



COST Action FP1202

Strengthening conservation: a key issue for adaptation of marginal/ peripheral populations of forest trees to climate change in Europe (MaP-FGR)

2016 TRAINING SCHOOL

Genetic diversity of marginal tree populations: from genomics to phenotypic variation

REPORT

13th June – 16th June 2016

Novi Sad, Serbia

LIST OF TRAINEES AND TRAINERS

	Surname	Name	Country	E-mail	Institution	Role
1	Andrić	Ivan	Croatia	iandric@hrast.sumfak.hr	Faculty of Forestry, University of Zagreb	Trainee
2	Cvjetković	Branislav	Bosnia	cvjetkovicb@gmail.com	Faculty of Forestry Banja Luka (Bosnia and Herzegovina)	Trainee
3	Čortan	Dijana	Serbia	dijanacortan@yahoo.com	University of Novi Sad, Faculty of Education	Trainee
4	Daničić	Vanja	Bosnia	vanja.danicic@sfbl.org	Faculty of Forestry Banja Luka (Bosnia and Herzegovina)	Trainee
5	De Dato	Giovanbattista	Italy	giovanbattista.dedato@crea.gov.it	CREA SEL Arezzo	Trainee
6	Kapetanidou	Danai- Evrykleia	Greece	kapdanai@gmail.com	Department of Democritus University of Thrace	Trainee
7	Kišek	Mateja	Slovenia	kisekmateja@gmail.com	Biotechnical Faculty, Department for Forestry and Renewable Forest Resources, Ljubljana (Slovenia)	Trainee
8	Korompoki	Ino-Vasileia	Greece	ikorompo@for.auth.gr	Department of Forestry and Natural Environment, Faculty of Agriculture, Forestry and Natural Environment, Aristotle University of Thessaloniki	Trainee
9	Kotina	Vasiliki-Maria	Greece	vmkotina@for.auth.gr	Department of Forestry and Natural Environment, Faculty of Agriculture, Forestry and Natural Environment, Aristotle University of Thessaloniki	Trainee
10	Lanšćak	Miran	Croatia	miranl@sumins.hr	Croatian Forest Research Institute	Trainee
11	Srdoč	Mihael	Croatia	mihaels@sumins.hr	Croatian Forest Research institute	Trainee
12	Stanković	Milena	Bosnia	stankovic.milena08@yahoo.com	University of East Sarajevo, Department for Forestry	Trainee
13	Zacharopoulou	Irene	Greece	ezacharo.for@gmail.com	Aristotle University of Thessaloniki	Trainee

	Surname	Name	Country	E-mail	Institution	Role
1	Kraigher	Hojka	Slovenia	hojka.kraigher@gozdis.si	Slovenian Forestry Institute (Ljubljana, SI)	Trainer
2	Mátyás	Csaba	Hungary	matyas.csaba@nyme.hu	Institute of Environmental and Earth Sciences, University of West Hungary, (Sopron, HU)	Trainer
3	Avramidou	Evangelia	Greece	aevaggelia@yahoo.com	Faculty of Forestry and Natural Environment, Aristotle University of Thessaloniki (Thessaloniki, GR)	Trainer
4	Aleksić	Jelena	Serbia	aleksic_jelena@yahoo.com.au	Institute of Molecular Genetics and Genetic Engineering, University of Belgrade (Belgrade, RS)	Trainer
5	Kovačević	Branislav	Serbia	branek@uns.ac.rs	Institute of Lowland Forestry and Environment (Novi Sad, RS)	Trainer
6	Trudić	Branislav	Serbia	brauxsimple28@gmail.com	Institute of Lowland Forestry and Environment (Novi Sad, RS)	Trainer
7	Stojnić	Srđan	Serbia	srdjan.stojnic@uns.ac.rs	Institute of Lowland Forestry and Environment (Novi Sad, RS)	Trainer

