European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

3rd International Workshop *EuNetAir* on

*New Trends and Challenges for Air Quality Control*

University of Latvia - Faculty of Geography and Earth Sciences

Riga, Latvia, 26 - 27 March 2015

# THE MOSSCLONE FP7 PROJECT: MONITORING AIR QUALITY USING MOSS AS PASSIVE SENSOR


**J. Ángel Fernández**

MossClone Project Coordinator

jangel.fernandez@usc.es

**University of Santiago de Compostela / Spain**



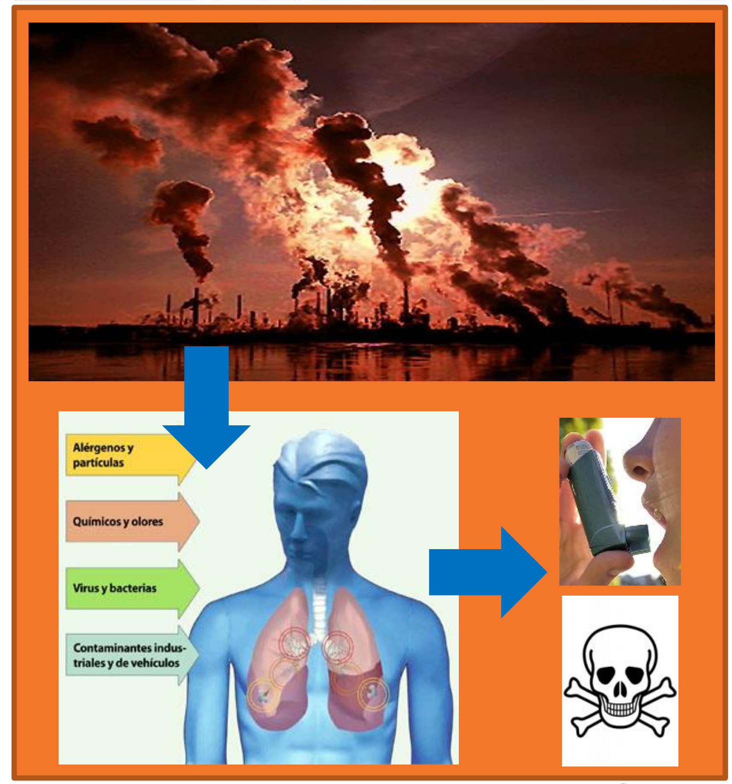
COST is supported by the EU Framework Programme

ESF provides the COST Office through a European Commission contract

# Air pollution and health

- Air pollution affects human health. According to the World Health Organization each year 2 million of deaths are related to atmospheric contamination.

- Several EU Directives aimed at reducing pollution to levels which minimize its harmful effects.
  - 1999/30: $SO_2$, $NO_2$, $NO_x$, particulate matter and Pb
  - 2004/107: As, Cd, Hg, Ni and PAHs

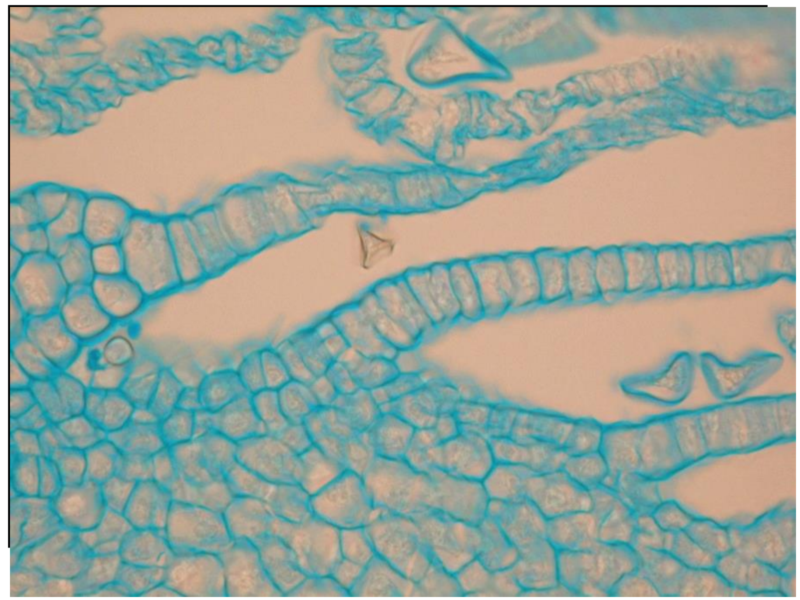
# Air pollution monitoring

- The levels of air pollutants in urban and industrial environments are monitored by automated stations.
  - Technical complexity and high costs → mainly gases and particles are controlled.
  - Lack of data about many heavy metals, metalloids or PAHs.
  - Monitoring stations are installed depending on number of inhabitants.

