

# A EUROPEAN NETWORK ON AEROBIOLOGY (SPORE TRAPS AND DNA METHODS) TARGETED CROP HEALTH AND DISEASE EARLY WARNING

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Chair of the COST Action **ADOPT** CA18226 (2019-24), New approaches in **d**etection **o**f **p**athogens and aeroallergens

# Problem addressed in ADOPT

(COST Action 18226: New approaches in detection of pathogens and aeroallergens)

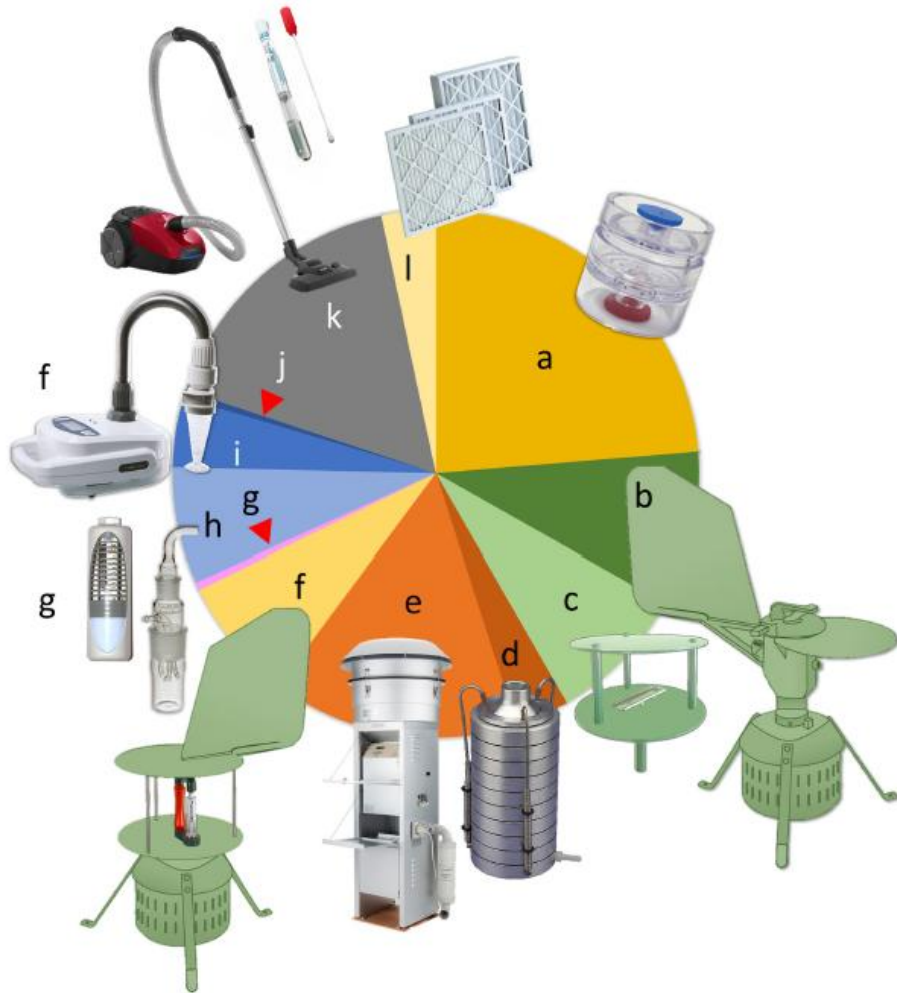
- Airborne fungal spores and pollen episodically undergo long distance transport (LDT).
- ADOPT focused on two new complementary technologies used for early warning related to LDT: Real-time detection and DNA based detection
- New skills and new instruments may be needed. Can we build a network. How to do this?



# Step 1: Formulate the COST application to create a network

- Designed key working groups: WG1 – real-time detection. WG2 – molecular detection. WG3 – low cost methods and use COST structure by adding training and testing of network into objectives. Examples:
  - D2.3: Programme for training school in molecular approaches (immunological and nucleic acid sequencing) to be executed in Y1, Y2 or Y3
  - D4.3: A programme and design in relation to an intercomparison of methods from WG1, WG2 and WG3 with pan-european participation.
- Consequence1: A substantial part of the funding from COST, about 1 mio Euro, could be used on to build a network.
- Consequence2: used COST support to (e.g. STSMs), to formulate national and international proposals around a network -> 2 international and 2 national funded

