IUFRO W.P. S 2.02.11
„Norway spruce provenances and breeding”

Conference Session Abstracts

“Norway Spruce in the Conservation of Forest Ecosystems in Europe”

Organized by:
IUFRO W.P. S 2.02.11
General Directorate of State Forests, Warszawa
Agricultural University of Krakow,
Faculty of Forestry, Department of Forest Trees Breeding
Forest Research Institute, Sękocin Stary

Warszawa - Malinówka - Warszawa
September 3-5, 2007

IUFRO W.P. S 2.02.11

'Norway spruce provenances and breeding'

„Our Mission is to promote the coordination of and the interational cooporation In scientific studies embeacing the whole field of research related to forests and trees for the well-being of forests and the people that depend on them"

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Conference
"Norway Spruce in the Conservation of Forest Ecosystems in Europe"

Warszawa – Malinówka – Białystok – Warszawa
September 3-5, 2007

Objectives of the Conference

1. Information about the achievements of the Polish forest genetics in the selection and conservation of gene resources.
2. Formulation of the rules for the conservation of forest ecosystems with spruce in Europe.
3. Assessment of the feasibility of restituting endangered tree stands, and improving stability of and conserving the most valuable mountain and lowland forest ecosystems.
4. Intensification of the international exchange within the IUFRO W.P. S 2.02.11 „Norway spruce provenances and breeding".

Organizing Committee:

Prof. Stefan Zajączkowski, President of the Polish Committee for Collaboration with IUFRO
Prof. Janusz Sabor, IUFRO W.P. S 2.02.11
Eng. Wojciech Fonder, M.Sc., General Directorate of State Forests
Eng. Jan Matras, M.Sc., Forest Research Institute
Eng. Piotr Zbrożek, M.Sc., Director of the Regional Forest Directorate, Białystok

Patronage:

Eng. Andrzej Matysiak, M.Sc., General Director of State Forests
Prof. Andrzej Klocek, Director of Forest Research Institute, Sękocin Stary
Prof. Janusz Żmija, Rector of the Agricultural University of Krakow
Prof. Gabriela Lorenc-Plucińska, Director of the Institute of Dendrology
Polish Academy of Sciences

Programme Council:

Prof. Jarosław Burczyk
Prof. Władysław Barzdajn
Prof. Władysław Chałupka
Tomasz Dziemidek, PhD
Eng. Wojciech Fonder, M.Sc.
Prof. Andrzej Lewandowski
Eng. Jan Matras, M.Sc.
Prof. Piotr Paschalis-Jakubowicz
Prof. Wiesław Prus-Głowacki
Prof. Janusz Sabor
Prof. Stefan Zajączkowski
Prof. Henryk Żybura

Conference Technical Assistant:

Eng. Anna Faber, M.Sc., Department of Forest Trees Breeding, AU Krakow

Secretary:

Eng. Urszula Zabrodzka, M.Sc., General Directorate of State Forests
Jan Kowalczyk, PhD, Forest Research Institute
Jacek Banach, PhD, Department of Forest Trees Breeding, AU Krakow
Eng. Jarosław Ćwik, Regional Forest Directorate, Białystok

Conference schedule

3.09.2007 (MONDAY)

10.00 **Opening of the Conference.**
Location: Warsaw Agricultural University, Faculty of Forestry, Building 34, Lecture Hall II.
Address: 159 Nowoursynowska St., 02-776 Warszawa

Speakers in the Opening Session:

Prof. Stefan Zajączkowski
President of the Polish Committee for Collaboration with IUFRO

Dr Peter Mayer
International Union of Forest Research Organisations

Prof. Piotr Paschalis-Jakubowicz
European Forestry Institute (EFI)

Eng. Wojciech Fonder, M.Sc.
General Directorate of State Forests

Prof. Janusz Sabor
Coordinator of IUFRO W.P. S 2.02.11 „Norway spruce provenances and breeding"

12.00: Departure for the Wyszków Forest District (by bus)

13.30-14.15: Visits to experimental plots

14.15: Lunch

15.00: Departure for the Knyszyn Forest District

17.00-18.00: Visits to selection objects. Spruce provenance plot - IUFRO 1972

18.00-20.00: Transfer to Malinówka. Check-in

21.00: Welcoming dinner

4.09.2007 (TUESDAY)

7.30: Breakfast

8.15-8.30: Director of the Regional Forest Directorate, Białystok, Eng. Piotr Zbrożek M.Sc. : Forest Menagment in the Regional Forest Directorate Białystok. Norway spruce in the conservation of forest ecosystems in North- East occurance in Poland.

Scientific Session

Topic 1. Variability and genetic breeding value of spruce provenances in provenance trials

Chairs:
Dag Lindgren, Department of Forest Genetics and Plant Physiology,
Swedish University of Agricultural Sciences, Umeå, Sweden
Władysław Barzdajn, Department of Silviculture, Faculty of Forestry, Agricultural University of Poznań, Poland

8.30: R. Longauer[1], D. Krajmerová[2], M. Pacalaj[1], D. Gömöry[2]: The influence of provenance transfer on the growth and survival of Norway spruce provenances.
[1]Forest Research Centre Forest Research Institute, Zvolen, Slovakia,
[2]Technical University in Zvolen, Forestry Faculty, Zvolen, Slovakia

8.45: O. Mauer, E. Palatova, F. Beran: The effect of origin on the root system emergence in Norway spruce (*Picea abies* (L.) Karst.).
Mendel University of Agriculture and Forestry, Faculty of Forestry and Wood Technology, Department of Forest Establishment and Silviculture, Brno, Czech Republic

9.00: M. Guz: Current state of spruce stands in Ukrainian Carpathians.
Ukrainian State Univiversity of Forestry and Wodo Technology. Lviv. Ukraina.

9.15: J. Sabor[1], H. Stanuch[2]: Assessment of the height increment of Norway spruce according to the geographical regions of Krutzsch (IPTNS-IUFRO 1964/68, years 1969-1988)
[1]Department of Forest Trees Breeding, Faculty of Forestry, Agricultural University of Krakow, Poland
[2]Jagiellonian University Medical Collage in Kraków, Department of Bioinformatics and Telemedicine, Kraków, Poland

9.30: A. Żółciak[1], T. Oszako[1], J. Sabor[2]: Evaluation of the health status of Norway spruce provenances growing on IUFRO 1964/68 observation plots.
[1]Forest Phytopathology Department, Forest Research Institute, Sękocin Stary, Poland
[2]Department of Forest Trees Breeding, Faculty of Forestry, Agricultural University of Krakow, Poland

9.45: W. Barzdajn: Results of the provenance trial of Norway spruce (Picea abies (L.) Karst.) of IUFRO 1972 series in the Forest Experimental Station in Siemianice.
Department of Silviculture, Faculty of Forestry, Agricultural University of Poznań, Poland

