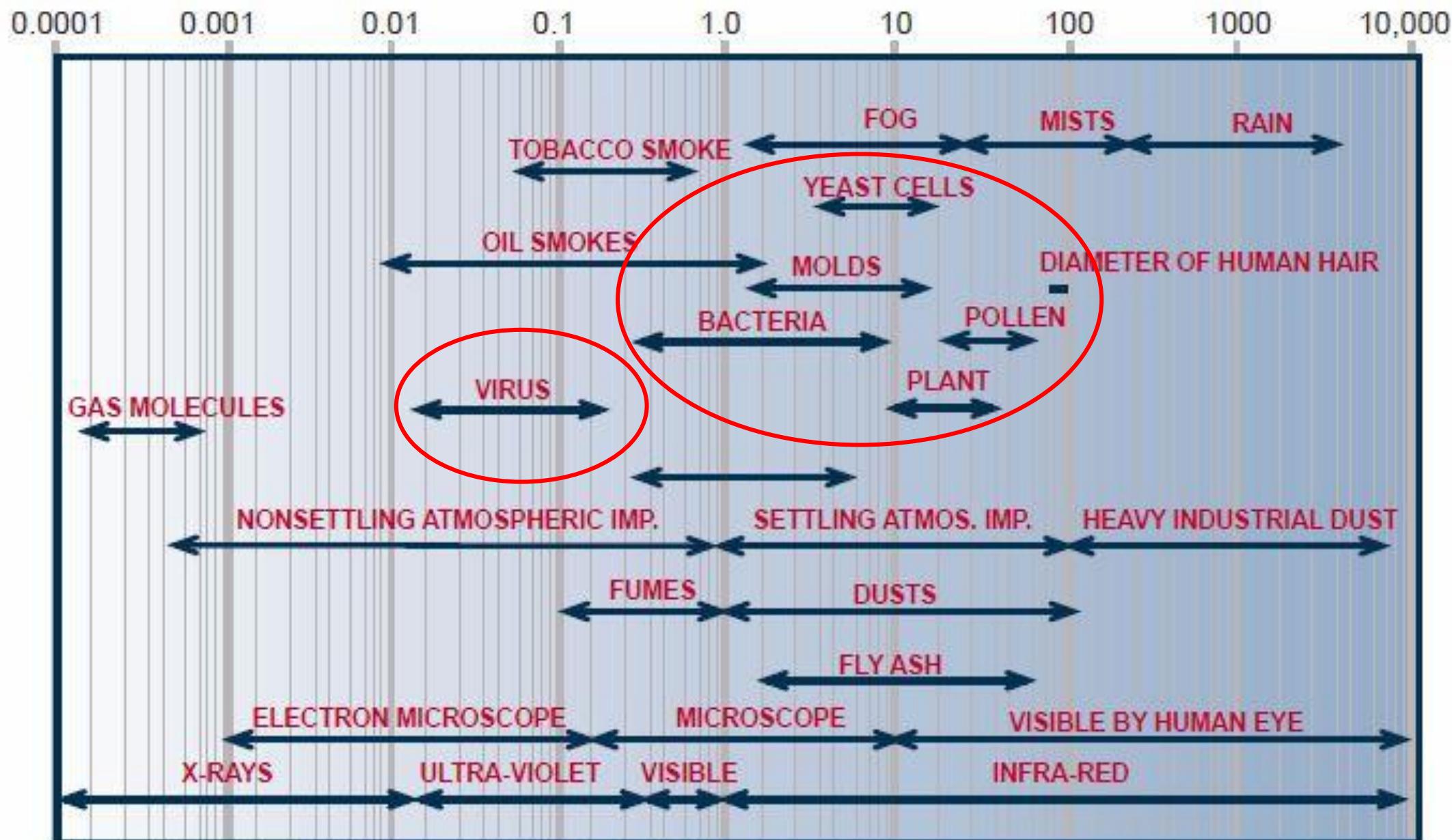
- biological-derived particles in air suspension
- subcategory of particles released from terrestrial and aquatic ecosystems into the atmosphere.
- mainly in the planetary boundary layer (<1000m) and their concentrations decrease with altitude.

Bioaerosols – Who/What are they?

- consist of both **living** and **non-living** components
 - Organisms such as bacteria, yeast, mold and other fungi
 - dispersal methods of the organisms: spores and pollen
 - Biological excretions
 - Debris: human and animal skin cells, animal dander, plant or fungi parts
 - viruses

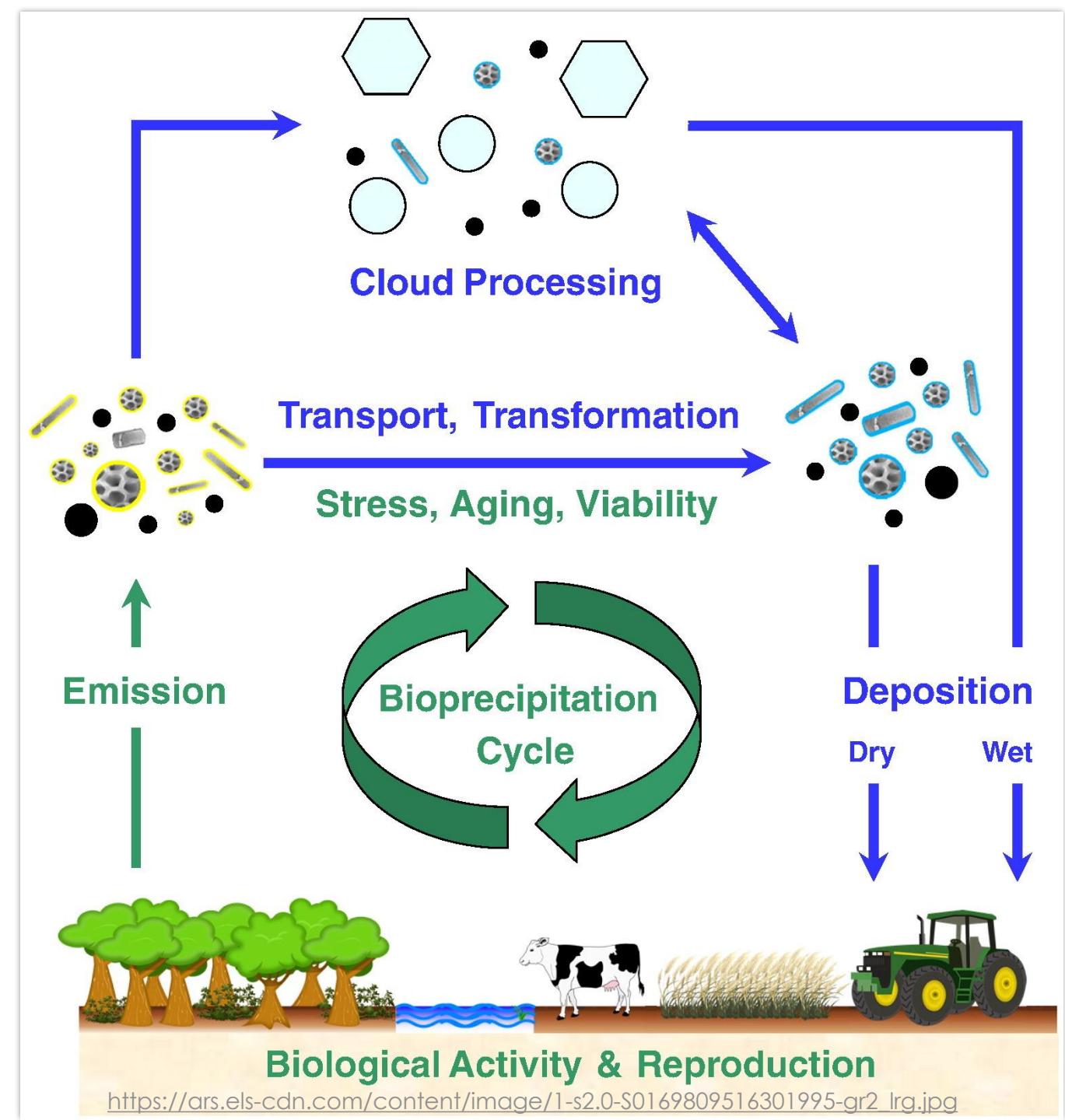


Relative Size Chart of Common Air Contaminants (Shown in micrometres)