**Currently there are no data on many airborne pollutants for much of the EU territory.**

# Air pollution biomonitoring

- New tools are needed that combine robustness and low costs.
- The use of biomonitoring is a suitable alternative and terrestrial mosses are the best choice.
- **Why mosses?**
  - Lack of a root system.
  - High surface/mass ratio.
  - Good ion exchange capacity.
  - Scarce seasonality.
  - Absence of protection tissues.



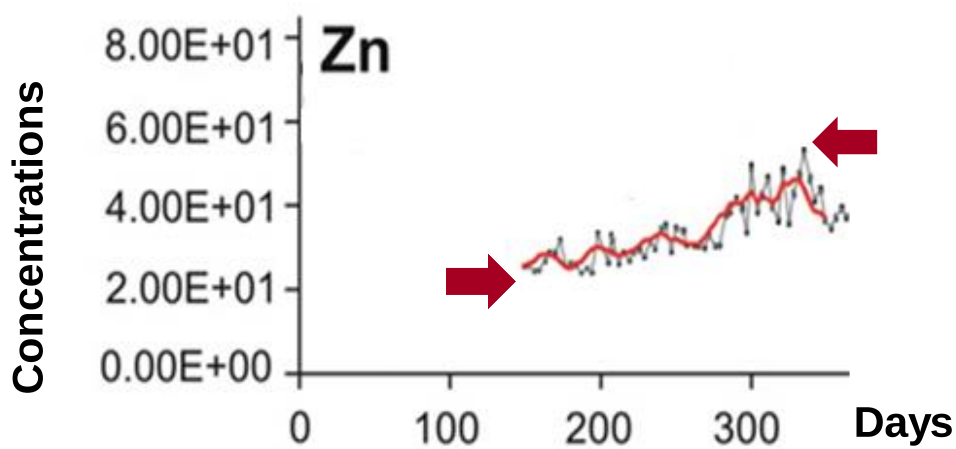
**High efficiency in loading particulate and gaseous organic and inorganic pollutants.**

# Air pollution biomonitoring: moss-bags

- In urban and industrial environments is difficult to find native mosses.
- Mosses are suitable to be transplanted in so-called ‘**moss-bags**’.
- **Why moss-bags?**
    - The material can be exposed in *ad hoc* sampling grids.
    - It is possible to calculate enrichment rates.
    - The exposure period is known.
    - Surveys can be repeated on time.

# Moss-bags technique

- Moss-bags are made from naturally growing mosses collected from unpolluted areas.
- **Some problems can arise when preparing moss-bags**:
  - The environmental impact due to sampling native mosses.
  - There may be changes in their availability in the field.
  - The inherent natural variability of their body concentrations → effect on the estimates of the enrichment after exposure.

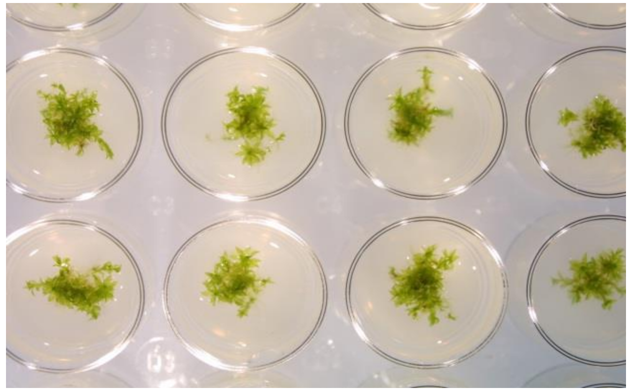


# Moss-bags technique

- Solution:

**Culture moss in laboratory ensuring homogeneity of the material and its continuous availability.**

- Isolating a clone → high level of standardization.
- Development of a new biotechnological tool for pollution control.
- New material for simultaneously controlling of pollutants on the same matrix.



# Moss-bags technique

- Additional problem when using moss-bags: **lack of standardized protocols and well-established methodology.**
    - Most suitable moss species.
    - Material for making bags.
    - Shape and size of bags.
    - Exposure height
    - Exposure period.

