European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir* COST Action TD1105

### **Special Session: Measuremetns of PM Pollutants Accumulated on Plant Leaves in Poland**

## Duisburg, Germany, 4 - 6 March 2013

<u>Action Start date</u>: 01/07/2012 - <u>Action End date</u>: 30/06/2016 Year: 2012-2013 (*Starting Action*)



### Helena Gawrońska

**Function in the Action** : replacement for MC Member of WG 3 - Stanislaw W. Gawronski



#### Laboratory of Basic Research in Horticulture

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COST is supported by the EU Frant arsaw University of Life Sciences-SGGW, Warsaw, Portan ough a European Commission contract

# Major pollutants in air

PCB ozon SO<sub>2</sub> PAHs Gases<sup>CO</sup>2 CO dioxins NO<sub>x</sub> Dioxins PCB Particulate Matter - PM Heavy

PAHs

metals



## **Background/Problem statement:**

- Particulate matter (PM) are harmful for man, being responsible for various allergic, respiratory and cardiovascular systems diseasis including cancer of both
  - PM is the 2nd after nicotine factor causing lung cancer

- PM, on average, shortens Europeans life expectancy by

8 months, in cleanest part like Finland only by 4 months

but in some sites in Europe even by 3 years (Silesia, Poland;

Po Valey, Italy; border Belgium and Germany).

Challenge(s): Improving air quality and reduce human<sup>cooperation in science and technology</sup> <sup>3</sup>

## • Objectives of our studies were/are to:

(i) compare genetic ability of various plant species in PM capturing

(ii) estimate potential of selected species for "harvesting" PM

from air

(iii) evaluate effect of PM presence on leaves on leaf vital

processes and

(iv) using plants to clean up air in places where we live, work

and play including indoor

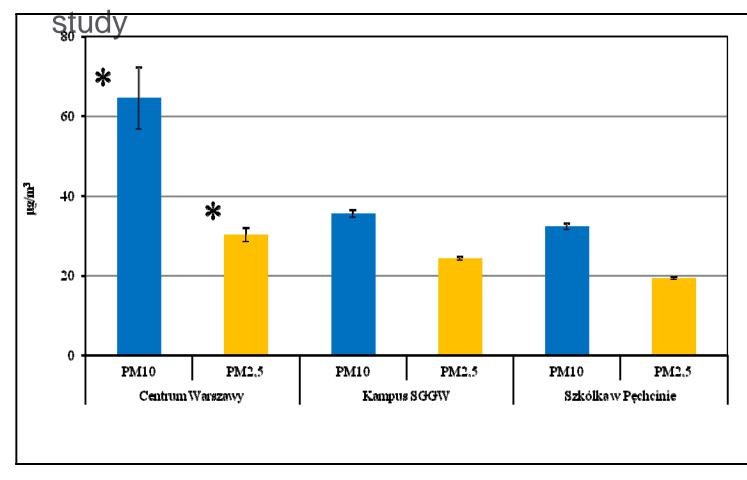
# • Involvement in WP3 of this COST Action

## **Current activities:**

- (i) Measurements of PM accumulated on leaves of selected, for urban areas, 22 trees species exposed to nearly the same level of PM in air
- (ii) Searching for relationships between amount of PM accumulated on leaves and selected leaves characteristics: amount of waxes, leaf shape, hairiness

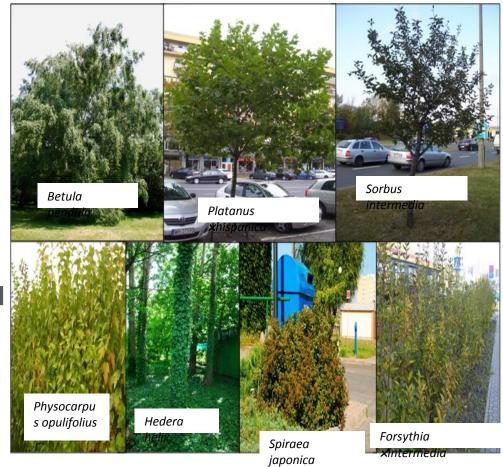


Concentration of PM in the air in 3 locations used in this



## **Current activities:**

- (iii) Comparative study on amount of PM accumulated on leaves of 7 selected plant species grown in locations varying in the level of PM (high/ medium and low) in the air (locations as above)
- (iv) Evaluation of the effect of PM on leaves functions based on some physiological processes on leaves of 7 selected plant species grown in locations varying in the level of PM (locations as above) and