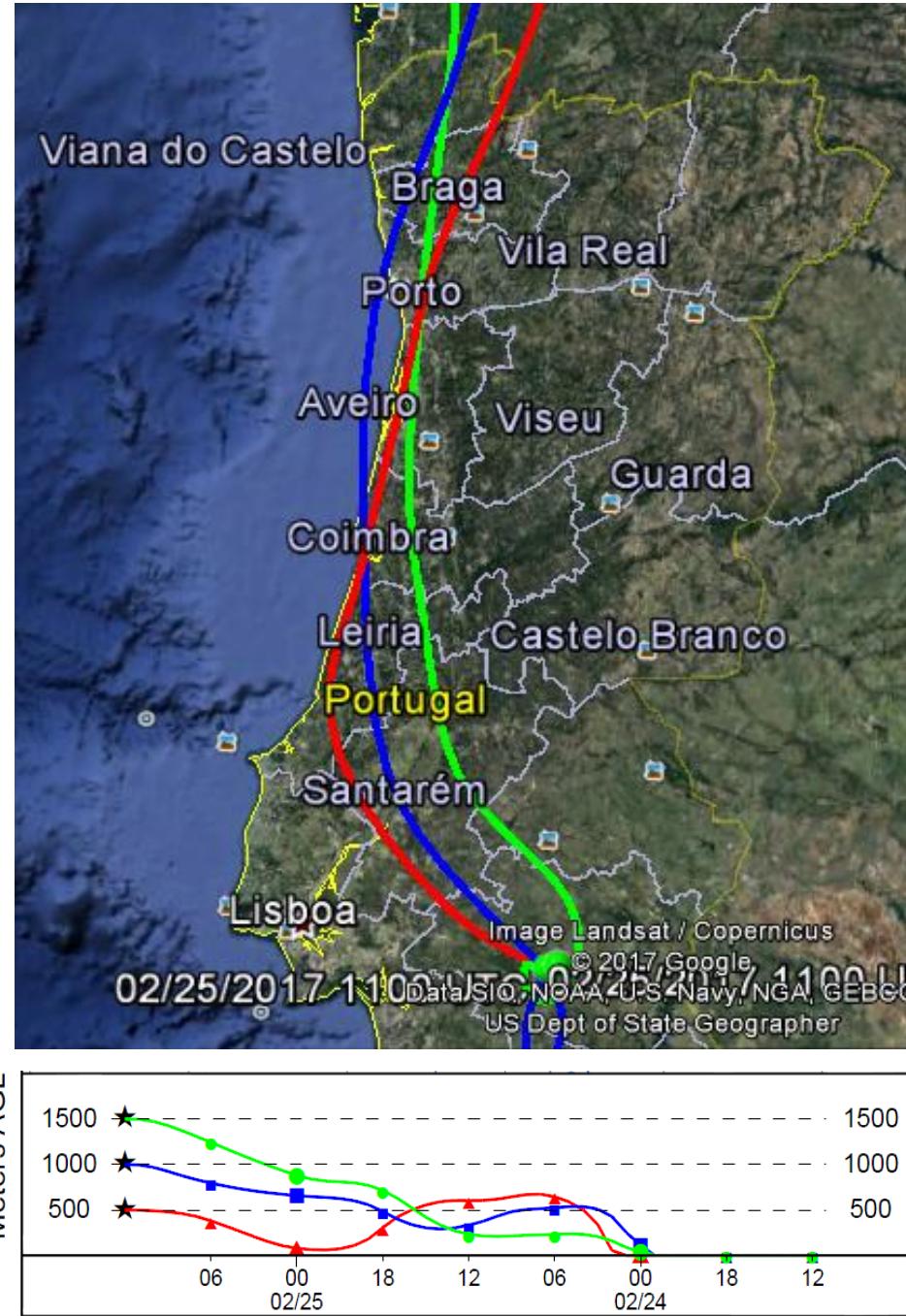


Bioaerosols composition depends on emission and transport

- o over water environments primarily consist of bacteria, and algae, cyanobacteria
- o over terrestrial environments are rich in bacteria, fungi and pollen.



- Ejection of bioaerosols into the atmosphere
- Transported by air masses
 - Small scale transport via clouds
 - Large scale transport via dust plumes
- Community dispersal – dependent on meteorological conditions

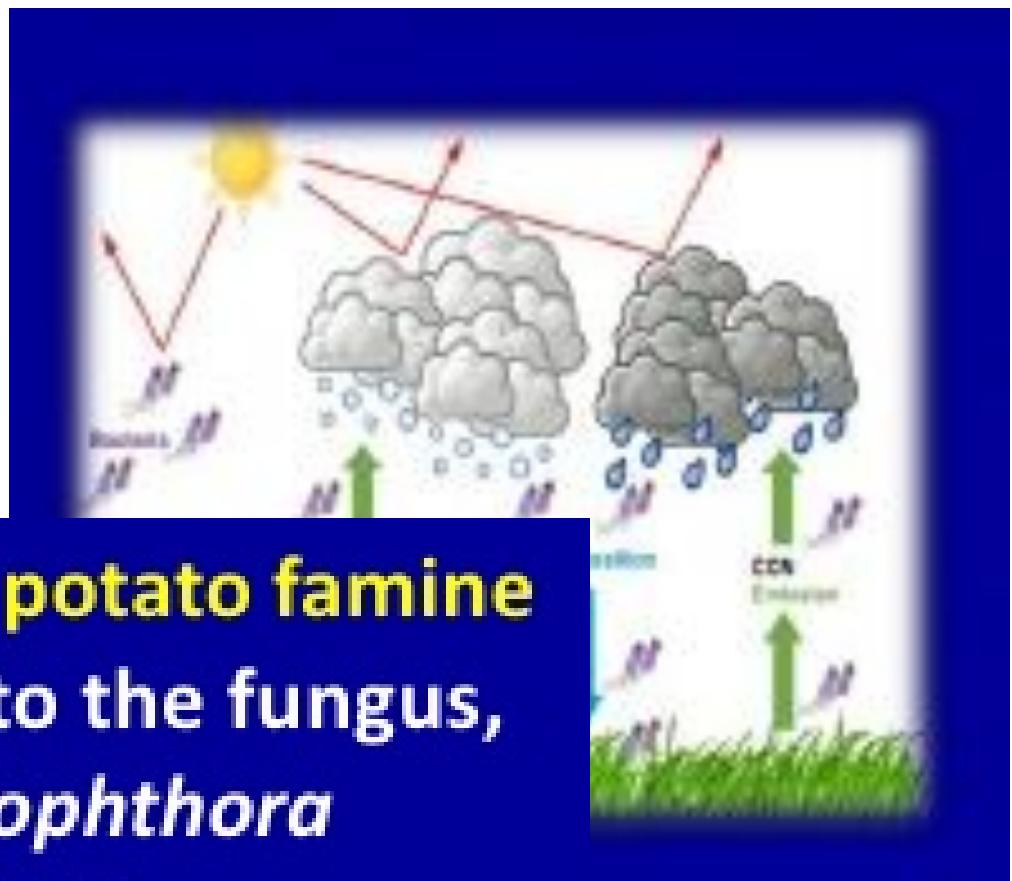


Pollen can fly for hundreds of Km in air masses!!