# The MossClone project

**“Creating and testing a method for controlling the air quality based on a new biotechnological tool. Use of a devitalized moss clone as passive contaminant sensor”**

| | | | |
|---|---|---|---|
| Call: | FP7-ENV-2011-ECO-INNOVATION-TwoStage | | |
| Period: | 01/04/2012 – 31/03/2015 | | |
| Total budget: | 4.485.293 € | (UE contribution: 3.492.220 €) | |
| | 1.499.005 € | (42.9%) | Personnel |
| | 77.000 € | (2%) | Subcontracts |
| | 734.119 € | (21%) | Other direct costs |
| | 1.181.899 € | (34%) | Indirect costs |
| | 211.760 € | (6%) | Management |

# The MossClone consortium

- University of Santiago de Compostela (Spain). Coordinator.
- AMRA (Italy)
- University of Freiburg (Germany)
- University of A Coruña (Spain)
- CNRS-University Paul Sabatier (France)

- Biovia (SME, Spain)
- ORION (SME, Italy)
- T.E. Laboratories (SME, Ireland)
- Tecnoambiente (SME, Spain)
- Maderas Ornanda (SME, Spain)

| | |
|---|---|
| Academic/public institutions: | 63% of total budget |
| Small-Medium Enterprises: | 37% |

SEVENTH FRAMEWORK PROGRAMME

cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

# Objectives of the MossClone project

1. **Selection of moss species** on the basis of existing knowledge about their use as bio-monitor, and their geographical and ecological distributions. Selection is further directed based on sampling and study of physical-chemical characteristics for the species selected based on the existing knowledge.

2. **Creating a pilot bioreactor for the cultivation** of the selected species. Based on these results and those of objective 1, one moss species will be selected for the isolation and culturing of moss clones.

3. **Characterization of the selected moss clone**: molecular characterization (DNA finger printing, etc.), chemical composition (multi-elemental analysis), and physical and physical-chemical characterization (e.g. surface stability constants, specific surface area, maximal surface adsorption capacity, physical heterogeneity, porosity, surface charge, etc.).

# Objectives of the MossClone project

4. **Scaling up moss clone cultivation** from pilot bioreactor scale to large-scale clone production.
5. **Design and standardization of moss-bags** through the selection of type of mesh and shape for bags, and determination of the ideal ratio weight of moss to size of bag.
6. **Methodological standardization** for exposure conditions: effect of height and exposure time on exposure.
7. **Moss-bags vs. current state-of-the-art methods for air pollution monitoring**: comparisons with pollutants in bulk deposition, with particle samplers, with gaseous samplers, and with pollutant passive samplers.
8. **To develop** a method and perform an initial validation of its usefulness for the **detection of atmospheric small scale pollution focus** using moss clone bags.