(v) Estimation of the potential of selected species for PM "harvesting PM EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY from air

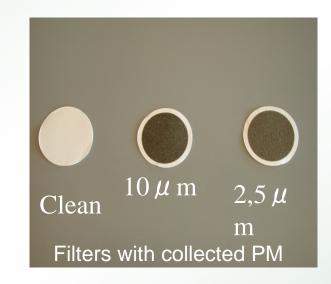
#### LBRH of WULS is eguipped with: apparatus for PM<sub>10</sub> and PM<sub>2.5</sub>

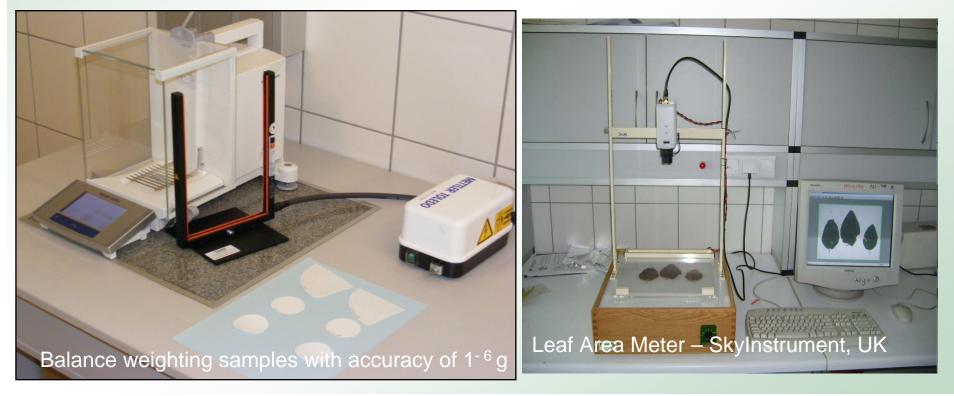




#### Equipment and utensils used for PM measurements







# Equipment for evaluation of efficency of photosynthetic apparatus and plant water status





Portable Photosynthesis System LICOR model 6200 (A) and 6400 (B) (Lincoln, Nebraska, USA)







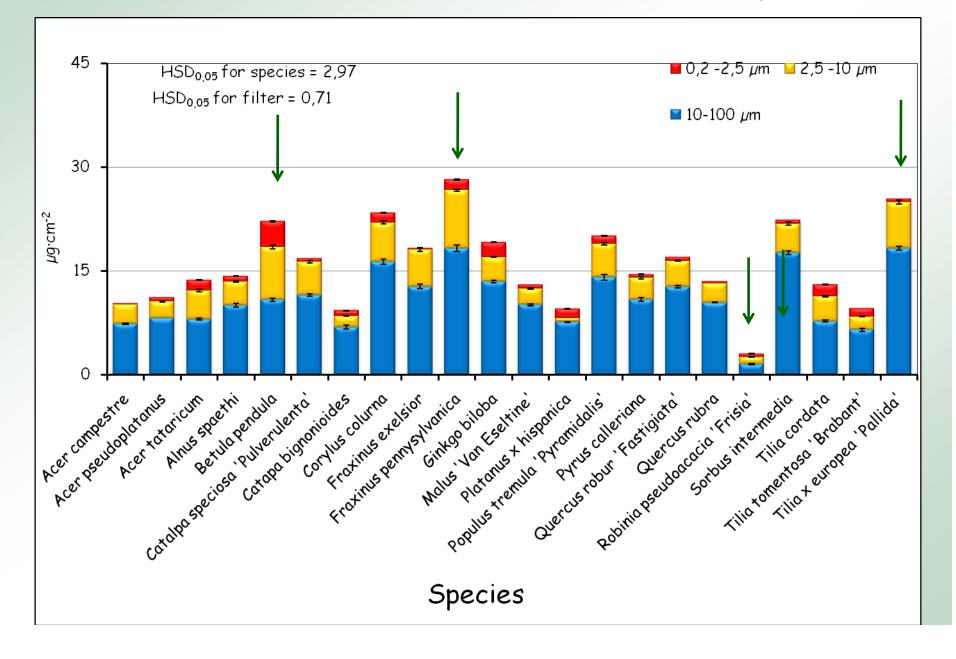
Chlorophyl Meter CCM 200, OPTI SCIENCES, USA

