International conference held on the occasion of the 90th anniversary of the Forestry and Game Management Research Institute

Applied Forestry Research in the 21st Century

Book of abstracts

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International conference held on the occasion of the 90th anniversary of the Forestry and Game Management Research Institute

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Forestry Research in the Czech Republic – past and present

Petr Zahradník

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The history of forestry research in our country in the broadest sense of the word dates back to the 16th century, when were made the first "experiments" making forests thrive. Most of all the various experiments delt with the introduction of artificial regeneration. But some order in research was reached much later, in the 19th century. Since around 1840, the foresters in their regular gatherings devoted to experimental issues, mainly the forest tending, and partly also the area of forest protection. At that time, the first voices proclaiming the institutionalization of forestry research were heard. The result of this effort was then in 1869 – approval of the establishment of research station in Mariabrunn near Vienna, which began to operate until 1875. Because this station had a scope on the whole territory of Austria – Hungary, there were subsequently established regional research stations in Praha and Brno (authorized in 1886 and 1888 respectively.), which co-ordinated research in our country.

After the First World War started preparatory work for building national forestry research institutes. As the first was created by decision of the Ministry of Agriculture on 31st October 1921 Department of Forest Protection (later Institute for Forest Protection). The reason for its establishment was then gradation of nun moth and its first leader became at home and abroad famous zoologist Julius Komárek. This was followed by the establishment of Biochemistry Institute in Praha. The following year, was established in Brno Institute of Forest Economics and Institute of Silviculture. Biological Institute was established in 1923 in Banská Štiavnica and one year later, Institute for Harvesting and Wood Technology. In 1925 was attached to Institute of Forest Economics Geodetic and photogrammetric station. In 1926, Institut of Forest Economics was renamed to Institute of forest production with Department of Forest Economics and Department of Silviculture and Forest Biology. In the Institute of Forest Protection was established in 1931 Department for Game Management. In 1933 was established Institute for Forest Politics and Administration in Praha. Besides these institutes, a network of stations, which were placed in forestry high schools was found. Forestry institutions financially ensured the Ministry of Agriculture. Forestry research mainly engaged external staff from the forestry faculties and the other universities. Since 1929 the Institutes were active members of the International Union of Forest Research Organizations.

Institute for Harvesting and Wood Technology was established in 1940 in Praha. In 1946 were established new institutes in Praha – Institute of Dendrology and Geobotanics and Institute for Forest Constructing, Transport, Amelioration and Torrent Control. Detached was Institute for Game Management.

After 1946, were abolished forestry research stations by the forestry high schools. On the 1.1.1951 all Institutes were merged into a single departmental Research Institute for Forest Production with the seat in Praha and the branch, therefore were in 1947 established new research stations – Research Station for Breeding of Forest Tree Species in Kostelany, Research Station for peat in Rolava and Kvilda and Research Stations in Kýchov and Zděchovec. At this time were allocated for research institutes 9 forest districts in different environmental conditions under the name State Experimental Forests of the Research Forestry Institutes. Their total area was 8 850 ha and they were a part of the Czechoslovak state forests.

Furthermore, the Czechoslovak state forests and farms established on the same date the sector research institutes – Research Institute for Silviculture, Seed Production and Nursery Management in Opočno, Game Management Research Institute in Zbraslav, Peaty Research Institute in Hora Svatého Šebestiána, Forest Management Planning Research Institute in Bratislava, Forestry Mechanization Research Institute in Oravský Podzámok. On the 4.1.1952 Forestry Research Institute was established in Zbraslav – Strnady with the branch in Banská Štiavnica, of Game Management and Forestry Zoology Research Institute in Zbraslav and Research Institute for Mechanization Forest Industry in Oravský Podzámok.

In 1954 the Research Institute of Agrotechnical Amelioration in Zbraslav was newly established. On the 1st April 1955 Game Management and Forestry Zoology Research Institute was renamed on the Forest and Game Management Research Institute in connection with the transition of workers from Strnady. On the 1st January 1959 were merged the Forest Management Research Institute in Zbraslav – Strnady and the Forest and Game Management Research Institute in Zbraslav into one institution under the current name the Forestry and Game Management Research Institute. Institutes in the Slovak Republic finally became independent.

The beginnings of forestry education in universities can be dated back to 1775 when at the seat of Field Management at Charles University was taught Silviculture, which at that time included all forestry knowledge. At that time, the forestry was also lectured at the Theological seat in Olomouc. In January 1919 a petition for the establishment of the Forestry

Department at the Czech Technical University in Prague was made and also the proposal to establish a separate University of Agriculture in Brno, where would be taught also forestry. Both universities had their own complicated history. In terms of research it is clear that there was always conducted an interesting research. Many employees of these schools were associated also with forestry institutes. And this connection is evident to these days.

Current challenges in the management of forest research

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The presentation firstly describes the frame conditions in which forestry is presently acting in Central Europe. It is influenced by the experience of the author as director of the Baden-Württemberg Forest Research Institute (FVA) in Freiburg, Germany. In a second step emerging issues in forest research are listed, clearly dominated at present by the case of climate change. The core competences of forest research institutes as integral parts of public administration are described and special emphasis is put on the question how the agenda in defining research topics is set. Finally the most important present challenges in the management of forest research concerning cooperation with other institutions, personnel recruitment, funding and financing, organisation and quality management are discussed.

Frame conditions

Globalisation and internationalisation deeply influence all aspects of the branch of forestry in Europe. This holds true especially for timber trade, European and international regulation on the protection of biodiversity, standards of sustainability and many other activities in the sector. At the same time the importance of forests as places of biodiversity and nature protection remains undoubtedly high. Concepts to integrate both requirements are still not fully developed. A further characteristic of forest research is the increasing competition inside the sector but also with other research institutions. This is due to the fact that more and more institutional donors for forest related research (and of course other research fields too) turn to problem-oriented and integrated research programs and less to the funding of single research projects or funds for clearly defined sectors like forestry. As a result of this it becomes more and more difficult for a single scientist to maintain a full overview of the funding landscape of research programs related to the expertise and competence of a single scientist.

Emerging issues

Taking into account the findings of many scientists and the broad public discussion it is obvious that the issue of climate change in all aspects related to it will be the most important field of research in forestry for the coming years. Without going into it in more detail other research fields also are important, such as

- Sustainability of forests & forest management
- Biodiversity
- Economic viability of forests
- Valuation of non commercial forest products
- Bio-energy
- Forests and water
- Genetics and breeding
- Forest ecosystem services
- Urbanisation
- Invasive species
- Forest fires.

Core activities of National Forest Research Institutes

The standing expertise of the Forest Research Institutes is based on long-term forest monitoring data collected with reliable and scientifically sound methods sometimes over many decades. Especially the monitoring activities become more and more important for qualified political decision making processes. Such research institutions stand for solutions for relevant and applied problems in practical forestry. In order to be able to warrant the above mentioned benefits the research institutes must be well rooted in the scientific community. According to a survey carried out by the European Forest Institute in 2007 the number of forest researchers at forest research institutes in Europe add up to some 3 600 researchers having more than 300 Million \in annually at their disposal. Knowledge transfer to political decision makers, foresters, forest owners and the whole variety of other stakeholders is an important task assigned to forest research institutes.

Setting the agenda

One of the crucial challenges in the management of forest research is the question who and how the topics for research projects are defined. Signs of high quality research are

- originality of ideas,
- validity and appropriateness of methodologies,
- documentation of results and
- relevance of the results.

Consequently scientists need to be given a high degree of autonomy. Unlike universities where scientists or chairholders autonomously define their field of research, setting aside the question of how to find funding for it, forest research institutes are not free in deciding on the agenda of their research. Funded and governed by ministries they have to observe the demands and needs of political decision makers.

With decreasing resources in personnel and funding it therefore seems inevitable for bigger research institutions to apply structured processes in setting a coherent research agenda. This includes strategic processes in which long-term competencies are defined based on which mid-term objectives can be derived which eventually open out into clear and concise annual plans including all resources in personnel as well as finances. In this context structured foresight studies seem to be a good instrument for defining fields of research.

Current challenges

Further current challenges for the management of forest research can be seen in many fields such as cooperation with other research institutions, recruiting personnel, funding and financing, organisation, and quality management.

Air pollution and forests in the 21st century

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Air pollution affects forests by direct effects of toxic gases such as ozone (O_3), sulfur dioxide (SO_2) or nitrogen oxides (NO_x) and indirectly through atmospheric deposition of acidifying nitrogenous (N) and sulfurous (S) compounds in various forms. Air pollution is also an integral part of climate change because numerous pollutants participate in complex processes that influence ambient temperature and precipitation. Among air pollutants, N_2O and ground-level O_3 are potent greenhouse gases, while ammonia (NH_3), NO_x , nitric acid vapor (HNO_3) and SO_2 contribute to atmosphere cooling through formation of fine aerosols that reflect solar radiation. However, N air pollutants may also have a warming effect since they increase N deposition which in turn leads to a release of N_2O . Elevated concentrations of O_3 , NO_2 , NH_3 and HNO_3 may have various phytotoxic effects, while increased N and S deposition may affect ecological integrity of forests and other ecosystems. Levels of air pollutants change in time and space, and their effects on vegetation depend on climatic conditions and many other abiotic factors. Discussion of potential effects and interactions between those various factors and their impacts on forests in the 21st century will be provided with a special emphasis on North America and Europe.

Molecular markers in forest biotechnology – genes in time and space

Berthold Heinze

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Apart from the human desire to understand how populations of forest trees "function" on a molecular basis, there is a need to understand genes and genomes in order to sensibly manipulate the composition of tree populations for human needs, while still maintaining their high level of productivity and adaptation to current and future growth conditions. "Markers" have so far replaced the real objects of interest, i.e. the genes, in studies of forest trees. Markers in forest trees have come a long way, from visual traits with clear Mendelian inheritance to terpenes and phenols, isoenzymes (allozymes), proteins, and different kinds of DNA markers, and finally to SNPs from (almost) whole genomes. In this presentation, examples of the usefulness of such markers will be discussed, with a special reference to forest biotechnology. These include markers for establishing species identity and true-to-type ness of tissue cultured plants (clone identity), for assessing relatedness, for genetic mapping, or for tracking inheritance of organelles. Moreover, the objects that are "marked" by these, i.e., genes and genomes, and their variability in time and space, will be discussed with a few examples from previous or ongoing work in my lab.

Trees and forests are often sampled in the form of "populations", which originally meant to comprise separate breeding units. Exhaustive (complete) sampling is seldom possible. DNA markers, the focus of this presentation, can be obtained from a range of plant tissues – a few options will be discussed. DNA extraction is necessary for most of these methods. Amplification of pieces of DNA to visible amounts is done with biochemical (enzymatic) methods, and partially from chemically synthesized precursors. Marker visualisation requires some investment in laboratory equipment and techniques. Data analysis, however, is increasingly dependent on computer hard- and software for making sense of the biological complexity that is revealed by the data.

The following examples will be discussed: markers for species identity in native and introduced *Populus* trees and their offspring in Austria; tissue-cultured plants of *Picea abies* and *Populus tremula* and their genetic stability; relatedness in *Fraxinus excelsior* seedlots from separately harvested trees; and an almost range-wide study of genetic variation in chloroplast DNA in *Populus tremula*.

Genetic markers and genes can answer many questions in forest biology, but will increasingly be useful for general forestry problems as well. Future applications may include much higher resolution in identifying sources of biological material (e.g., wood and timber), predictive methods for the performance of planting stock from its genetic composition, and probably a new understanding of the ecological processes necessary to maintain genome and population evolution of forest trees on a continent-wide scale.

Main Trends and Prospects in Current Breeding and Improvement of Forest Tree Species

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During the last 60 years, forest tree breeding has been very active throughout Europe at genetically improving the main commercial forest tree species. Even if it met from place to place several phases of up- and down- activities, it globally succeeded to set up first-generation commercial seed orchards and to provide improved seed from a broad range of species for reforestation. In parallel, a better knowledge in the biology of the species was gained, which was exploited in particular in mass-propagation.

However for diverse reasons, interest in tree breeding decreased or even collapsed in some countries and at the beginning of the 21th century, only a few active, innovative and well-funded teams subsist across Europe, usually in the most forested countries. The attraction for new fields of biotechnology and genetic research such as molecular genetics, genomics and in vitro propagation, has diverted funding and human forces from traditional breeding. As a result, science has much progressed in these new fields but in many places, disconnected from their final aim linked to breeding. They loose as such part of their justification and benefits to society: indeed, with the weakening of traditional breeding, progress in these techniques and scientific results can not be integrated anymore to breeding work and participate to genetic progress.

Global changes including climatic threats and its cohorts of new pests, as well as new socio-economical needs impact forests and forestry and impose new challenges to foresters. Climatic changes are sometimes so rapid or predicted to be so rapid that nature alone is or would not be able to cope at the same speed and maintain economical sustainability of forests.

Needs and requests from forest and forest products have been enlarging: biodiversity, new wood products (bio-molecules, fuel wood, etc). Sustainability of forest is more than ever a priority not only to increase productivity but in some more frequent instances just to maintain productivity.

In this context, geneticists and breeders have a major role to play. Question about the suitability of existing varieties – sometimes selected 30 or even 40 years ago-, is real and the lack of ongoing breeding to provide new better adapted and suitable varieties may now appear as detrimental.

To efficiently cope with these challenges, breeders will have to be more than ever efficient and reactive towards environmental and socio-economic requirements. This will impose them among others:

- to develop and benefit from interdisciplinary research with eco-physiologists, wood scientists, pathologists, etc. The single traits 'height-diameter-stem form' approach was reductionist as many other traits more complex are of concerned nowadays, such as tree reaction to climate, pest resistance, etc. As well the simple approach of assessing a global trait (is resistant or is not) traditionally selected for look by far minimalist; a close understanding of how traits build up and of their genetic architecture is now needed to develop high throughtput phenotyping methods, to make selection more efficient,
- to integrate any progress in biotechnology, which imposes a reciprocal understanding, not always easy between the two communities: several tools are now available to speed up selection, make it more precise, control genetic diversity, reduce breeding costs, deploy more efficiently improved varieties, measure their impact on the environment, etc.
- to join forces at the European level; few countries may reasonably financially justify their breeding efforts in relation to reforestation efforts for a given species; species and threats have no frontier and joined experimentation in highly contrasted environments will offer a unique opportunity to study species adaptability and plasticity; the breeders and geneticists community across Europe share a large genetic patrimony and experimental resources for many common species, which should help in assisting migration if needed. Few countries have the privilege to have access and/or to excel in all research fields connected to breeding, mass-propagation of varieties and deployment and all will benefit from reinforced cooperation and share of experimental facilities.

European infrastructure networks such as TREEBREEDEX and now TREES4FUTURE should stimulate a better organisation of genetic research and breeding across Europe to make it more efficient and reactive.

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New and alternative methods in the forest pests control

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Agents that influence the health of trees are divided into abiotic, biotic and anthropogenic groups. Biotic injurious agents are part of the forest ecosystems. Under certain circumstances an outbreak of these agents may occur, which results in forest damage. Biotic injurious agents are also called pests. The most important of them to be aware of are insects and diseases (caused by fungi and other pathogenic microorganisms).

The eight-toothed spruce bark beetle (*Ips typographus*) is one of the most harmful bark beetle. Its outbreak in older spruce forests in central parts of Europe is causing the dieback of whole stands. Also other bark beetle species as *Pityogenes chalcographus*, *Ips sexdentatus*, *Tomicus* ssp. and others damage forest tree species.

The harmful effects of leaf-eating insects are regarded as less dangerous in comparison to bark beetles. The most dangerous species of this group is the gypsy moth (*Lymantria dispar*) an outbreak occurring about every 8–10 years in oak stands causing defoliation. There use to be hundred thousand hectares of predominantly oak and poplar stands damaged. Similar damages cause nun moth (*Lymantria monacha*) in spruce and pine stands.

Honey mushroom species (*Armillaria* ssp.) are the most serious fungal pathogens in the Central European region. They cause the rotting of root systems. Stands where these species occur can be regenerated either naturally or artificially but only with great difficulty.

Many insect and diseases are serious pests because they are not native to the ecosystem; they were accidentally introduced through commerce or the transport. When these alien pests are accidentally introduced and established in a new area, it is usually without the complex of natural enemies them controls it in its native location.

To control the pests, chemical or synthetic insecticides are usually used in different ways in agriculture. The insecticide has along many advantages also many disadvantages. They can pose danger in our environment like air pollution and inherited pest resistance disables their efficacy.

The classical biological control is one of the possible solutions how to substitute the chemicals. The goal of classical biological control is to find useful natural enemies, introduce them into the area of the target pest, and permanently establish them so that they will provide continuing pest control with little or no additional human intervention. Detailed information about the natural enemies of the pest is required.

Biological control using diseases as viruses, bacteria or microsporidia is still the most effective biological control method. They are widely used in the forestry.

With mounting controversy over using chemicals against pests, the sterile insect technique (SIT) programs have become increasingly more important as a successful technology in eradicating and controlling of them. The aim of SIT normally involves introducing sterile adults into the pest's habitat to over-flood the fertile population, with the goal of reducing the pest population by interfering with reproduction.