Time	Monday (13 th June)	Tuesday (14 th June)	Wednesday (15 th June)	Thursday (16 th June)
09:00-10:30	Why are marginal tree populations from the Balkans threatened by the global warming? (Dr. Jelena Aleksić)	Root symbionts of MaP-FGR species as a key factor for survival of seedlings in a changing environment (Prof. Dr. Hojka Kraigher)	<p>FIELD TRIP</p> <p>Conservation of Pedunculate oak forest genetic resources in light of climatic changes</p> <ul style="list-style-type: none"> • Climate change impact on Pedunculate oak forests and modeling • Adaptive forest management in Pedunculate oak natural stands • Visiting of the Institute of Lowland Forestry and Environment 	Quantitative data management in forest studies (Dr. Branislav Kovačević)
10:30-11:00	Break	Break		Break
11:00-12:00	Conservation of MaP-FGR species through measures for production and use of forest reproductive material – a case study from Slovenia (Prof. Dr. Hojka Kraigher)	Evolutionary ecologic interpretation of genetic field trials – conclusions for adaptive strategy of forest trees (Prof. Dr. Csaba Mátyás)		Quantitative data management in forest studies (Dr. Branislav Kovačević)
12:00-12:30	Break	Break		Break
12:30-13:30	Forest genetic resources of marginal populations: A case study of <i>Prunus avium</i> in Greece (Dr. Evangelia Avramidou)	Modeling difficulties of extreme events and expected shifts of productivity and of distribution of forest trees – a specific issue of distribution margins (Prof. Dr. Csaba Mátyás)		Phenotypic variation of <i>Fagus sylvatica</i> provenances in Serbian common garden experiments (Dr. Srđan Stojnić)
13:30-14:30	Lunch	Lunch		Lunch
14:30-16:00	Proper sampling methodology – basic step toward successful genomic and transcriptomic analysis of forest tree species (Dr. Branislav Trudić)	New insights into genetic patterns among and within populations of a relict and endemic conifer, <i>Picea omorika</i> (Dr. Jelena Aleksić)		Assessment of FGR: "From theory to practice" (Dr. Evangelia Avramidou)
16:00-16:30	Break	Break		Break
16:30-17:30	Presentation of the trainees (app. 5-10' each)	<i>Quercus robur</i> from Srem region, Serbia - old selection story become new climate change reality (Dr. Branislav Trudić)	Open discussion, evaluation and closing	

The Training School has been organized in collaboration with the University of Novi Sad, Institute of Lowland Forestry and Environment (ILFE-UNS) (www.ilfe.org).

Lectures on the topic: "Genetic diversity of marginal tree populations: from genomics to phenotypic variation" were covered by TS trainers (H. Kraigher, C. Mátyás, E. Avramidou, J. Aleksić, B. Kovačević, B. Trudić and S. Stojnić).

In detail the topics covered in the lectures and according to the program of the Training School were the following:

- **Why are marginal tree populations from the Balkans threatened by the global warming? (Dr. Jelena Aleksić)**
Trees and the on-going climate change; responses of tree species to climate changes; migration; extinctions; adaptations; levels of genetic diversity; gene flow; Balkan Peninsula; specific geological history of Balkan Peninsula; the Balkans during the Quaternary; relict populations within the Balkans; peripheral refugial populations; peripheral populations of cold-adapted species within the Balkans; genetic patterns within the Balkans; ACC within the Balkans; short- and long-term forecasts.
- **Conservation of MaP-FGR species through measures for production and use of forest reproductive material – a case study from Slovenia (Prof.Dr. Hojka Kraigher)**
Terminology defining MaP-FGR; measures for protection of FGR; example of a decision cascade process for selecting genetic conservation actions in peripheral populations; measures for conservation of FGR – the case of Slovenia; sustainable, close-to-nature and multifunctional forest management; silviculture based on forest genetics; basis for the delineation of regions of provenances; directions for tending and collection of seeds; the Slovenian FRM certification scheme and the Slovenian forest gene bank; EUFGIS and the basis for the network of DCU; forest gene reserves in Slovenia; adaptive forest management supporting FGR; forest genetic monitoring; Population characteristics in time: demographic characteristics and genetic variability.
- **Forest genetic resources of marginal populations: A case study of *Prunus avium* in Greece (Dr. Evangelia Avramidou)**
Climate change; definition of marginal and peripheral population; definition of rear; leading margin and disjunct population. Forces alter allele sequences; natural selection; mutation; gene flow; genetic drift; inbreeding; a case study of *Prunus avium* in Greece; presentation of results He; AMOVA; Structure; FCA; effective population size for five natural *Prunus avium* populations; beyond population genetics; epigenetics; definition of epigenetics; DNA methylation; epigenetics in *Prunus avium* populations; comparison of genetic and epigenetic analysis; epigenetic variation completely uncoupled from genetic variation.
- **Proper sampling methodology – basic step toward successful genomic and transcriptomic analysis of forest tree species (Dr. Branislav Trudić)**

Sampling and sample preparation of plant tissues; number of samples; plant material; genomics vs transcriptomics vs forest genetics vs proteomics; steps and equipment; bark-cambium type of plant material; leaves and roots; gene expression analysis (transcriptome analysis).