It may change during the transport!

Monitoring bioaerosols? Why?

- Biogeochemical impacts
 - Climate - Impact on cloud formation acting as **ice nuclei**
- Environmental health impacts and welfare
 - Fungal infection of crops



Monitoring bioaerosols? Why?

- Because Bioaerosols greatly account for the **QUALITY** of the **AIR** that **WE** in **CONTACT** **WITH** and that **WE BREATH**



Monitoring bioaerosols? Why?

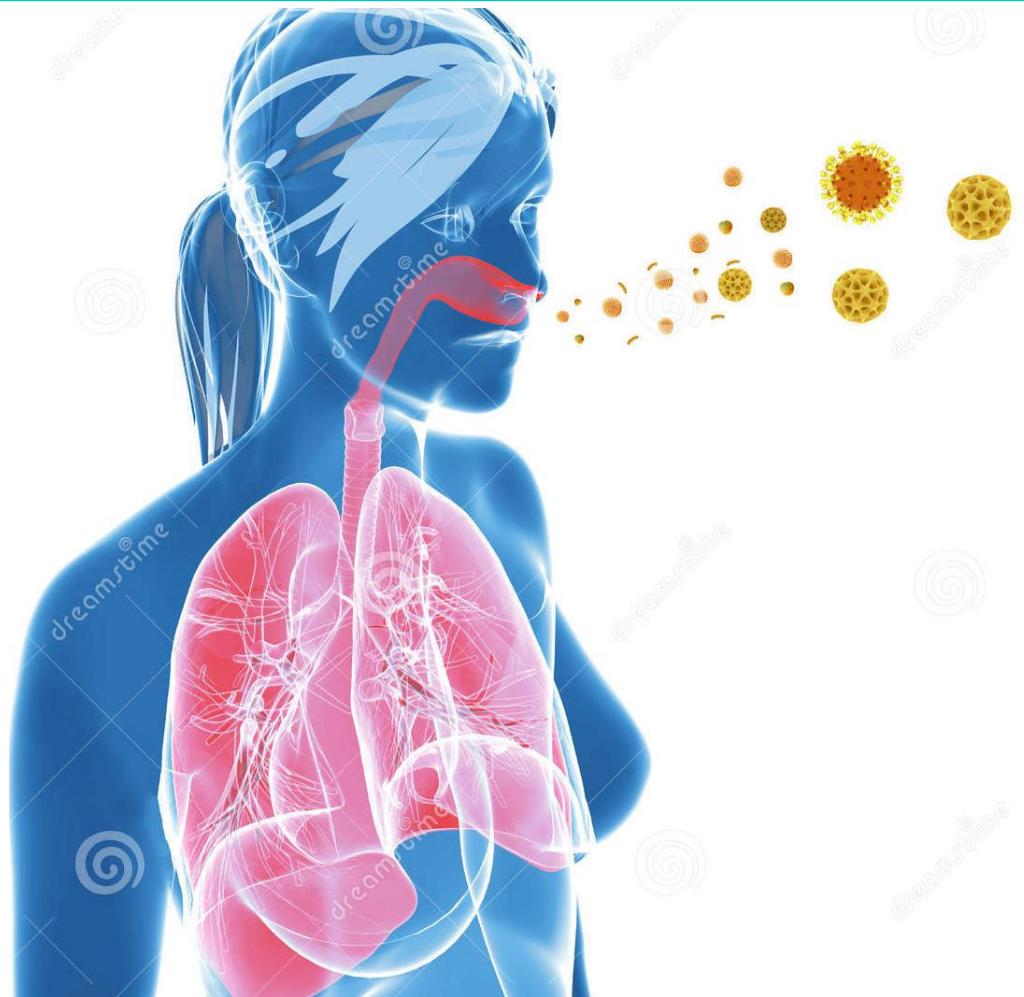
Unknown Inhaled substances at
unknown doses



Morbidity

Disease

DEATH!!





Available online at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/jes

JES

JOURNAL OF
ENVIRONMENTAL
SCIENCES

www.jesc.ac.cn

Airborne bioaerosols and their impact on human health

Ki-Hyun Kim^{1,*}, Ehsanul Kabir², Shamin Ara Jahan³

1. Department of Civil and Environmental Engineering, Hanyang University, Seoul 04763, Republic of Korea

2. Department of Farm, Power & Machinery, Bangladesh Agricultural University, Mymensingh, Bangladesh

3. BRAC Clinic, Dhaka, Bangladesh

The AIR we BREATH...

Contents

Introduction	24
1. Sampling of bioaerosols	25
2. Components of bioaerosols	25
2.1. Fungi and bacteria	25
2.2. Endotoxins	27
2.3. β glucans	28
2.4. Mycotoxins	28
2.5. Allergens	28
3. Potential health effects of bioaerosols	28
3.1. Infectious diseases	28
3.2. Respiratory diseases	29
3.3. Cancer	29
4. Guidelines and assessment of exposure risk to bioaerosols	30
5. Conclusions	31

Methods for bioaerosol sampling

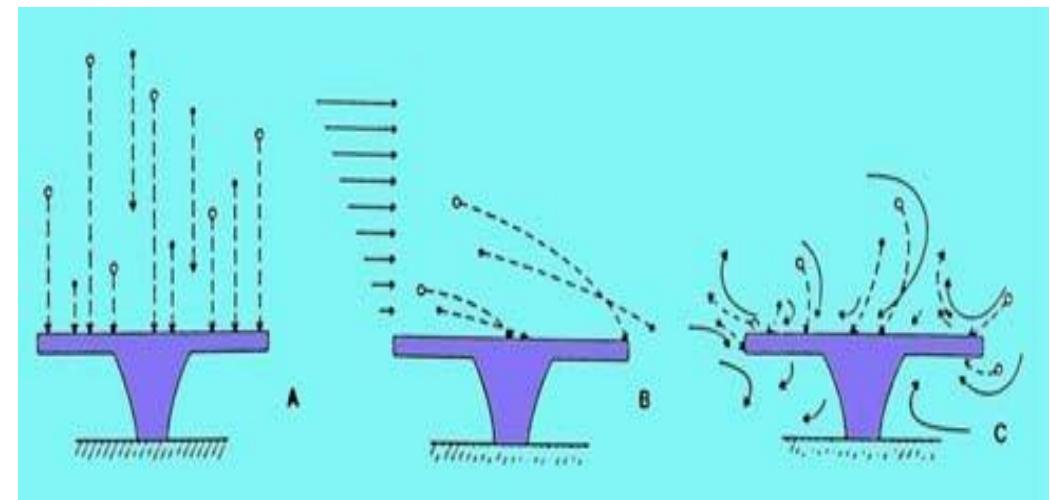
Métodos de amostragem astrobiológica			
	Princípio físico	Modo de amostragem	Captadores
Gravimétricos	Amostradores de precipitação	Precipitação gravimétrica	Placas de Petri Captador Durham Captador Tauber
		Precipitação eletrostática	
		Precipitação térmica	
Volumétricos	Amostradores de Impacto	Impacto por sucção	Captador Hirst
		Impacto em cascata	Captador Andersen Captador ChemVol
		Ciclónico	Captador Ciclónico
		Inercia	Captador Rotorod
	Amostradores de filtração	Meio sólido	Filtros de fibra Captador Cour Filtros de membrana Filtros em cassetes
		Meio líquido	Captador Mcleod AGI
AUTOMATED SYSTEMS – image recognition; specific fluorescence			