Some results of the research, which has been done in Slovakia for last 20 years in mentioned areas including several examples and successful cases are added.

Health, sustainable nutrition and productivity of forests in Central Europe

Klaus v. Wilpert

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Anthropogenic acid- and nitrogen deposition changed the chemical properties of forest soils and ecosystems in Central Europe decisively. The new "chemical climate" impairs forest health and growth. Soil acidification and eutrophication cause severe disturbance in forest nutrition. In most areas of Central Europe ecosystems change chronically by soil acidification and nitrogen saturation rather than by the acute impact of toxic gases or other chemical compounds. Additionally to chemical destabilization, global climate change causes new stress factors.

In order to observe and forecast the ecosystem status under the influence of changed environmental conditions forest monitoring systems have been set up since the early 1980s and step by step harmonized among European countries.

The hierarchically organized monitoring systems are characterized by a combination of intensive process studies and gridoriented survey networks which enables researchers to recognize new spatial patterns of chemical indicators or to derive time series of the ecosystem development. The results of these environmental survey networks do not only monitor the forest ecosystem status and reveal its causal background rather than provide valuable technical information for ecosystem management enabling to set up decision support system on the basis of quantitative monitoring data. Thus the results of monitoring and ecosystem research are the indispensable basis for the development of forest management practices which are suitable to stabilize forest ecosystems and their functions under the influence of the new boundary conditions emerging from the interaction between climate stress and the prior charge of soil acidification.

The assessment of fuel wood potential at a regional scale, combined with quantification of nutrient sustainability by means of element budgets derived from monitoring data will be given as an example for the potential of monitoring data as practical decision support tools.

Silvicultural options for increasing the resilience of forests to climate change

Bill Mason

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Confronting the challenges that will be posed by climate change will be the defining issue for current and future generations of natural resource and forest managers. Silviculture, which involves the manipulation of the establishment, growth and composition of forest vegetation to meet management objectives, will be a key discipline in translating the insights of climate change science into practical recommendations for sustaining forests in the face of rapid change. While in the short-term it may be possible to implement silvicultural practices that increase stand resistance to climate change, in the medium to long-term the essential need is to use silviculture to increase the resilience of a given forest ecosystem. Achieving greater resilience implies that forests adapt quickly to the impacts of climate change so that the ecosystem services provided by forests are maintained. Measures widely recommended to increase resilience include thinning to change stand structure and composition, greater use of species mixtures, and the planting of species and provenances likely to be better adapted to a warmer climate. However, interpreting these general recommendations at a forest landscape or stand level can be difficult because the vulnerability of an area to climate change is confounded by local conditions such as aspect and soil type. Using a case study based on a 5000 ha plantation forest in Scotland and results from long-term experiments, I show how local site factors influence the way in which the general recommendations can be applied. For instance, in exposed conditions, ill-timed thinning can result in increased risks of wind disturbance and catastrophically compromise the future stability of a stand or forest. Similarly, creation of mixed species stands can be difficult without an ongoing commitment to intensive management to control the growth dynamics of different and competing species. These, and other examples, will illustrate how successful implementation of adaptive silviculture is a long-term project which must be based on careful monitoring, informed evaluation of model predictions and founded on a sound knowledge of local sites and forest types.

Protection of mountain forests in Poland against insects: past achievements and future challenges

Wojciech Grodzki

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The talk contains the outline of the history of the forest protection in the Polish mountains since 1945. The most important problems, such as the outbreaks of defoliating insects (e.g. *Zeiraphera griseana* Hb., *Cephalcia* spp.) and bark beetles, and related forest decline, are briefly described. The main results of past research related to occurring problems, with special regard to the newly developed methods of forecast and control of biotic injurious factors, are summarized. The perspectives of the application of new technologies and tools (e.g. GIS based analyses) in the risk assessment and research concerning forest protection are discussed. The future challenges, such as wider application of biotechnology towards more environmentally friendly forest protection, are proposed.

Environmental risks for forest health, production and vitality of forests

Department of Forest Ecology – assessment and prevention of environmental risks on forest stands and forest ecosystems

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The department of Forest Ecology has passed through its 79-year-old history under different names and with various general tasks. It was founded as the Institute of Forest Biochemistry and Pedology in 1922 with the main research activities aimed at the amelioration of unproductive forest sites. During 1950s and 1960s the base for long-term hydrological research was founded in the forest catchments in Beskydy Mts. and later also at the experimental MaB site Želivka. Since the late 1960s until the mid-1990s the air pollution and its influence on forest vitality and quality of forest soils was one of the main topics. Large areas of Czech mountain regions (110,000) had been deforested due to air pollution, which has pronounced effects on ecosystem properties and on the vitality and stability of newly grown forest stands of substitutional or target tree species. Experiences obtained by research in damaged stands and polluted regions were applied by the set up of international monitoring program ICP Forests in 1986, where the Institute played for some time the role of PCC East – Program Coordination Centre for the eastern European countries.

Nowadays the monitoring of forest health and studying of ecosystem processes which influence the forest vitality and forest growth at the intensive monitoring sites is one of main research tasks of the department. The scientific knowledge is used in expert services for forest owners and forests policy. In last ten years we have experienced and studied serious damage of Norway spruce stands caused by the various combinations of pure nutrition at historically heavy polluted sites, climatic stress in lower altitudes and attack of biotic pests. The Department of Forest Ecology cooperates at planning and coordination of forest liming in the Ore Mts. and other areas. Recent surveys show very poor conditions of forest soils in the Czech Republic, with very low contents of base cations – mainly calcium and magnesium, so the soil protection and soil amelioration is still highly important topic for the forest management.

Alterations in growth dynamics of beech crowns as an indicator of forest sites with drought stress risk for beech

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The upper crown of beech trees plays a major part in the carbon assimilation and build up of biomass. Beech trees use this advantage together with the upper crown's shading effect in competing with neighbouring trees and lower levels of the crown canopy.

According to Roloff (2001), the systematic shortening of shoot lengths of apical beech twigs may be regarded as a first step towards diminishing vitality. The growth dynamics of beech alters fundamentally when long shoots with well-developed side shoots dwindle and short shoot sequences occur. Apart from the tree's age, environmental factors bear upon shoot and crown development.

The thoroughly revised ICP Forests manual (Eichhorn et al. 2010) contains definitions for the rating of shoot development, foliation assessment as well as determination of trunk diameter increment of beech, which are binding for the whole of the European Union.

In a pilot study comprising 147 beech plots (852 trees) in Hesse, Lower Saxony and Saxony- Anhalt, it was shown by means of site gradients how ramification of beech crowns changes with the gradients of the soil water budget. The vitality of beech is quantified by means of shoot length measurements, rating of the ramification structure, proportion of heavy defoliation and trunk diameter increment. Site characteristics, especially the climatic water budget and available field capacity as derived from the Nation-wide Forest Soil Survey II, serve as important indicators of soil water budget.

On the one hand, the results show that beech is well adapted to differing levels of field capacity, on the other hand they show that under extremely adverse water budget conditions, characteristic changes in the growth dynamics of crowns and trees occur.

Literature

Roloff A. (2001): Baumkronen. Verständnis und praktische Bedeutung eines komplexen Naturphänomens. Verlag Eugen Ulmer. 164 pp.

Eichhorn J., Roskams P., Ferretti M., Mues V., Szepesi A., Durrant D. (2010): Visual Assessment of Crown Condition and Damaging Agents. 49 pp. Manual Part IV. In: Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. UNECE ICP Forests Programme Coordinating Centre, Hamburg. ISBN: 978-3-926301-1. (http://www.icp-forests.org/Manual.htm)

The effect of temperature and precipitation on growth of beech (Fagus sylvatica L.) in Mátra Mountains, Hungary

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Weather conditions (for example precipitation and temperature) play important role as environmental factors affecting the tree growth. In a wider sense the climate and growth relationship is significant in understanding the possible consequences of climate change and in developing forestry strategies to mitigate the impact of this change.

In the frame of the intensive monitoring of forest an investigation is being carried out on the influence of temperature and precipitation on girth increment in a 100-year-old beech stand in the Mátra Mountains, north-eastern Hungary. In our study we use weekly girth band data of eleven beech trees that represent the different social classes of the stand. The precipitation data come from the event dependent throughfall measurements, while the temperature is measured by meteorological station located in the stand. The time series range from 1999 to 2010.

The relationship between tree growth and environmental factors was investigated by a special correlation calculation method developed by us. The method is based on correlation analysis and includes common procedures like autocorrelation or cross-correlation. In addition, this procedure provides the opportunity for us to analyse time series by introducing periods with different lengths and their temporal shifting. Accordingly, previously unknown relationships and lagged impacts can be discovered.

We demonstrate the results of two main issues in our presentation. Firstly, the effects of the precipitation and air temperature on annual increment were studied using different temporal aggregates (1-16 months) and shifting (till May of the previous year). Secondly, the connection between a new-formed parameter (the proportion of the temporal length of the intensive growth period and the increment of it) and environmental parameters were examined.

Changes of the health and nutrition status of spruce stands in the Ore Mts. 15 years after catastrophic winter 1995/96

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Forests in the Czech Republic are highly influenced by antropogenous factors. Among them in the past it was mainly air pollution as SO₂, currently acid deposition and ozone. Since 1994 the nutrition status and immision load have been evaluated on 20 research plots situated in young spruce stands in ridge area of the Ore Mts. During the winter 1995/96 the last acute damage of spruce stands was connected with a long-lasting inversion situation in the eastern part of the Ore Mts. Worsening of health status and nutrition occurred. At the present time the health status of spruce stands, expressed as the crown defoliation, reached a level before winter 1995/96 (20-25%) and it is comparable with other areas of the Czech Republic. Concentrations of sulphur and fluorine in the needles significantly decreased. Permanent risk for forest ecosystems, not only in the Ore Mts., remains the long-term negative effect of acid deposition (especially nitrogen), which significantly contribute to degradation of forest soil and to the symptoms of lack of nutrition and negatively affect the growth of forest trees in the ridge parts of mountain regions. In the recent years concentration of nitrogen and sulphur in the needles has slightly increased again. There is obvious long-term tendency to decreasing of calcium and phosphorus concentration in the needles.

The aim of this contribution is the comparison of changes in nutrition and defoliation of spruce stands in the Ore Mts. during 15 years after catastrophic winter 1995/96.

Changes in the threat of spruce stand disintegration in the Beskid Śląski and Żywiecki Mts. in the years 2007 – 2010

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The present paper describes the dynamics of changes in spruce stand disintegration in the Beskid Śląski and Żywiecki Mts on the basis of the results of stock-taking performed in 2010 as compared to those in 2007. The research was done in 6 forest districts in the Beskidy Mts, belonging to the Regional Directorate of the State Forests in Katowice. The area of spruce stands in degrees of disintegration threat on the day of 30th September in the research period was determined by all forest districts, namely: Bielsko, Ustroń, Wisła, Węgierska Górka, Jeleśnia and Ujsoły, on the basis of data in the State Forests Electronic Database (SILP) in degrees of stand disintegration threat and in plant and climatic zones, according to the algorithm proposed by the present Authors (Barszcz et al. 2009).

Rules of classification of the stands to be reconstructed in degrees of reconstruction urgency:

- 1 very urgent reconstruction within a very short period (up to a few years), which should include the following stands:
 dying ones, where the harvesting of sanitary deadwood (NPS) is above 50 m³/1ha, which corresponds to the active deadwood increase index (NPC) over 16, tree coverage in the stand of 0.1-0.3 and degree of coverage with a young generation of 0.1-0.3;
- 2 urgent reconstruction within a relatively short period (up to several years), which should include the following stands: weakened ones, where the harvesting of sanitary deadwood (NPS) is 30-50 m³/1ha, which corresponds to the active deadwood increase index (NPC) of 10-16, stand tree coverage of 0.4-0.5 and degree of coverage with a young generation of 0.4-0.5;
- 3 relatively urgent reconstruction within a longer period (within 20-30 years), which should include the following stands: weakened ones, where the harvesting of sanitary deadwood (NPS) is below 30 m3/1ha, which corresponds to the active deadwood increase index (NPC) below 10, stand tree coverage of 0.5-0.7 and degree of coverage with a young generation above 0.5;

Data analysis showed that it was necessary to distinguish the 4th degree of stand reconstruction urgency in order to include the remaining spruce stands, mostly cultures, with tree coverage above 0.7, as well as the few spruce stands which should undergo reconstruction within a long period (over 30 years).

The data obtained from SILP allowed for an attempt at visualization of the results of the current stock-taking in the form of digital maps showing different degrees of stand reconstruction urgency in accordance with the divisions within each of the 6 forest districts under analysis.

Comparison of the results of stock-taking of the stands threatened with disintegration in 6 forest districts of the Beskidy Mts, namely: Bielsko, Ustroń, Wisła, Węgierska Górka, Jeleśnia and Ujsoły in 2007 (altogether 24,446 ha) and in 2010 (altogether 16,891 ha) indicate a decrease in the rate of spruce stand disintegration. A decrease in the area of such stands in the period under analysis amounted to 7 555 ha (i.e. about 30%) altogether. This may point to the slowdown of the rate of spruce stand disintegration as well as to considerable intensification of reconstruction work.

The spruce stands still currently facing the highest threat of disintegration are located in the forest districts of Ujsoły and Wisła, those under medium threat are in Węgierska Górka and Jeleśnia while those under the lowest threat are in Bielsko and Ustroń. This points to the fact that the rate of the disintegration remains constant in the same, southern and south-eastern part of the research area.

There are a total of about 22,780 ha to be reconstructed in the 6 forest districts, most of which are located in the lower forest zone. At higher altitudes, there are fewer stands to undergo reconstruction but they are likely to cause problems due to the small area of the seed producing spruce and beech stands and a lack of such a base for fir and admixture species, and particularly due to a deficient amount of natural regeneration.

The highest percentage of spruce stands to be reconstructed (in the degrees of urgency 1-3) is still situated in the lower forest zone. Spruce stand reconstruction in this zone as well as in the foothills will be relatively easy thanks to favourable site conditions, a possibility to use a wide range of species as well as a large number and large area of the existing seed producing stands containing the main forest creating species. What may become an obstacle is the amount of effort resulting from the size of the area to undergo reconstruction.

Threatened spruce stands in the middle forest zone are a smaller but still considerable group in terms of area. This zone contains fewer seed producing spruce stands, little beech and no seed base for fir and admixture species; for this reason the reconstruction of these stands will be more problematic.

In the upper forest zone, the reconstruction of spruce stands which are almost entirely in the course of dying and disintegration, will, cause the largest problems despite their small area, because there are no recognized seed producing stands in this zone, few species for potential use and unfavourable site conditions, especially in the mountain top and range locations.

According to the present authors (cf. also Barszcz et al. 2009), the reconstruction should also include the remaining spruce stands, i.e. cultures (about 18,000 ha), classified as the 4th degree of threat, and revealing the least visible symptoms of damage.

Literature

Barszcz J., Małek S., Majsterkiewicz K., (2009). Dynamika zmian zagrożenia rozpadem świerczyn Beskidu Śląskiego i Żywieckiego. Prace Komisji Nauk Rolniczych, Leśnych i Weterynaryjnych PAU. 11, 93-113.