## **Achieved results:**

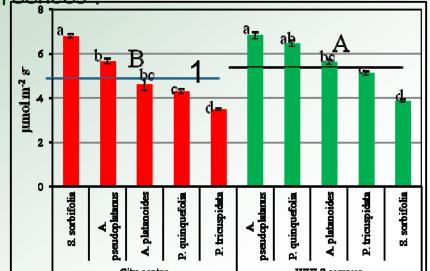
Particulate matter and waxes deposited on trees leaf surface ( $\mu g \text{ cm}^{-2}$ )

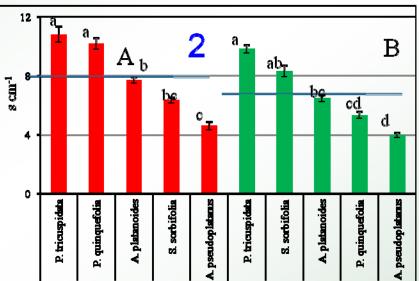
	Chaolod	PM			Waxes
	Species	PM 11	PM <sub>2,5</sub>	Σ	
	Quercus rubra	12,0	2,8	14,8	110,6
	Populus simoni	27,4	9,9	37,3	86,5
	Betula pendula	34,3	9,5	43,8	645,7
Leeds	Pyrus calleryana	33,4	10,0	43,4	157,2
	Fraxinus excelsior	23,2	5,6	28,8	94,9
	Sorbus intermedia	31,0	11,4	42,4	91,0
	<b>COPPLIES ALDA</b> ROPEAN COOPERATION IN SCIENCE AND TEC	<b>15,5</b>	5,3	20,8	122,3

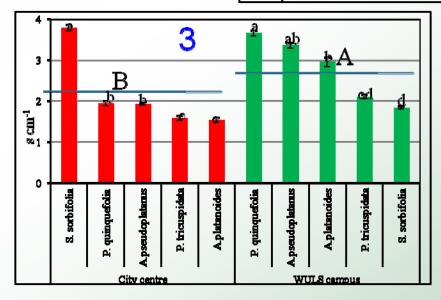
## Amount of particulate matter deposited on leaf surface and in waxes of 22 tree species



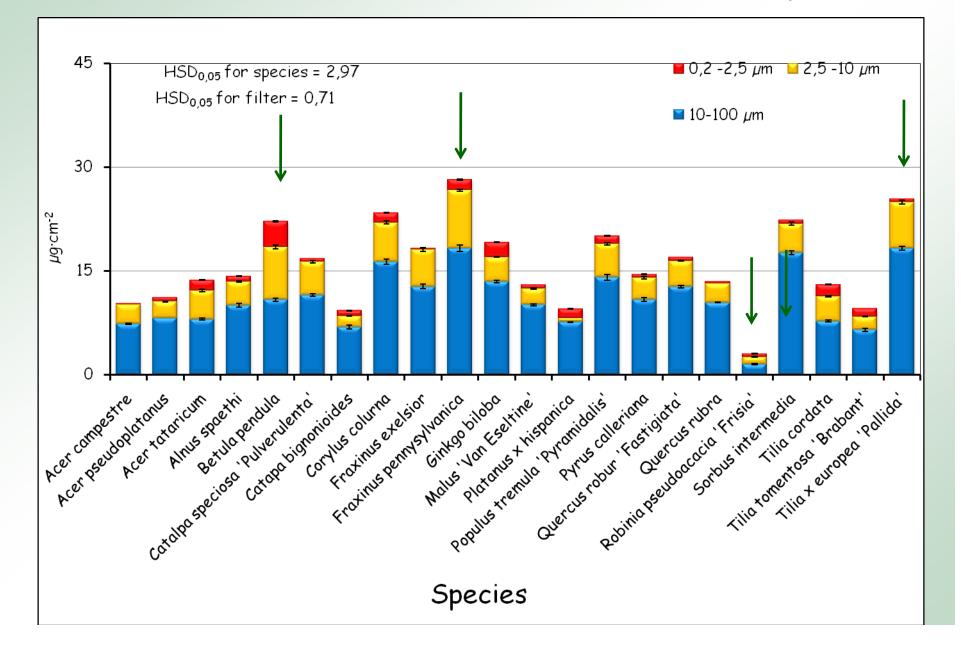
Effect of PM level recorded in 3 tested locations on intensity of photosynthesis (1), stomatal resitance (2) and transpiration (3). Data are mean  $\pm$ SE, n= 200 (with 4 months x 10 biological replications = individual plants x 5 measurements in each, Horizontal lines represents average for location and letters reffer to significant diffeences.