- **Root symbionts of MaP-FGR species as a key factor for survival of seedlings in a changing environment (Prof. Dr. Hojka Kraigher)**

Forest and forest soils as regulators of C dynamics, pools and fluxes; organism in soil; mycorrhiza; interactions between the form and the function of mycorrhiza; mycorrhiza in forest successions; form of mycorrhiza of some tree and shrub spp in Slovenia; hormonal regulation: mycorrhizal fungi produce the whole list of PGR; cytokinins; cytokinins and pollution; strigolactones; root to shoot to root signalling; common mycelial networks link belowground part of ecosystem; ectomycorrhizal diversity; multiple symbioses in mycorrhiza; interactions in mycorrhizosphere: mhb (mycorrhiza helper bacteria).

- **Evolutionary ecologic interpretation of genetic field trials – conclusions for adaptive strategy of forest trees (Prof. Dr. Csaba Mátyás)**

Definitions of evolutionary ecology; ecological genetics' applied areas; natural selection along climate severity clines; genetic diversity linked to ecological status; (Micro-) evolutionary effect of diversity; gene diversity characteristics of forest trees; connection between genetic diversity and distribution, density and mating type in trees; reproduction biology; genetic constraints of effective genetic adaptation through selection; evolutionary-historic effects; human effects on forest gene resources; ecological genetic „dogmas” in practical forestry.

- **Modeling difficulties of extreme events and expected shifts of productivity and of distribution of forest trees – a specific issue of distribution margins (Prof. Dr. Csaba Mátyás)**

Adaptive management for an uncertain future; how will trees respond within a generation; reproductive material for the next tree generation; choosing forest reproductive material; how to match FRM with future climates; management options for FRM choice in changing environments; choosing provenances adapted to future climates; principles for adaptive management; phenotypic plasticity; creation of phenotype across environments; importance of plasticity for adaptivity; functioning of plasticity; genotype x environment interaction; plasticity in growth response across environments; plasticity in allocation of assimilates; epigenetics.

- **New insights into genetic patterns among and within populations of a relict and endemic conifer, *Picea omorika* (Dr. Jelena Aleksić)**

Serbian spruce as a rare conifer endemic to the central Balkans; molecular spruce phylogenies; flaws of previous molecular phylogenies; Serbian spruce reproductive strategy; Serbian spruce natural range and consensus data; genetic profile of Serbian spruce populations and species *per se*; how Serbian spruce maintains high levels of genetic diversity in populations/species *per se*; Serbian spruce and the climate change.

- ***Quercus robur* from Srem region, Serbia - old selection story become new climate change reality (Dr. Branislav Trudić)**
Pedunculate oak forests in Serbia; actual strategies regarding conservation/breeding of pedunculate oak gene pool in Srem; climate change influence on pedunculate oak gene pool; determination of biochemical and genetic bases for the difference in drought tolerance in pedunculate oak varieties; genetic structure profile using SSR markers; monitoring of the candidate gene expression level; assessment of oxidative stress; genomic/transcriptomics of pedunculate oak.
- **Quantitative data management in forest studies (Dr. Branislav Kovačević)**
Variability; assessment and description of genetic diversity; leaf morphological characters; *Populus nigra* L.; descriptive statistics; analysis of variance; F-test and coefficients of variation; correlation; multivariate analysis; principal component analysis; discriminative analysis; stepwise discrimination analysis; cluster analysis.
- **Phenotypic variation of *Fagus sylvatica* provenances in Serbian common garden experiments (Dr. Srđan Stojnić)**
Climate change impact on European beech; provenance trials; the networks of beech provenance trials; beech provenance trials in Serbia; stability and adaptability of provenances based on height growth; gas exchange parameters; plasticity of wood anatomical structure; stomatal features in response to drought stress; phenotypic plasticity of leaf anatomical structure; intra- and inter-provenance variation of leaf morphometric traits; xylem vulnerability to embolism in European beech *in situ* populations.
- **Assessment of FGR: "From theory to practice" (Dr. Evangelia Avramidou)**
Measure changes in allele frequencies for marginal populations; molecular markers; molecular techniques; which marker for what purpose; codominant and dominant markers; SSR markers; advantages and disadvantages of SSR; overview of DNA extraction; genotyping procedure; capillary electrophoresis; Gene mapper presentation; genetic programs used in genetic studies of populations; GenAlex practice; example dataset of *Prunus avium* for estimation of H_e ; Fstat; AMOVA, HWE; PCoA.