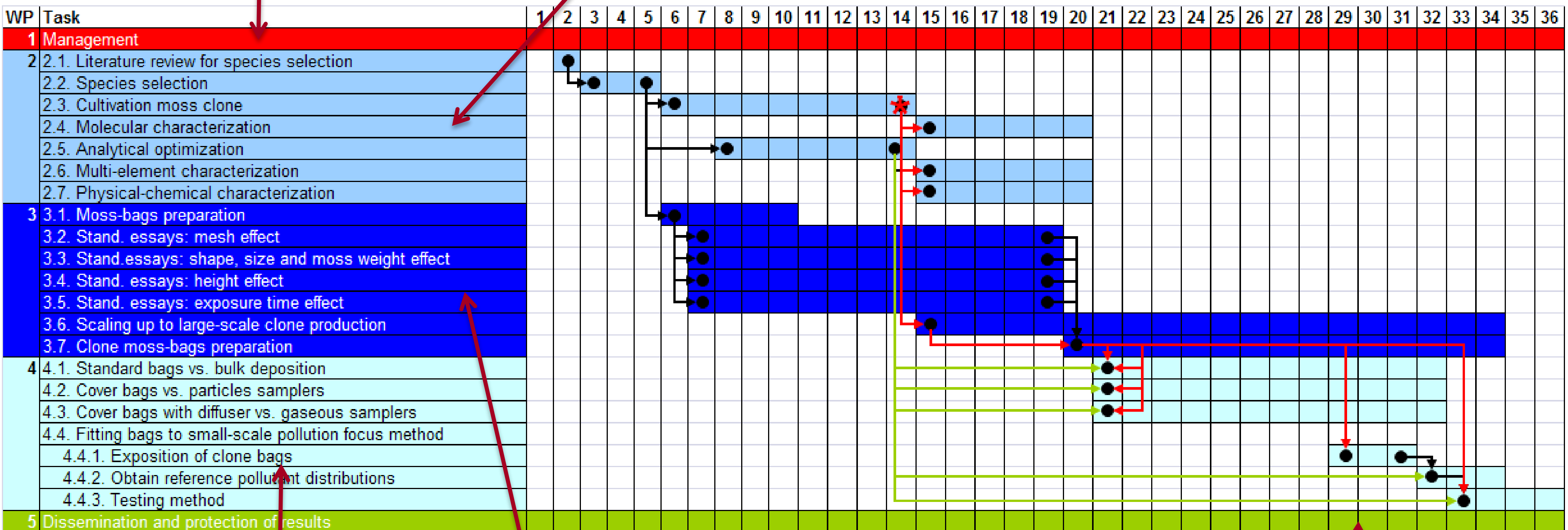
SEVENTH FRAMEWORK PROGRAMME

clone Moss

# Project activities and interconnectivities

WP1-Management

WP2-Clone cultivation & characterization

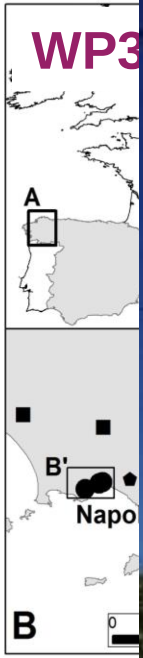



WP3-Tool development

WP4-Detectors

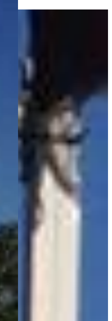