10.00: J. Kowalczyk, P. Markiewicz, J. Matras: Intrapopulation variability of Norway spruce (*Picea abies* Karst.) from Zwierzyniec Lubelski and Bliżyn.
J. Matras: Growth of Norway spruce (*Picea abies* Karst.) in IUFRO 1972 experiment.
Forest Research Institute, Department of Genetics and Forest Tree Physiology, Sękocin Stary, Poland

10.20-10.30: Coffee break

Topic 2. *Role of spruce in forest ecosystems. Current state of species protection. Programmes for selection and gene pool conservation*

Chairs:
D. Ballian, Faculty of Forestry, University of Sarajevo, Bosnia and Herzegovina
Władysław Chałupka, Polish Akademy of Sciences, Institute of Dendrology, Kórnik, Poland

10.30: D. Lindgren: Norway spruce breeding in Sweden is based on clone testing.
Department of Forest Genetics and Plant Physiology, Swedish University of Agricultural Sciences, Umeå, Sweden

10.45: J. Danusevičius, R. Gabrilavičius, D. Danusevičius: Norway spruce gene conservation and breeding programs in Lithuania.
Department of Forest Genetics and Tree Breeding, Lithuanian Forest Research Institute, Girionys, Lithuania

11.00: D. Danusevičius: Future strategy for long-term breeding of Norway spruce in Lithuania. Where to head in the future? Common research and breeding plans?
Department of Forest Genetics and Tree Breeding, Lithuanian Forest Research Institute. Girionys, Lithuania

11.15: H. P. Schmitt, J. Heyder: History and genetics of Norway spruce in Northrhine-Westphalia.
Landesanstalt für Okologie, Bodenordnung und Forsten/Landesamt für Agrarordnung Nordrhein-Westfalen (LOBF/LafAO), Arnberg, Germany

11.30: S. Małek: Sustainability of Norway spruce Istebna provieniences in different age classes on the Dupniański Stream Catchment in the Silesian Beskid Mts. on the base of ecochemical indexes.
Department of Forest Ecology, Faculty of Forestry, Agricultuiral University of Krakow, Poland

11.45: W. Chałupka, A. Misiorny, R. Rożkowski: Provenance contribution to genetic composition of progeny from the outbreeding seed orchard of Norway spruce.
Polish Academy of Sciences, Institute of Dendrology, Kórnik, Poland

12.00: K. Szabla: Health and sanitary condition of spruce stands in Beskid Śląski and Beskid Żywiecki Mts. and determinants of their reconstruction.
Regional Forest Directorate Katowice, Poland

12.15: B. Suszka[1], P. Chmielarz[1], R. Walkenhorst[2]: How long can seeds of Norway spruce (*Picea abies* (L.) Karst.) be stored?
[1]Polish Academy of Sciences, Institute of Dendrology, Kórnik, Poland
[2]Jahnstrasse 11, 63517 Germany

12.30: Z. Prochazkova: Quality assessment methods of Norway spruce seeds.
Forestry and Game Management Research Institute, Research Station Kunovice, Czech Republic

12. 45: Dyskusja

13.00-15.00: Lunch

Topic 3. Genetic polymorphism of spruce. Genetic markers

Chairs:
Monika Konnert, Bayerisches Amt für Forstliche Saat- und Pflanzenzucht (ASP), Teisendorf, Germany
Wiesław Prus-Głowacki, A. Mickiewicz University, Institute of Experimental Biology, Genetics Department, Poznań, Poland

15.15: M. Mengl: Geographical pattern of haplotypic variation on native stands in Norway Spruce in Austria.
Federal Research and Training Centre for Forest, Vienna, Austria

15.30: J. A. Nowakowska: Mitochondrial and Nuclear DNA Differentiation of Norway spruce (*Picea abies* L. Karst.) Populations in Poland.
Forest Research Institute, Department of Genetics and Forest Tree Physiology, Sękocin Stary, Poland

15.45-16.00: Coffee break

16.00: M. Dering, A. Lewandowski: Postglacial re-colonization of Norway spruce (*Picea abies* (L.) Karsten) in Poland based on molecular markers.
Institute of Dendrology, Kórnik, Poland

16.15: M. Konnert: Genetic variation of spruce in Southern Germany as determined by isozyme and STS markers.
Bayerisches Amt für Forstliche Saat- und Pflanzenzucht (ASP), Teisendorf, Germany

16.30: D. Ballian[1], F. Bogunić[1], G. Božič[2]: Genetic research of Norway spruce (*Picea abies* (L.) Karst.) from extreme areas *Spaghno-Piceetum* in Slovenia, and Bosnia and Herzegovina.
[1]Faculty of Forestry, University of Sarajevo, Bosnia and Herzegovina
[2]Gozdarski Inštitut Ljubljana, Slovenia

16.45: M. Polak-Berecka: Genetic structure of selected populations of Norway spruce from Carpathian region as determined by isoenzyme genetic markers.
Agricultural University in Lublin, Poland

17.00: A. F. Korczyk, M. Krzakowa, R. Paluch: Demographic and genetic structure of the native *Picea abies* Karst. population from the Białowieża Forest.
Forest Research Institute, Białowieża, Poland

17.15: A. Wojnicka-Półtorak, W. Prus-Głowacki: Genetic changes between age classes of naturally regenerating population of *Picea abies* (K.) from Białowieża primeval forest.
A. Mickiewicz University, Institute of Experimental Biology, Genetics Department, Poznań, Poland

19.00: Dinner

Poster Session

J. Socha: Relationship between Environmental Factors and the Potential Productivity of Norway Spruce in the Beskidy Mountains, Poland.
Department of Forest Mensuration, Faculty of Forestry, Agricultural University of Krakow, Poland

P. Tylek: A set of the aerodynamic properties of spruce seeds.
Department of Forest Work Mechanization, Faculty of Forestry, Agricultural University of Krakow, Poland

J. Sabor[1], K. Skrzyszewska[1], B. Orzeł[2]: Preliminary assessment of the genetic structure of Carpathian spruce using terpene markers.
[1]Department of Forest Trees Breeding, Faculty of Forestry, Agricultural University of Krakow, Poland
[2]Department of Forest Mensuration, Faculty of Forestry, Agricultural University of Krakow, Poland

M. Kempf, A. Faber, J. Sabor: Isoenzymatic and DNA polymorphism in progenies of spruce stands from some Krutzsch regions of IUFRO 1964/68 provenance test in Krynica.
Department of Forest Trees Breeding, Faculty of Forestry, Agricultural University of Krakow, Poland

G. Rączka[1], Z. Siewiera[2], M. Slugocki[1], : Zawadzkie Forest Division – general characteristics of the region and history of Norway spruce (*Picea abies* (L.) H. KARST.) IUFRO experiment 1964/68
[1]Agricultural University of Poznan, Department of Forest Management, Poznan, Poland,

[2]Zawadzkie Forest Division, Poland,

G. Rączka[1], Z. Siewiera[2], M. Slugocki[1]: Area and volume analysis of Norway spruce (*Picea abies* (L.) H. KARST.) stands in Zawadzkie Forest Division in years 1952 – 2004

[1]Agricultural University of Poznan, Department of Forest Management, Poznan, Poland,

[2]Zawadzkie Forest Division, Poland,

G. Rączka[1], Z. Siewiera[2], M. Slugocki[1]: Spatial analysis of Norway spruce (*Picea abies* (L.) H. KARST.) stands in Zawadzkie Forest Division in years 1952 - 2004 as a location test of nonexistent motherly population Kolonowskie 0293, IUFRO 1964/68

[1]Agricultural University of Poznan, Department of Forest Management, Poznan, Poland,

[2]Zawadzkie Forest Division, Poland,

J. A. Nowakowska: Mitochondrial and Nuclear DNA Differentiation of Norway spruce (*Picea abies* L. Karst.) Populations in Poland.