Methods for bioaerosol sampling: Gravimetric methods

Deposicion by gravitacional forces:

- Passive collection
- Does not allow to determine concentration
- Very good to evaluate viability of the bioaerosols



Gravimetric samplers

- Slides / Petri dishes
- Durham method
- Tauber traps

Durham samplers



Catalunya (1983-1988)



Wind wing

Tauber Traps

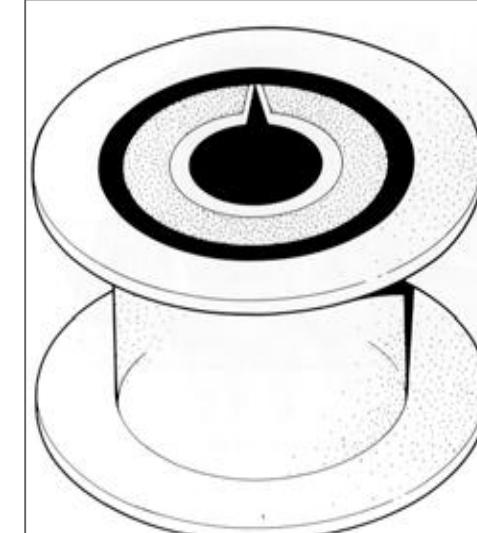


Fig. 2.1 The Tauber trap.



Fig. 2.2 University of Minnesota type inlet of a static size-selective bioaerosol sampler.

Methods for bioaerosol sampling

Impact by
Suction

- Single-stage impactors
- Cascade impactors
- Cyclones
- Impingers
- Electrostatic precipitators
- Filters

VOLUMETRIC METHODS

Methods for bioaerosol capture: Volumetric methods

Volume of sampled air is known

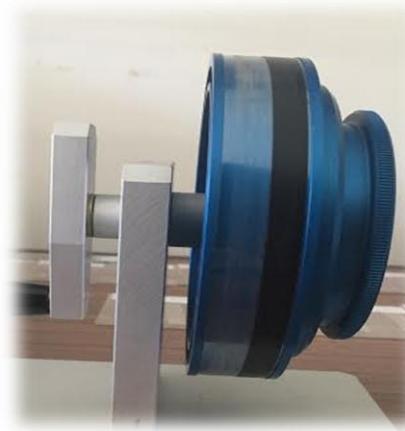
Allows determination of airborne bioaerosols concentration

Hirts type pollen and spore trap – single stage



10 L/min

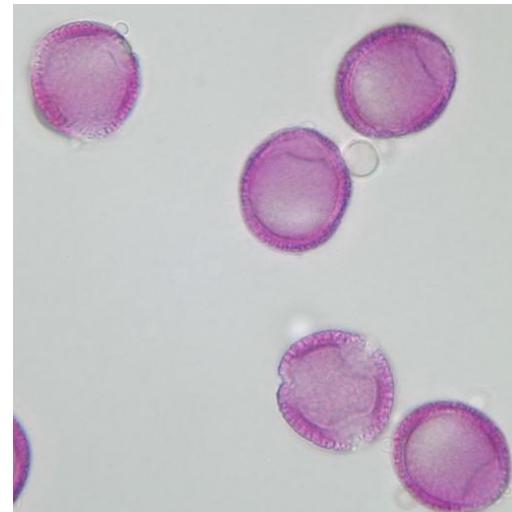
The drum



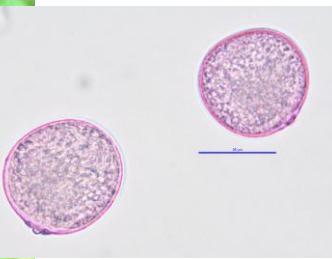
- 7 day;
- Particles impact over a adhesive tape embeded with silicon grease;
- Allows hourly analisys of the pollen and spores content in the air



Olea



Dactylis glomerata



Phleum pratensis



Pl. 382. Phléum des prés. Phleum pratense L.

