

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

COST Action TD1105

## WGs and MC Meeting at ISTANBUL, 3-5 December 2014

Action Start date: 01/07/2012 - Action End date: 30/06/2016

Year 3: 1 July 2014 - 30 June 2015 (*Ongoing Action*)

## Phytoremediation of particulate matter from indoor air by *Chlorophytum comosum* L. plants

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Function in the Action: MC Member  
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 COST  
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY



# Scientific context and objectives in the Action

## Background:

- people living in urban areas spend up to 85–90% of their time indoors (Soreanu *et al.* 2013)
- indoor air pollution has been ranked among the top five risks to public health (US EPA)
- the level of air pollution indoors can be more than 10X higher than of the outdoors (US EPA)
- in the case of some harmful substances, their concentrations can even exceed permissible norms by up to 100 times (US EPA)
- **PM has are recognized as one of the most dangerous health pollutants to human life** (EEA 2007).
- heavy metals (Voutsas and Samara 2002), polycyclic aromatic hydrocarbons (PAH) (Caricchia *et al.* 1999; Kaupp *et al.* 2000) and environmentally persistent free radicals (EPFRs) (Saravia *et al.* 2013) are settled on PM and inhaled with air by man



- *Chlorophytum comosum* L. (spider plant) is among 120 plant species assayed for phytoremediation of pollutants from indoor air (Soreanu *et al.* 2013).
- it removes formaldehyde, nitrogen dioxide, carbon monoxide and dioxide, ozone, benzene, toluene, cigarette smoke and ammonia (Peart 1992; Giese *et al.* 1994; Costa *et al.* 1995; Cornejo *et al.* 1999; Wolverton 2008).
- Giese *et al.* (1994) showed that the spider plant uses formaldehyde as a source of energy and carbon for biosynthesis of new molecules.
- literature on particulate matter uptake from the air by outdoor-growing plants is very extensive, most probably because of this pollutant's increasing negative impact worldwide on human health **but**
- **No data on PM phytoremediation from indoor by plants so far are available**

# Scientific context and objectives in the Action

The **objectives** of this study were:

- (i) to check whether the spider plant accumulates PM from indoor air and, if so,
- (ii) to establish whether the amount of accumulated PM and deposited waxes is affected by the activity taking place in rooms and
- (iii) to establish whether factors other than gravity play a role in PM accumulation on the plants' leaves.

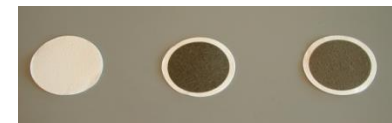
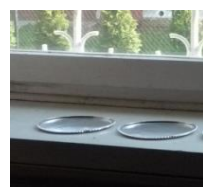
Results are published: H. Gawrońska, B. Bakera 2014. Phytoremediation of particulate matter from indoor air by *Chlorophytum comosum* L. plants, Air Qual Atmos Health DOI 10.1007/s11869-014-0285-4

# Materials, methods, equipment used in PM measurements

Plants and Al-plates were exposed for 2 months to indoor air in 5 rooms differing in activities:

- dental clinic,
- perfume botling room
- suburb house
- apartment and
- office.

Leaf samples and Al-plates were first washed with water and next with chloroform

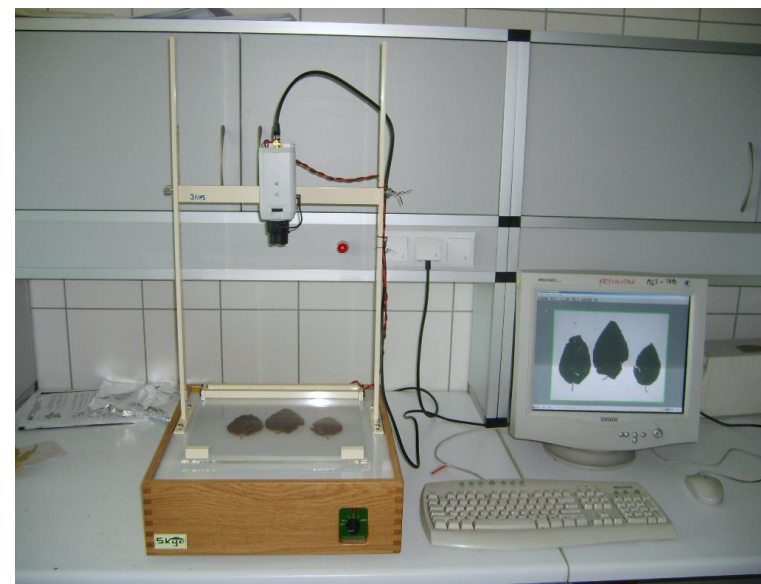


Clean    10 -100    2.5 - 10  
                  $\mu\text{m}$              $\mu\text{m}$   
Filters with collected PM