Forest Research Institute, Department of Genetics and Forest Tree Physiology, Sękocin Stary, Poland

5.09.2007 (WEDNESDAY)

7.00: Breakfast.

Feild Trip

7.30: Departure for the Gołdap Forest District

9.30: Meeting with the representatives of the Gołdap Forest District

9.45-10 45: Visits to approved seed stands and progeny plantations of Norway spruce. Approved seed stand, Maków Forest Range, comp. 231 a; 'Dziki Kąt' reserve

10.45-11.45: Snack (local delicacies, drinks)

11 45-12 45: Transfer to the Romincka Primeval Forest. History. Hunting tradition

12 45-13 30: Visit to an approved seed stand of Norway spruce in the Ostrówek Forst Range, comp. 35 f, 34 j. Windbreak areas. Artificial and natural regeneration of spruce

14.00: Farewell dinner. „Leśny Zakątek" Centre in Gołdap.

14.30: Recapitulation. Submission of proposals by the relevant committee. End of the Conference. Departure for Warsaw (by bus)

Note

There is an opportunity to attend the IUFRO European Regional Conference on Forestry in the Context of European Regional Development (6-8.09.2007, Warsaw Agricultural University, Faculty of Forestry),
or
to make a trip to Białowieża (at one's own expense).

INFORMATION

Arrival

• The participants are kindly requested to indicate the date and time of their expected arrival in Warsaw (airport, bus terminal, or train station).

• The most convenient way to get to the location of the Opening Session (Warsaw Agricultural University, Faculty of Forestry, 159 Nowoursynowska St.) is by taking the metro and getting off at the station 'SŁUŻEW'.

• The organizers could provide transportation from Krakow to Warsaw upon earlier request specifying the date, time and place of their arrival in Krakow (airport, bus terminal, or train station).

Important date

15 October 2007 – deadline for submission of papers to be published in 'Dendrobiology' (for details see 'Information' in Announcement 2)

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Maciej Giertych

Participation of Poland in IUFRO studies on Norway spruce

Poland joined IUFRO in 1926 and already at the Stockholm Congress in 1929 there were 11 participants from Poland. At the Sopron Congress in 1936 there were 12 participants from Poland. The Congress appointed a 7-person Commission on Seed and Races of Forest Trees which included a representative from Poland, Dr Stanisław Tyszkiewicz. The Commission decided to establish in member countries comparative studies of pine and spruce provenances from all over the range. It is in connection with this work that Poland's participation in IUFRO research on the genetics of spruce started.

The oldest methodically out-plated provenance experiment with Norway spruce dates from 1938. At that time the International Union of Forest Research Organisations (IUFRO) organised a series of trials in several countries, using jointly collected seed material from 36 origins in various parts of the species range. In 1939 another series was started with 14 origins, but this one in view of the onset of World War II included only a small number of co-operators. In 1964 IUFRO undertook a next series of experiments collecting seed from 1100 origins, representing the whole range of the species. In 1972 a series of trials was established in several countries with seeds originating from Polish seed stands. This experimental series later obtained IUFRO status. All remaining trials with Norway spruce scattered throughout Europe were organised on a national basis, even though some of them included also some foreign provenances.

For the 1938 trial Poland supplied seed from 6 stands (Białowieża, Istebna, Radom, Stolpce, Wilno and Dolina) the latter three being today beyond the eastern frontier of Poland, while the provenance known in literature as Pförten, is from a place that is now in Poland (Forest District Brody, on the Nysa river). The seeds were sown in nurseries and preparations were made to establish several trials in Poland. However the onset of the war and the departure or death of people responsible for the plans, have rendered them useless. The trials in Adrychów and Rycerka lost their documentation during the war. In 1941 an area was established in Forest District Lubień, outside the natural range of spruce, however in view of considerable mortality soon after out-planting it was supplemented with spruce of unknown origin by people who did not realize the area was an experiment, so now it is unsuitable for scientific use.

The Germans established a trial in what is now Forest District Lubliniec (sub-district Dobrodzień – then under the name Guttentag), however it proved impossible to find it due to lack of documentation. It contained the full set of provenances. It was supervised by the Prof. Werner Schmidt from Eberswalde in Germany, head of the IUFRO Commission on Seed and Races of Forest Trees. After the war Prof. Schmidt lived in West Germany. When I wrote to him asking about the documentation of this trial he replied that it was destroyed by Poles after the war. The Guttentag Forest District archives are available but there is no record in them of the trial. The East German authorities also failed to provide me with any answer when I queried about the documentation likely to be held in Eberswalde. Also after reunification of Germany and the opening of archives in Eberswalde our German colleagues failed to find records of the trial.

In the 1939 trial Poland did not participate. It includes a provenance under number 10 called "Poland", but its actual origin is unknown.

For the 1964 trial Poland supplied seed from 91 stands. Seedlings were grown in the Pein and Pein commercial nursery near Hamburg, Germany, for the whole experimental series and the transplants were delivered to 20 co-operators in 1968, including prof. Stanisław Bałut from the Kraków Agricultural Academy. He established his trial in the Academy experimental forest in Krynica, with the full set of 1100 provenances included.

For the 1972 trial all the seeds were supplied by Poland, from 20 seed stands. In Poland 5 trials were established (in Knyszyn, Kórnik, Siemianice, Niepołomice, Głuchów). The trial obtained IUFRO status and is coordinated from the Forest Research Institute in Warsaw (originally Stefan Kocięcki and later Jan Matras).

The results of the 1938 and 1939 trials were summarised jointly for IUFRO by me in several papers (Giertych 1976. 1979, 1984).

The 1964 trial had only one joint IUFRO report (Dietrichson et al. 1976) this however had no data from Poland or Hungary. In a later paper adding data from Poland and Hungary (Giertych 1978) I have summarised information on the best provenances and on all the Polish ones. I was searching for the most plastic provenances, that is those that perform well at many different locations. I have established a seed orchard for the most plastic provenance (Kolonowskie) and an outbreeding seed orchard for the 5 most plastic provenances (Giertych 1993).

The 1972 trial had no joint report except in the form of table with latest height measurements, by provenance and location, supplied periodically to all participants by the coordinator.