Nitrogen in forest ecosystems in the Drahanská vrchovina Upland (Czech Republic)

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Increased atmospheric depositions of nitrogen substances in recent decades were recognized to be a threat endangering the structure and functioning of natural and semi-natural ecosystems. The excessive nitrogen load can be a risk factor for forest ecosystems. Atmospheric depositions of anorganic nitrogen are the cause of acidification and eutrophication of forest soils. Anthropogenic nitrogen inputs can have a great impact on particular stages of nitrogen transformation in forest ecosystems. The aim of our research is to describe nitrogen cycle in forest stands with various species composition. The research is aimed at forest stands dominated by spruce and at comparative beech or mixed stands in the fir-beech forest vegetation zone on modal oligotrophic Cambisol at an altitude of 600-660 m. Experimental sites are situated in the area of autochthonous mixed forests with an average annual temperature of 6.5°C and average annual precipitation of 638 mm. Litterfall was sampled by litterfall-meters of an area of 0.25 m² in 5 repetitions in each forest stands once a month. The sampling of forest floor and soil for chemical analyses was carried out always at the end of the growing season (in November). Samples of the forest floor were taken at 10 repetitions per each horizon and year, and in the soil in 5 repetitions each year. Samples of bulk precipitation and throughfall were taken by means of permanently open collectors, samples of seepage water were collected by gravitation lysimeters placed below the surface humus horizon and soil solution was sampled with vacuum lysimeters (suction cups) in the depth of 20 and 40 cm below the surface. Samples of water were taken once in two weeks in the growing season, and in winter once a month only from bulk precipitation and throughfall collectors. Total nitrogen in litterfall, forest floor and soil samples was determined using automatic LECO TruSpec CN analyser (MI USA). Water amount caught in precipitation and throughfall collectors, gravitation and vacuum lysimeters was determined volumetrically for every sampling event, anions (NO₂, NO₃) were analyzed using ion exchange chromatography with KOH gradient elution (DX-600 ion chromatographic system equipped with GP50 gradient pump, ED50 electrochemical detector, EG40 eluent generator and IonPac* AS11-HC AS11 HR (250 × 2 mm) analytical column with AG11 HR (50×2 mm) guard column, operated under PeakNet 6.0 software, all parts Dionex Corp.), ammonium nitrogen /NH₄^{+/} was determined by the method of flow injection analysis with FIA-lab 2500 analyzer (FIAlab Instruments, Inc., USA) according to the international standard ISO 11732 (2005). Total dissolved nitrogen /TDN/ was analysed with SHIMADZU TOC-VCSN analyzer with TNM-1 unit and ASI autosampler (all parts Shimadzu, Japan) using the method of high temperature catalytic combustion with chemiluminiscence detection according to the ČSN EN 12260 (2004) standard.Total nitrogen (N) deposition with bulk open field precipitation in 2010 was 8.0 kg ha⁻¹ year⁻¹. Nitrogen flux with througfall under the spruce in the first generation (age 106 years) amounted to 18.8 kg ha⁻¹ year⁻¹, under the spruce in the second generation (age 35 years) it was12.7 kg.ha⁻¹.year⁻¹, under a mixed stand of beech, spruce and fir (age 130 years) the N flux achieved 19.2 kg ha⁻¹ year⁻¹ and under the crowns of the beech stand (aged 45 years) it was 9.5 kg.ha⁻¹.year⁻¹. The contribution of anorganic nitrogen compounds (NO₃, NH₄) to potential acid deposition in the open air was 0.49 kmol (H⁺).ha⁻¹.year⁻¹. Under a spruce stands in the first generation 1.09 kmol (H⁺).ha⁻¹.year⁻¹ in the second generation 0.78 kmol (H⁺).ha⁻¹.year⁻¹, under a mixed stand of beech, spruce and fir 1.24 kmol (H⁺).ha⁻¹.year⁻¹ and in a beech stand 0.60 kmol (H⁺).ha⁻¹.year⁻¹. Through litterfall, 23.3-83.7 kg N ha⁻¹ year⁻¹ were deposited on the soil surface. The nitrogen reserve in the forest floor and soil at experimental stands was within 6,500-10,300 kg per ha. The drain of N from humus layer ranged from 2.3 to 10.8 kg ha⁻¹ year⁻¹. The implemented research brings new findings on the actual level of nitrogen cycling in model stands in relation to forest management.

Quality assessment of spring water from the area of the Łysogory Mts. in Świętokrzyski National Park

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The study was carried out in 2010 in Pokrzywianka and Bielnianka catchments lying on opposite slopes of Łysogóry in Świętokrzyski National Park. Water samples were collected from springs in three measurement campaigns. The first session was carried out after snowmelt (March 30 – April 3, 2010), the second after intensive rainfall (May 27-31, 2010) and, the third after rainless period (August 21-24, 2010). A data set consisting of conductivity, water pH, concentrations of major anions (Cl⁻, NO₃⁻, SO₄⁻²) and cations (NH₄⁺, Na⁺, K⁺, Ca²⁺, Mg²⁺). Concentrations was generated and classified according to Polish standard (Dz.U. 2008 nr 143 poz. 896 from 2008). Research confirmed water quality strongly depended on wet acid deposition. It was found that most of water samples was unfit for drinking according to Polish standard from 2008. The main reason for that was too low pH and high NO₃⁻ concentration. Chemical composition of spring waters depended also on plant cover and measuring session. Springs located in mixed stands characterised higher concentrations of cations, higher PEW and pH than in conifers stands.

Chlorine in the forest ecosystem: a comparison of continental and coastal regions

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In the forest environment, chlorine is present in two main forms, chloride and organic chlorine. The concentrations of both organic chlorine and chloride were determined in soil samples collected from 12 forest stands located in different parts of the Czech Republic, representing inland conditions. For comparison, two additional forest stands situated near the Norwegian coast, with relatively high input of sea salts, were investigated. By determining the storage in the organic layer and two layers of mineral soil it was found that the storage of organically bound chlorine is prevalent. The organic chlorine concentrations, and thus the total storage of organic chlorine, in the soil in the coastal region of Norway are much higher than in continental regions in the Czech Republic, apparently due to much higher chloride deposition. Relationship between foliar and soil chemistry in forest stands was investigated. Foliage contained chloride as well as organic chlorine. Any relationships between soil and foliar concentrations of chloride and organic chlorine were not confirmed. From the foliar analysis the impact of air pollutants could be estimated. High concentrations of certain elements in the leaf or needle tissues may be the effect of intoxication or of high air pollution levels. Despite high chloride deposition and elevated chloride concentration in the soil increased needles chloride concentrations were not found at Norwegian plots and also no visible damages to tree foliage were observed. On the other hand, there is evidence of negative effects of de-icing salts on roadside vegetation; Norway Spruce (Picea abies (L.) H. Karst.) is particularly sensitive. Along the Czech roads damage occurs at different chloride content, even within the same species. This illustrates that the plants have different ability to defuse the harmful effects of salt. Moreover sodium chloride alters the soil structure and composition of cations during ion exchange in soils and soil solutions. Thus, damage extent is dependent on a number of factors.

Problem of use and/or removing of logging residues: how to compensate nutrition loss when the logging residues are used as an energy source

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In theCR, in recent years, logging residues are more and more used for energy purpose. Increased output of elements of the circulation in forest stands is connected problem. Mainly in localities of poor and acid soils is to be considered, whether and in which level the forest environment can cope with nutrient output, due to removing of not only raw timber, but also of all other logging residues.

Up to date results of the research confirm that in the mass of logging residues there is significant amount of important nutrients (N, P, K, Ca, Mg). Having in mind the long-term/sustainable forest management, it would be desirable rather to use the positive potential of the logging residues, e.g. to crush it and leave it in the stand. It can hardly be expected that in conditions of the CR, nutrient removing due to use of logging residues for energy purpose will be compensated, partly or fully, by weathering of mother rock and element input in deposition. In case of removing of logging residues of the forest stand has to be considered that nutrient output has to be compensated by chemical amelioration – fertilizing and liming of forest stands and application of wooden ash.

Forest protection in central Europe in the beginning of 21 century: problems and new methods of control

Recent Forest Protection Department in FGMRI

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The department, recently called Forest Protection Service, deals with research, expert and monitoring activities concerning forest biotic harmful agents and is providing the Forest protection service, Testing laboratory of biological efficiency of pesticides in forest protection and processing the confirmations in appropriation system. Employees of the department are working on the research studies on "Importance of insect and fungi in forest ecosystems under changing environmental conditions" within the main project "Stabilisation of forest functions in anthropically disturbed and changing environmental conditions" (project MZe0002070203, part 02). In the other research activities they deal with study and effectiveness of forest protection methods against selected harmful factors, e.g. bark beetles, fungi, rodents etc. Beside the research activity, nearly all members of the department are involved in Forest protection service. Members of the department are active in IUFRO WG 7.03.10 "Methodology of Forest Insect and Disease Survey in Central Europe".

Head of the department is Miloš Knížek, deputy is Vítězslava Pešková.

Other research projects:

Rodents as an important factor influencing forest regeneration

Geospatial model of potential risk assessment of forests stands

Study and optimisation of real efficiency of control measures against Ips typographus in various gradation phases

Aluminium content in forest soils – the identification of hot spots, ameliorative methods on degraded sites; forest management practice for sustaining the productive- and non-productive function of forest sites

Gene resources of oak species for reproduction of adaptable forest ecosystems

Development of transgenic tissue lines of spruce (*Picea abies*) showing high toxicity towards bark beetle (Scolytidae) species

Forest Protection Service

Forest Protection Service was established as an organizational part of the Dept. of Forest Protection, based on the accreditation by the Ministry of Agriculture CR in 1995. It is divided into three regional working sites: Strnady (headquarters, for Bohemia), Znojmo (for south Moravia) and Frýdek-Místek (for north Moravia and Silesia). The main activities are_survey and monitoring of biotic harmful agents, advisory service in forest protection for all forest owners and users, methodical assistance in large-scale control operations against pests, central records of occurrence and damage of biotic and abiotic agents within the whole republic, publication of annual reports on occurrence and prognosis of forest harmful agents, organization of workshops and symposia in forest protection, issuing of pest leaflets, a journal for forest protection and other materials, testing of biological efficiency of pesticides in forest protection, issuing of List of pesticides in forest protection, processing the confirmations in appropriation system and others.

New technology in forest protection against spruce bark beetles

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Current forest protection is closely connected with using chemistry (pesticides). Protection against spruce bark beetle deals with pheromone baits and insecticides. Nowadays, trend to avoid using every chemical protection calls for new technology. Such environment friendly pesticide could be Woodnet. It is new product of company BASF. Originally it was destined for African people as a protection against insect transferring malaria. Also it is tested for protection against insect in greenhouses, under beds in hotels against bedbugs or for soldiers in Africa.

It is a net with special structure which is able to keep insecticide inside. Insecticide is released gradually so that its efficiency is on the same level the whole season. Effective substance is alpha-cypermethrin, the same substance as for example in Vaztak 10 EC. Advantages of using Woodnet are: 1) just one application, 2) no water and sprayer necessary, 3) weather independence (possible application in rain). Its biological efficiency has been tested in our institute since last year. Its biological efficiency was 100% in 2010. Great option for using Woodnet is during large gradations of spruce bark beetle. Woodnet is able to cover big landings and prevent their infestation easily. Using classical spraying is less effective. Liquid is not able to treat timber in inner space and spruce bark beetles can survive there.

Variant of Woodnet is tripod Trinet. It is alternative to chemical treatment trap tree. Its advantages are easy application (Trinet is light and quickly put together), construction allows standing above high grass (telescopic construction) and one person can carry even two whole Trinets. It is meant for prevention of stand wall infestation and decreasing of population density. In our test in 2010 Trinet worked the whole season, this year the same tripods are in forest and are tested again.

Project ClimIps – Assessment of climate change impacts on spruce bark beetle (Ips typographus L.) in the Czech Republic

Marek Turčáni

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Spruce bark beetle *Ips typographus* (L.) (Col.: Curculionidae, Scolytinae) is the most important forest insect pest in Europe whose development is strictly regulated by air temperature. Therefore, climate change is anticipated to induce changes in the pest's distribution and development. The ClimIps project delivers a profound knowledge of spruce bark beetle responses to climate change in the Czech Republic, develops system of measures mitigating the expected impacts, and disseminates the acquired knowledge to academia, decision makers and various end-users.

The project uses the most recent generation of climate change scenarios developed for the Central Europe. The PHENIPS model (A Complex Phenological Model of *I. typographus*) is used to evaluate the climate change impacts on the distribution and voltinism (annual number of generations) of spruce bark beetle.

The results suggest that while a two-generation regime dominated in the Czech Republic in the reference period (1961 – 1990), significant three-generation regime regions are projected to appear in the near future. In the distant future, the three-generation regime can be expected to occur over all existing coniferous stands in the Czech Republic.

The proposed measures mainly address silviculture and forest protection. All system of measures has been made available through web-based decision support system; hence all users can approach project results through the web www.climis.cz.

We wish to acknowledge the project of the Ministry of Agriculture of the Czech Republic No. QH91097, "Analysis of climate change impacts on the distribution and voltinism of *Ips typographus* in spruce forests of the Czech Republic as underlying information for their sustainable management".

The purpose of active forest management for nature protection on the example of wind calamity in High Tatras

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Forestry Protection Service, Banská Štiavnica, Slovakia

There is a different view on a management of large wind calamities in Slovakia as well as in Europe. The paper shows results from a research on the influence of an active and passive management of the great wind calamity in 2004 in Tatra Mountains upon the spread of a forest damage caused by the secondary pest agent *Ips typographus*. The information about the forest damage comes from aerial infrared photos taken annually from 2005 to 2008. The area of damage spreading from 4 paired research plots was measured in 4 different buffer zones as far as 300 m from core zone border and statistically evaluated. Impacts of both managements are discussed.
Gregarina typographi (Eugregarinorida: Gregarinidae) in the bark beetle lps typographus (Coleoptera: Curculionidae)

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Changes in *Gregarina typographi* Fuchs, 1915 (Eugregarinorida: Gregarinidae) infection levels were studied in a population of the bark beetle *Ips typographus* (L., 1758). Beetles were repeatedly collected from three logs of trap trees during 2009 and 2010 at one study site in the Czech Republic with a high level of *G. typographi* infection (seasonal mean of 15.7% in 2009 and 19.8% in 2010). Infection levels did not differ statistically between sexes, logs, and trap trees but did differ among sampling dates. During the beetle reproductive period, the infection levels nearly doubled in 2009 (from 10.7 to 19.8%) and more than tripled in 2010 (from 9.3 to 31.3%). We infer that the continuous increase in the *G. typographi* infection level within each of the two years resulted from transmission among beetles in nuptial chambers during the May–June reproductive and egg-laying period.

Recent forest protection problems in Hungary – causes and consequences

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Detailed analyses of forest health conditions and recent forest protection events were performed in the frame of a broadscale research project (TÁMOP) for Hungary's forestry. Special emphasis was given for the effects of climatic factors and their impacts on forest health.

Drought has a major influence on the health conditions of several tree species in Hungary. A single drought year usually does not have dramatic effects, but after 2-3 consecutive drought years the health status of trees shows already obvious negative trends. The symptoms become apparent often only with 1-3 years delay. In some special case (e.g. beech stands in the South-Transdanubian region) already one drought year can cause significant deterioration. Further, the area damaged by forest insects is predictably increasing after 2-3 severely dry years.

Damage of half of the major forest insect pests shows an increasing trend. The increase is most evident for the major oak insects (*Lymantria dispar, Euproctis chrysorrhoea, Thaumetopoea processionea, Curculio* spp.). The moderately decreasing damage trends for the major pine pests can partly be explained by the decreasing area covered by pines. The area of pines and spruce will probably continue to decrease, so the damage of pine and spruce pests is likely to decrease accordingly.

Climatic extremes are often followed by mass mortality of some tree species, e.g. beech (*Fagus silvatica*) and Norway spruce (*Picea abies*). The mass mortality of beech in Hungary is the result of a typical damage-chain. The symptoms appear first on marginal sites, isolated stand margins and in opened-up stands. In mass mortality events observed in West Hungary, both insect species, such as the green jewel beetle (*Agrilus viridis*) or the beech bark beetle (*Taphrorychus bicolor*) and also some fungi (e.g. *Biscogniauxia nummularia*) play an important role. Further pest and pathogen species causing damages on beech are expected.

Mass mortality of (mainly man-made) Norway spruce stands started in the early '90s. The hot and dry summers, the decrease of winter precipitation were favourable for the main pests (bark beetles), which had up to three generations per year. The outbreak of *Ips typographus* and *Pityogenes chalcographus* resulted in a strong decrease of this tree species (1990: 1.4%, 2008: 0.7% of forests of Hungary) and a high volume of sanitary cuttings (approx. 800,000 m³ 1990-2008). Bark beetles (especially *Ips typographus*) attacked not only their main host (*Picea abies*), but also many other coniferous species of the genera *Picea, Pinus, Larix, Abies, Pseudotsuga* or even *Taxodium* and *Thujopsis*.

Besides the increasing damage (level and area) caused by different forest insects, we have to mention some other trends, which are also in connection with climate change. Extinction or at least remarkable population density reduction of some species and change in ecology and behaviour. We are expecting the area expansion of several (mainly thermophile, Mediterranean) insect species will be considerable in the future. There will be definitely some with economic impact too. However, it has to be emphasize that the number of 'new' species is rather depending on the new introductions from other continents (invasive species) then on the area expansion.

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Spruce bark beetle in National Park Šumava

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Problems with spruce bark beetle in the modern history of Šumava began even before the establishment of a national park in the first half of 1980s. Windbreaks in Modrava were not processed in time due to "Iron Curtain" (affected forests were located in the border zone). At the turn 1980s and '90s, it seemed that the tremendous efforts could stop the bark beetle gradation, unfortunately originated larger clearings and the large died stands. On our territory was at that time spread spruce bark beetle mainly due to the prevailing wind direction from the Bavarian Forest National Park, where the gradation culminated at the time. But the period of 1990 - 1993 was an end to these hopes, in connection with the announcement of unmanaged mode on large territories. Change of management came up with director Žlábek. Everywhere was heavily intervened with the exception of the Ist zone and some small parts of the IInd zones which were declared as unmanaged. Late 1990s, however, heavily began to enforce activists and their connection to the Ministry of the Environment. Spruce bark beetle was mostly under control and cuttings were significantly reduced. Again followed by a significant increase of gradation caused by leaving some untreated focuses of outbreak. The peak occurred in the past three years. This year is only a consequence of this situation. In the last three years, it was interfered also in selected IInd zones. In 2010, based on approximately 115 exceptions were logged more than 7500 cubic meters in the unmanaged areas. There were used more than 4,000 chemical treated trap trees (especially in the form of tripods). Pheromone traps were used in tens of thousands. Using about 100 harvesters in the past two years was no problem, but now is the use of "limited" number of harvesters considerable obstacle. Furthermore, no one in the past questioned the use of pheromone traps. Also there were no problems with the use of insecticides. In the current legislation, i.e. Act No. 114/1992, respectively in Government Regulation No. 163/1991 Coll. no prohibition of the use of pesticides is mentioned! The use of insecticides for sanitation of infested wood, respectively for the preparation of sprayed trap trees, can be understood neither as intensive technology nor as a threat of specially protected fauna and likewise it does not threat the areas of NATURA 2000.