Trainees' Presentations

During the first day, the trainees had the opportunity to present an overview of their research, research achievements and interests in 5-10' presentations that were followed by short discussion and questions. The trainees presented following presentations:

- Genotypic and phenotypic variability of narrow-leaved ash (*Fraxinus angustifolia* Vahl) in clonal seed orchards (Ivan Andrić)
- Genetic and physiological characteristics of Norway spruce (*Picea abies* Karst.) in progeny tests in Bosnia and Herzegovina (Branislav Cvjetković)

- Genetic diversity of black poplar (*Populus nigra* L.) natural populations in the area of Vojvodina assessed by genetic markers (Dr. Dijana Čortan)
- Genetic diversity and morphological variability of natural populations of *Castanea sativa* in BiH (Vanja Daničić)
- Genetic structure of *Betula pendula* (Roth) marginal populations in their Southern European limits (Dr. Giovanbattista de Dato)
- Genetic diversity of *Fagus sylvatica* rear edge populations (Danai- Evrykleia Kapetanidou)
- Morphology and genetic diversity of european crab apple (*Malus sylvestris* Mill.)
- Genus *Eucalyptus* tree breeding (Vasiliki-Maria Kotina and Ino-Vasileia Korompoki)
- Croatian Forest Research Institute, Divison for Genetics, Forest Tree Breeding and Seed Husbandry (Miran Lanščak)
- Croatian Forest Research Institute, Research center for other forest goods and services "Josip Ressel" (Mihael Srdoč)
- Wild cherry (*Prunus avium* L.) in Republic of Srpska (Milena Stanković)
- Genetic improvement of fast growing forest tree species for biomass production and CO₂ sequestration (Irene Zacharopoulou)

Field trip

On Wednesday, June 15th, 2016 a field trip was organized to visit (1) a pedunculate oak generative seed orchard, (2) an ancient pedunculate oak virgin forest under strict protection of the Institute for Nature Conservation of Vojvodina Province (Serbia) and (3) managed oak stands.

- Generative seed orchard is founded in the period between 2000 – 2004 at the area of 10 ha. Orchard is composed from 129 families, in different number of replication, so the total number of plants (genotypes) in orchard amount 2585. All pedunculate oak varieties indigenous in the valley of the Sava river are represented in the generative orchard - early pedunculate oak (*Q. robur* var. *praecox*), typical pedunculate oak (*Q. robur* var. *typica*) and two varieties of late pedunculate oak (*Q. robur* var. *tardiflora* and *Q.robur* var. *tardissima*).



- Strict nature reserve "Stara Vrtična" is located in the forests of Sremska Mitrovica, Višnjićevo Forest Administrative Unit (N 44°54.90; E 19°14.6; 80 m a.s.l.). This location was first protected in 1954, although some more than 400-year-old individual trees had been designated for protection already in the early nineteenth century. The current conservation framework was established in 1978, when 10.3 hectares were put under strict protection. The reserve consists of 222 oak trees (Stojanović et al. 2015). Dr. Dejan Stojanović, research associate of the Institute of Lowland Forestry and Environment gave a presentation on growth decrease and mortality of oak floodplain forests as a response to change of water regime and climate.
- The purpose of visiting of managed oak stands was to introduce trainees with shelterwood cutting management system which is applied in these forests. The trainees had chance to see several plots in which preparatory cuttings and establishment cuttings have been already conducted, as well as to see newly regenerated plots.

Novi Sad, June 21, 2016

Training School Coordinator

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