Dietrichson J., Christophe C., Coles J.F., de Jamblinne A., Krutzsch P., König A., Lines R., Magnesen S., Nanson A., Vinš 1976 The Iufro provenance experiment of 1964-1968 on Norwaz spruce (picea abies (L.) Karst.).IUFRO Oslo Congress handout duplicated bz the Norwegian Forest Research Institute: 1-14.

Giertych M. 1976 Summary results of the IUFRO 1938 Norway spruce (Picea abies (L.) Karst.) provenance experiment. Height growth. Silvae Genetica 25(5-6): 154-164.

Giertych M. 1979 Norway spruce (Picea abies (L.) Karst.) provenance experiments in Eastern Europe. Proc. IUFRO Norway spruce Meeting, Bucharest: 15-27.

Giertych M. 1984 Report on the IUFRO 1938 and 1939 provenance experiments on Norway spruce (Picea abies (L.) Karst.). pp. 179. Instytut Dendrologii PAN, Kórnik.

Giertych M. 1993 Breeding of Norway spruce in Poland: from provenance tests to seed orchards. In Rone V. (Ed.) Proc. IUFRO S2.02.11 Symposium "Norway spruce provenances and breeding", Riga, Latvia: 193-199.

Address: M. Giertych Institute of Dendrology, Kornik, Poland,
e-mail: macgier@rose.man.poznan.pl

Mister President of the International Union of Forest Research Organizations, Ladies and Gentlemen,

Welcome to the Conference "Norway Spruce in the Conservation of Forest Ecosystems in Europe"!
As a Coordinator of the IUFRO Working Party S 2.02.11 "Norway spruce provenances and breeding", I am extremely pleased that the Conference is hosted by Warszawa, the capital of Poland. We have come here to share our research findings, experience and ideas concerning the preservation of this tree species in the declining forest ecosystems of Europe.

Today, Norway spruce in its European range of occurrence faces considerable threats, one of which is climate change. The gradual warming and drying of the climate has far-reaching consequences, among them the appearance of thermophilous tree species in northern areas, more frequent droughts and fires, larger extent of damage caused by winds and pests, greater damage at tree-felling operations due to the shorter duration of snow cover. All these factors pose a serious danger to the spruce forest resources in Europe.

Norway spruce has entered Poland from two directions: southern (Carpathian) and northeastern. Under the influence of the oceanic and continental climate, many valuable spruce populations of high genetic breeding value have developed in the country. In the field session, we are going to visit stands of spruce from the northeastern range of distribution. What is interesting, most of the stands occurring there show relatively small changes produced by human economic activity. The form of their protection is mainly passive conservation. In the northeastern part of Poland, large complexes of primeval forest (former royal property) have survived. Knowing that they have immense ecological value, we still need more information on the genetic value of their partial populations. I hope that the Conference will offer an opportunity to broaden the knowledge of this subject.

The main goals of the Conference are as follows:

- *To formulate the rules governing the protection of forest ecosystems with spruce in Europe. This is an urgent task in view of the current degradation of the forest environment resulting from the destabilization of forest ecosystems. A number of interacting factors such as adverse climatic changes, soil degradation, industrial emissions affect forests, causing their defoliation, fungal infections (leading to increased insect pest infestation), visible signs of hampered growth, lack of natural regeneration, intense tree thinning, deteriorated condition of natural tree populations (among them seed stands and plus trees that form the basis for seed selection), etc.*
- *To propose the measures for restituting endangered tree stands, conserving the most valuable ecosystems and improving their stability.*
- *To strengthen international exchange within the IUFRO W.P. 2.02.11 "Norway spruce provenances and breeding".*
- *To acquaint the Conference Participants with the achievements of Polish forest geneticists in the selection and conservation of Norway spruce gene resources.*

We will try to address these matters in our oral, poster and field sessions.

Dear Colleagues,

I wish you a very fruitful meeting and a wonderful time in Poland.

Let me finish my speech with a beautiful traditional greeting of Polish foresters, which in free translation means "May the forest give us all the best":

DARZ BÓR!

Warszawa 3.09.2007 *Janusz Sabor*

Distinguished President, His Magnificence Rector, Ladies and Gentlemen!

I have a great honor to welcome such prominent group of outstanding European scientists working on spruce (*Picea abies*) - in person and on behalf of Director General of the State Forest.

Together with the representatives of Polish field forestry present in this room who are working all over Poland we will have a pleasure to be your host and to make a brief presentation of on Polish forestry as well as dilemma of sustainable forest management.

Global climate changes, especially global warming being an effect of increasing greenhouse gases concentration will have a negative impact on conditions of spruce in Poland. We already have such serious problem in Beskidy Mountains. We will talk about that tomorrow during presentations.

I hope that the Conference, lectures and discussions will get us a prediction on future of spruce, show the fields of most urgent scientific problems to be solved by forest scientists. I mean problems of cultivation and protection of spruce that plays a unique and important role in European ecosystems. In Poland spruce covers 8.2 percent of forest area.

IUFRO – International Union of Forest Research Organizations holds its congress in Warsaw. I want to thank you for choosing Poland as the host of the congress and for enabling us to organize the conference we are just starting.

WELCOME TO POLISH FORESTS!

Wojciech Fonder

Scientific Session

Topic 1. Variability and genetic breeding value of spruce provenances in provenance trials

Topic 2. Role of spruce in forest ecosystems. Current state of species protection. Programmes for selection and gene pool conservation

Topic 3. Genetic polymorphism of spruce. Genetic markers

Posters

Chairs:
Dag Lindgren, Department of Forest Genetics and Plant Physiology, Swedish University of Agricultural Sciences, Umeå, Sweden
Władysław Barzdajn, Department of Silviculture, Faculty of Forestry, Agricultural University of Poznań, Poland

Roman Longauer, Diana Krajmerová, Marián Pacalaj, Dušan Gömöry

Influence of provenance transfer on the growth and survival of Norway spruce provenances

Abstract: Two provenance experiments with Norway spruce in Slovakia were used to reveal the trends in the behaviour of provenances after their transfer. Correlations between average height and survival of provenances and differences between geographic and selected climatic characteristics of place of origin and provenance plots were significant for most of tested characteristics. Data from the experiment with Polish and Slovak provenances from 1972 indicated that transfer into warmer regions with a longer vegetation period results in improved height growth and survival, with the exception of survival at initial stages. For the experiment from 1964 with a broader altitudinal range of provenance plots only the latest measurements were analysed and revealed that the best height growth of Slovak Norway spruce provenances can be reached when transferred to regions with an average annual temperature ca. 1 °C higher and with a vegetation period 12 days longer than at places of origin. Transfer into lower altitudes, a warmer climate and a longer vegetation period improved survival. In both experiments transfer to areas with increased rainfall had a negative effect on growth which is probably associated with the fact that provenances are not able to exploit additional precipitation for the growth in areas with a colder climate and a shorter vegetation period.

Key words: provenances, Norway spruce, adaptation

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Oldřich Mauer, Eva Palátová, František Beran

Effect of origin on the root system emergence in Norway spruce (*Picea abies* (L.) Karst.)