WP5-Exploitation and dissemination

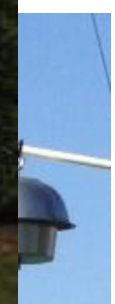
# Experimental set-up





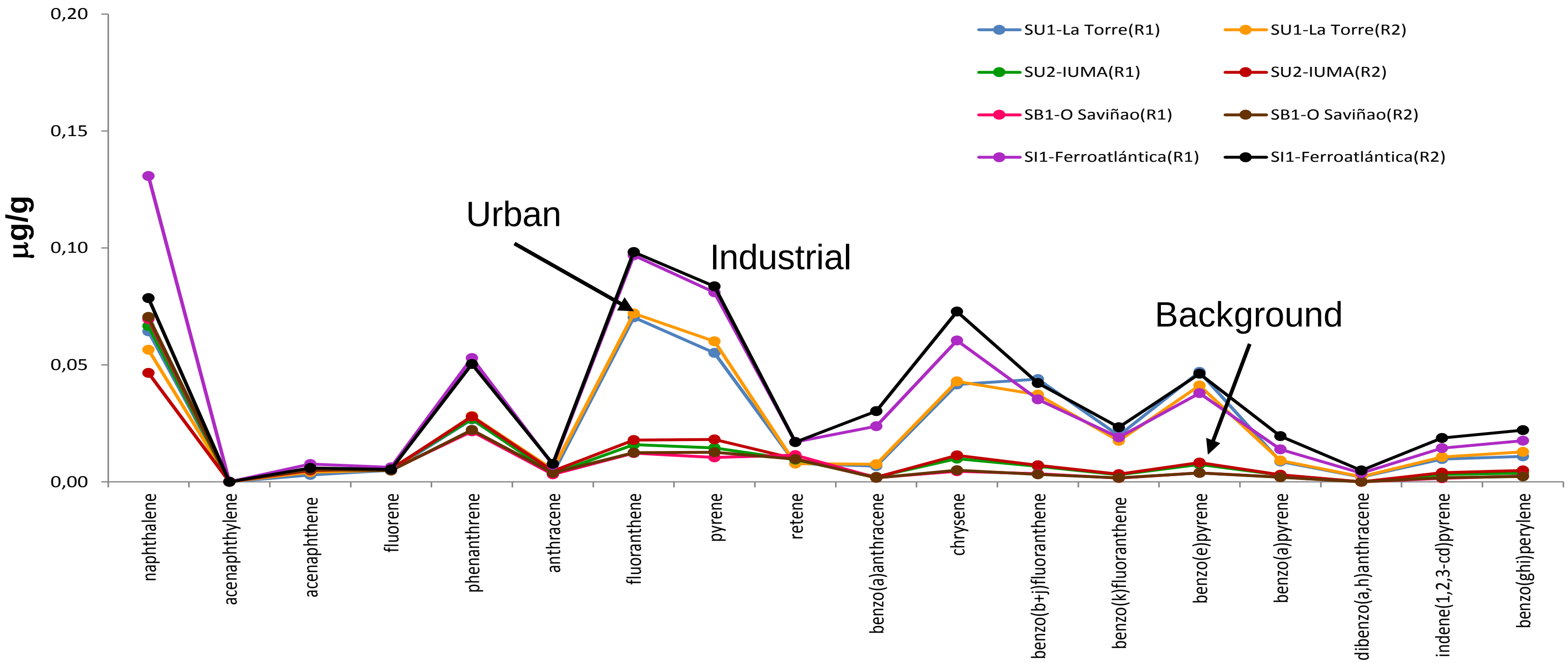
gs

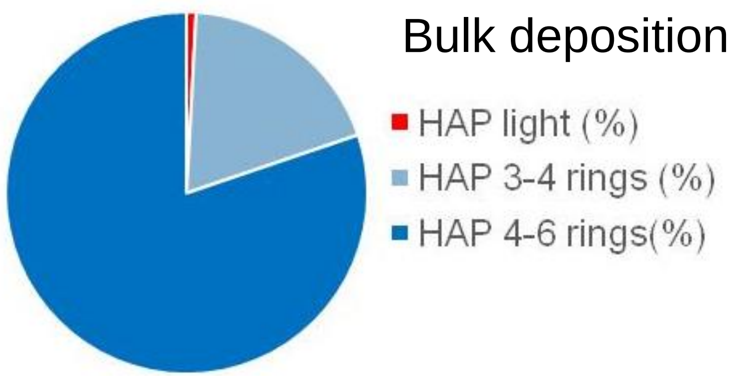


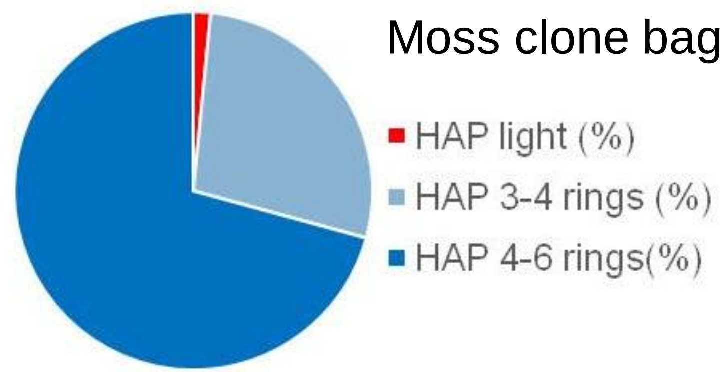


**Instruments**

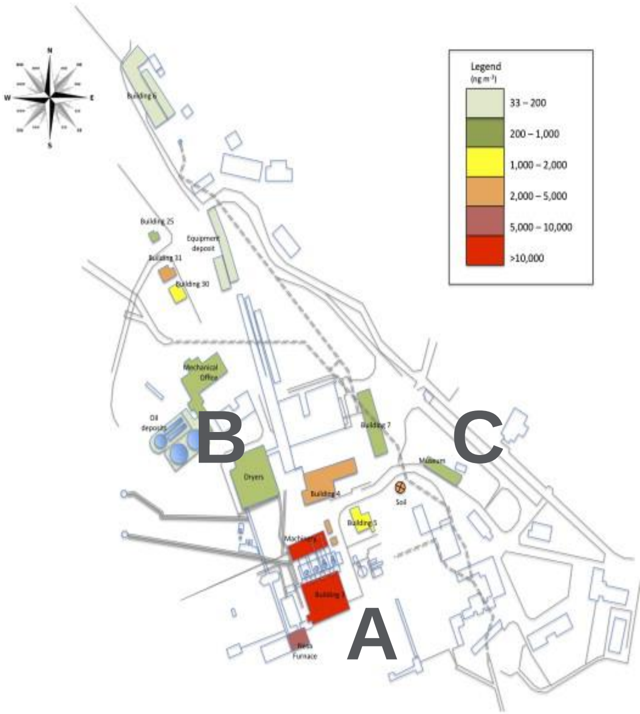
# Bulk deposition *vs.* moss clone: PAHs