Efficiency of sprayed tripod trap trees as control method on spruce bark beetle (*Ips typographus*): comparison of numbers of killed beetles with lure baited traps catches

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The numbers of beetles captured under tripod trap trees sprayed against *Ips typographus* were compared to catches from Theysohn pheromone traps. In 2010, at each of three localities five traps and five tripods baited with Pheagr IT pheromone evaporators were installed with 10 m spacing. Weekly inspections were made during the entire period of *I. typographus* flight activity (30 April–1 October). The traps were sprayed with Vaztak 10 SC insecticide on 23 April 2010 and then again every seven weeks along with renewal of the pheromone evaporator. The study showed that the traps caught approximately one-third more beetles than did the tripods. The trap captures showed a dominance of females over males, while in tripods the sex ratio was balanced. The traps and tripods both caught approximately the same numbers of males, but the females were distinctly more numerous in the traps. In both cases, more adults were captured during spring than in summer.

The influence of sex mature of wild boar to reproduction in the CR

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Within the frame of our study were morphometric measurements of hunted wild boars in 3 different areas of the Czech Republic provided. Study took place in region of Doupov (NW Bohemia), Sušice (SW Bohemia) and Kostelec nad Černými lesy (Middle Bohemia). There were 654 measurements of wild boar taken in the period of 2003-2007, which involved body length, height at withers, ear length, length of metatarsus and tail length. Age was determined according to evolution of teeth set.

We found regional influence to all morphometric characteristics in each age category. This means that environmental factor affect physical development.

To test differences among regions we used one way ANOVA, differences issue was proven on different significance level (F = 15.4 - 3.6; p = 0.035 - 0.000). Growth curves have polynomical courses and sexual dimorphism is perceptible from the age of 18 months. Furthermore we examined fertility of juveniles (up to 12 months) and subadults (from 13 to 24 months). Depending on region 25 - 60% juveniles in age 7 - 10 months and up to 100% subadults in age 18 - 22 months became pregnant between November and January. The average number of fetuses was from 2.5 to 3.5 at juveniles, and from 4 to 7 at subadults, depending on region.

Poster session

Development of hydrological patterns in two forest catchments in the Beskydy region – a half century experience

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Hydrological patterns have been studied at two experimental catchments (Červík – CE and Malá Ráztoka – MR) in the Moravian – Silesian Bedkydy Mts. since 1954. The research is focused on the monitoring of forest management influence on the ecosystem water balance. Both catchments represent mountain area with particularly steep slopes covered by managed forests. During the first "calibration" period 1954 – 1965, the forest management was minimized with no regular felling of trees at both experimental sites. In the second phase 1966 – 1985 forest stands were quickly harvested and regenerated. The assumption that there will be distinct differences in hydrological patterns between the calibration- and intensive forest management period was, surprisingly, not fulfilled. The water behavior is quite complicated in both catchments and needs long-term series of measurement to be studied. The data analyses show that the precipitation/outflow relationship depends not only on the forest management procedures, but primarily also on the environmental and ecological conditions. During "standard" weather condition the subsurface water flow prevails in forest stands. The lush expansion of ground vegetation in the felled stands contributes significantly to the ecosystem evapotranspiration and decreases the catchment outflow. In the periods of extreme precipitation, however, the forest ecosystem is unable to prevent floods. The long-term observation and hydrological measurement on the catchment area is essentially needed for understanding and describing of these processes.

Model analysis of wildlife habitats, animal populations and measures to minimize damage on the forestry management in the region of Horní Planá

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The problem was to define risk areas on the basis of field studies as well as the methods which were verified in practice and then to formulate appropriate management of hoofed game populations and the environment. It concerns a large unstocked forest land which is being afforested after the Kyrill hurricane having the area of about 800 ha.

Information layers in GIS were made at first. GIS application tools were used which allow to work with different input data in different scales, their graphic projection and to make a subsequent evaluation. Data were processed in ArcGIS 9.0 programme (Extract, Join, Interpolation, Overlay, Clip analytic tools). It was based on the LHP map and those available at servers of UHUL and CENIA portals.

I Layer of hunting district carrying capacity defined on the basis of plant community composition; II Layer showing how the underbrush is stressed due to hoofed game grazing according to field investigation; III Layer showing how the underbrush is stressed due to hoofed game gazing according to damages caused by the animals given in CZK /100 ha; IV Layer of animal density in the region as related to stay signs; V Animal density level according to number of kills; VI Layer of vertical distribution of hoofed game populations in winter (areas determined with contour lines of 950 and 1,050 m above sea-level; VII Layer of recreational stress on the animals defined by means of road and path network density (tourist pathways, solid surface roads, etc.).

We can say that an information agreement on the hunting district carrying capacity and animal distribution was achieved on the level of validity of the methods used and the scope in which they were applied. The resultant database defining both the condition of the environment in the region and the state of hoofed game populations (which were additionally evaluated from the viewpoint of trends and a reverse calculation) was quite informative and it made possible to create a synthetic layer. The result then was a cartographic intersection of hunting district carrying capacity and population density layers and other cartographic outputs were created such as model localization of hunting facilities - orthophoto. Then methods how to minimize risks of conflicts of the forestry management (unstucked forest land afforestation) and hoofed game population management (hunting system and localization of hunting, localization and creating of special grazing areas, repellent application, and so one).

Veterinary applications – an integral part of the decision was the monitoring of health condition and food deficits of the animals, which was realized mostly by means of parasitological and haematological examinations. That enabled to determine the feeding ration in such a way that increased wood species browsing did not occur.

Estimation of aboveground biomass in Norway spruce forests in the eastern Carpathian mountains, Ukraine

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Forests have important influences on climate change because of functions they provide related to carbon sequestration, storage, and cycling. Aboveground biomass tree quantification is essential for accurate forest carbon sink estimation and encompasses many different methods. Temperate forests accumulate high levels of carbon storage over time as stands undergo processes of structural development. Quantifying aboveground carbon stocks in regional forest systems allows us to determine the bigger picture in carbon fluxes. One aspect of carbon estimation is calculation of tree productivity, which depends on the surrounding conditions. We conducted our study in the eastern Ukrainian Carpathian mountains. Spruce forests in the Ukrainian Carpathians are distributed on approximately 1 million hectares and are the dominant forest type (42%). The largest stand of native spruce (Picea abies) are located in the Chornogora mountain region reserve, as well as in the Gorgany, Hrynyavskyh, and Chyvchynskyh mountains and Marmarosh area. Study sites were situated on a Cheremosh river basin area where 12 different forest management units operate. The studies were completed on seven temporary plots with stand ages ranging between 70 and 110 years. For the stand measurements, we used the Field Map and our standard forest inventory methodology. We have used the statistical software "Corg" to analyze correlations and regression relationships between diameter and height in the stands. For the biomass studies, we conducted detailed stem analyses on 3-5 sample trees per plot. In each case, we took an average model tree and at least one bigger tree from the upper part of canopy (dominant) and one smaller sized sample tree that would characterize the subordinate part of the canopy. For the complete estimation of the biomass fractions, we developed a "section" method. This included measuring more than 24 model trees, 200 sample branches and 3670 additional branches in total. Aboveground biomass fractions and biomass energy for model trees were calculated and extrapolated for the whole stand depending on diameter class. For the comparability of the defined characteristics between different model trees we assumed that the amount of calculated biomass fraction corresponds with the basal area of the trunk section at relative height (h) of the trunk or crown length (L). As a result we obtained a value index, which is within the section ($H_{n+1} - H_n$ and in relative values) and belongs to a relative height (h, L) at which a given section is situated. Total tree biomass productivity (and for the different components) is determined by summing the same components of all tree sections. Thus, our research resulted in a biological productivity estimate for Carpathian spruce stands, describing relationships between different fractions of biomass and their morphological position and characteristics. The quantity of dry aboveground biomass on the sites depends on the specific local climatic conditions, density of tree stands (relative basal area), composition, and stand age. This studied total live tree biomass ranges from 99 tons per ha in thin stands to 368 tons per ha in highly productive sites. The aboveground biomass structure of an average spruce tree (540 kg of dry mass and 31,8 cm of dbh) found as follows: stem wood - 79.6%; stem bark - 6.3%; main (first order) branches - 4.6%; additional branches (of 2nd order and above) - 3.1%; needle - 6.5%. Carbon storage from non-used parts of biomass after harvesting was estimated to be 29 % and postharvest C is expected to be near 28 Mg ha⁻¹ on average.

Distribution of double-spined spruce bark beetle (Ips duplicatus) (Coleoptera: Curculionidae) in the Czech Republic in 1997 – 2009

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Ips duplicatus has ranked among major pests of spruce stands in the north-eastern part of the Czech Republic since the beginning of 1970s. In order to map the occurrence of *I. duplicatus*, monitoring was conducted during 1997, 1998, 2000, 2002 and 2005 – 2009, mainly in state forests. Beetles of the overwintering generation were captured in Theysohn pheromone traps baited with a lure of ipsdienol and E-myrcenol, and after 2005 in ID Ecolure evaporators. Surprisingly, *I. duplicatus* was found virtually throughout the Czech Republic already in 1997. In 2002, there was a nationwide decrease in their numbers. Particularly since 2005, there has been a spreading from the main centre of occurrence in the eastern areas to the south and west into the central part of Bohemia where until that time its population densities had not caused economically significant damage. The recorded amount of spruce wood infested by *I. duplicatus* significantly correlates with the amount of spruce recorded as damaged by *Ips typographus*, *Ips amitinus* and *Pityogenes chalcographus* infestation as well as with the numbers of individuals of *I. duplicatus* captured within the aforementioned monitoring.

Breeding billets - study method of larval development of pine weevil – Hylobius abietis (L.)

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Attracting pine weevil adults onto breeding billets was the method used for control of this pest already in the early 20th century. However, like in case of bark traps, the ability to influence population density of pine weevil adults showed to be minimal; or very high number of these control measures was necessary for successful reduction of this pest.

The breeding billets from spruce or pine trees, with their smooth and not too thick rough bark usually 1 m long and with diameter up to 20 cm, are buried in such an angle that their lower part is 30 cm under the surface and the upper respectively their top part protrudes over the ground surface. Billets prepared in such a way imitate tree roots or stumps and are resemble to places for pine weevil ovipositing. As manipulation with billets is easier than with stumps, using of breeding billets is suitable method for studying behaviour during oviposition as well as for observing development and life cycle of pine weevil.

The breeding billets can be dug into the ground either separately or together into the hole. The latter way seems to be more convenient due to lower laboriousness. The place with dug billets is recommended to equip with datalogger for temperature measurement. It is possible to use device with connector for external probe that enables measurement of temperature in various depth of soil profile.

For assessing behaviour during oviposition it is suitable to divide billets into sections both in transversal and radial direction. Gathering of billets carried out through the whole growing season in regular monthly intervals enables to observe larval development in Central European conditions; length of pine weevil life cycle can be investigated on base of lifted billets for several monthly intervals in the course of many years.

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The influence of ecoclimatical factors on the size of cockchafers (*Melolontha* spp.) population in main outbreak centers in Poland

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Cockchafers (*Melolontha spp.*) are the most dangerous insects pest in Polish forests. The area of theirs mass incidence increased over the last twenty years by nearly 100 times. Additionally, EU legislation and forests certification causes that none of the insecticides can be applied against cockchafers. This is the reason of increasing number of research on the biological plant protection products. Biopreparations, which are based on pathogenic fungi or nematode, must be provided suitable climatic conditions of the soil in order to be an effective tool in the fight against cockchafer grubs. To do this, one should get to know the environment of both cockchafer grubs and their natural pathogens.

Depending on the tree stand structure, which in the managed forests is shaped by silvicultural treatments, each forest community creates its own unique forest ecoclimate. The aim of the study was to recognise the ecological conditions in forest stands, forest cultures and soils, where cockchafer grubs occurred.

The studies were conducted in 2010 in so-called primary outbreak centres in the Narol, Lubaczów, Ostrowiec Świetokrzyski and Smardzewice Forest Districts. The tasks on nineteen randomly selected plots (with three measurements and observations made on each plot) included: assessment of canopy openness in the stands in different age classes and habitats using a fisheye lens camera, vegetation surveys (phytosociological relevés), assessment of grub colonisation in soil (1 x 0.5 x 0.5 m pits). On six selected plots were additionally installed soil microclimate data recorders (each recorder outfitted with three measurement sensors). There were placed on a depth of grubs feeding to measure soil temperature and humidity throughout the growing season.

An important part of the study was also to analyze data on forest soils grub colonization in 2008 and 2009 in all forest districts, in which the researches were done.

The results showed that the figure of cockchafer grubs in soils of forest ecosystems was weakly negatively correlated with canopy openness (p = 0.05). It was stated that the grubs are numerous in forest soils, even in spite of its considerable overshadowing (the highest number was recorded in hardwood stands with a high density). Data analysis of grub soil colonization, obtained from the forest districts surveyed, confirmed earlier that although the cockchafers can be found in all forest habitats, they prefer fertile sites. The obtained results contradict to the general opinion on the occurrence of grubs in poor soils of coniferous forest habitats.

The results of measurements of soil microclimate showed the existence of statistically significant differences between objects. However, the specific trends of temperature and humidity of soil, which could diversify places where cockchafer grubs occurred or not, were not found. This indicates that cockchafer larvae have a high capacity to live in a wide range of environmental conditions.

Level of mycorrhizal infection: the standard method

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The growth conditions and health state of trees as dominant fraction of forest ecosystems are reflected in the quality and quantity of their root network. New, less invasive and simple standard methods are necessary for a clear evaluation of root systems. These methods enable us to compare different stands as well as to study year round root dynamics and long-term changes caused by climate fluctuation and by anthropic influence.

In this poster presentation we describe the standard method for fine root analyses which has been used since 1993 in our studies of correlations between quality of root and crown systems. Similar protocol is also adopted for root analysis of seedling mycorrhizal infection. In this case, however, the whole root system is tested.

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Occurrence of Phytophthora spp. in young oak stands

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The increase of dying oak stands has been seen across Europe in the last few decades. The research has brought an evidence of growing share of *Phytophthora* species in the oak forests rhizosphere. We studied the spread and damage symptoms of *Phytophthora* spp. in oak stands at the age of 25 to 30 years.

Research plots are located in South (Netolice) and West Bohemia (Plasy), in South (Tvrdonice) and Central Moravia (Troubky, Malenovice). Three plots (stands) are characterised by higher groundwater level: Netolice at water-logged soil, Tvrdonice and Troubky in flood areas of floodplain forests. Sampling of oak roots was done regularly in periods of high activity of the pathogen (in spring and autumn in 2008 – 2010).

The highest occurrence of *Phytophthora* spp. was recorded in the Tvrdonice stand (71%). This stand is situated in the area of regularly flooded floodplains of the Morava River and suffers from annual floods in the spring (from 2 weeks to 3 months). In contrast, no *Phytophthora* spp. damage was observed in the Plasy stand with the drained gravel soil.

Forest breeding, seed management and silviculture

Forest tree breeding and improvement programs at the Forestry and Game Management Research Institute

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To maintain and improve biodiversity, consideration must be given to preserving genetic diversity. In the Czech Republic, genetic variability of forest trees species, principally Norway spruce, Scots pine, European larch, silver fir, pedunculate oak, sessile oak, sycamore maple, black alder and European beech, is being studied in relation to geographic variability and the ability to adapt to variations in site quality and human impact. These treatments include gene-source preservation and reproduction by establishment and management of genetic conservation units, plus the classical methods of hybridization and provenance trials. Methods of molecular biology (e.g. isozyme and DNA analyses) are used to determine adaptability characteristics which provide information about the genome of forest tree species much faster. In the Czech Republic, breeding programs for individual coniferous and broad-leaved forest tree species focus not only on research aimed at increasing the quality of the species as well as the volume production and resistance, but also on the necessity of partial populations' genetic variability preservation, such as establishment of seed orchards and clone archives. We use both traditional breeding procedures for biodiversity preservation and biotechnological methods for micropropagation of forest tree species, e.g. clonal micropropagation by means of somatic embryogenesis and organogenesis.

The goal of breeding, as the practical application of knowledge derived from forest genetics in forestry practice, is to identify suitable populations and verify appropriate collections of forest tree species for practical use. Special breeding programs are aimed at hybrid poplars including hybrid aspen, or by using micropropagation for preserving of threatened species and populations of forest trees.

While employing provenance testing and the more modern diagnostic methods (especially analyses of isozyme and DNA analyses), we must maintain our hybridization programs to achieve improved qualitative and quantitative properties of future generations of trees. Also, further research is needed on procedures for vegetative propagation of forest tree species, focusing especially on improved and verified populations and cultivars. Expanded research on early diagnostic tests is needed to evaluate breeding material more quickly. Finally, we must improve the methodology for sampling design and evaluation of results, making use of new applications of statistics.