Abstract: A survey made on two provenance plots established in the Czech Republic in 1988: in Krtiny (altitude 540 m a.s.l., mean annual air temperature 7.0 °C, mean annual precipitation 540 mm, lowland, eutrophic site, modal Cambisol) and in Ostravice (altitude 820 m a.s.l., mean annual air temperature 5.6 °C, mean annual precipitation 1171 mm, sloping terrain, acidic site, ranker Cryptopodzol), covered provenance No. 34 (originating from an elevation of 320 m a.s.l.) and provenance No. 45 (originating from an elevation of 1100 m a.s.l.). The root systems of 12 average trees from each provenance on the two plots were lifted and then examined for a total of 36 parameters of skeletal roots architecture, the health condition, biomass, mycorrhizal infection, longevity and specific length of fine roots (roots with a diameter below 1 mm), and the type of mycorrhiza. It follows from the results that the root system emergence is not affected by origin but rather and unambiguously by site. In both localities the two provenances developed nearly uniform root systems of similar size: in Krtiny, an anchor root system of circular ground plan with a rooting depth of 80 cm, in Ostravice, an elliptical superficial root system with a rooting depth of 45 cm. Both provenances on the two plots exhibited a similar type of the termination of horizontal roots and anchors. No differences and no variances were found in the biomass, vertical distribution and specific length of fine roots. In Krtiny no differences were observed in the longevity of fine roots, while in Ostravice a 40% decrease in the longevity of fine roots was recorded with an occurrence of black ectomycorrhizas of up to 20%. The cause may be seen in a 100% infestation of this provenance with honey fungus (*Armillaria mellea*).

Key words: Norway spruce origin, provenance plot, climatic conditions, root architecture, health condition, ectomycorrihza

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Current state of spruce stands in Ukrainian Carpathians

The forests of Ukraine fulfil mostly environmental functions, such as water-protective, sanitary and hygienic, recreational, etc., and have limited usage. The general area of the forest fund is 10.8 million ha, of which 9.5 million ha are covered with forest vegetation (15.7% of the area of the country). The proportion of forest-covered areas in Ukraine is the highest (41.4%) in the Carpathians. The general forest area in the Ukrainian Carpathians is 2.26 million ha, and the area of land covered by forest is 1.5 million ha. In forest stands, 70 types of arboreal and 110 shrub species occur. Among the stands, the natural and artificial stands of Norway spruce (*Picea abies* Karst.) dominate: the area they occupy (42%) considerably exceeds the areas covered by other main forest species. Original stands of Norway spruce are concentrated in three of the eleven sylvicultural districts of Ukrainian Carpathians. Apart from such stands, derivative fir groves occupy a considerable area (ca. 150 thousand ha) and grow in all sylvicultural regions.

Norway spruce is the main typological species in the conditions of the Ukrainian Carpathians: it forms about 30 forest types from spruce-pine forest to beech-fir spruce forest. Wet beech-fir subspruce forests (53%), wet highly-elevated subspruces (23%), wet beech-fir spruce forests (15%) and wet pure spruce forests (5%) are the most widespread types. Very unique forests are composed of *P. abies* mixed with *Pinus cembra* L. of pre-glacial origin. Norway spruce forms mixed and pure stands of different productivity. The most productive forests grow in the middle and lower parts of slopes at an altitude of up to 1100–1200 m a.s.l. on heavy subclay and subloamy soils. The stock volume of spruce stand achieves 750–900 m^3/ha stem wood. At higher altitudes the stand productivity gradually decreases.

In the second half of the 20th century, deterioration in spruce stands, especially derivatives of spruce forest created in the place of felled beech (*Fagus silvatica* L.), oak (*Quercus robur* L.) or fir (*Abies alba* Mill.) forests, became visible in huge areas of the Ukrainian Carpathians. The degradation of fir groves is accompanied by their mass dieback beginning at the age of 30–40 years and caused by a complex of anthropogenic and natural factors.

Key words: spruce stands, environmental functions, Carpathian forest types, composition, productivity

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Assessment of the height increment of Norway spruce according to the geographical regions of Krutzsch (IPTNS-IUFRO 1964/68, years 1969–1988)

Abstract: The juvenile height growth of Norway spruce was studied in 1095 spruce provenances included in the IUFRO inventory provenance test of 1964/68. Trees growing on the experimental site established in Krynica in the Beskid Sadecki Mts (Carpathians) were measured at 3-year intervals in the period 1969–1988, i.e. from the age of 6 years (2 years after the seedlings were planted) to 25 years. The variability of tree height in the spruce population under study was assessed on the basis of the mean values of the trait expressed in units of standard deviation in successive years of measurement, calculated for each provenance and each geographical region as established by Krutzsch. Using the standardized units made it possible to characterize the dynamics of spruce growth in provenances from 96 geographical regions representing the whole European range of the species. The effects of geographical region and tree age and their interaction on the variability of height growth within this range were estimated using a multi-way analysis of variance with replicated measurements. The regions showing similar spruce growth trends were grouped by using a hierarchical cluster analysis. The genetic reactivity of spruce at a provenance region level was assessed by Finlay-Wilkinson's and Gallais' methods.

The results on the juvenile (6–25 years of age) dynamics of height growth showed that spruce provenances from various geographical regions of Krutzsch differ significantly in their genetic reactivity. Based on this, the following groups of regions were identified:

1. Regions with an average or weak but stable spruce growth characterized by no significant effect of age and of genotype × age (G × A) interaction in the whole measuring period (group 1, 2 and 3), or regions with height growth improving with age (group 4);
2. Regions of spruce provenances constituting a selection elite, with a very good height growth in the whole period of observation or in its later part, characterized by no G × A interaction (group 5 and 6);
3. Regions with a varied genetic reactivity of height growth dynamics in the juvenile period (group 7 and 8), and regions of Scandinavian populations with the poorest height growth in the whole measuring period (group 9).

The studies proved the high selection value of spruce provenances from the regions of Štiavnické pohorie, Low Tatras (Slovakia), Masurian Lakeland, Augustow Lakeland, Podlasie, Silesian Beskid Mts, Beskid Zywiecki Mts (Poland), Jutland (Denmark), Bihor Mts, Transylvania, and Eastern Carpathians (Romania).