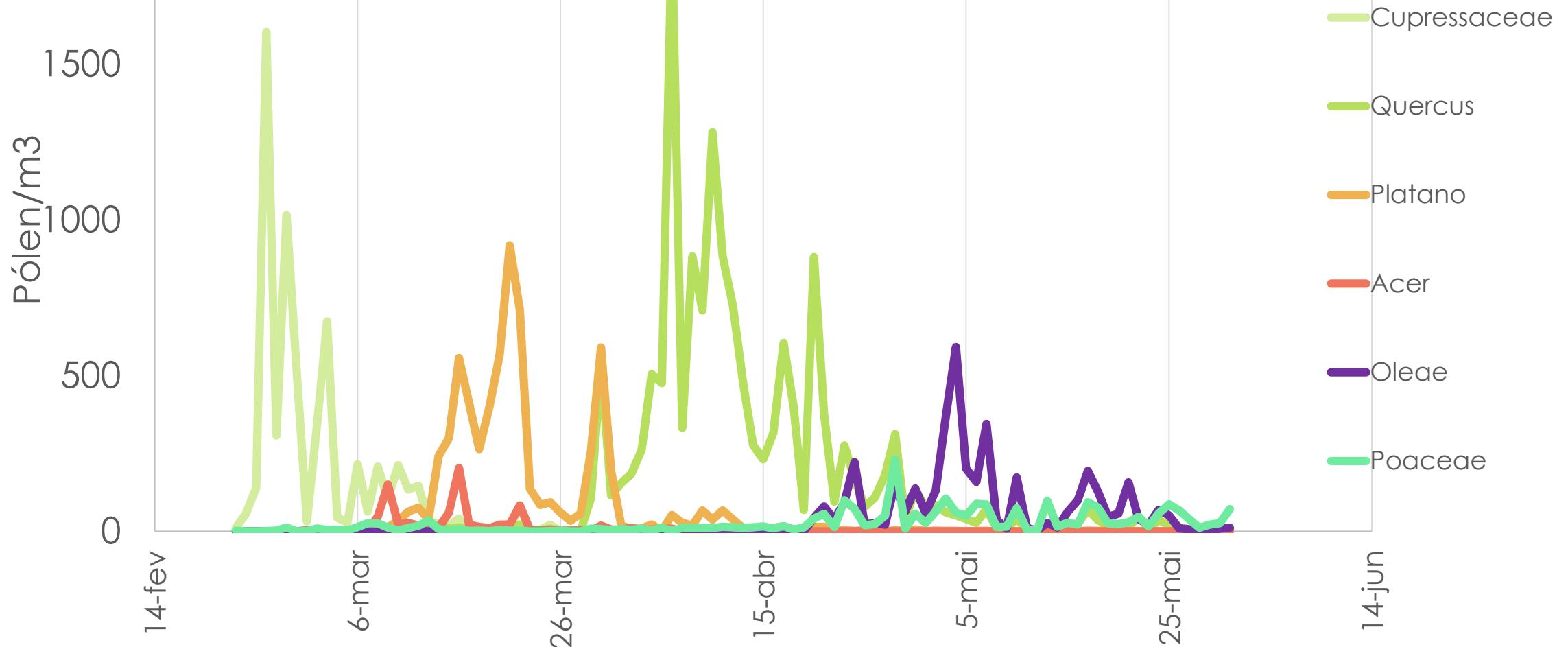


Quercus



Platanus hybrida

Tipos polínicos mais abundantes na região de Évora (2017)

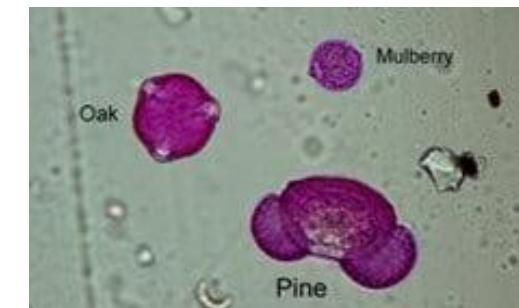
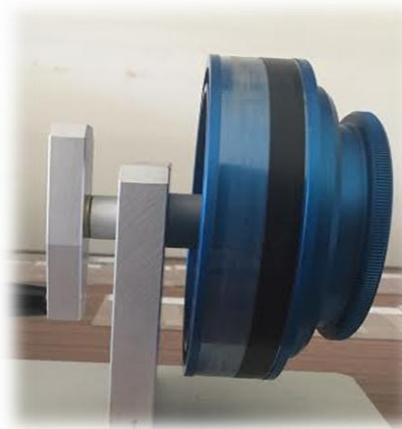


Hirts type pollen and spore trap – single stage



10 L/min

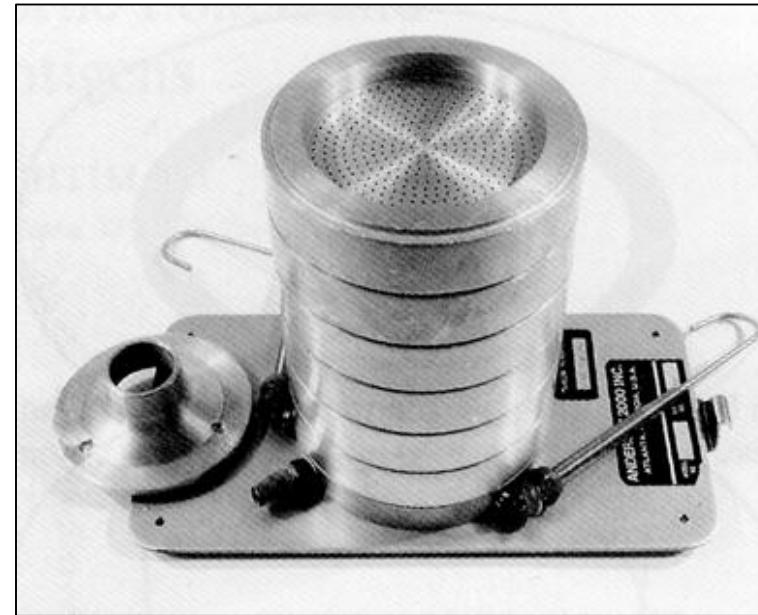
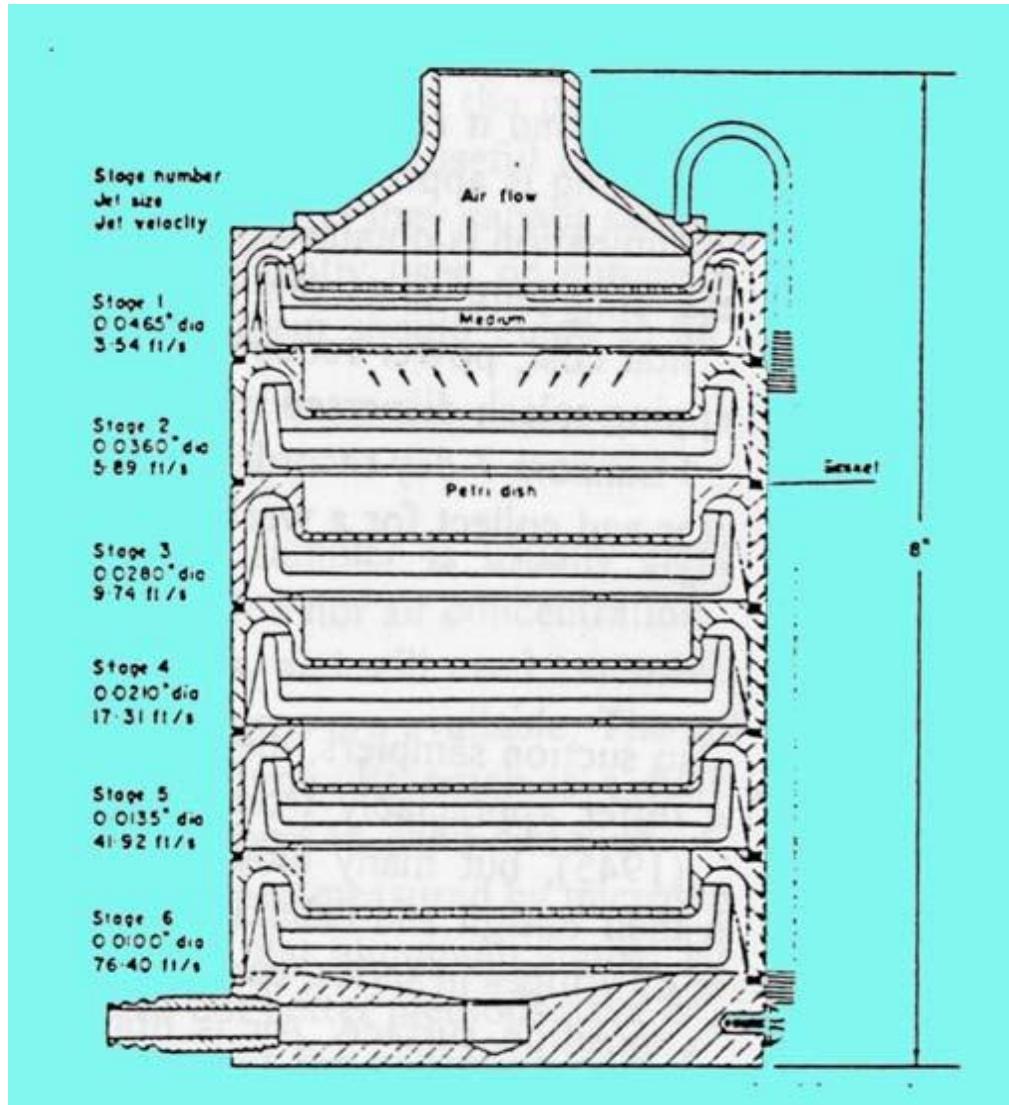
The drum