Improved characterization of genetic variants using sophisticated laboratory and on-the-ground methods will allow us to both maintain local biodiversity and regional varieties, and to determine the most suitable species or the suitability of species for regeneration on a particular site and under particular conditions. We can then use information about conditional traits and properties of partial populations (e.g. sources of reproductive material as seed orchards, and forest stands certified for seed collection) to further select the best of them as categories of verified sources of reproductive material (category E according EU classification).

All of the improved laboratory and field techniques of genetic analysis and improvement are intended to aid forest practice by increasing biodiversity, ecological stability and the production of forest products, plus selecting the appropriate species mix and regeneration practices for restoration, preservation and enhancement of valuable and threatened populations. The results of past, current and future research contribute to remediation of past ecological problems and respond to alterations and renewals of forest tree species composition within the framework of expected potential climatic changes.

Forest tree seed management research focuses on fructification of Scots pine and European larch seed orchards, improvement of protocols for collecting, storing, pre-treating and evaluating the quality of the forest shrub and tree seeds, and investigation of factors influencing beechnut germination and beech seedlings emergence.

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Study of the natural regeneration in stands of Quercus robur L. in Galicia (NW Spain) by Computer Aided Design (CAD) and digital photography

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The monitoring of the natural regeneration in stands of *Quercus robur* L. has been studied. These stands are localized in the following areas: i) Natural Park "Fragas do Eume" (A Coruña province), ii) Fraga das Saímas and iii) San Fitoiro oak forest (Lugo province) and iv) Taboadelo oak forest (Pontevedra province). After stand stratification by its canopy: opening-clearing, semi-closed and closed canopy, the regeneration in closed and semi-closed canopy has been quantified by CAD and digital photography.

Quercus robur stands are the climax forest that should cover most of Galicia (NW Spain). However, its location in deep soil and with little slopes, and the high quality of its wood have resulted in widespread loss of what once must have been a continuous surface of deciduous hardwood forests in most part of Central and Western Europe. Today, most of its potential area is occupied by other fast-growing tree species, in addition to pastures and land dedicated to farming. Despite all this, the area now covered by deciduous hardwood forests in Galicia has increased. In Galicia, this species occupies 187,789 ha according to IFN3 data, representing 13.36% of the forested area, and 33.39% of the area occupied by hardwoods. In Lugo, it's noteworthy that nearly 27% of the forest surface corresponds to *Q. robur* stands, representing over 54% of the area occupied by hardwoods. Its regeneration seed thus appears rather uncertain, since it's random and discontinuous, and although the acorn formation is annual, abundant harvests generally occur with time intervals of 3-5 years. Mast year apparently to a large extent driven by climate, but also relates that after a year of good harvest the tree is exhausted and needs to accumulate reserves. In Galicia, regular or semi-regular many mature stands have a rich regenerated (regenerated advance), but the absence of silvicultural treatments, causes the seedlings die for light lack.

Until now, information on the regeneration of the oak forests by acorns in Galicia was minimal. Just found a job on how grazing affects oak regeneration and another that it describes the problem of regeneration of deciduous and semideciduous oaks in NW Spain. In the rest of Europe, studies on regeneration of *Quercus robur* are quite numerous, analyzing natural regeneration of these stands as forestry, ecology,...For this, it's very important to know the regeneration process of this species in the study area.

The total radiation under canopy, it's the more important factor that it involved in this process, not only for its direct effect on photosynthesis, but also for its regulatory action on other variables that influence on growth (air and soil temperature, relative moisture,...). Thus, the knowledge of the growth response of seedlings to variations of the main factors of site, i.e., total radiation under canopy, it's fundamental for establish the basis on which to propose the most appropriate measures to enhance natural regeneration.

To estimate the canopy cover, through graphic representation each stands and the surface of canopy cover found on each of the sampling points of regenerated, it was performed to measure the horizontal projection of the crowns, treating them as ellipses. Then, we proceeded to graphically position each three inventory of each plot. The data were analyzed with CAD to create a graphic image of each plot and estimating canopy cover. To estimate the crown surface, digital photographs are made canopy, being the best weather conditions are fully covered skies, to avoid reflections. Processing of the images used image processing software IMAGEJ 1.43, developed by the National Institute of Health (USA), which allows us to determine the area for vegetation-free zones over the total area photographed.

Norway spruce gene conservation and breeding programs In Poland

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Spruce covers 7.7% of the forest area in Poland being, apart from common pine, the most important commercial species in our country. It is characterized by a pronounced variability. Polish provenances are tested in many provenance experiments with the most important IUFRO 1938, IUFRO 1964/68 and IUFRO 1972. The genetic-breeding evaluation of Polish spruce races was presented on the basis of results obtained in the above-mentioned experiments. The presentation concerns the lowland, mountainous spruce races, also Istebna, Orawa, Bieszczady Mts. and Sudeten Mts spruce as well as genetic polymorphism divergence evaluated using isoenzyme, terpene and DNA markers. Against this background methods used in the *in vitro* conservation of gene resources were presented as well as the chief directions of the currently realized new stage of the program of forest trees selection and of the tests applied in the evaluating the progeny of the forest reproductive material in Poland.

Testing of Norway spruce hybrids Picea abies L. and Picea abies F. Pendula (Nxp) and reciprocal one (Pxn), in Puru high elevation experimental trial

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Four selected parents from each of two pendula (narrow-crowned) and normal – crowned *Picea abies* L. were used in two separate complete diallel mating designs. The research was performed upon hybrids between narrow - crowned and normal-crowned spruce trees (PxN), and reciprocal one (NxP), when the hybrids were 13 year old in Puru high elevation experimental trial. The evaluated parameters were: the genetic variance; variance components, GCA and SCA effects, narrow and broad-sense heritability and heterosis of the traits. The potted families were distributed in a randomized complete block design with 4 replications and 10 seedlings per plot, in 5 experimental trials. Five traits were measured, such as: total height (TH), yearly increment of height (YIH); number of branches per whorl (NBW); forking % (F); survival % (S). Computer analysis, using Schaffer and Usanis (1969) DIALL programme produced the results presented below.

Genetic variability of spruce hybrids tested is higher and it occurs under different forms, both in the (PxN) and (NxP) hybrids types. There were found highly significant differences (p < 0.00.1) among the hybrids families (excepting the S% trait in PxN hybrids, and for YIH and S% traits in NxP hybrids). It may be noticed the additive genetic control of the traits in both spruce hybrids, which makes possible the selection of the best performing parent to be used in the spruce breeding programme.

The estimation of general (G C A) and specific (S C A) combining ability effects was calculated in order to allow classification of the best genitors and specific crosses which will be used in the spruce breeding programme.

Narrow-sense heritability was low to high level, ranging between 0.104 for NBW and 0.892 for TH and between 0.108 for NBW and 0.788 for F in PxN and NxP hybrids, respectively.

There were estimated both high and mid parents heterosis in pendula x normal crowned spruce hybrid and reciprocal one.

The influence of weather conditions on flowering of European larch (*Larix decidua Mill.*) in seed orchard

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The aim of the study was to examine the influence of 3 weather factors (air temperature, precipitation and solar radiation) on flowering of European larch. The investigations were carried out in 10-year-old clonal seed orchard and 9-year-old seedling seed orchard in Syców Forest District.

The observations of flowering intensity of larch trees were conducted in 5 following years, the female flowering was estimated in 10-graduate scale and male flowering in 6-graduate scale. The weather factor's changes were recorded by the automatic weather station localised about 300 m away from the seed orchards. For each of 5 years of flowering observations, the Pearson correlation coefficient was calculated between mean female and male flowering and mean values of each weather factor in 28 months preceding flowering, i.e. from the April of the year of flowering (Year-0) back to the all year before flowering (Year-1) and all year in 2 years before flowering (Year-2).

Intensive flowering of larch was observed when in the year in 2 years before flowering (Year-2) were found: (*i*) cold, sunny and snowy January; (*ii*) warm, cloudy and wet period from February till April; (*iii*) cold and cloudy May and June and abundant precipitation in June; (*iv*) not so hot but sunny and dry July; (*v*) rather warm, cloudy and wet August; (*vi*) cloudy and wet autumn and (*vii*) not so warm, cloudy but dry December. The influence of air temperature on flowering was particularly significant in February (positive correlation) and July (negative correlation) of the Year-2; the solar radiation was the most important in February, May and August (negative correlation for every month) and the precipitation had the greatest impact in March (positive correlation) and July (negative correlation) of the Year-2.

In the Year-1, when the flower buds were formed, different weather conditions were favourable for abundant flowering of larch: (*i*) warm, cloudy and not so wet January; (*ii*) cold but sunny and dry February, March and April; (*iii*) cold, cloudy and wet beginning of May; (*iv*) worm, sunny and dry end of May and June; (*v*) July cold and wet in the end; (*vi*) warm, sunny and dry from the end of August till the half of September; (*vii*) rainy the second half of September; (*viii*) cold, cloudy but dry autumn and (*ix*) cold and wet December. The air temperature had the greatest impact on flowering in the end of May of the Year-1 (positive correlation). The solar radiation was the most important in March and May (positive correlation) and January (negative correlation). The influence of the precipitation on flowering was significant in June (negative correlation), the beginning of May, the end of July and the half of September (positive correlation).

In the year of flowering (Year-0) favourable for intensive flowering of larch were cold but sunny and dry January and cold and cloudy February and March.

Summarising, European larch requires for abundant flowering specified weather conditions following in 2 years before flowering and different in each year. These optimal for flowering weather conditions occur rather rarely, which is one of the reasons of the irregular flowering of this species. The good seed yielding of European larch usually does not occur in 2 following years.

Limited local adaptation patterns in provenance experiments: implications for seed transfer

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Under a rapidly changing climate, plant populations may choose between two strategies to persist on the original location: relying on phenotypic plasticity or genetic adaptation to local climate through a shift of genetic structures leading to phenotypes able to survive. The idea underlying the regulation of forest reproductive material transfer (mainly in East Europe) is that local adaptation is the predominant strategy. We looked for patterns of local adaptation in growth and phenological traits in two provenance experiments.

In a local provenance experiment with Norway spruce (*Picea abies* Karst.) comprising 11 provenances plants on 5 sites along an elevational transect, we examined responses of populations in terms of growth and survival at the age of 45 years to climatic transfer. Transfer rates (ecodistances) were defined as differences in altitudes or climatic variables between the site of plantation and the site of origin. Optimal transfer rates and optimal climates for individual provenances were derived from quadratic response functions. Optimal transfer rates were consistently negatively correlated with the underlying environmental variables, and optimal climates were consequently nearly the same for all provenances irrespective of the response traits and ecodistance variables.

The second analyzed experiment was the international beech (*Fagus sylvatica* L.) provenance experiment established under the coordination of the German Federal Forestry Research Institute in 1996/1998. In total, 54 provenances and 18 trial sites were included in the analysis of growth responses of beech provenances to transfer using the same methodology as for spruce. In spite of an incomparably larger scale of the experiment, the same patterns were found. Optimal transfer rates were negatively correlated with the underlying geographical coordinates and climatic variables (temperatures, precipitations, Ellenberg's quotient), whereas optimal position were positively correlated with the geographical/climatic variables only in one case.

Detailed observations of vegetative phenology and late frost damage were available for the Slovak plot of the beech experiment (6 to 12 scorings per spring/autumn in two years, from which the Julian dates of achieving the mid-stage budburst/leaf discoloration were derived by fitting to sigmoid function). Clear rangewide longitudinal clines in the timing of phenological processes were observed. There was a significant positive genetic correlation between height and vegetation season length contrasted with negative correlation ($r_g = -0.88$) between spring flushing date and frost damage. Phenology seems thus to be quite fine-tuned to climate due to a trade-off between growth and frost risk.

Clustering of beech provenances based on their optimum transfer rates and phenological behaviour yielded regions where provenances exhibited similar growth and survival responses to transfer. These 'adaptively homogeneous areas' were geographically consistent, but much larger than the existing seed transfer zones in Central and East-European countries.

The results indicate that populations in different climates remain adapted to a common optimum, the extent of local adaptation is quite limited both in conifers and broadleaved species. Considering this fact, the existing seed transfer legislation in East Europe, frequently prohibiting transfers across the boundaries of relatively small provenance regions, may be too restrictive and needs revision.

Certification of forest reproductive material based on reference samples and genetic methods

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When artificial regeneration is performed the selection of the proper provenance is of greatest importance. Forest reproductive material (FRM) of unsuitable provenance leaves the forest owner with high risks and low revenues. The existing legal regulations on FRM moved in trade can, however, only provide for an absolute proof of identity at an unproportionally intense level of controlling. The rapid development in the field of genetic investigations on forest tree species during last two decades opened new control possibilities.

Posibilities and limits for the application of genetic markers (isozymes, DNA markers) for proof of identity in case of some species governed by the European and national regulations on FRM (e.g. *Acer pseudoplatanus, Abies alba, Picea abies, Prunus avium*) are presented. The use of genetic lab tests has significantly improved the quality of controll checks. Perspectives for further developing procedure in this field are also presented.

The two new certification systems for FRM based on reference samples and comparison of genetic structures established operationally in Germany are presented. Both schemes apply private law while being fully compatible with the German Law on Forest Reproductive Material and enforce its application. Reference samples are drawn during harvest, after mixing of seed lots and in the time of delivering the plants to the owner. Genetic comparisons of reference samples by means of genetic markers, especially with highly variable microsatellites, and documentation in an Internet-data-base allows for checking the number of trees harvested and the ancestry of seeds and seedlings from a certain seed source. The systems are constantly adjusted regarding the recent scientific knowledge. Certification schemes are necessary, because they lay down uniform and generally accepted rules and assure their implementation with acceptable input.

Genetic variability of silver birch (Betula pendula Roth) seed traits and its relationship with height growth at juvenile age

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The aim of investigations was to estimate provenance and family variation of Polish and Latvian silver birch in traits of seeds and height growth. Seeds were collected in 10 selected seed stands in territory of Poland, from 20 trees in each stands.

Viability and weight of seeds were determined as well as measurements of embryos (based on scanned X-ray film). Differences in average characteristics of the embryo (length, width, elongation degree) between families within provenance are greater than differences between provenances. The percentage of full seeds (r = -0.67) and embryo length (r = -0.87) were negatively correlated with longitude.

3 experimental plots were established in 2006 – 2007 using seedlings from examined seeds. There were 10 Polish provenances mentioned above and 3 Latvian provenances, about 10,000 trees and nearly 200 families in each experimental plot.

The provenances were assessed for height growth and survival in each experimental plot during 3 years. North-eastern Polish provenances (Augustów and Browsk) were the most flexible and had the best growth in each experimental plot. Results also showed that provenances originated closer to experimental plot are characterized by better growth. The provenance (0.91 - 0.98) and family (0.28 - 0.83) heritability for height growth were high.

On the basis of 3 traits (height growth, height increment, budburst), economic weight and heritability of these traits there was calculated quality index for each family (*WIR*):

$$WIR = \frac{1}{o} \sum_{k}^{o} \sum_{j=1}^{4} a_{jST} h_{R}^{2} E_{j};$$

where: a_{jST} – standardized value of trait *j* for *i*-family (*i*=1,..., m; *j*=1,...4); h_{jR}^2 – family heritability of trait *j*; E_j – economic weight of trait *j*. Results showed that silver birch is characterized by great genetic differences among both provenances and families and one can find families of good and bad values in each provenance. The most number of families with positive value of quality index were also in north-eastern Polish provenances (Augustów and Browsk).

It was found a few, but statistically significant correlations between height growth and some characteristic of seeds (share of full seeds, embryo length and width).

Influence of fungicide treatment and storage on the dynamics of seed germination of Serbian spruce (Picea omorika Panč. / Purkyně) from natural forests and planted forests

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Serbian spruce areal occupies the mid-course of the river Drina in B&H and Serbia and inhabits rocky and hardly accessible terrains. It is characterized by good productivity and properly formed crown, which makes the species appreciated in forestry and horticulture. There are difficulties in natural regeneration by seeds in natural habitats. Because of narrow pyramidal crown, it is difficult to collect seed, while, on the other hand, the need for seed in forestry and horticulture is significant.

During 2010 seed from 17 tress were collected from two natural forests and one planted forest. The seed storage was conducted both with and without the treatment with fungicide "Captan 50" during 2 months on the temperature of 4°C. Germination which lasted 28 days was observed on the seed which were not treated, then after the storage, with and without the fungicide treatment. The seed which were stored for 2 month at 4°C and without fungicide treatment had the highest germination energy, then the seed without any treatment, while the stored seed which had been treated with fungicide had the lowest germination energy. At the end of the testing, there were no significant differences in average values of germination based on treatment. It is obvious that low temperatures favorably influenced germination energy of Serbian spruce, whereas the negative influence of fungicide is evident.

There are significant differences between the analyzed populations (natural and planted) as well as within the population, among the tested trees. Seed originating from the planted forest have the highest level of germination, while seed from natural forests have significantly lower germination or similar level of germination. The reasons should be looked for in the environmental conditions and spatial tree distribution in natural and planted forests.