Key words: provenances of Norway spruce, height, provenance regions of Krutzsch, genetic reactivity, selection value

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Evaluation of the health status of Norway spruce provenances tested on IUFRO 1964/68 observation plots

Abstract: With the aim of protecting the gene resources of Norway spruce provenances tested under the IUFRO 1964/68 experiment, an inventory was carried out in the years 2002 and 2003 on the experimental plots in Krynica to determine the threats to the health status of trees. The first symptoms of dieback were observed in 1999. The health status of trees (144 in total) was assessed on the basis of the appearance of crowns. Twenty nine trees were cut and examined for disease symptoms. The inventory revealed that individual trees or groups of trees in some blocks were on the decline. A number of trees fell to the ground, leaving gaps in the stand. Some trees had dying tops and thinning crowns. Many resin exudates, turning dark near the trunk bases, were observed. The roots of some trees developed necrosis and died. There were also trees showing needle discoloration and shedding the needles during the vegetation period; the phenomenon was especially visible at the tops of trees and spread down. In several cases the root pathogen *Armillaria* sp. was noted and found to cause substantial damage. White mycelia and rhizomorphs occurred beneath the bark of some trees. A lot of dead rotting roots without a visible biotic factor and sometimes the white mycelium of non-identified fungus were observed. Out of 29 cut trees, 17 were dying, 11 dead and 1 was toppled over by wind due to severe root damage. In one case (tree No. 14, block 3), inner rot several meters in length, attributed to *Heterobasidion* sp., appeared along the log. The pathogen was isolated from wood samples. The wood (xylem) and the bast (phloem) of other trees were considered as healthy. Six dying trees showed the presence of the following pathogens: *Phytophthora citrophthora* (isolated from the roots of 3 trees), *Fusarium avenaceum* (from 4 trees), *F. solani* (from 2 trees) and *Trichoderma* sp. (from 4 trees). The spruce decline phenomenon observed on the plots may be attributed to several factors. First, the trees were planted using a large spacing (2 × 2 m) on post-agricultural land. Second, the year 1999 was very dry, which could have cause damage to the fine roots of trees. This, in turn, increased their susceptibility to infections by root pathogens (*Armillaria* sp., *Heterobasidion* sp., *Phytophthora* sp.) which might be responsible for growth inhibition, dieback and eventual death of many trees. Examination of the annual radial increments of trees, made in 2002, showed that they dramatically decreased during the previous four years. With age, the root systems of trees grew thickly and expanded vastly to form very often a dense network in the soil. The numerous root grafts created between the diseased and healthy trees certainly facilitated the spread of the disease. There is significant interaction between provenances and number of diseased trees. It was found spruce susceptible to pathogens from following provenances: 04 75 Babenhausen from region 23 – Swabian-Bavarian Upland (Swabia) 2; Germany, 07 31 Frantiskovy Lazne from region 10 – Erzgebirge; Czech Republic, 08 04 Traunstein ¼ D, 6 A, B, 7 A from region 26 – East Alps, Germany, 08 43 Wundsiedel-Weissenstadt from region 19 – Franconia, Upper Palatinate, Germany, 08 78 Mestwinowo from region 67 – East-Pomeranian Lakeland, Warmia, Masuria; Poland, 08 86 Magland from region 2 – West Alps; France.
Key words: IUFRO 1964/68 test, Norway spruce, necrosis symptoms, root pathogens, provenance resistance

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Władysław Barzdajn

Performance of Norway spruce (*Picea abies* (L.) Karst.) in IUFRO 1972 provenance test

Abstract: The provenance trial of IUFRO 1972 series with Norway spruce, conducted at the Experimental Forest Station in Siemianice, tested 20 Polish provenances from the Hercynic-Carpathian and boreal ranges of the species. An analysis of morphological features and growth characteristics showed that spruce from the Tatra Mts is distinct from other groups. Boreal spruce, having the limit of its natural range in northeastern Poland, is also quite well distinguishable. The population from Tarnawa in the Bieszczady Mts bears close similarity to boreal spruce. An analysis of the growth characteristics and productivity confirmed the very high value of the Istebna provenance and the provenances from Roztocze (Zwierzyniec Lubelski).

Key words: IUFRO 1972 trial, Polish provenances, morphological features, growth, differentiations, Boreal spruce

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Intrapopulation variability of Norway spruce (*Picea abies* Karst.) from Zwierzyniec Lubelski and Bliżyn

Abstract: The study examines the intrapopulation variability of the growth and quality traits of Norway spruce populations from Bliżyn and Zwierzyniec Lubelski, included in the IUFRO 1972 experiment. The populations exhibit a high growth dynamics and a narrow crown form. The research was carried out on the experimental plot established in 1996 in the Kutno Forest District where the total number of 8228 two-year-old seedlings from 191 open-pollinated families were planted in a single-tree plot design using a spacing of 1.5 × 1.5 m. The material represents 93 families of Norway spruce from the Bliżyn region and 98 families from the Zwierzyniec Lubelski region. Several periodic measurements of total height, height increment and DBH were made on all trees. Selected quality traits were also scored. The last results came after 10 years of growth, the measurements were done in autumn 2005. The average height of all trees was 414.2 cm. In the Bliżyn population, the average height ranged from 341.1 cm (family 208) to 502.5 cm (family 236), and in the Zwierzyniec Lubelski population, from 343.8 cm (family 99) to 510.0 cm (family 101). The average DBH of all trees was 43.3 mm. It ranged between 35.8 mm (family 221) and 54.4 mm (family 236) for Bliżyn, and from 33.1 mm (family 17) to 56.8 mm (family 137) for Zwierzyniec Lubelski. The traits under study were statistically significant at a family level but nonsignificant at a population level. As follows from the results, there is a high genetic variability inside the populations, which suggests that it is possible to select highly productive families that could be recommended for use in forestry practice.

Key words: intrapopulation variability, Norway spruce, family variation

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Jan Matras

Growth and development of Norway spruce *(Picea abies* Karst.*)* populations in IUFRO 1972 experiment

Abstract: The genetic variability studies concerned growth traits and their plasticity in Polish Norway spruce populations grown on 30 experimental plots in Europe and Canada according to the IUFRO 1972 concept. The trees were evaluated on the basis of increment traits, i.e. height, DBH or volume per ha, and the degree of plasticity of the traits on all experimental plots. In all populations, the total variation in DBH values (including height and volume increment) amounted to 6.049 units of deviation, which means that it was very high. At the level of a single population the variation was also quite high: 4.676 in Kartuzy and 2.192 in Rycerka Zwardoń provenances. Due to the wide range and substantial level of the overall variability of Norway spruce from the IUFRO 1972 experiment, it is impossible to choose any population that would be suitable for the whole experimental area. Growth traits were not positively correlated with plasticity almost in any case, which made it difficult to group the populations according to these traits. The research demonstrated that populations from Bukowiec and Zwierzyniec Lubelski, having a high economic value and a high plasticity, should be used for general afforestation and reforestation purposes. Spruce populations from Wisła, Istebna Zapowiedź, Zwierzyniec Białowieski 2, Rycerka Praszywka 700 m, Rycerka Zwardoń, Tarnawa and Bliżyn, showing good growth and plasticity traits, could be spread over a broader range that before. The populations whose spread should be limited are those of Witów, Stronie Śląskie, Rycerka Praszywka 950 and Międzygórze.