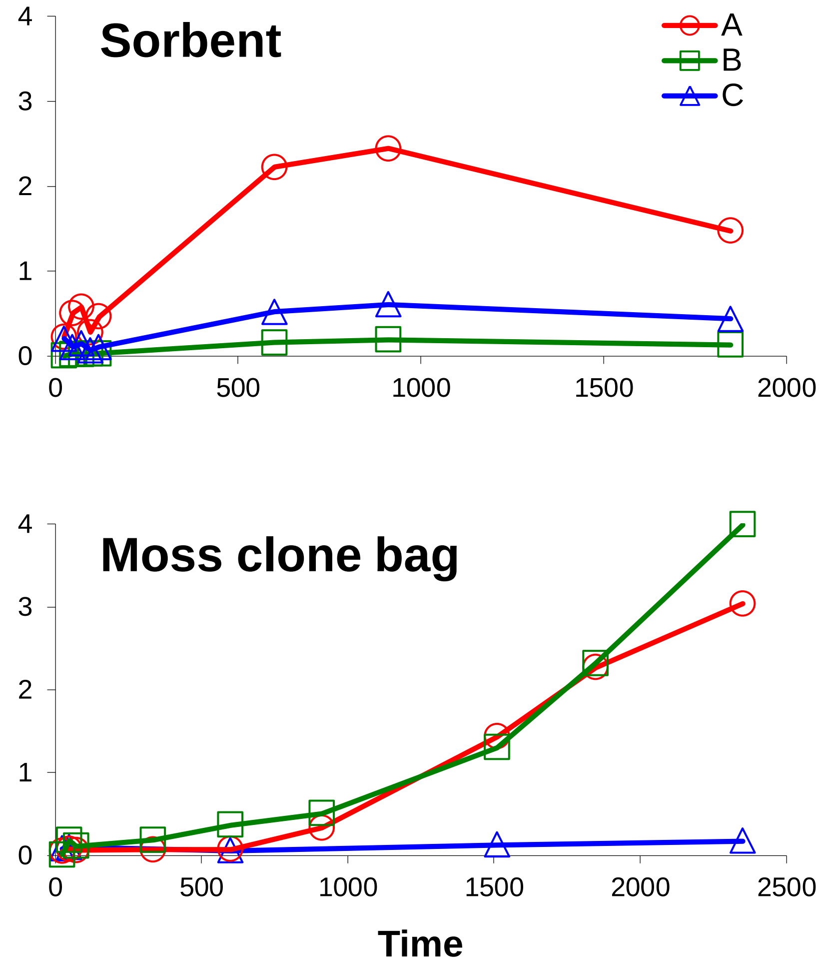


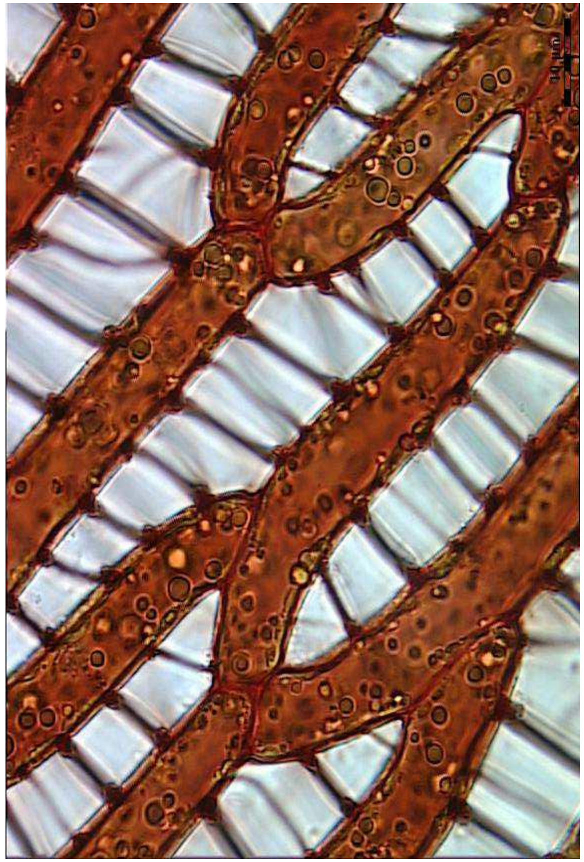
# Passive sorbent *vs.* moss clone: Hg



# CONCLUSIONS

- A moss clone has been isolated and is growing under laboratory conditions.
- The clone has been fully characterized (i.e. genetically, chemical and physic-chemically).
- The moss-bag technique has been optimized: shape, weight/volume ratio, height and exposure time.
- Preliminary results for PAHs and some metals show that concentrations in moss clone bags reflect clearly changes in atmospheric pollution.
- Higher accumulation of Hg in clone bags than commercial sorbents, without saturation and fully operative outdoor and indoor.



clone Moss

SEVENTH FRAMEWORK PROGRAMME