- 7 day;
- Particles impact over a adhesive tape; silicon grease is needed;
- Allows hourly analysis of the content in pollen and spores

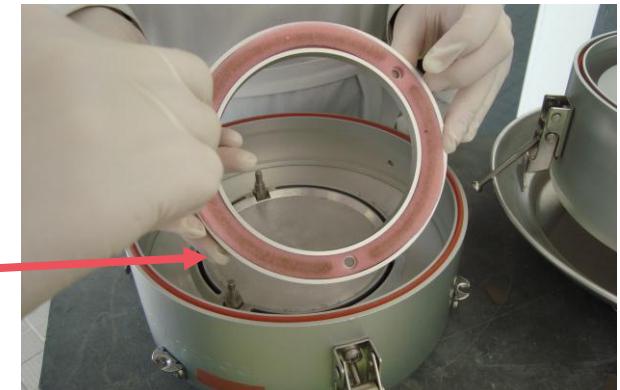
**NOT SUITABLE FOR SMALL PARTICLES NOR
FOR BIOCHEMICAL ANALYSIS**

Multi-stage impact - Andersen sampler

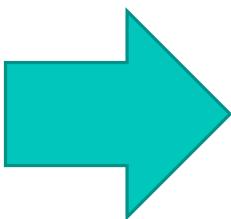


- **6 stages mimicking pulmonar deposition**
- **Fractionation of aerosols by size**
- **Top stage - PM>10µm**
- **Lower stages might have ultrafine fraction**

Multi-stage impact - Chemvol 2400 sampler



Biochemical analysis



Impact substrate processed
and the extract may be analysed:

- Protein contente
- allergen contente
- DNA analysis (PCR, etc)

Considerable amount of material for biochemical analysis

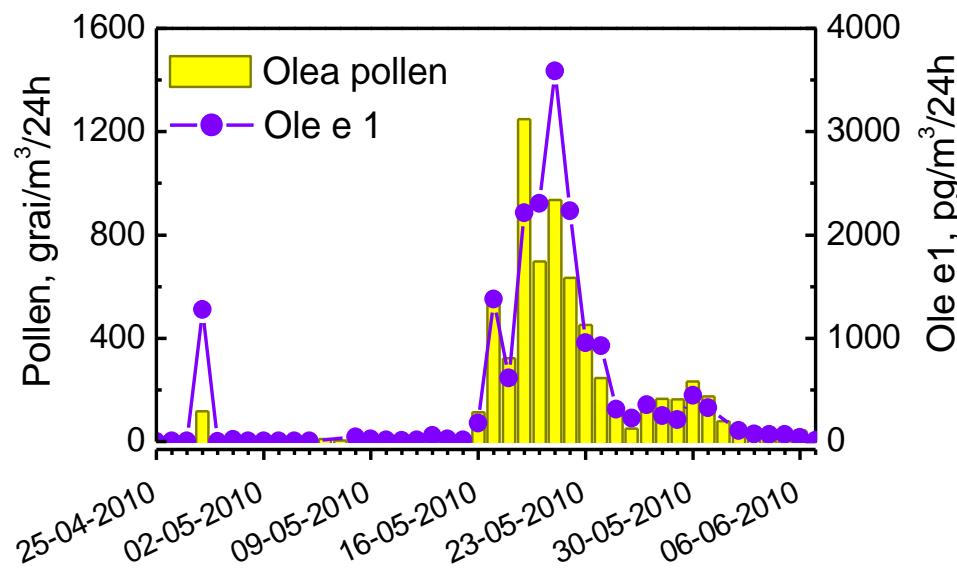
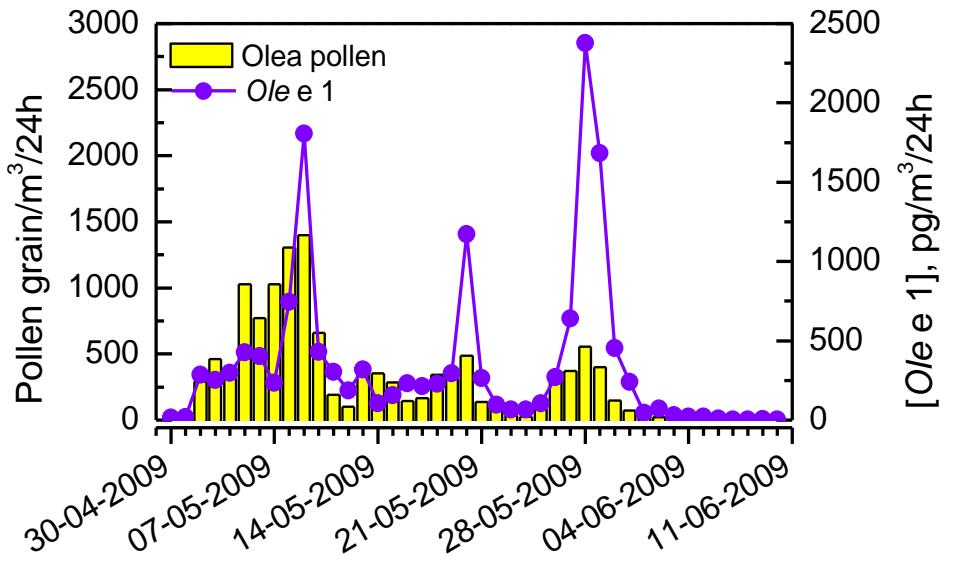
Metodos – Amostragem do Pólen e Alergeno Atmosférico