Unit for filtration



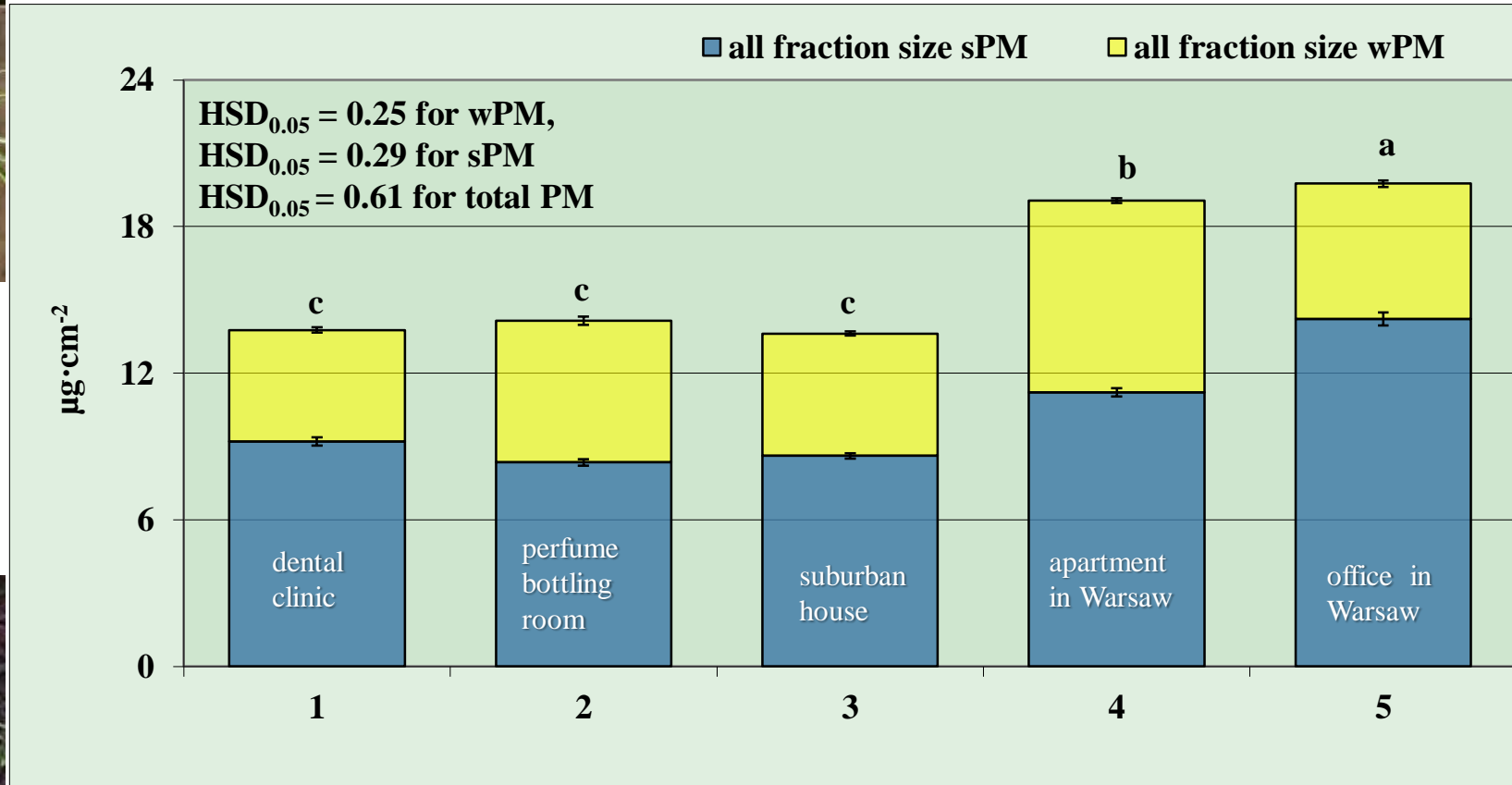
Balance weighting  
Samples (accuracy of  $1 \cdot 10^{-6}$  g)