Endemic species of rowan tree in the Czech Republic and their reproduction by *in vitro* methods

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In the Czech Republic there are several endemic rowan species of hybridogenous origin from whitebeam (*Sorbus aria*) range, most of them were already described at the end of the 20th century. They are scattered in one or a few populations up to several tens or hundreds of individuals. Their natural regeneration is usually very weak and little successful. Moreover, the young seedlings and trees are permanently at risk game grazing. They therefore belong to extremely rare and endangered woody species, and therefore it is important to take steps for their reproduction and conservation. New data about their distribution and variability in different site conditions were obtained and various possibilities of vegetative reproduction were examined and tested.

For reproduction of endemic rowan the method of micropropagation, induction of organogenesis on terminals of dormant buds was successfully used and was succeeded to establish of the multiplicating cultures and save them into bank of explants from all the individuals collected. The reproduced microcuttings will be used in the forthcoming trial to develop a methodology of rooting and growing of complete plants of these rare rowan species and their transfer to outdoor nature conditions.

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Silviculture research in Opočno Research Station

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Research Station at Opočno is a department of silviculture of the Forestry and Game Management Research Institute (FGMRI) at Strnady. The Station is oriented on applied research and consultancy and expert activities (services for forest owners) in silviculture with statewide range of the Czech Republic. There are research sections within the Station:

- Section of forest nursery management and afforestation incl. Forest nursery inspection and accredited laboratory.
- Section of forest tending (thinning) and forest regeneration.
- Section of forestry amelioration.
- Library.

The station was established as an autonomous Research institute for silviculture, forest seed and forest nursery management in 1951. The famous Opocno shelterwood management system, whose base had been formed by Hugo Konias in 1930s, represented the main argument for founding the station. In 1952, it was included into the Research Institute of Forest Management at Zbraslav-Strnady as a Research Station of silviculture at Opocno.

At present, the Station covers silvicultural applied research, expertises, and consultancy according to needs and demands of the Ministry of Agriculture, state administration, forest owners, etc. The main part of investigation is concentrated on the long-term research project "Silviculture in ecotopes disturbed by human activities" subsidized by the Ministry of Agriculture. Station research workers also participate in the other projects subsidized by the National Agency for Agricultural Research, the Grant Agency of the Czech Republic, the Ministry of Environment, etc.

Long-term operated research plots for regeneration and thinning present the base for research activities. Those research plots have been founded in various immission and site conditions in the whole Czech Republic since 1950s. Machines for automatic measuring and logging climatic, pedologic, and hydrologic data equip the most important research objects. The Station operates also a small experimental forest nursery with automatic control and registration of microclimate data and irrigation.

Consultancy and expert activities are an integral part of investigation and they are covered by demands and assignments of the Ministry of Agriculture of the Czech Republic. These activities support forest owners and civil service. They also help to subsidize the maintenance of long-term demonstration plots. The accredited laboratory for evaluation of physiological and morphological quality of plants operates in the framework of forest nursery activities.

See web pages http://www.vulhm.opocno.cz for more details (staff, projects, publications, etc.).

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Management concept in Baden-Württemberg forests in changing growing conditions

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This lecture is oriented towards silviculture and forest management. It consist of an assessment of the current situation of Baden-Württemberg forests, expected climate change conditions and measures we as a forest research institute recommend for the treatment of forests with respect to tree-species composition, rotation time, regeneration, tending, forest protection etc. In our institute we are involved in several projects related to these questions.

Early growth performances of sycamore maple (Acer pseudoplatanus L.) treated as high forest or coppice: a case study

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Sycamore maple (*Acer pseudoplatanus* L.) is one of the most valuable broadleaved tree species in Europe, its wood being widely used in the manufacture of furniture, veneer, marquetry, plywood, as well as for sawn timber, pulp and fuel wood. It is also considered as one of the fastest growing broadleaved species when grown on suitable sites, with a high potential for coppicing quickly after cutting.

Under these circumstances and taking into account the scarcity of research data on this important forest species in the Romanian forestry, a research project on early growth performances of sycamore trees treated as high forest or coppice was settled in 2011. It uses the field data collected in a mixed sessile oak-European beech-sycamore-European larch plantation of 3.4 ha, spacing 1.8 x 1.1 m (5,000 plants/ha), inter-planted with strawberries in an agro-forestry system and established back in April 2003. In December 2005, because of their quick height growth and over shading of strawberries, many individuals of sycamore were cut at about 10 cm height and coppiced freely afterwards. In April 2011, 60 independent sycamore trees planted in 2003 (high forest trees) as well as 137 coppice stools of sycamore regenerated on 30 stumps produced in 2005 were measured in terms of diameter at breast height and total height.

The main preliminary results of this project are as follows:

- a. *High forest trees* 8-years-old:
- mean diameter at breast height: 5.67 cm (range 3.9-8.1 cm); mean diameter increment: 0.71 cm/year (range 0.49-1.01 cm/year); proportion of individuals with a mean diameter increment at least 0.6 cm/year: 83%; proportion of individual trees with a mean diameter increment at least 0.8 cm/year: 22%
- mean height: 5.34 m (range 4.07-6.45 m); mean height increment: 67 cm/year (range 51-81 cm/year); proportion of trees with a mean height increment at least 70 cm/year: 38%
- mean slenderness (stability) index $SI = h \times 100/d$: 95 (range 76-111); proportion of trees with a SI at least 100: 30%.
- b. *Coppice trees* 5-years-old:
- mean diameter at breast height: 3.39 cm (range 0.8-6.1 cm); mean diameter increment: 0.68 cm/year (range 0.16-1.22 cm/year); proportion of individuals with a mean diameter increment at least 0.6 cm/year: 65%; proportion of individual trees with a mean diameter increment at least 0.8 cm/year: 9%
- mean height: 4.63 m (range 2.33-6.52 m); mean height increment: 93 cm/year (range 47-130 cm/year); proportion of trees with a mean height increment at least 70 cm/year: 96%; proportion of individuals with a mean height increment at least 100 cm/year: 34%
- mean slenderness (stability) index SI = h x 100/d: 150 (range 94-300); proportion of trees with a SI at least 100: 98%; proportion of individuals with a SI at least 150: 44%.

The mean diameter increment of sycamore trees is similar in the two completely different regeneration conditions while the coppiced sycamore trees are faster height growers that the ones planted. However, before age 10, sycamore trees in both regeneration conditions have confirmed their reputation as fast height growers.

Taking into account the early growth performances shown above as well as its high potential for coppicing (mean number of coppice stools/stump: 4.57; range 2-9), sycamore can also be considered as a potential valuable biomass producer in short rotation coppices.

Broadleaves used for reforestation of formerly air-polluted areas

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Large areas of spruce-dominated forest were affected by air pollution in the past. Norway spruce was in decline at that time; therefore large areas of forest had to be logged off. The experience with this forest destruction made foresters to change the tree species composition of new forest stands. There were used tree species such as mountain ash and birch which were supposed to cope with imission-affected conditions creating substitute forest stands. In 1990s, air pollution load diminished and this situation led to restoration of Norway spruce. However, the broadleaves remained a recommended admixture being planted to ameliorate formerly polluted soil by litter-fall. Besides, the natural forests restoring after disasters are first dominated by pioneer tree species. Therefore, utilization of broadleaves in renewal process emulates the natural vegetation succession and helps to establish a first-stage forest environment. The aim of our study is to find whether these broadleaves perform well under mountain conditions. There were planted three tree species (mountain ash, Carpathian birch and white birch) in the summit part of mountain ridge at the altitude of 975 m above sea level in 2000. Both growth rate and survival have been investigated every year. The species were planted within 80×50 m area and plots (four for each species) with the species were randomly distributed. To avoid a pseudo-replication effect, we compared the treatments using mean values of height and variability expressed as standard deviation. The white birch was the tallest species though differences among the species cannot be considered significant due to great variability of the height achieved. Both birch species showed also better survival compared to both mountain ash treatments. The number of living individuals did not drop bellow 40 (80% survival) for all birch plots during the investigation period.

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Soil forming and production effects of forest stands established on former agricultural lands: Czech – Moravian Highland example

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Afforestation of marginal agricultural lands represents important topics in the Czech forestry of the last decades. Up to 500,000 ha of these areas are disposable for land use change in the country. In the last century, there were several periods of intense conversion of agro-ecosystems into forest ones. The stability and diversity as well as ecosystem dynamics are less known features of these secondary ecosystems. The presented paper evaluates the soil forming and production potential of forest stands established in the 1960s on former agricultural lands and compares them with stands on the forest ones. The studied stands are located close to village Krucemburk in the Czech-Moravian highland on water-affected sites in the 6th vegetation altitudinal zone. The set of permanent research plots was established in 5 Norway spruce stands, 1 larch and 1 sycamore stand. In selected stands, the soil conditions were described and the humus form restoration was documented, comparing with the meadow and arable soil sites in the vicinity.

The studied area is a part of the Natural Forest Area (PLO) 16 – Czech-Moravian Highland, NW part. It is represented by the newly established 45 ha forest complex, in relatively flat water-influenced territory, by maximum slope 5%, in the altitude 610 - 640 m a.s.l.. The area is mildly warm to cold, estimated mean average precipitation reaches 700 - 800 mm, mean year temperature 5 - 6 °C. The geological bedrock is formed by acid poor metamorphites – gneiss to phyllites, the ecological series are wet to gleyed. The reconstructed forest types are 601 and 6P1, soil types Pseudogleys modal.

The soil forming and restoration potential was studied in 2 Norway spruce plots (PRP 1: Forest Type 6P1, age 48 years – 2010, PRP 2: Forest type 6O1, age 53 years 2010), 1 European larch stand (PRP 4: Forest Type 6O1, 52 years 2010) and 1 sycamore stand (PRP 5: Forest Type 6O1, 53 years 2010). Comparing plots were arable land and meadow. In forest stands, L+F1, F2, H horizons were quantified, the soil chemical characteristics (pH, soil adsorption complex characteristics – S – base content, H – hydrolytical acidity, T – cation exchange capacity, V – base saturation by Kappen, Cox, N Kjel, total nutrient content, plant available content in citric acid and Mehlich III) were analyzed both in holorganic layers and in horizons 0 – 10 cm and 10 – 20 cm, comparing to agricultural lands. The accumulation of surface humus reached the values 63.62 t/ha (PRP1), 82.02 t/ha (PRP 2), and 77.19 t/ha (PRP 4) respectively. No surface humus determined in the sycamore stand. The values correspond with typical forest sites of the region, so the close-to-nature stand is reached within $\frac{1}{2}$ of the rotation. On the other side, the chemical characteristics indicate the effect of former agricultural use – approximately double humus content in the mineral soil of forest stands and higher total nitrogen content there too. Among the tree species, the sycamore showed the least acidification effect.

The standing volume inventory documents high production potential of stands on former agricultural lands. The highest standing volume was quantified in the Norway spruce stand on site LT 6O1, 866 m³/ha at the age of 53 years, exceeding the model production of respective species by 50%. For compared pairs of spruce stands, in one case was documented higher standing volume compared to steadily forested site, in the other this characteristics being comparable.

The results document the fact that the afforestation of agricultural lands is a highly economical treatment comparing to traditional use. Their production is high, they need a care because of rot danger as well as qualified thinning for higher stability. The lowering of rotation period, sooner regeneration start and completing with site corresponding stabilizing and soil improving species represent proper management.

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The effect of deforestation on springs water on Skrzyczne (Silesian Beskid Mountains Poland)

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Landscape of Silesian Beskid Mountains in last few years has changed radically. Slopes of mountains previously covered by spruce stands are now almost entirely deforested. This change is not indifferent for environment and among other consequences it has its reflection in chemical features of spring waters. The research was carried out in two catchments lying on opposite slopes of Skrzyczne – in Czyrna catchment and Malinowski Potok catchment. Samples were taken from 29 springs in 2004, when the process of spruce dieback was noticeable, however it turned out to be only the beginning. In 2009 unstable spruce stands on Skrzyczne died and 16 springs were examined in this area. In neighborhood of 11 springs plant cover did not change along the 5 years, in case of 4 springs spruce stands growing previously in the area of alimentation reservoir have been just cut down and alimentation reservoir area of 1 spring was afforested after previous clearcut.

The chemical features were measured in the Department of Forest Ecology laboratory. Ions concentrations (Na⁺, K⁺, Ca²⁺, Mg²⁺, NH₄⁺ Cl⁻, NO₃⁻, SO₄²⁻) were determined on chromatograph Dionex –320, pH – with Eijkelkamp 18.37, conductivity - with Eijkelkamp EC 18.34. Deforestation affected not only number of springs but also water chemistry and water quality.

Conservation of stability and biodiversity of Norway spruce mountain populations

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Mountain populations of Norway spruce (*Picea abies* (L.) Karst.) show in first years (in nursery) greater variability in height growth compared to populations originated from lower altitude. In the scope of preceding research we found out that spruces with slower juvenile growth show excellent adaptability after outplanting on extreme localities and most probably they will form the climax part of regenerated stands. Problems result from the fact that for many years these spruces were culled in nurseries due to their small sizes and only more intensive growing seedlings were used in reforestation.

The important question arises, whether extensive localities in mountain regions under emission load reforested in 1980s and 1990s will be able to withstand the extreme mountain conditions. On the research plot established 15 years ago by spruce planting stock sorted in specific way with special attention focused on slowly growing seedlings the physiologic, genetic and morphologic features will be studied in relation to growth intensity of seedlings.

The target of the research is examination the importance of spectrum of spruces with various initial growth intensity for stability and successful performance of stands established in mountain conditions and adjudication the risks of stand destruction due to unsuitable sorting of seedlings in nursery.

The monitoring of plantations on mountain research plot in the course of 16 years showed that the out plantings established from seedlings growing slowly in a nursery and discarded as culls by a current sorting method (designated as "small") were vigorous in mountain conditions and their growth was good.

Initial height differences from plants growing faster in a nursery were gradually reduced. The initial average tree height of variant "small" was 24 cm and 16 years later it increased to 317 cm. The average height of "large" plants increased at the same time from 36 cm to 218 cm. The same trend was observed in diameter growth.

The health status results document the initial assumption of very good adaptation to adverse mountain conditions in trees grown from seedlings characterized by slow growth in a nursery.

The results of evaluation of morphological and physiological parameters and health status confirm a hypothesis that plants with the initial slow growth are a stable component of the population spectrum of mountain spruce trees. The results document good preconditions for the establishment of vital and stable stands when the entire growth spectrum of planting stock and particularly of plants produced from originally slow-growing seedlings is utilized.

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Poster session

Molecular and physiological studies of Quercus ilex response to drought stress

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Holm oak (*Quercus ilex* L.) dominates many forests over large areas of the Western Mediterranean Basin. Besides its high agronomic and social impact, holm oak forests harbour an enormous degree of biological diversity. *Quercus ilex* is considered a species well adapted to dry and high-temperature climates, but water deficit cause severe seedling mortality, and drought stress is considered one of the triggering causes of *Q. ilex* decline [1]. Thus, the development of efficient conservation strategies is a priority, and requires the study of *Q. ilex* genetic diversity and their adaptation to changing environments, assisted by a better understanding of the molecular drought-tolerance mechanisms, and the identification of the proteins and genes implicated in the efficient adaptability [2-5].

To characterize the molecular response of holm oak to drought stress, one year-old Q. ilex seedlings (Jaen, Southern Spain) were subjected to no irrigation (drought treatment) for a 28 days period; control plants were continuously watered to field capacity. In order to test the physiological status of the plants during the assay, we measured plant growth; soil water content, leaf water potential, photosystem II quantum yield efficiency and stomata conductance [3] along the experiment in both, control and plants subjected to drought. For transcriptomic analyses, leaf samples were collected at 14 and 28 days after starting the drought treatment, frozen in liquid nitrogen and kept at -80°C until RNA extraction. Total RNA was isolated using the procedure optimized in our laboratory for Q. ilex leaf samples [6]. Due to the absence of genomic sequence information for Q. ilex, gene expression analyses were conducted in two steps. First, the RNA was reversetranscribed using heterologous primers for a set of selected drought-related genes identified in other plant species to amplify the corresponding Q. ilex gene fragments. Afterwards, the obtained sequences were used to design Q. ilex gene specific primers for analysing the leaf transcript levels by quantitative RT-PCR [7]. Tested genes were: glyceraldehyde 3-phosphate dehydrogenase (GAPDH), 60S ribosomal protein L13 (Rpl-13); glutathione S transferase 1 (GST1); NADH dehydrogenase subunit 6 (NADH 6); formate dehydrogenase (FDH); dehydrin 3 (DHN3); Rubisco large subunit (RUBL) and protein phosphatase 2C (PPC2). The plants were symptomless at the collection days, but data for the photosystem II quantum yield efficiency and stomata conductance indicated that 20 days after the drought treatment the plant physiological and photosynthetic status were affected. The gene expression analyses indicated changes in the transcript levels of these genes in reponse to the drought treatment. Our results are discussed and compared with those reported in other plant systems, both herbaceous and woody, in an attempt to find general and specific drought-responsive proteins.

