Short Scientific Visit Report

Particulate Matter Mitigation Potential of *Fraxinus excelsior* and *Platanus orientalis* - a Case Study for Yerevan

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The relevance of research topic: Theme 1 - Forests for people  
b. The role of forests and trees in rural and urban areas for human health, wellbeing and quality of life

* Before October 2018 the Research Institute on Terrestrial Ecosystems (IRET) of the National Research Council of Italy (CNR) was known as the Institute of Agroenvironmental and Forest Biology (IBAF)
Background

A major air pollutant on urban and industrial sites is known to be Particulate Matter (PM). Abundant researches have indicated that urban trees effectively reduce concentrations of different air pollutants emphasizing PM.

Commonly, when exceeding acceptable limits, PM poses a serious threat to human health. For instance, particles with a diameter <10 μm (PM10) may enter human lungs and cause cardiovascular diseases, lung dysfunction and even lung cancer. PM is also a carrier of toxic substances and particularly heavy metals, which can also cause negative health effects e.g. disorders in hematogenesis, the central nervous, cardio-vascular and urogenital systems. That is why it is so essential to both investigate peculiarities of PM deposition on urban tree leaves and get a better understanding of its mechanism.

However, so far almost no in-depth researches into PM mitigation by urban trees have been done in Armenia, while the PM deposition issue is particularly urgent to Yerevan – Armenia’s capital.

Purpose of Short Scientific Visit

The overall purpose of this Short Scientific Visit (SSV) was studying PM mitigation potential in Fraxinus excelsior and Platanus orientalis - the most widespread tree species found in Yerevan and exhibiting high tolerance to the city conditions. As a result, due to SSV first ever PM mitigation data were obtained for the two Yerevan tree species which are the study objects for my current PhD research as well.
Sampling

The research materials were the leaves of *F. excelsior* and *P. orientalis*. Leaf sampling was done a day before the start of my SSV on September 16, 2018 from 4 sites throughout Yerevan – not only the capital, but also the biggest and most populous industrial and economic center accommodating some 42.1% of all industrial enterprises of the country. It is also worth to mention that the city has been under the impact of steadily increasing dust load resulting from its heavy traffic, intense construction and so on.

![Fig. 1. Fragment of sampling process](image)

On three sampling sites mature park and street specimens of *F. excelsior* and *P. orientalis* were selected and green, intact, fully mature leaves gathered from the central layer of each tree crown. On the 4th sampling site located in a heavily industrialized district of the city leaves were sampled only from street specimens of *F. excelsior* and *P. orientalis*.

Per specimen and per sampling site 3 replicas were gathered constituting a total of 42 samples which were transported to Italy at once.
Work carried out during SSV

Implementation of PM analyses through a washing/filtering method

In compliance with the Work Plan (see attachment 1) during the first month of SSV I analyzed PM employing a washing/filtering method. The analyses were carried out in stages as follows:

1. Drying the labeled filters in the Tecnovetro M150-TB thermostat at 65°C (fig. 2) for an hour and then stabilizing for 30 min. in a closed room under controlled humidity and temperature.

Fig. 2. Drying labeled filters in the thermostat.

Filters used included

- FILTER-LAB, cellulose, type 1250, pore size 10μm;
- FILTER-LAB, cellulose, type 1244, pore size 2.5 μm;
- mdi, cellulose nitrate, type CN-S, pore size 0.2 μm

2. Weighing the clean filters on the Sartorius scales (R-180D model ),
3. Washing approximately a 300-500 cm² leaf area per sample with micro-distilled water,
4. Filtering the generated water by 3 steps: 1) a sieve with a 100mm pore size, 2) cellulose and 3) cellulose nitrate filters forced by a vacuum pump (fig. 3).
5. After the water had been filtered, the filters were dried and weighed as described earlier in Stages 1 and 2.

6. After being washed the sampled leaves were dried in room conditions and leaf surfaces measured applying the ImageJ open source software. The analyses were followed by data collection and compilation of a relevant database to be then analyzed and interpreted.

**Characterization of a leaf-level PM by scanning electron microscopy (SEM)**

The second stage of my research ran in IRET affiliation in Naples and involved application of a Phenom ProX (Phenom-World, The Netherlands) scanning electron microscope equipped with X-ray analyzer (EDX) and a charge-reduction sample holder intended for bio-substances. SEM was done on a separate leaf randomly taken from the sampled leaves. From each leaf, two portions sized 1 cm² were cut from the central rib area, then the abaxial and adaxial leaf surfaces were stuck on PELCO Tabs coated with carbon conductive material.

Subsequent imaging was supported by electron energy of 5 keV in order to avoid the surface charging. Per leaf surface 10 random images with resolution of 1024 × 1024 pixels were obtained by 150 µm wide scans.
The Phenom Pro Suite software underpinned elemental analysis for determining heavy metals in PM particles. The leaf surfaces were scanned at 50 μm scan size, with electron energy of 15 keV. The corresponding EDX spectra were produced by directing a laser beam onto the center of particles.

In order to determine the number and the dimensions of the leaf deposited particles most of the generated SEM images are planned to be analyzed at my home institution - CENS through a Gwyddion software.

**Fig. 4. Working process with scanning electron microscope**

**Fig. 5. Images obtained through Phenom ProX scanning electron microscope**
Data analysis and interpretation.

According to the Work Plan, the 3rd stage of my research was planned to include analysis and interpretation of overall data obtained during the first two stages of my research in Italy. However in the result of two-months long analyses a huge amount of data was generated, of which 10% only were analyzed over the final month of my SSV. Both the analysis and interpretation of the rest of data are planned to be carried out later on in Armenia.

Participation in scientific events

I wish to place a special emphasis on a fact that due to IUFRO- EFI Young Scientists Initiative Grant Program I could take part in two exclusively important scientific events:

1. EFI Annual Conference 2018, 26-28 September, Alghero, Sardinia, Italy,
2. World Forum on Urban Forests, 28 November - 01 December 2018, Mantova, Italy,

which were held in Italy during my SSV and were attended by worldwide recognized scientists. It was a unique opportunity for me to build scientific links to outstanding professionals in the field of urban forestry, and I firmly believe that these links will transform into effective collaboration in the future.

Initiated or projected publications/articles resulting or to result from the SSV

One of major achievements from SSV will be publication of a joint Italian-Armenian article, which is currently being prepared and is devoted to identification of PM mitigation potential of *Platanus orientalis* and *Fraxinus excelsior* in conditions of city of Yerevan.
Acknowledgement

I would like to express my cordial thanks to the organizers of IUFRO-EFI Young Scientists Initiative Grant Program for providing me such an opportunity to improve my professional skills and knowledge so essential for me as a PhD student. I extend my sincere thanks to Daniel Boehnke for his kind assistance and consideration.

I would like to express my deepest gratitude to my supervisor Dr. Carlo Calfapietra for his supporting and hosting me at CNR IRET.

I extend my special gratitude to Dr. Gregorio Sgrigna, who shared most of my research in the IRET labs, readily and patiently guided, assisted and encouraged me in my routine work. It’s a special pleasure for me to thank all of my colleagues, mates and all those who did every effort to make my short scientific visit to beautiful Italy unforgettable!

Fig. 6. Left to right: Lilit Khachatryan, Dr. Carlo Calfapietra and Dr. Gregorio Sgrigna
## Attachment 1.

**Work Plan Template of my Short Scientific Visit**

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