Leaf Area Meter – SkyInstrument, UK

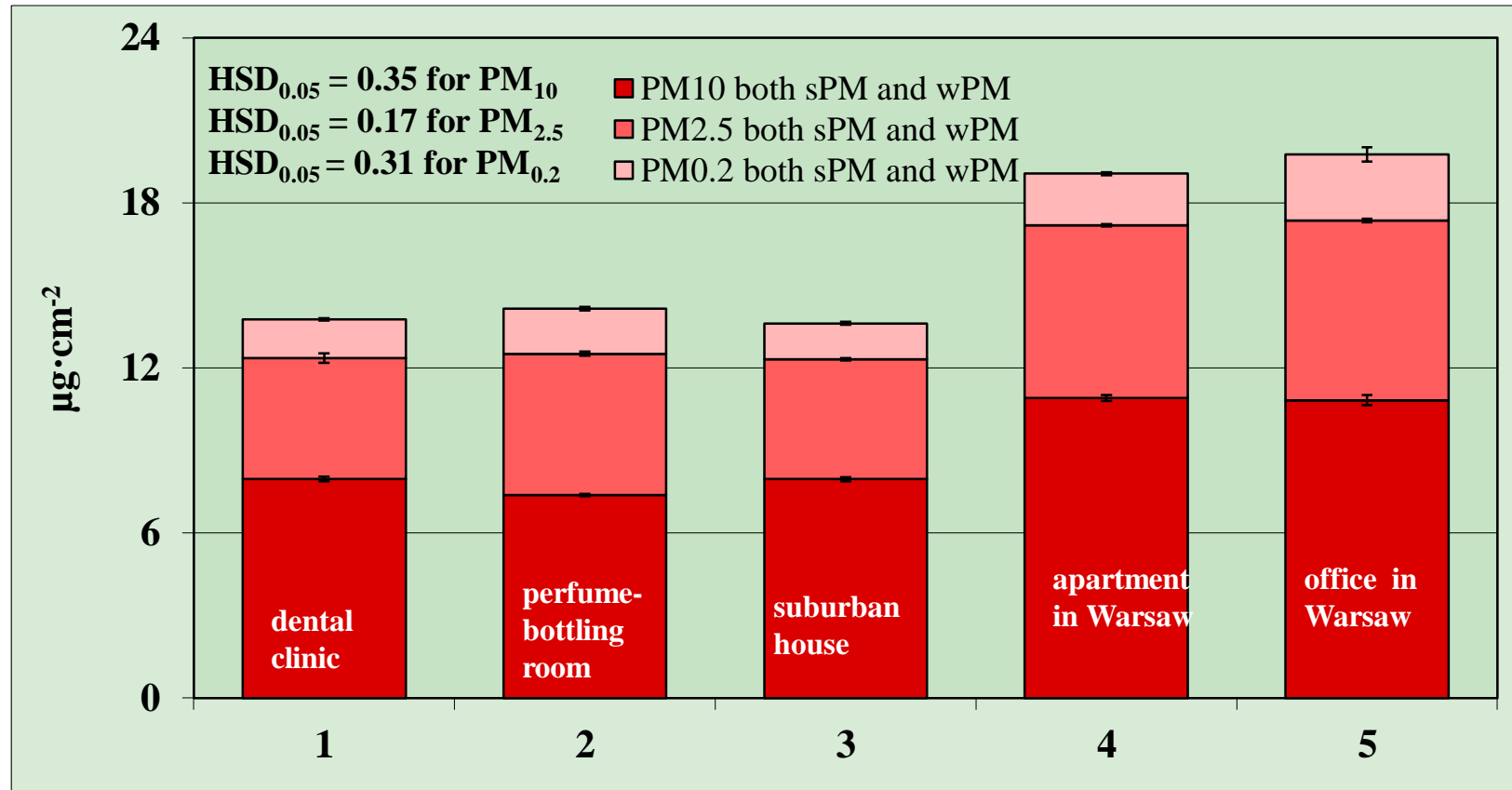
# RESULTS:

Amount of total PM (sPM+wPM) accumulated on leaves of *Chlorophytum comosum* L. growing for 2 months in five rooms differing in activities.