# Step 2: Make reviews aiming at creating networks



*Pogner et al. Airborne DNA: State of the art – Established methods and missing pieces in the molecular genetic detection of airborne microorganisms, viruses and plant particles. Science of the Total environment, 957 (2024), 177439*

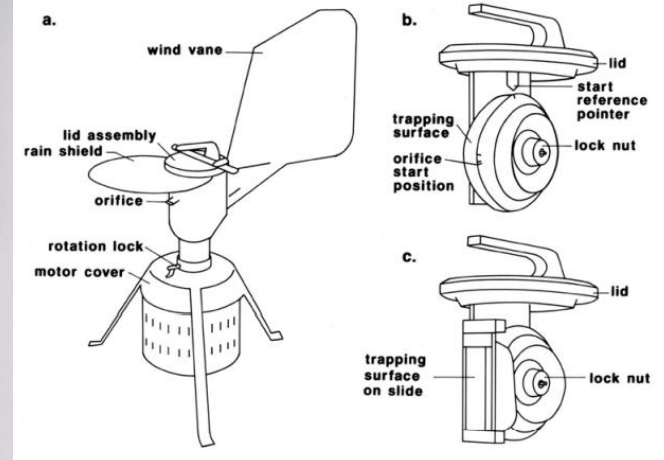
## Some of the conclusions:

- Not all instruments are strong candidates for networks
- No protocols for establishing international networks detecting airborne biodiversity
- Combined use of several types of instruments has a much higher chance of revealing the full picture

# Strenghts and weaknesses of samplers

- Impactors

- Strenghts: Limited effort to collect samples. A very large network. Decade-long time series
- Weaknesses: Requires laboratory work. Time consuming. Cut-off for smaller bioaerosols hazy. Limited taxonomical detail. Data availability often 5h – 7 days old



Pollen and spore trap of the Hirst design (left & top right).

# Strenghts and weaknesses of samplers

- Wet cyclones
  - Strengths.: Efficient in capturing a large size range. Efficient in maintaining some characteristic such as viability. Limited expenses
  - Weaknesses: Bioaerosols may be lost again. Sampling liquid can be lost very quickly. Designed for short period. Network capability not demonstrated. Sampling in liquid can be problematic for some sampling campaigns



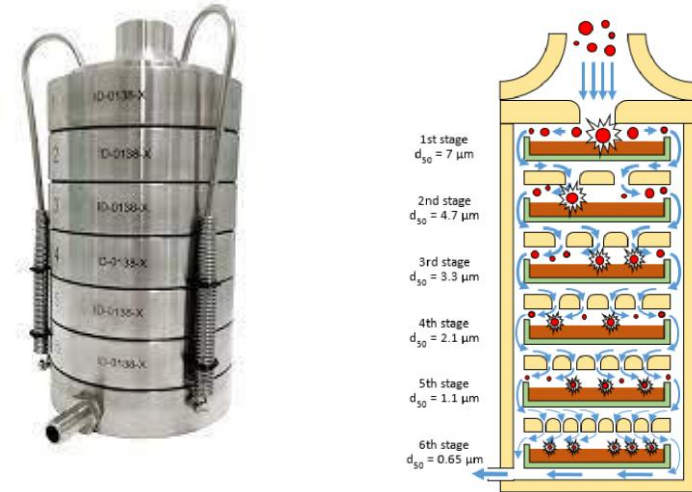
# Strenghts and weaknesses of samplers

- Dry Cyclones
  - Strenghts: Very limited effort to collect samples. Very little impact on sample and sample usually dry. Well designed for post processing such as ELISA or eDNA approaches. Reasonable size network demonstrated. A strong candidate for an early warning network on potato blight.
  - Weaknesses: Requires laboratory work. Cut-off for smaller bioaerosols hazy. Some analytical methods costly.

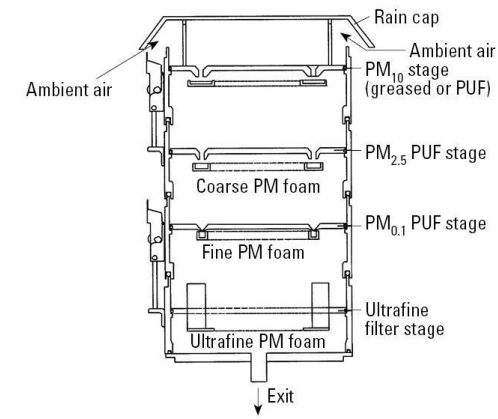


# Strengths and weaknesses of detectors, analytical methods and associated networks

- Filters and cascade samplers
  - Strengths: Can separate size fractions and in principle collect everything. Well designed for post processing such as ELISA or eDNA approaches. Limited network demonstration.
  - Weaknesses: time consuming and expensive. Requires extensive laboratory work



Top. Concept in Anderson cascade sampler. Often  $\sim 46\text{l/min}$ . Entire package in a suitcase, hence movable. Bottom sampler head to Chemvol high volume sampler. Often supplied with a pump  $\sim 100\text{kg}$ , hence less mobile.