Monitorização dos
Aeroalergenos
Colector de Impacto
CHEMVOL 2400
800 L/min

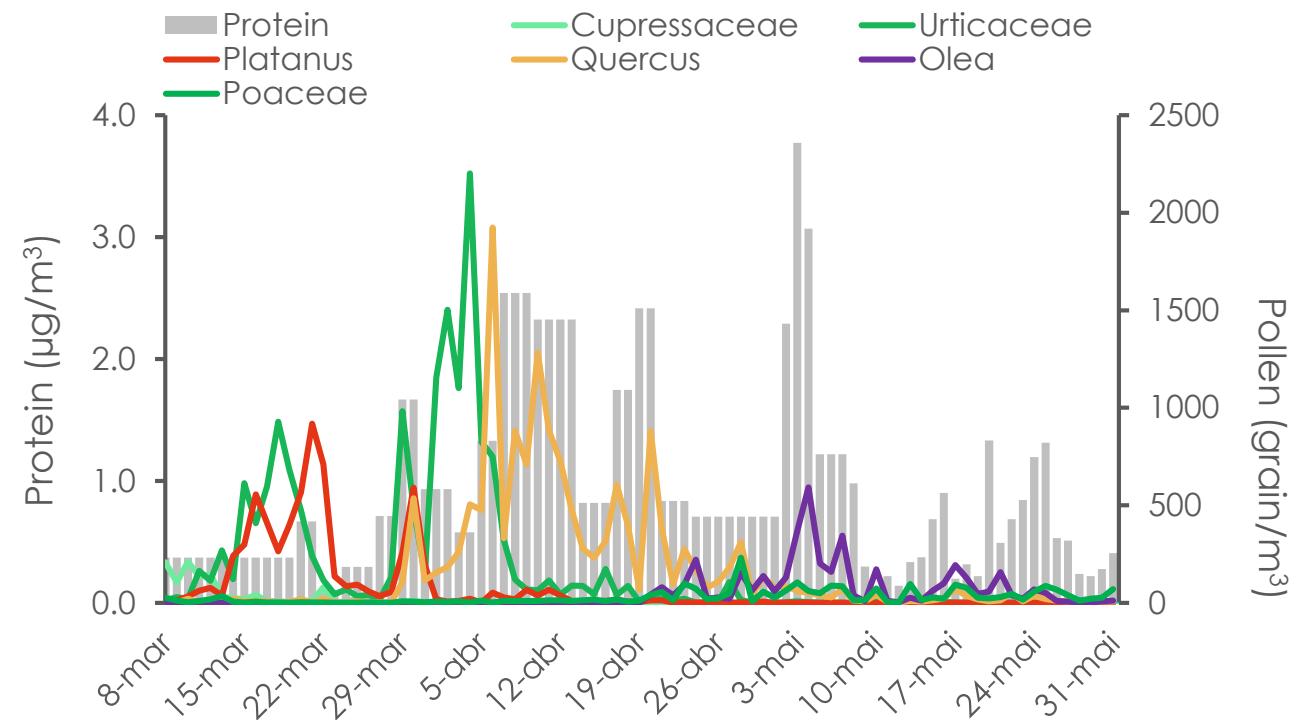


Monitorização Polínica Colector
tipo-HIRST 10 L/min





Allergens are proteins carried by pollen!!!



Cyclone sampler - μCoriolis



Weight: - 3 kg (with battery)
Dimensions: 22 x 33 x 36 cm
Air flow rate: 100 to 300 L/min
Collection time: 1-10 min
Collected particle sizes: from 0.5 micro meter
Liquid output volume: 15 mL
Autonomy on battery: 1 hour
Decontamination: Hydrogen peroxide

PORTABLE
Adequate for
microorganisms

<https://www.bertin-instruments.com/product/air-samplers/coriolis-micro-air-sampler/>



Summary



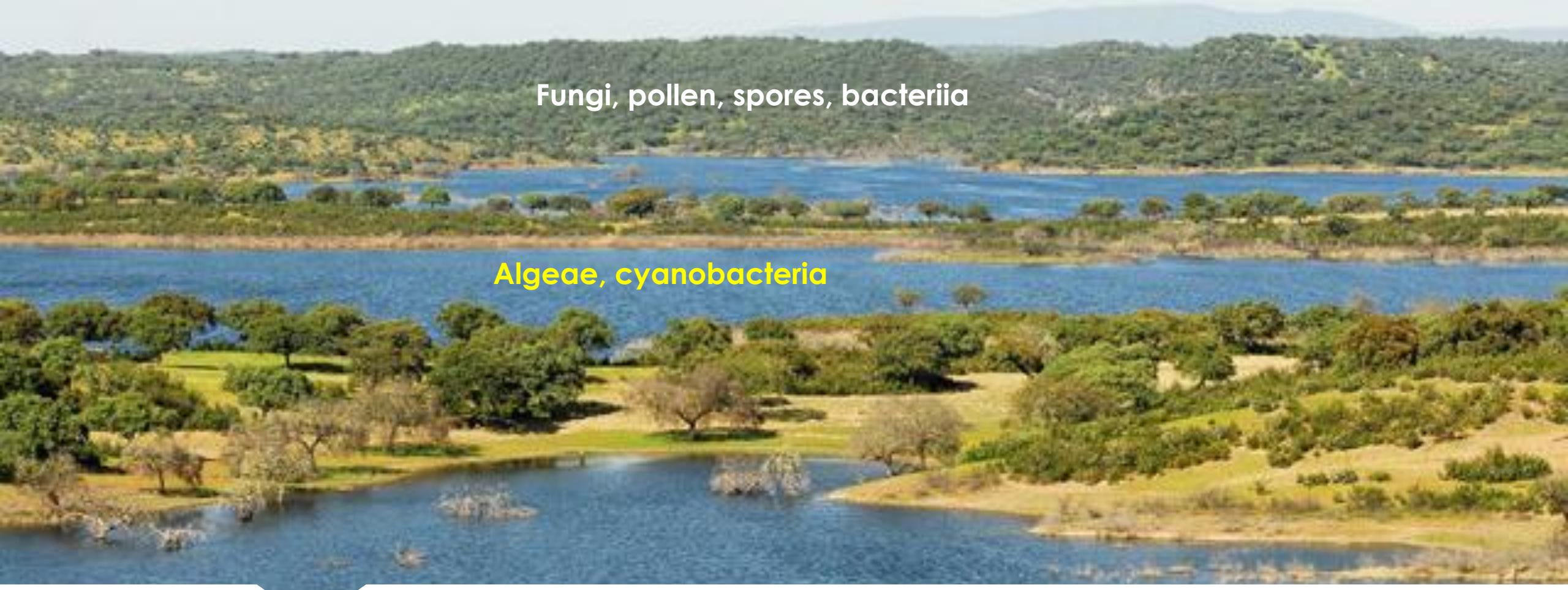
Pollen and spore



Allergens / Protein /
Toxins



Microorganisms
Allergen / Protein
Toxins / DNA



Fungi, pollen, spores, bacteriia

Algeae, cyanobacteria

**Relevance of lake / watershed to bioaerosol composition:
water surface emissions ≠ land emissions**

Preliminary results on cyanobacterial aerosol emissions from the Alqueva reservoir, southern Portugal

E.A. Morales^{1,2}, C. Antunes², A. Costa², M.J. Costa², M.H. Novais^{1,2}, M.A. Penha^{1,2} & M.M. Morais^{1,2}

¹Laboratório da Água and ²Instituto de Ciências da Terra, Universidade de Évora, Portugal

Presenting author email: mjcosta@uevora.pt



Laboratório da Água

Main Objective

Detect cyanobacteria in aerosol samples, simultaneously testing the effectiveness of a novel sampling technique.