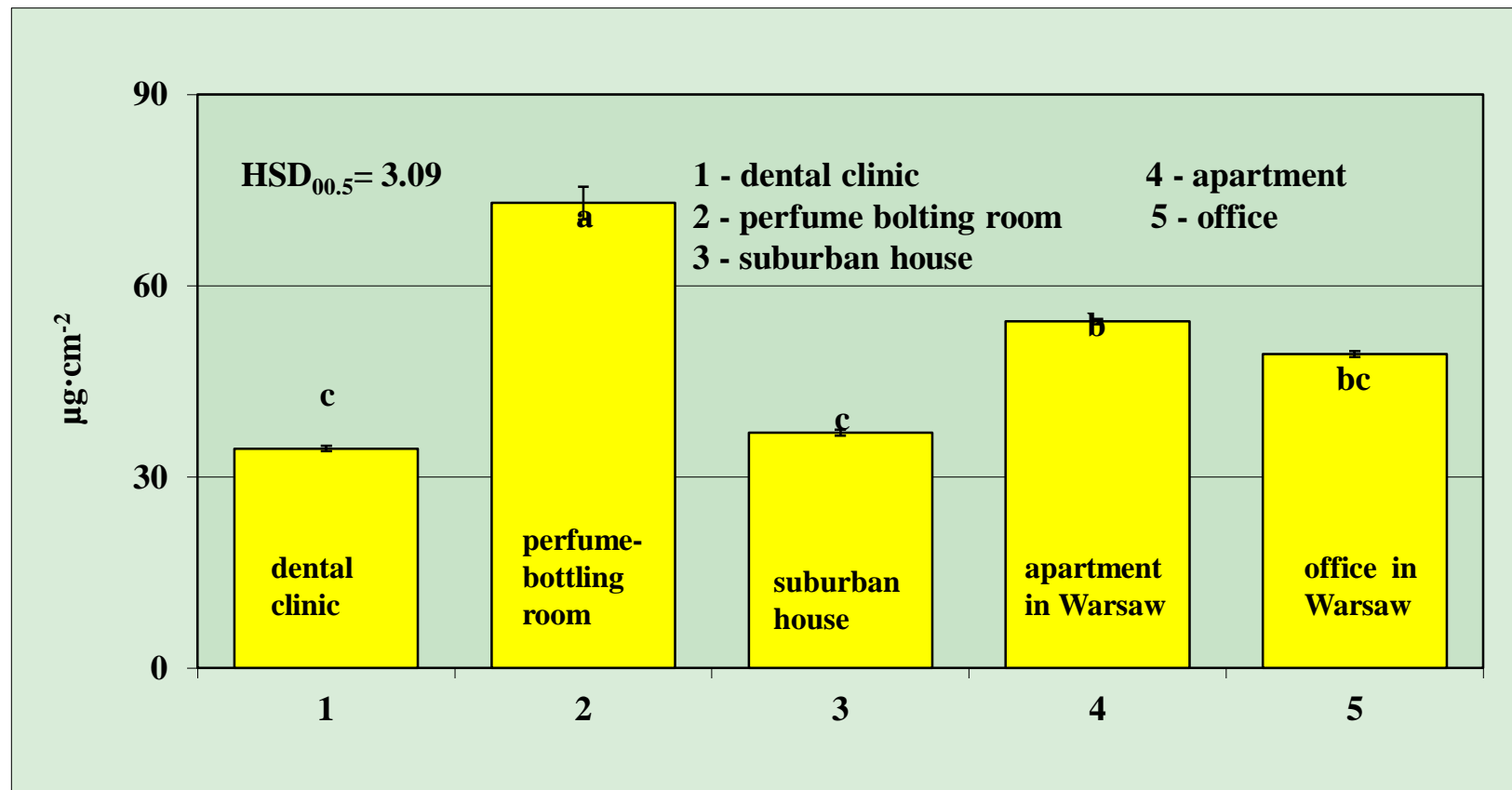
# RESULTS:

Amount of total PM (sPM+wPM), taking into account the size fractions, accumulated on leaf blades of *Chlorophytum comosum* growing for 2 months in five rooms differing in activities