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Literature

- [1] Brasier CM (1996). Annales Des Sci. Forestie`res 53, 347-358.
- [2] Jorge et al., (2006). Proteomics 6: S207-14.
- [3] Echevarría-Zomeño et al., (2009). J Plant Physiol 166: 233-245.
- [4] Valero-Galván et al., (2011). J Prot. In press doi:10.1016/j.jprot.2011.05.003]
- [5] Abril et al., (2011a). Phytochemistry 72(10):1219-42
- [6] Echevarría-Zomeño et al.,(2011). Acta Physiol Plantarum, under revision.
- [7] Abril et al., (2011b). J Toxicol Environ Health A. 74 (15-16): 1001-19.

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Propagation of elm (Ulmus minor Mill.) by means of in vitro shoot tip culture technique

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This work is first study which has got subject about Elm (*Ulmus minor* Mill.) between Forestry Reseach Centers in Turkey. This study is done between 2007–2011 in order to determinate propagation possibility *in vitro* shoot tip culture of Elm (*Ulmus minor* Mill.). Using explants collected as buds from young trees near Central Anatolia Forest Research Institute Greenhouse Ankara in December and March beetween 2007–2010. There were a dormancy situation in buds in December in Ankara so we could effective buds as a explants which collected in March in Ankara.

In Research , 0.5 mg/L BAP and 0.5 mg/L BAP+ IBA (0,01 mg/L ,0,02 mg/lt , 0,1 mg/L) dozes add MS with $\frac{1}{2}$ NO₃ media pozitive effect in according to appear shoot development in four weeks. Quality shoot which height 2-3 cm and has got 3 number shoots appeared in this shoot development stage.

In vitro rooting phase (second 4 four weeks) effective dosez 0.5 mg/L NAA , 1 mg/L NAA and 0.1 mg/L NAA but there was a callus formation in 2 m/L NAA .

Rooting plants dip in 0.1 mg/lt IBA, 0.5 mg/lt IBA, 1 mg/lt IBA and without IBA in vase soil and than they are adapted in soil. These IBA dosez effective but no needs in according to transfer from vase soil to soil.
Variability of silver fir (Abies alba Mill.) progenles in the populations from Central Bosnia

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Silver fir (*Abies alba* Mill.) is one of the most significant forest species in Bosnia and Herzegovina. Research within and between population variability was conducted on five populations from Central Bosnia (Igman, Crepoljsko, Kakanj, Olovo, Fojnica).

Traits used for this analysis were a diameter above the root neck and height of plants during first four years of age, as well as a number of lateral branches in the third and fourth age. Research was conducted in the nursery with 142 half-sib families, in three repetitions on 4260 plants in total.

Variance analyses were conducted for all analysed traits, and suitable correlation indicators between height of plants and diameter above the root neck were produced. Presence of statistically significant variability within and between populations was discovered. Duncan and Post-hoc tests confirmed registered variability and defined grouping of populations according to the mean values.

In regards to correlation between height and diameter above the root neck, it was determined that with age progeny becomes more harmonised and it shows more significant differentiation within populations.

Obtained results showed possibility of implementation of selection process between families and provenances for diameter and height growth traits.

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Morphological modification and phenological variability of hybrid plane (*Platanus X Acerifolia /* Aiton./Willd.) in the avenue and parks of Sarajevo during 2009

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In this study phenological variability of hybrid plane trees (*Platanus x acerifolia* Aiton./ Wild.) was analysed on six different sites in the area of Sarajevo in the period from late March until the end of October 2009 (27.03.-24.10.).

During this period, observations of eight phenological phases for each site were carried out. Observations are made on all tress and recorded in the form on the same day.

Research of phenological phases in the investigated species in the field showed that there was variability in all localities. Thus, treatment of obtained data for each analysed unit were carried out after observations.

Analysis using nonparametric tests (Kruskal – Wallis test) showed that there are significant differences among the locations and different dates of measurement, while statistically significant differences are not present between phases of leafing within the sites on both levels of significance (p < 0.05, p < 0.01). Also, the same test noted statistically significant differences between the phases of leafing trees at observed sites in relation to the date.

The analysis of the results obtained from six different sites in the hybrid plane trees showed significant differences between observed phenological phases, both in their creation phase and in duration of vegetation period of each of them.

Great influence microclimatic characteristics of the area have at the time of occurrence of phenological phases, as well as the rhythm of their development in the urban environment which can vary between two relatively close locations where the plants are located. That was showed by the results obtained in this study which determined differences in movement and duration of individual phenol-phases of leafing of hybrid plane trees between sites that are on a very small geographical area.

Analysis using nonparametric tests (Kruskal – Wallis test) showed that there are significant differences among the locations and different dates of measurement, while statistically significant differences are not present between phases of leafing within the sites on both levels of significance (p < 0.05; p < 0.01).

Using nonparametric tests (Kruskal – Wallis Test) statistically significant differences are obtained on interpopulation level between phases of leafing on both levels of significance (p < 0.05 and p < 0.01), and that there are statistically significant differences between phases of leafing in analysed sites in relation to date.

Beginning of opening buds, open buds, opening of leaves, young leaves and fully developed leaf occur earlier in those localities where there are younger trees whose origin is from Spain. These phenological phenomena in the year of observation firstly occurred at sites Alipašina Street, Alipašino field, the Memorial park Mirza D. and Davorin P., at Mejdan Park, Ilidža – beginning of Velika aleja, and as last at the site near Ilidža – end of Velika aleja.

Phenological phases, beginning defoliation, and winter aspect of the firstly occurred at sites in Ilidža, where the values of temperature are lower, daily exposure to sunlight is shorter, and humidity higher than in other parts of Sarajevo, all due to the proximity of Igman mountain. Further, these phases occurred at the site at Mejdan Park, and later on site of the Memorial park Mirza D. and P. Davorin that is quite dry and warm.

Period of vegetation in 2009 for the analysed hybrid plane trees is the longest at the site of the Memorial park Mirza D. and Davorin P. lasting 198 days; then at Mejdan Park lasting 196 days, and the shortest is at the site near the Ilidža-end of Velika Aleja lasting 174 days.

Determined the variability between different localities and different dates of observation of phenological phases in hybrid plane trees, are effects of the action of external (environmental) influences, and to a lesser extent, of the genetic modifications (modification width). So, how will individual species respond to metrological changes is individual and determined by genetic constitution of the species as well as with its adaptation to climatic conditions during the evolution.

No final conclusions can be made based on a one-year observation of leafing of hybrid plane tress. However it can be said that the hybrid plane trees do not begin leafing at the same time on all sites due to different influence of microclimate.

Further studies should confirm that the older trees, originally from Hungary, are more stable and resistant to climatic characteristics in Sarajevo, which is understandable, because the species native to Spain are not adapted to our conditions and needs, and thus need some time to adapt to different environmental conditions.

Since these phenological observations are carried out in order to determine how the seasonal development of species at different sites, do not allow making general conclusions about the phenological properties of the analysed species and legality which in regards to seasonal changes in vegetation are present at different locations. They can serve as a good foundation and a guideline in further studies, of this and other species.

Effect of pre-sowing treatment on the germination and emergence of silver fir seeds

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This paper gives the results of experiments made over 2 years to determine the best pre-sowing treatment for overcoming dormancy in silver fir (*Abies alba* MILL.) seeds. Three silver fir seed lots were cold stratified at 4 °C for 3, 4, 5, 6 or 7 weeks and then germinated at 20 or 20/30 °C. The effect of a longer period of prechilling on spring germinant emergence was also determined in a nursery.

Cold stratification of seeds for 6 or 7 weeks significantly improved germination rate compared to that for 3 or 4 weeks cold stratification. Emergence of stratified seeds (3, 6 and 7 weeks at 4 °C) sown in April, 2011 was compared to field emergence of non-stratified seeds sown in March, 2011. Seeds after stratification emerged within 9 weeks, whereas non-stratified seeds needed 15 weeks. This study showed the beneficial effect of a longer prechilling period on the germination and emergence of silver fir seeds.

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Somatic embryogenesis in transgenic Norway spruce (Picea abies (L.) Karst.) embryogenic masses.

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Recently, we reported stable *Agrobacterium*-mediated (Pavingerová et al. 2010) as well as biolistic (Pavingerová et al. 2011) transformation of Norway spruce embryogenic mass by vector harbouring *gus*-intron chimeric gene. Maturation of somatic embryos was achieved in one transgenic line after biolistic transformation, resulting in dark blue somatic embryos when histochemically assayed for GUS activity. Presently, we obtained several tens of transgenic lines *via* both *Agrobacterium*-and biolistic-mediated transformation using vectors carrying modified versions of *cry3A* gene of *Bacillus thuringiensis*. After Southern hybridization analysis and Northern blot, 15 lines showing relatively high transgene transcription levels were chosen for somatic embryogenesis initiation on Litvay's medium (Litvay et al. 1985) supplemented with 50 μ M abscisic acid, 6.8 % sucrose and 0.6 % Gelrite. Following desiccation (3 weeks, 16 h photoperiod, 18°C, 98 % humidity) the somatic embryos were planted onto germination medium (half strength of Litvay's medium, 1 % sucrose, 0.8 % Gelrite, 0.4 % activated charcoal) and cultured in 16 h photoperiod, 22°C with 5000 lux light intensity. To date, many somatic embryos are being rooted and they will be analysed by PCR and/or Northern blot for transgene presence and expression. On the base Southern and Northern hybridizations we can believe that successful genetic transformation of several embryogenic lines of Norway spruce and expression of transferred modified *cry3A* gene were achieved.

Literature

- LITVAY BI, VERMA DC, JOHNSON MA (1985) Culture medium and its components on growth and somatic embryogenesis of the wild carrot (*Daucus carota* L.). *Plant Cell Rep* 4: 325-328.
- PAVINGEROVÁ D, BŘÍZA J, NIEDERMEIEROVÁ H (2010) Comparison and improvement of *Agrobacterium* and biolistic transformation of Norway spruce. In: *Fifth EPSO Conference "Plants for Life*", Olos, Finland, 29 August-2 September 2010, p. 68, European Plant Science Organisation, Brussels, Belgium.
- PAVINGEROVÁ D, BŘÍZA J, NIEDERMEIEROVÁ H, VLASÁK J (2011) Stable Agrobacterium-mediated transformation of Norway spruce calli using somatic embryo explants. J Forest Sci 57: accepted, 2011.

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Fast-growing trees in forest research

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FGMRI research station in Kunovice (near Uherské Hradiště) long-term deals with breeding, testing and planting of fastgrowing trees, poplars and willows. Primary material for breeding research is obtained from natural localities. Valuable species and clones of *Populus* and *Salix* are maintained in clonal archives. There are about 900 clones of *Populus* and 1300 clones of *Salix*.

The main goal of research is to get hybrid clones suitable to nature conditions of the Czech Republic. For hybridization are used mainly poplar species *Populus tremula*, *P. tremuloides*, *P. trichocarpa*, *P. maximowiczii*, *P. deltoides*, *P. nigra*. New clones and clones imported from abroad are tested on variable experimental plots together with different cultivation technologies. Clones with the highest production of wood and good health are afterwards recommended for cultivation in the Czech Republic. Instruction for cultivation and quality standards of planting material have been developed for forest nurseries. Assortment of 23 tested poplar clones is currently recommended for plantation in the Czech Republic.

Willow clones obtained in earlier breeding programmes are investigated in plantations for production of energy biomass. Yield of biomass on the experimental plots is evaluated depending on site conditions. The phytoremediation of willow clones and their capability to accumulate heavy metals (Cd, Pb) has been in FGMRI in recent years.

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The scale of forest windthrows in Poland and silviculture strategy as method of prevention

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Wind is an important factor causing damages to Polish forests. Since the World War II, a systematic recording of the extent and the area of windthrows in Poland shows that damages amount nearly 60 million cubic metres. Only in last decade, the area of damaged forests achieved almost 1.8 mln ha. Nearly 90% of blowdowns occurred during autumn and winter or early spring.

Stand resistance to winds is determined by appropriate silvicultural methods applied to a stand at various stages of its development, including: species composition, planting density, systematic thinnings and the choice of the most suitable cutting system. The base for silvicultural strategy is localization of forest in one of the three wind risk zones.

Adjustment of species composition to site conditions is the fundamental postulate of the semi-natural forest management, the application of which increases stand resistance to wind. The postulate to increase species richness in the stands must take into account the natural characteristics of the habitats occupied by forests in Poland, which are the poorest habitats at this geographical latitude in Europe.

The enhancement of the resistance of pine stands that prevail in Poland can be attained by proper tending treatments. The paper presents the case studies on influence of thinning intensity on slenderness index of trees, which is a major factor of their resistance to wind.

Cartographic sources for the management of Protected Natural Areas (PNA): Natural Park of Urbasa and Andía (Navarra; Spain)

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Nature Park of Urbasa and Andía is located in the NW Navarra (Spain). It's a natural area with significant geological, biological and ecological aspects, which enabled its declaration as a Natural Park, to ensure their conservation in harmony with traditional and new uses of enjoyment of nature. It has an area of 21,408 hectares, whose territory is occupied mainly by beech forests and mountain pastures, and given its nature was appointed SCI (Site of Community Importance). For its statement as a Natural Park, was developed the Management Plan of Resources Natural (MPRN), which establishes the basic rules for the activities that take place. Also, it was approved the Plan of Use and Management (PUM), which defines the standards, guidelines and criteria for use of territory. The Forest Planning tool is the Management Project of Urbasa Forest, it was approved in 1903. In its latest review of 1999, the approach was modified by integrating the planning of multiplicity, giving special relevance to the maintenance of biodiversity.

The main objective of this work is the application of GIS methodologies for obtaining information sources, mainly mapping that can be used to support the management of the natural park. Therefore, in some cases proposed methodologies have been applied by other authors and, in others, their own methodologies. It's intended that the use and application of the mapping results obtained that can improve various aspects of natural park management, either optimizing the mechanisms of action when dealing with a fire, whether in action to prevent soil erosion. Another secondary objective is to obtain maps for tourist use and/or educational-informative, with the ultimate aim of attracting visitors to the natural park and make them partakers of his beauty.

Within the methodology, the previous step has been to install various operating systems. When working with different software needs to take into account its compatibility. If it's necessary to install more than one operating system you can choose the partitions or a virtual console with the help of Virtual Box program, which will install a second operating system. Then, you can work with multiple systems, even simultaneously. In this case we have worked with Windows XP, Vista and Linux. Regarding the necessary software, Arcview, Geomedia and Autocad are programs which can work using the USC licenses. These programs have been supplemented with others, free software in some cases and in others, "demos". It has worked, e.g., gvSIG MultiSpec, DWGTrueview, Faststone, ERMapper, OzziExplorer, ERViewer.

The Mapping Service of Navarra provides data in format "shape" the georeferenced limits of the PNA. We have also used 1:10000 scale aerial photographs. These photos, in format ECW, they have the particularity that included in the data file georeferenced. The topographic maps used at 1:5000 scale, consists of 63 layers of administrative limits, altimetry, hydrography, buildings,... The layers that include contour lines are of great interest to create the Digital Terrain Model. It has also used information from the Corine Land Cover that develops the creation of a database 1:100000 land use in the European Union and has as main objective the capture of digital data and geographic images collected through the series of LandSat and Spot satellites. The main problem with this project, which was designed to a large area, it's that in local scales does not always work well. Therefore, this information was completed with that obtained by aerial photography and map habitats of SCI. We have obtained numerous maps from these data. The interpolation of the historical climate data it has given us a climate mapping can be considered a cartographic product itself, as well as an intermediate step for the development of a subsequent mapping.

Training shapes and forms in broadleaved clonal seed orchards

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In accordance with the delineation of Regions of Provenances of forests in Croatia into ecogeographic seed regions and zones, the following clonal seed orchards have been established: three orchards of pedunculate oak (Quercus robur L.), two of narrow-leaved ash (Fraxinus angustifolia Vahl), one of sessile oak (Quercus petraea (Matt.) Liebl,) and one of wild cherry (Prunus avium L.). Phenotypical selection and heterovegetative propagation of plus trees, as well as the establishment of clonal seed orchards were aimed at obtaining regular yield periodicity and forest seed of good genetic quality in the categories Qualified and Tested. Different pomotechnical treatments (training systems) were applied to each tree species; for pedunculate and sessile oak oval spindle training system, for narrow-leaved ash spindle pyramid and for wild cherry spindle bush training system. Training systems should provide a strong framework and good light penetration in the canopy. The forming pruning is used to bring the grafts into the required training shape whereas pruning for higher yield maintains the adequate balance between the growth and the seed production. Tree pruning and training started right after the planting with a goal to gain desired canopy shape with well-deployed scaffold branches in the next 7 or 8 years. The main function of pruning is the removal of competing shoots to enforce the growth of remaining desired ones. Pruning intensity, i.e. the relation between vegetative and generative buds in the canopy determines the tree's condition, density and yield. The balance between vegetative and generative buds can only be achieved by appropriate underground and aboveground tree parts pruning. The evaluation of genetic values of mother trees in progeny tests and genotypic selection were also started to obtain increased genetic gain.