Key words: spruce, population variability, plasticity

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Norway spruce breeding in Sweden is based on clone testing

Abstract: The last decades clone testing has become an important component of long-term breeding and seed orchards for Norway spruce in Sweden. For more than three decades considerable resources have been spent on testing clones for clone forestry, but Swedish foresters have never seen it worth to pay the added cost involved in the added gain. The efforts, however, resulted in many clone trials and the development of a technique for clone production and propagation. Theoretically, clone testing is faster and cheaper than progeny testing and more reliable than selecting individuals forwards. Nowadays the main line in long-term breeding is to make crosses between the best trees, then to clone test these progenies and select the best clones for long-term breeding and use in seed orchards. Controlled crosses are still a bottleneck for long-term breeding. A possibility is to rely on wind pollination (Breeding Without Breeding), either among the tested clones in seed orchards or in the clone tests. That the father is a desirable genotype can be controlled by molecular markers. It is not easy to design an efficient breeding system based on this strategy, but it ought to be possible, and it is easier for species where clone testing is in the centre, reducing the number of genotypes of interest.

Key words: rooted cuttings, seed orchards, long-term breeding, Breeding Without Breeding

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Norway spruce gene conservation and breeding programs in Lithuania: present-day achievements

Abstract: Compared to 34% 100 years ago, Norway spruce stands occupy now 22% of the total forest area in Lithuania. Most of the stands are located in the northeastern highland (Žemaitija) and the central part of the country. 25% of the spruce-dominated stands are pure, the rest are mixed. Natural calamities like storms, droughts and pests cause large damage and occur quite frequently. About 40 thousand ha of stands are cut after each storm. The mean wood yield of the spruce stands is 304 m^3/ha, and the current annual increment is 6.2 m^3/ha. In Lithuania, climatic conditions are variable enough to cause differentiation of several adaptive environments. For Norway spruce, 6 regions of provenances were established. The national gene conservation program is based on (i) in situ genetic reserves, seed collection stands and selected genotypes, and (ii) ex situ clonal archives, seed orchards, experimental plantations and gene bank collections. The present-day breeding of Norway spruce consists in family tests of populations for individual and population selection and plans for inter-population hybrids. A strategy for Norway spruce breeding has been approved for the years 2004–2013. There is a genetically diverse material for future breeding: long distance provenance tests, population and family tests. Assessments of two provenance tests in central Lithuania (age 9 and age 17) revealed superior performance of central and northeastern Polish provenances: superior height, good stem quality and late budburst in spring. The possible cause is the favorable transfer effect: avoidance of spring frosts (late budburst and good stem quality) and utilization of the later part of the growing period for growth (late budset and superior height). Norway spruce is a climax species with different domestic and Darwinian fitness. We suggest that the domestic fitness of local genotypes should be improved by introducing a few Polish clones in our breeding populations.

Key-words: breeding, provenance, fitness

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Darius Danusevičius

Future strategy for long-term breeding of Norway spruce in Lithuania

Abstract: The breeding program in Lithuania is at the stage where long-term plans need to be developed. Our strategy is to proceed with closed-nucleolus breeding population, which is structured into sub-populations according to adaptive zones (4–5 subpopulations). The size of each sub-population is 50 progeny-tested individuals. The breeding cycle consists of double- pair-mating and balanced within-family selection forward. Advanced genotypes will be selected into an advanced nucleus; an isolated foreign breeding population is planned. An experimental "shuttle-breeding" strategy may be tested: selection of few best genotypes (very high intensity); controlled crosses; nursery tests for vigor and growth rhythm; cloning by hedges into short-rotation clonal plantations. Positive assortative mating is used for deployment. Research is focused on paternal fingerprinting to replace full sib breeding and optimization of deployment to seed orchards.

Key words: long-term breeding, "shuttle-breeding", within-family selection

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History and genetics of Norway spruce in Northrhine-Westphalia

Abstract: The most economical stands of spruce in Northrhine- Westphalia are located in the Sauerland region of the state. Historical research and genetic analysis have shown that the seed for these stands was imported from Thuringia around the year 1880. Northrhine- Westphaliais therefore working closely with the state of Thuringia in order to secure the genetic variety of the spruce and develop new sources of seed supply.

The survival of the Hochsauerland spruce is under threat. These stands have already been harvested or are due for harvesting shortly. Many of the existing older stands were destroyed by the gale known as "Kyrill" in January 2007 and only a few stands have remained. The gale did extensive damage to the forests in Northrhine-Westphalia and destroyed many of the valuable stands of Hochsauerland spruce. However, the genetic information of the Sauerland spruce of Thuringian origin has been secured and substantial stocks of seed are available for reforestation.

Storage of seed

Since 1985, the Forest Gene Bank of Northrhine- Westphalia has harvested seed from 100 representative trees in all the most valuable stands of spruce. The seed material from each tree has been prepared and stored separately. In addition, 204 fine specimens which appeared to be resistant to air pollution and damage by snow were selected and their seed harvested for storage fulfil all the requirements for scientific or reproductive use, large quantities of seed were also stored as a reserve for emergencies.

Seed plantations

In order to secure the genetic information from the original stands as well as the production of high-quality seed material, NRW has established a number of spruce seed plantations. Of particular importance is the collaboration between Thuringia and Northrhine- Westphalia in expanding the genetic base of the origins of the spruce in the Thuringian Forest and the Hochsauerland.

Replacement stands

The genetic information of the Hochsauerland spruce is preserved in replacement stands established with plants raised from the seed produced by the older stands. As soon as the trees fructify, it will be possible to make the genetic material available at any time.

Key words: Sauerland region, Norway spruce, survival, gene resources, storage of seeds orchards.

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Sustainability of the Istebna provenances of Norway spruce in different age classes in the Dupniański Stream catchment in the Silesian Beskid Mts as studied on the basis of ecochemical indexes

Abstract: The sustainability of the Istebna provenances of Norway spruce in different age classes of stands (class I, II, V and VI: 11, 24, 91 and 116 years old, respectively, in 1999), was studied on the basis of ecochemical indexes: soil buffer reaction (pH), acid neutralizing capacity (ANC_{aq}), alkalinity (ALK), soil acidity (Ma%), basic cation saturation (BS), and molar ratios Ca:Al and BC:Al. The data were derived from the research conducted in the Dupniański Stream catchment in the Silesian Beskid Mts.

It was found that the acid neutralizing capacity, alkalinity and soil acidity depend on the age of spruce stands. The increased acidification of deposits was due to the presence of sulphate and nitrate ions which were washed away from the surface of plants. The transformed deposition in throughfall caused a decrease in the acid neutralizing capacity, alkalinity and basis cation saturation, and an increase in the soil acidity with the age of stands, which confirms their negative effect on throughfall and soil water chemistry. The soil acid reaction shifted to the range of the aluminium and iron buffer capacity but the Ca:Al and BC:Al ratios were still above normal when the aluminium stress is not probable. The washout of the basic cations beyond the spruce root system and the low level of exchangeable Mg, basic cation saturation of soil water and effective base saturation of soil may in future affect the vitality and health of spruce stands. To maintain the sustainability of Norway spruce from Istebna provenances in the Dupniański Stream catchment, it is necessary to increase the retention of basic elements, especially Mg^{2+}, through stand conversion or fertilization.