# RESULTS:

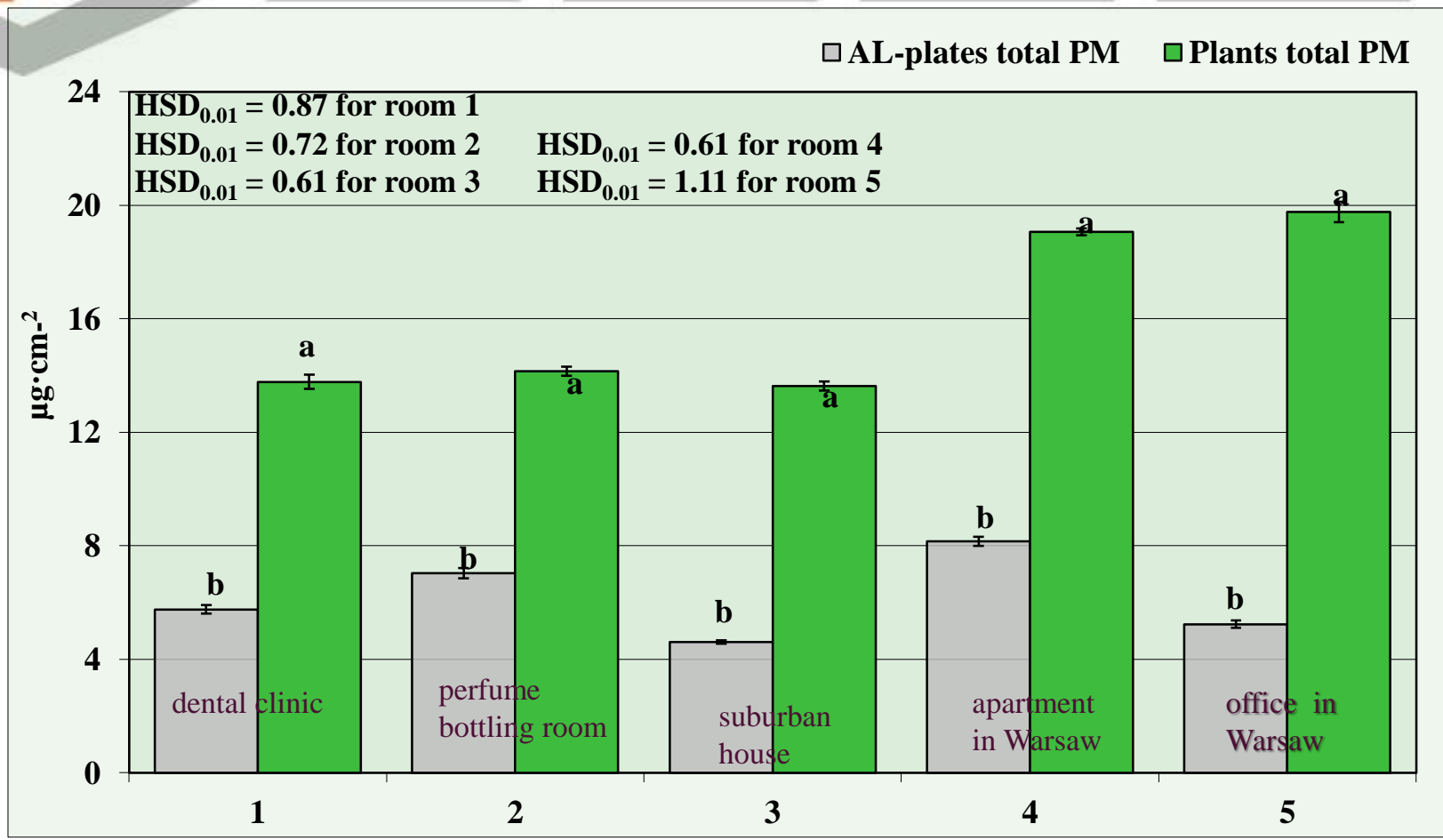
Amount of epicuticular waxes deposited on the surface of leaf blades of spider plants (*Chlorophytum comosum* L.) growing for 2 months in five rooms differing in activities





# RESULTS:

Amount of total PM accumulated on leaves *Chlorophytum comosum* L. and deposited on aluminium plates during 2 months of exposure to indoor air in five rooms differing in activities



# Summary and conclusions:

1. Spider plants (*Chlorophytum comosum* L.) grown indoors accumulate particulate matter of both categories and all size fractions, irrespective of their location and the type of activity taking place in the examined room. **They therefore phytoremediate PM from indoor air.**
2. The amount of PM accumulated on leaves depends on the kind of activity taking place in the particular room.
3. Fine PM, the most harmful to human health, is accumulated to a greater extent as wPM than sPM because it is attached more tightly to leaves and is thereby phytostabilised more effectively. This reduces the risk to human health to a greater extent.
4. Of the three size fractions examined, large PM constitutes the greatest proportion of PM accumulated on plants' leaves.
5. Accumulation of particulate matter on leaves also involves factors/forces other than gravitation.