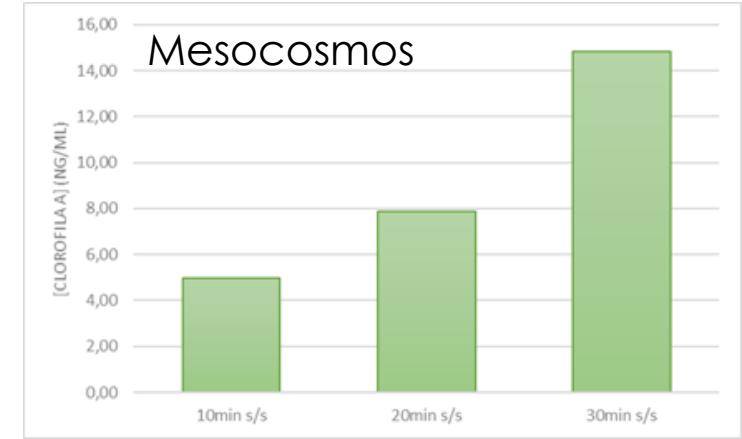
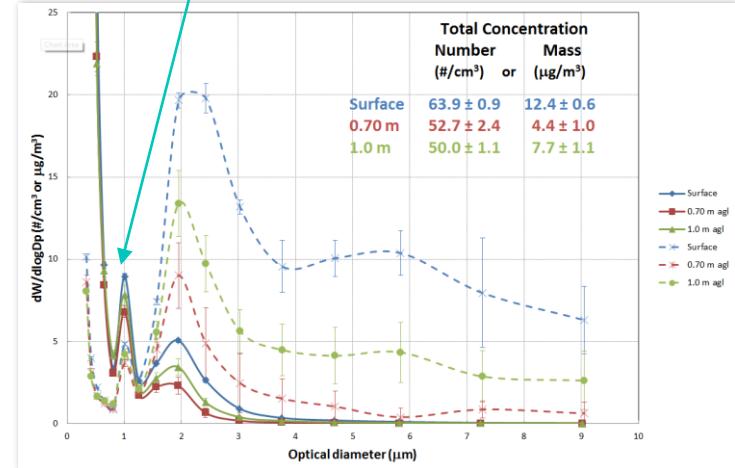
Justification

- Blooms caused by cyanobacteria have increased worldwide, probably due to climate change and to contamination of water bodies.
- More than a quarter of blooming cyanobacteria are known to produce dermo-, hepato- and/or neurotoxins, which have adverse effects on animal and human health.
- Bioaerosols containing cyanobacterial cells and their toxins have been formally studied only twice (Murby & Haney, 2016; May et al. 2018). This

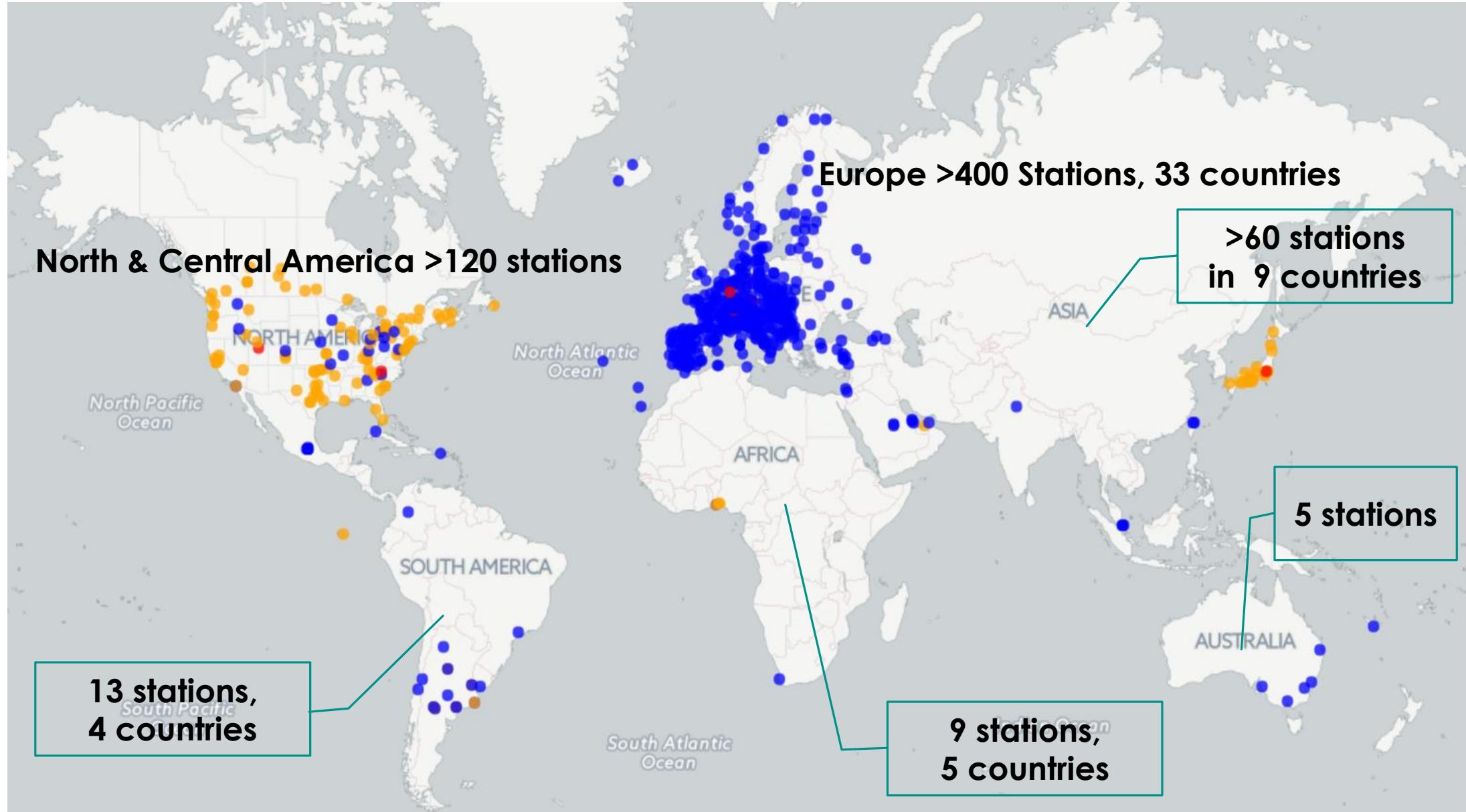
Results...



Bacteria / Cyanobacteria?







<https://www.zaum-online.de/pollen-map.html>

<https://lince.di.uevora.pt/polen/>

The screenshot shows a web browser window with the URL <https://lince.di.uevora.pt/polen/> in the address bar. The page content is in Portuguese and discusses pollen, specifically from the Urticaceae family. It includes images of a flowering plant, individual pollen grains, and a tree.

Pólen

O que é?

O pólen é parte do sistema reprodutor masculino das plantas e participa na reprodução sexuada das mesmas. As plantas que utilizam o vento como agente disseminador do pólen (plantas anemófilas), na sua época polínica, emitem para a atmosfera enormes quantidades de pólen. Nos indivíduos suscetíveis, esse pólen pode desencadear doença alérgica respiratória.

Esta página mostrará alguns dados polínicos da região de Évora, podendo constituir uma ferramenta de consulta útil para investigadores da área da aerobiologia ou da imunoalergologia, bem como para o público em geral.

Tipo polínico: Urticaceae

Espécie : *Urtica spp.*
Família : Urticaceae
Forma geral : circular
Tipo de aberturas : periporados
Diâmetro : 9-13 μm
Tipo de polinização : Anemófila
Período de floração : julho a setembro

Tipo polínico: Urticaceae

Espécie : *Parietaria officinalis*
Família : Urticaceae
Forma geral : circular
Tipo de aberturas : triporado por vezes tetraporado
Diâmetro : 13-15 μm
Tipo de polinização : Anemófila
Período de floração : julho a setembro

Thank you!!

Windows taskbar icons: File Explorer, Edge, Google Chrome, Word, Excel, Powerpoint, OneDrive, Task View, Settings, and others. System tray icons: Network, Battery, Volume, and a notification for 06/03/2018 at 15:36.



Obrigada pela vossa atenção !!