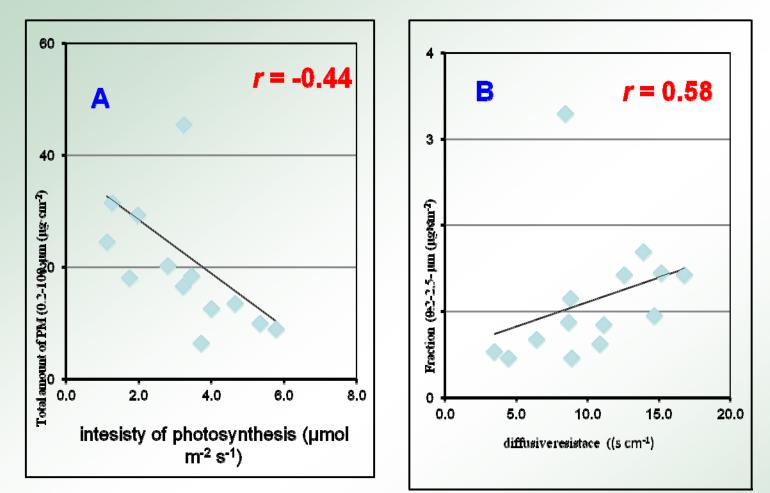






## Amount of particulate matter deposited on leaf surface and in waxes of 22 tree species





Correlation coeficient (r) between amount of PM of all size fractions accumulated on leaves and and intensity of photsynthesis (A) and between PM of size fraction 0.25 - 2.5 µm and stomatal diffuse resistance (B).



# Annual emission of PM<sub>10</sub> in Warsaw ~ 4 ton what means ~ 8 mg/m<sup>2</sup> of ground

Linden tree of 5 m in height might accumulate on leaves ~ 2 g PM<sub>10</sub>

# **INNOVATIONS:**

- Using, for cultivation in man surroundings, plant species with high ability for PM accumulation on leaf's surface and phytostabilization in waxes is recommended
- Phytoremedation of PM from environment, together with toxic compounds condensed on them, is possible via plant biomass composting and incineration in controlled manner.



## **Activities directions as future ACTIVITIES:**

- Selection of plant species of high phytoremediation ability and suitable for cultivation in surrounding of roads with heavy traffic
- Evaluation of usefulnes of plants for indoor phytoremediation



# **CONCLUSIONS:**

- Vegetation plays important role in uptake
  of particulate matter from air
- Plant species/cultivars significantly differ in ability to uptake particulate matter from air
- There are plant species which are able to survive in polluted city environment without inhibition of crucial vital processes as photosynthesis.



#### **Recent, related to topic of this meeting, publications:**

1.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

2.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 3.Gawroński S.W. Greger M., <u>Gawrońska</u>.2011. Plant taxonomy in metal phytoremediation. In: Eds. Sherameti I., Varma A. 2011. Detoxification of Heavy Metals, Springer-Verlag: 91-110.

4.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.

Team: Robert Popek Kajetan Dzierżanowski Helena Gawrońska Stanisław W. Gawroński - team leader

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