## ***Recent related to the subject publications:***

1. Popek R., Gawrońska H., Gawroński S.W..2015. **The level of particulate matter on foliage depends on the distance from the source of emission.** Accepted for press in *International Journal of Phytoremediation*
2. Gawrońska H., Bakera B. 2014.. **Phytoremediation of particulate matter from indoor air by *Chlorophytum comosum* L. plants,** Air Qual Atmos Health DOI 10.1007/s11869-014-0285-4
3. Przybysz A., Popek R., Gawrońska H., Grab K., Romanowska K., Wrochna M., Gawroński S.W. 2014. **Efficiency of photosynthetic apparatus of plants grown in sites differing in level of PM.** *Acta Scientiarum Polonorum Hortorum Cultus* (13) 216-222.
4. Popek R. Gawrońska H.; Wrochna M., Gawroński S.W., Sæbø A. 2013. **Particulate matter on foliage of 13 woody species: Deposition on surfaces and phytostabilisation in waxes – a 3-year study.** *Journal of Phytoremediation* 15, 3, 1: 245-256
5. Sæbø A., Popek R., Nawrot B., Hanslin H.M., Gawronska H.. Gawronski S.W. 2012. **Plant species differences in particulate matter accumulation on leaf surfaces.** *Science of the Total Environment* 427–428 (2012) 347–354
6. Gawroński S.W. Greger M., Gawrońska 2011. **Plant taxonomy in metal phytoremediation.** In: Eds. Sherameti I., Varma A. 2011. *Detoxification of Heavy Metals*, Springer-Verlag: 91-110.
7. Dzierżanowski K., Popek R., Gawrońska H., Sæbø A., Gawroński S.W., 2011. **Deposition of particulate matter of different size fractions on leaf surfaces and in waxes of urban forest species.** *International Journal of Phytoremediation* 13: 1037-1046.

# Research Facilities available for the Polish Partner

Full lab equipment for measurements of :

- PM collected on leaves
- selected VOCs
- content of elements in leaves and soil (XRF)
- PM<sub>10</sub> and PM<sub>2.5</sub> in the air (Aspirator Bravo Plus HV)
- lab fully eqipped for molecular (genome level) analysis
- 