# Strengths and weaknesses of detectors, analytical methods and associated networks

- Real-time devices
  - Strengths: Data available in real time. Expanding network. Higher flow rate -> higher temporal accuracy and better chance of early warning. Good for forecasting! A strong candidate for an early warning network on potato blight.
  - Weaknesses: Limited species recognition outside pollen. Very expensive. Separation beyond genus level not proven. New skills required



# 3 types of networks tested

COST ADOPT Network. Tested 2024/25 continued 2026

## CHARACTERISTICS

20 sites, European coverage

2 instruments at each sites

Main instrument: Burkard multi-vial cyclone (dry)

Hirst trap (microscope) or Swisens Polenos (holograms) companion instrument

Main analytical method:

qPCR/dPCR (Aarhus)

Complementary method:

Microscope counting (local sites)

Holograms + AI (local sites)

eDNA + Bioinformatics (Aarhus)

Funder:

COST ADOPT (training, travelling, distribution & pilot study)

Novo Nordisk Foundation (Salary at Aarhus, consumables)



European cyclone network



Cyclone at each site

# 3 types of networks tested

Biodiversa+ project (24/27)

Danish Network.



Campaign in 2026 with hv cyclones (blue) and Polenos (red)

## CHARACTERISTICS

125 sites, urban coverage in 5 European cities  
1 sampler at each site, 25 samplers in each city  
Main instrument: Passam passive sampler  
Companion instrument at one urban location

## Main analytical method:

eDNA + Bioinformatics (Trento, Aarhus)

## Complementary method:

Microscope counting (local sites)  
Holograms + AI (local sites)  
dPCR

## Funder:

Biodiversa+



Passam

## CHARACTERISTICS

3 sites in urban areas & 4 in potato growing areas  
3 Main urban instrument (permanent): Swisens Poleno Jupiter  
6 High volume cyclones, Agrisamplers Ltd

## Main analytical method:

Machine Learning on holograms, targeting pollen & spores  
dPCR, targeting grass species, Alternaria species, P. infestans

## Complementary method:

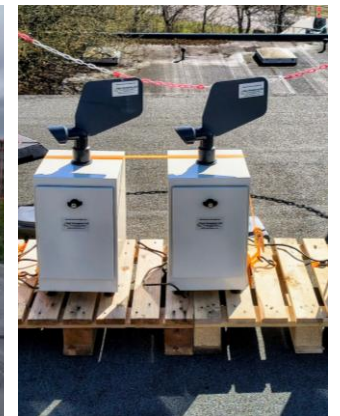
Microscope counting (one site)

## Funder:

Novo Nordisk Foundation,  
National Research Reserve



Poleno Jupiter



HV Cyclone

# Lessons learned so far

## Training:

Hands on training critical for a large network. Allocate technical support during year 2

## Transport & installation:

This may take much longer than one anticipates. Risk of instrument failure increases with size of network

## Storage and transport:

Only some sites have storage facilities for +2 months of storage. Transporting material to a permanent location is a logistic challenge. Storing daily material from large network at few sites requires planning and curating.

## Analytical method and data handling:

qPCR was the original idea gave problems caused by reference samples and inhibitors. dPCR/ddPCR is a way forward  
Both eDNA and AI(Machine learning) nededs more work. Gives technical challenges due to Big Data problem.

## Complementary sampling methods:

Several types of instruments help a lot, at least temporary. Duplicates at all not always needed throughout network.

## Sustainable network:

Concrete plans for funding on short term and long term

Concrete plans for gaining and maintaining skill

# Take home message

## Recommendation from a network designer:

The Grand Unified Instrument that does it all is yet to be developed.

Building an aerobiological network for *P. infestans* is possible. There are good candidates for instruments and analytical methods. Exact composition depends on especially *objectives, methods and geographical setup*

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