Pelleting of aspen seeds aimed at improvement of sowing technology and suitability for storage

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Trembling aspen (*Populus tremula* L.) are in great demand as renewable resource for biomass production. Especially on more dry and poor sites, they proved to be more suitable than other poplar and willow species. In contrast to easy-to-root poplars, the vegetative propagation of aspen can't be carried out in a cost-effective way. The use of high quality seed may be an alternative, if it would be possible to improve the suitability for storage and to simplify sowing technology. Under natural conditions, the seeds stay alive for a few weeks only. Due to their small size, sowing in greenhouse and in nursery beds is difficult and labour-intensive.

Within the framework of a project funded by the German Agency for Renewable Resources, investigations on pelleting of aspen seeds have been carried out since July 2010. The quality and usability of aspen seed pellets are tested with storage trials and sowing experiments. Additionally, possibilities to include growth-promoting microorganisms in the coating suspension and to fix seeds on carrier material will be checked. Seeds of other poplar species which are normally propagated via wood cuttings will be used for pelleting experiments too. The more forced use of high quality seed might contribute to higher genetic diversity in these species.

For the experiments within the project, large amounts of aspen or other poplar seeds must be harvested. During the pelleting process carried out at the SUET Saat- und Erntetechnik Company in Eschwege, seeds are coated with a suspension until the favoured size is reached. Subsequently, they are air-flow-dried. The application of growth-promoting and protecting compounds is possible, on the other hand the influence of moisture, heat and mechanical forces may reduce the quality of seeds.

In the first experiments, seeds were pelletted with two different dimensions and two consistencies of coating. With the two most successful variants, germination capacity of aspen seeds was reduced from 91 to 86 respectively 81%. A hybrid poplar seed sample pelleted with the same variants showed only 17 resp. 33% compared with 68% in the untreated control. These results have to be verified with further seed samples.

After sowing single seeds in containers, in most cases the results from germination testing in the lab were also approved in the greenhouse. Aspen seeds pelleted to a larger size germinated with a lower percentage than the untreated control, but surviving seedlings showed significantly higher dry weight after six weeks. More detailed experiments in this direction should follow.

A storage trial using pelleted and untreated aspen seed was started with different temperatures. At present, results from storage at room temperature and in the refrigerator can be presented. In pelleted seeds, germination capacity was maintained for a considerably longer period, particularly in the fridge.

German nurseries dealing with production of aspen seedlings are interested in the project results and offer support for future testing the use in nursery practice.

Somatic embryogenesis as a tool of conservation of genetic sources of rare genotypes of autochtonous population of Norway spruce

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Tissue culture approaches, in particular somatic embryogenesis, is considered as the advantageous technique for *in vitro* propagation and gene conservation of conifers. Generally, the development of embryos and their conversion into plantlets is closely associated with changes in endogenous phytohormone levels. Beside the key roles of auxin and cytokinins, very important function in differentiation processes belongs to polyamines. The polyamine (PAs) contents and activities of polyamine biosynthetic enzymes in Norway spruce somatic embryos (*Picea abies* L. (Karst.), highly responsible genotype) were studied in relation to anatomical changes during their development - from proliferation to germination. Activities of enzymes and PA contents steadily increased during development from embryogenic suspensor mass until early cotyledonary stages. The enzyme activity subsequently declined in mature cotyledonary embryos, accompanied by sharp reductions in PA contents (with the exception of spermine, its level significantly increased during the desiccation phase). The predominant PA in somatic embryos of highly responsible genotype was spermidine. This knowledge led as to compare embryo PA levels of this genotype with less responsible hurst ecotype of Norway spruce. Embryos of less responsible ecotype contained rather low level of PAs, predominant PA was putrescine and the content of spermidine was many times lower than in embryos of highly responsible genotype. The application of putrescine and spermidine into the growth medium in order to improve the efficiency of somatic embryogenesis of less responsible genotypes is discussed.

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Effect of harvest area size and locality on beechnut (Fagus sylvatica) germination: early results

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In the Czech Republic a beechnut seed lot can contain beechnuts collected from several forest stands (within the same approved unit) from which the collection is done often exceeding 10 ha in size and the distance between stands being several km. The aim of the present study was to determine how the size of beechnut (*Fagus sylvatica* L.) harvest areas affects seed quality and germination speed of dormant beechnuts.

In 2010, seed lots were collected from two or three harvest areas within four stands each in south-east Poland. For each stand a study sample was prepared by mixing together the lots from within each stand. Air temperature and humidity at the harvest sites were recorded from September until beechnut collection in November, The minimum and maximum distances between harvest sites within a stand was 300 and 1600 m, respectively. For the beechnuts data were collected for thousand seed weight, viability and germination.

The results showed that germination capacity differed significantly only for beechnuts collected from two harvest localities in two stands, but not for beechnuts harvested from different harvest places in other two stands. Different speed of germination (speed of dormancy relief) was occurred only for beechnuts collected from two harvest places in one stand (3 weeks) while beechnuts from different harvest places within the other three stands germinated similarly. Germination capacity and germination speed of mixed samples were different compared to the original lots. Our preliminary results suggest that beechnut seed lots collected from a large area can show high heterogeneity in germination and this in turn can negatively affect pre-sowing treatment and emergence in nurseries.

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Growth evaluation of European Abies alba provenances in the Czech Republic at the age of 29 – 39 years

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Silver fir (*Abies alba* Mill.) used to be considered as an important European forest tree species, mainly as for its high volume production and for some other positive properties in forest ecosystems (creation of desirable humus types, stands stability, etc.). In some especial site conditions, mainly on heavy clay soils, the foresters cannot use any other tree species, which will be able to substitute silver fir fully.

There was recognised worsening of health status of silver fir and mass extinction in frame of European distribution area during the last century. As for the Czech Republic, silver fir distribution area and number of localities with this species occurrence have been reduced, too. In that situation, there was established a large provenance trial with silver fir and other *Abies* species, which was aimed to find some adaptable domestic or foreign provenances. During 1973 – 1977, there were planted 20 research experimental plots with using of about 150 silver fir provenances originated from nearly whole natural distribution area of this species and 72 provenances of 16 exotic fir taxons.

The aim of this information is to present disposable preliminary results of European silver fir provenances in comparison with the Czech ones, which were obtained in frame of 8 research plots evaluation at the age of 29 - 39 years.

Totally, there are represented 73 silver fir provenances from the Czech Republic, 5 from Austria, 3 from France, 3 from Bulgaria, 5 from Bosnia and Herzegovina, 6 from Germany, 7 from Poland, 5 from Romania, 5 from Italy, 13 from Slovakia and 1 from Hungary on all of eight research plots. As for numerous Czech provenances represented on each plot, average values of their evaluation were used for final declaration of results and for possibility of comparison with foreign provenances, as well.

Statistically significant differences were found between provenances in their average height growth. According to obtained results, it is evidently, that was not found any universal provenance (or country of origin), which will be suitable for every type of site conditions of research plots. In comparison with Czech provenances, mainly German and Slovak provenances are often characterized by above average height growth; another German, some Austrian and, of course, also provenances from other countries have shown average values of height growth. As for Italian and for example Bosnian provenances on some research plots, their height growth was found as the low.

In spite of current certain regeneration of silver fir forest stands both in the Czech Republic and other European countries, results of evaluation are valuable and they can be used in concordance with original aim of experiment. Nowadays, evaluation of other measurable research plots of described experiment is continuing and final evaluation, which will include also other measured characteristics, is supposed.

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Forest-floor in the differently thinned Norway spruce stands

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The paper focuses on the effect of thinning on forest-floor in three experiments (Policka II, Blanik I and Plana). Experiments were established in 1664, 1966 and 1969 in 52, 32 and 67-year-old Norway spruce stands. The stands are situated on acid sites *Fagetum acidophilum*, *Abieto - Fagetum acidophilum and Piceeto - Fagetum acidophilum*. One experiment was established on former agricultural land (Blanik I) and the others lie on continual forest land.

All experiments consist of three variants: 1 – control stand without thinning, 3 – stand with light thinning from below and 5 – stand with heavy thinning from below. Experimental stands were measured for diameter at breast height and height regularly at 5-year periods.

In autumn 2009 (Policka II and Plana) and 2010 (Blanik I), forest-floor humus horizons (L, F and H) were sampled quantitatively and qualitatively on identical comparative plots. We used steel frames (25 x 25 cm) to define sampling area at six replications in each plot (1, 3, and 5). All samples were dried, first in open air, then in a laboratory oven at 80 °C, and subsequently weighed (dry mass).

We measured characteristics pH, C/N, amount of nutrients from composite samples (three per treatment) for horizon H using the common methods.

Results showed that under stands on experiment Blanik (76-year-old) on the former agricultural land, about 62-77 tons per hectare are stored in horizons L+F+H. Under older stands on continual forest land (Polička II – 97-year-old, Planá – 107-year-old), these amount range from 128 to 152 and from 93 to 95 tons per hectare, respectively. We observed some trends in the amount of forest-floor dry-mass between variants. Generally, amount of dry-mass was lower on control plots and higher on heavily thinned plots in the case of horizons L and F. On the other hand, dry mass stored in horizon H was higher on control plots and lower on heavily thinned plots. But differences between variants were insignificant in most cases. Similar picture was observed in the case of analyses of dry-mass quality in horizon H. But the trends were quite contrary and insignificant.

Observed results can support the theory about quicker decomposition in horizon H under thinned spruce stands. Trends were insignificant probably due to small amount of replications and mainly due to age of first thinning (32 – 67 years). Our results from previous studies confirmed the significant effect of thinning on forest-floor, when the thinning started at the age of 20 years or earlier.

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Testing French Douglas-fir seed orchards: a newly-established network of trials

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Tree breeding provides a major contribution to stand productivity and timber quality enhancement. Indeed, forest tree varieties simultaneously incorporate improvement for several traits related to site adaptation, growth, form and wood quality. Improved varieties, generally produced by sexual reproduction in seed orchards, are presently available for many forest species.

A lot of trials demonstrate genetic selection effectiveness and the superiority of improved varieties over controls. Nevertheless, the genotypes planted in seed orchards have been individually selected for only a part of the characters that determine tree value. Moreover, they have been selected in a limited number of sites and under a climate probably different from the climate that the next generation of trees will experience in their lifetime. Therefore, field testing of improved materials is essential to quantify genetic gains, assess the performances for non-selected characters, study genotype x environment interactions and specify the areas where the varieties can be used safely and advantageously.

In France, a programme of seed orchards was supported by the Ministry in charge of forests in the second half of the 20th century. INRA, Cemagref and ONF (French Forest Service) were the main actors. Currently, the productive orchards are operated by a consortium of two seed dealers (Vilmorin Company and ONF). The whole programme concerns 8 species among which Douglas-fir that is the 2nd reforestation species considering the number of traded seedlings. In the 1980s, eight clonal orchards were planted over 85 ha in SW France. Their components were selected within American natural populations (mainly Washington and Oregon but also California for an utilisation in dry regions) and in French selected stands. These orchards are now intensively managed and they currently produce 87% of the seedlings used in France.

For years, improved seed of Douglas-fir have been produced by two orchards whose performances were well known. Yet, the prospect of climate change incited the seed dealers to diversify their supply with seeds now available from six new orchards. As little is known about their behaviour, four French organisations of research and development (Cemagref, INRA, ONF, CNPF) gathered together to test the whole set of Douglas-fir orchards in various conditions of soil and climate and in comparison with the seed zone Washington 403. A special attention has been paid to seed lot representativeness *i.e.* clonal cone collections have been organised in several orchards where cone production was unevenly distributed among clones.

29 trials were established between 2009 and 2011. They are distributed in four categories of sites:

i) areas where Douglas-fir is widely cultivated and should remain appropriate in the 21st century

ii) mountainous areas (1000-1300 m a.s.l.) that climate change should make favourable to Douglas-fir

iii) and iv) climatic marginal areas that are expected to be unsuitable for standard varieties (north of the natural Douglasfir range) around 2050 (type 1) or are already too harsh (type 2).

The trials have a single-tree plot (TSP) design (96 seedlings per genetic unit) or a block design (49 seedlings x 4 blocks). The ratio TSP/block depends on the site and whether a response is expected at juvenile or adult stage. Furthermore, demonstration trials have been established in order to facilitate spreading of information among private owner community.

Though young, the Douglas-fir seed orchard testing network has already produced useful results. In particular, the 8 varieties have been ranked for lateness of bud flushing and, thus, sensitivity to spring frost. Sums of degree-days required for flushing have been computed. Data have also been collected for seedling health, polycyclism and initial height growth.

In the long term, this network will give information on adaptability, growth and form of French improved varieties of Douglas-fir. As the trials are established in a large range of environments, the results should also provide useful information to foreign silviculturists.

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Dynamics of acorn production and quality of pedunculate oak acorn (Quercus Robur L.) in disrupted ecological conditions

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Pedunculate oak is a climatogenic species and it constitutes principal forest communities. If some ecological factor in its habitat is altered, due to unfavorable biotic and abiotic factors, pedunculate oak cannot adjust fast and it suffer substantial damage over the years. Current ecological imbalance can be recognized as main reason in oak dieback. Deterioration signs become visible and they are reflected in decline of tree vitality, unsettled and low yield and also remote natural forest regeneration.

Variability in acorn production is the result of sinecological and genetic factors. Acorn yield is the most influenced by maternal trees. Pedunculate oak belongs to subgenus *Lepidobalanu* and has tendency of periodical yield, with return of every 4 years (abundant), and every 2 years (normal).

Research on acorn production have been carried out in "Spačvanski bazen" area in period from 2006 to 2010. Main research goal was to monitor acorn crop according to quality and quantity, in stands of different age - middle aged, older and old forests, so production potential could be identified.

Experimental plots were established in 2006. Acorn production assessment- acorn growth and development, was monitored by cone-shaped acorn-collecting traps method. Acorn-collecting traps were placed beneath the canopy of selected trees of different crown damage classes. In the crop years acorns were collected, and in the spring next year seedlings were counted. Collected materials were analyzed in the Laboratory for testing seed quality. Seed quality was tested accordingly to ISTA methodology.

Monitoring of growth and development of acorns by acorn-collecting traps method proved the fact that most matured and normally developed acorns came from older stands, and the least in old stands. Regarding crown damage degrees the most matured acorns came from crown damage class 2A, and least from class 2B and 3.

First acorn crop was in 2006 and second in 2010. In year 2006 acorn crops was more abundant than in 2010. The best acorn crop was in old stands (on average 269 kg/ha), the worst was in middle aged forests (41 kg/ha). With reduction of tree age came reduction in acorn crop. Yield in 2010 was the best in older forests (90 kg/ha) and the worst in middle aged forests (30 kg/ha). Average number of seedlings was at its peak in old forests (40,000 pts/ha), the worst in older forests (16,167 pts/ha). Periodicity in acorn production during the period of 11 years in the management unit Slavir and on the area of Forest Administration Office Vinkovci followed same trend in 11 years time.

Annual acorn production was monitored for 11 years and crop years were: 2000, 2002, 2003, 2006 and 2010. Average quality values for acorns harvested on experimental plots were: 2006: viability 83%, insect's presence 12% 1000 seed weight 5384 g, and number of acorn/kg 185 pts/kg; yield. In 2010 were: germination capacity 71%, rotten and decayed seed 29%, 1000 seed weight 4933 g, and number of acorn/kg 203 pts/kg.

Based on study of acorn periodicity yielding and quality crops conclusions can be made: degree of crown defoliation significantly influences quantity of produced acorns, old forests produced the most acorns, seed production decreased with age. Number of seedlings shows us that the most quality acorns remains in crowns and its fells after commercial seed collecting are completed. In middle aged forest number of seedlings in double the quantity than other investigated stands, acorn maturation is longest, and acorn fells on ground later. Monitoring of dynamics and seed production quantity during 11 years, crop years occurs significantly every 2 to 3 years and they differ in quantity. During that period were 5 masting years. Abundance of yield represents production potential of stands. In old stand abundant acorn crops is identified with average yield of 269 kg/ha or 11,4748 pts of acorn /ha. Seed production abundance is far below what is considered as abundant, therefore significant effort is required for preserving acorns in crowns after maturing and felling on the ground.

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Thinning as an initiation tool of transformation from regular to irregular forest structure in Ireland

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The majority of forest stands in Ireland are managed under the clearfell system. However, in recent years there has been an increasing interest in alternative silvicultural systems to clearfell and the process of transforming even-aged and evenseized forest stands to irregular stands has commenced in Ireland. An experiment was established in January 2011 to increase the knowledge base on thinning systems that could be used to initiate the transformation process in *Picea sitchensis* Bong. (Carr) stands. Three different thinning patterns were applied to two pure *P. sitchensis* stands which were due to be thinned for the first time. These included a low thinning (i.e. the control), a crown thinning and a graduated density thinning (GDT). In both stands 0.25 ha plots were marked for each thinning system, with each system replicated three times. Prior to thinning, the position of each tree within each plot was recorded using the FieldMap© technology, along with each tree's diameter at breast height, branchiness, stems straightness and forking. Trees were marked for thinning and the productivity of the thinning operation was recorded. Post thinning, the occurrence of stem and root damage was recorded for all residual trees. In addition, the height, crown projection, crown shape and depth of live and dead crown were recorded for a sample of residual trees. The aim is to compare the structural diversity created as a result of the three thinning patterns with the aim of establishing their suitability for initiating the transformation process in Sitka spruce stands in Ireland.