- **Research Facilities** available for the Polish Partner

## Non-destructive, portable equipment for evaluation of efficiency of photosynthetic apparatus and plant water status



**Chlorophyll Meter CCM 200,  
OPTI SCIENCES, USA**



**Fluorimeter Handy PEA,  
(Hansatech, UK)**

**Portable Photosynthesis System LICOR  
MI 6200 (A) and 6400 (B) incoln, Nebraska, USA)**

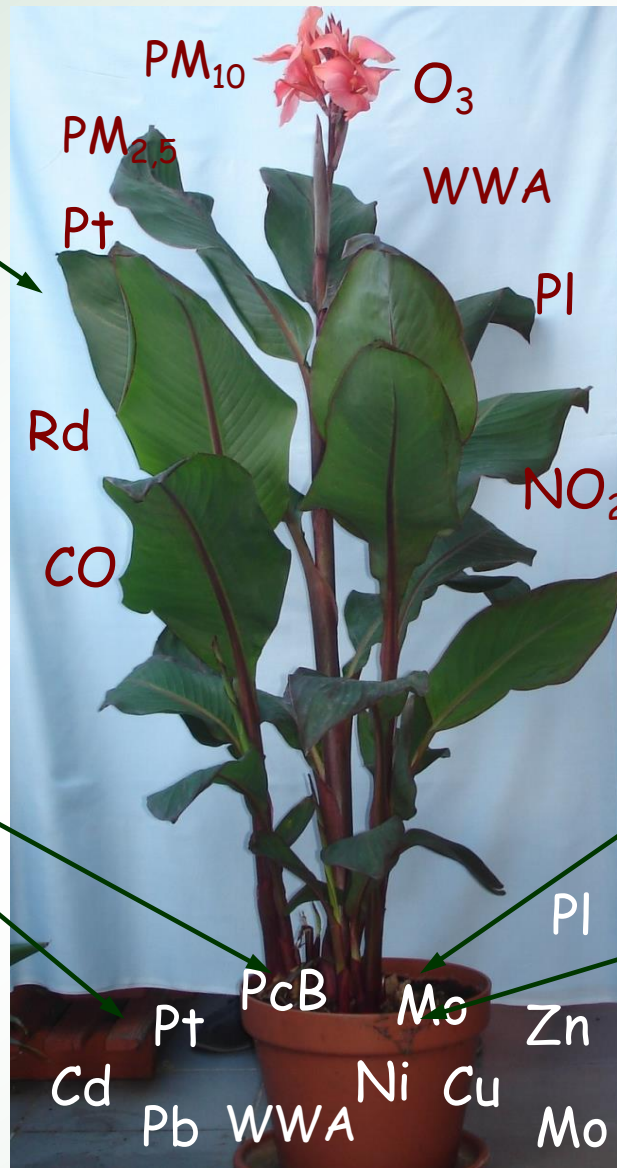


# IDEOTYP OF PLANTS FOR PHYTOREMEDIATION

(both indoor and outdoor)

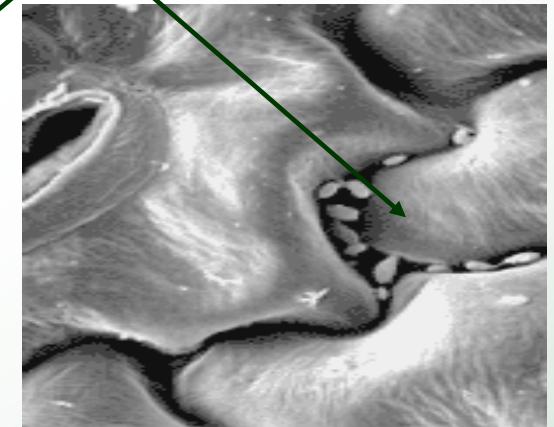
## Endobacterium:

*Burkholderia cepacia*  
*Microbacterium esteraromaticum*,  
*Tsukamurella paurometabolum*,  
*Pseudomonas chlororaphis*,  
*Kocura varians*



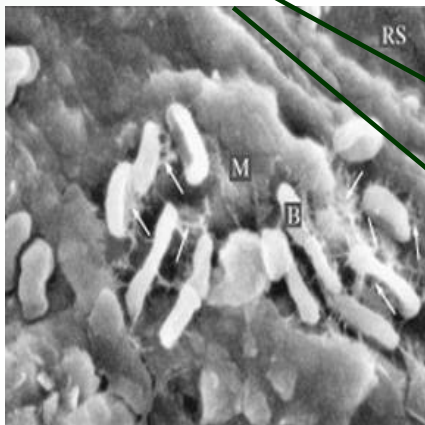
## Phyllobacterium:

*Pseudomonas*,  
*Micrococcus*,  
*Rhodotorula*  
*Erwinia herbicola*



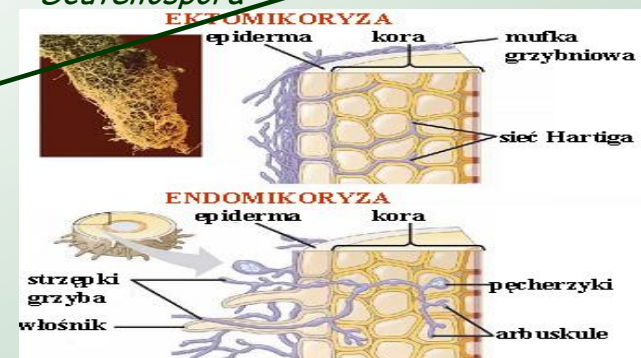
## Bacterium of rizospherum:

*Bacillus*  
*Arthrobacter*  
*Achromobacter*  
*Staphylococcus*  
*Alicialigenas*  
*Rhodococcus*  
*Pseudomonas*  
 i inne



## Endo- i Ecto mycorrhizae

*Glomus* 5000 gatunków  
*Giagospora* grzybów  
*Acaulospora*  
*Scutellospora*



# Suggested **R&I Needs** and plane for future research

Material and human capacity enhancement thanks to Warsaw Plant Health Initiative Project of REGPOT # FP7-REGPOT-2011-1-286093 funded within 7FP EU worth over 530,000€ allowed to establish Laboratory for the plant microorganisms interactions which is recognized as a key element for phytoremediation.





**Lyophilisator ALPHA 1-2 LO**



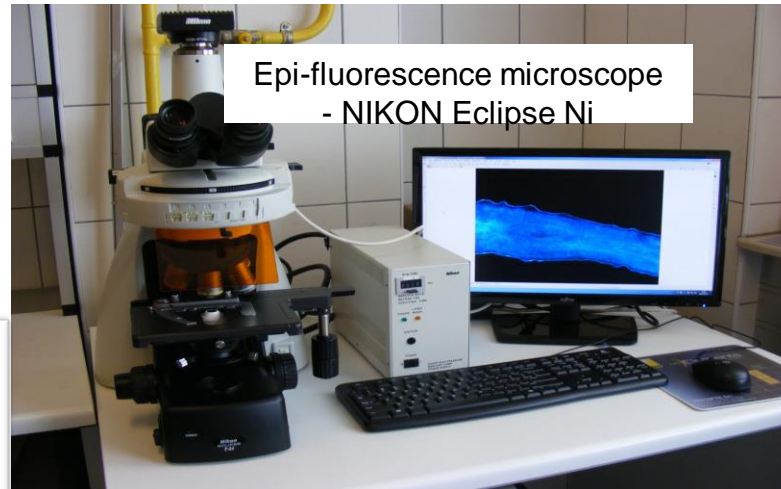
**HPLC –  
Shimadzu/Shimpo**



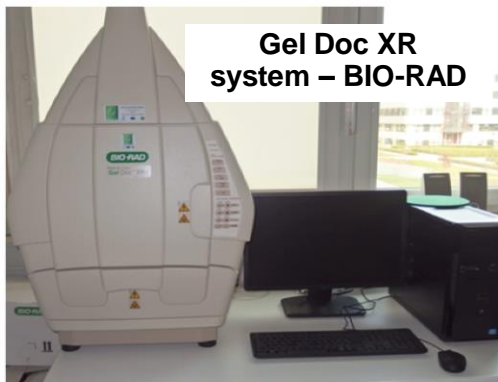
**Thermo Scientific™ Safe 2020  
Class II Biological Safety Cabinet**



**Small steam sterilizer  
CLASSIC 2100  
- Prestige Medical**



**Epi-fluorescence microscope  
- NIKON Eclipse Ni**



**Gel Doc XR  
system – BIO-RAD**



**System for metal content measurements  
XRF Alpha 4000 (Innov-X Systems, USA)**

# INNOVATIONS (of these and other our studies results):

- Using for cultivation, in humanosphere, plant species with high ability for PM and other pollutants uptake, degradation/detoxification is recognized innovative role of plants.
- Phytoremediation of pollutants from environment is possible via plant biomass composting and incineration in controlled manner in environmental biotechnology - phytoremediation.

Presented results are already published:

H. Gawrońska, B. Bakera 2014. Phytoremediation of particulate matter from indoor air by *Chlorophytum comosum* L. plants, Air Qual Atmos Health DOI 10.1007/s11869-014-0285-4

Websites for Chlorophytum photos:

<https://encryptedtbn2.gstatic.com/images?q=tbn:ANd9GcQLIGXY8I0L1kTlq3iphkti7MqsMO3FfkPITWt0Rm7d96T1YP65>

[https://encrypted-tbn3.gstatic.com/images?q=tbn:ANd9GcT1aGITUZi6KGdZuEr54OJML8Yqa3xQRNsVqYP8Fndd62zt\\_2j8Bg](https://encrypted-tbn3.gstatic.com/images?q=tbn:ANd9GcT1aGITUZi6KGdZuEr54OJML8Yqa3xQRNsVqYP8Fndd62zt_2j8Bg)

<http://www.google.pl/imgres?imgurl=http%3A%2F%2Fwww.hortipendium.de%2Fimages%2Fthumb%2F8%2F80%2FHierbabuena>

### Acknowledgments:

This study was supported by a grant from Norway through the Norwegian Financial Mechanism, # PNRF-193-AI-1/07, and by the Warsaw Plant Health Initiative, # FP7-REGPOT-2011-1-286093 granted to S.W. Gawronski

**Thank you for your attention**



**Welcome to Warsaw University of Life Sciences-SGGW**