Key words: Norway spruce, Istebna provenances, age of stand, soil buffer reaction (pH), basic cation saturation (BS), acid neutralizing capacity (ANC_{aq}), alkalinity (ALK), soil acidity (Ma%), molar ratio Ca:Al and BC:Al, Silesan Beskid Mts, southern Poland

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Provenance contribution to genetic composition of progeny from the outbreeding seed orchard of Norway spruce

Abstract: In 2004, abundant flowering was observed in the outbreeding seed orchard established in Kórnik, Poland, promoting crossing between clones of five geographically distant populations of Norway spruce (*Picea abies* (L.) Karst.). The latter were selected from a group of 1100 provenances used in the IUFRO 1964/1968 experiment and proved to be the best in terms of both growth traits and adaptability.

In the seed orchard, female strobili were produced by 91.3% of growing clones, represented by 64.1% of grafts, and statistically significant differences between clones were found in the number of mature cones. The mean number of mature cones in individual clones was also significantly correlated with latitude of the origin of their maternal populations ($r = 0.8826$, $p \leq 0.0470$). The majority (95%) of cones in the orchard was produced by only 28.2% of all clones, and 21.4% of all grafts.

The nearly equal percentage of clones representing each of five populations in the outbreeding seed orchard (from 23.2 to 17.5%) resulted finally in the very unequal production of full seeds by each population (from 5.2 to 62.9%).

These data attest to a disparity between the level of genetic diversity in seed orchard progeny expected from the growing number of clones and the genetic diversity resulting from the participation of clones in full seed production as a real measure of the genetic composition of progeny.

Key words: *Picea abies,* clonal variation, genetic diversity of progeny, cone yield, seed production

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Kazimierz Szabla

Health and sanitary state of Norway spruce stands in the Silesian Beskid Mts and Beskid Żywiecki Mts and the conditions for their reconstruction

Abstract: The present sanitary state of forests in the Beskid Mountains is due to many harmful phenomena and changes occurring in the 17th to 20th centuries. The area of the primeval Carpathian Forest decreased at first as a consequence of using forested land for pasture and agriculture purposes. The 19th century rise in the consumption of charcoal by industry, causing the large-scale exploitation of forest resources, led to the withdrawal of beach, plane-tree and fir from the Beskid Mts. In addition, the paper and mining industries made a high demand on spruce timber, which resulted in planting the species in monoculture. These factors, combined with the forest management model of the time, contributed to the domination of Norway spruce in mountain stands. For some time the model seemed to fulfil expectations as large amounts of good quality timber were obtained in a short production cycle. A flaw in the model became obvious in the middle of the 20th century when spruce stands suffered from domestic and trans-border industrial pollution. Such a situation required abandoning the economic criteria and adopting new ones. Instead of Norway spruce, more industrial pollution-tolerant broadleaved species were to be selected. Eventually, the idea to fit the tree species composition to a given habitat in typical Carpathian forest conditions was promoted. The spruce stands would be reconstructed and gradually transformed into stands with increasing proportions of beach and fir. The range and time schedule of such a reconstruction was defined in the „Beskid Mountains Programme" launched in 2003. Due to the later weather anomalies, extremely high temperatures and a lack of rainfall in 2006, the health condition of spruce in the Beskids deteriorated. Fearing that the decline of Norway spruce may soon left bare many mountain ridges and slopes, the forest service workers considered that their basic tasks should be slowing down this process to maintain sustainability of the stands and ensuring the necessary extent of forest reconstruction. Not having any influence on weather conditions or infestation with pathogenic fungi, they focused on the control of bark beetle. That is why the " 2007 Strategy of Norway Spruce Pest Numbers Control in the Silesian and Żywiecki Beskid Mts" was worked out. It includes two scenarios of the rate of infestation for 2007 and defines the necessary means and resources to remove the infested trees in due time. Regrettably, the progress of the removal operation to date looks rather pessimistic which suggests that the „Beskid Mountains Programme" should be revised with the aim of improving the effectiveness of reforestation. It is necessary to enlarge the seed base, seed storage capacity and nursery area, and to boost the production of container-grown seedlings.

Key words: Norway spruce stands, Beskid Mst., forest conditions, sanitary state, programme of forest reconstuction, reforestation, seed base.

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How long can seeds of Norway spruce (*Picea abies* (L.) Karst.) be stored?

Abstract: The seeds of Norway spruce (*Picea abies* (L.) Karst.) belong to the orthodox category because they can be desiccated to a low moisture content and be stored at low temperature without damage. Here we present the original results of germination tests and observations of seedling development after storage of seeds for 17 years at –5 to –6 °C, followed by 12 years at –3 °C, i.e. a total of 29 years at subfreezing temperatures. We also investigated cryopreservation in liquid nitrogen at –196 °C as an alternative method of seed storage. Before cryopreservation, seeds were desiccated to a moisture content of 3 or 6%. After 2-year storage in liquid nitrogen, their germination course and development of seedlings did not differ from those of freshly extracted and non-stored seeds and also from those of seeds stored for 2 years at –3 °C.

Key words: Norway spruce seeds, orthodox category, storage, cryopreservation.

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Optimising the quality assessment methods of Norway spruce seeds

Abstract: The quality assessment of Norway spruce (*Picea abies* (L.) Karst) seeds consists in determining their germination capacity, including germination energy (speed), but also purity and weight. The internationally recognised methods, listed in the ISTA Rules for Seed Testing, contain the detailed specifications of test conditions, among other things. However, some countries, e.g. Poland, use modified methods. In addition to providing information about species purity, a purity test can also identify the proportion of winged seeds in each seed lot. A germination test determines the maximum germination potential of a seed lot which should be used to compare the quality of different lots, and establishes the field planting value. The paper presents the methods used for assessing the quality of Norway spruce seeds and discusses their advantages/disadvantages and problems that need future investigation.

Key words: sampling, purity, weight determination, germination, health testing, validity of results

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Michael Mengl, Thomas Geburek, Silvio Schueler

Geographical pattern of haplotype variation on native stands in Norway Spruce in Austria

Abstract: Norway spruce (*Picea abies*) is the major and economically most important tree species in Austria, prevailing in approximately 54% of the Austrian forests. A huge proportion of these forests have been planted, often in unsuitable regions. Those allochthonous populations are especially prone to biotic and abiotic stress. Hence, the identification of autochthonous stands has become an important issue in the context of genetic conservation as well as for the selection of suitable seed stands.

In the present study, we analysed the haplotype intraspecific variation in natural populations by means of a mitochondrial DNA marker. We used the second intron of the nad1 gene, which.contains two polymorphic short tandem repeats. Due to the maternal inheritance of mitochondrial DNA the spatial distribution of haplotypes allows insights into gene flow and artifical seed transfer. The samples were collected in a high density grid of 4 × 4 km in the framework of the National Austrian Forest Inventory from putatively autochthonous stands. In total, 504 trees were screened and 9 different haplotypes could be found. A geographical map of the haplotype variation pattern is presented. This work will be the prerequisite for a future study to identify the intensity of artificial introduction of forest reproductive material.

Key words: *Picea abies*, mitochondrial DNA, biogeography, genetic diversity

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Mitochondrial and nuclear DNA differentiation of Norway spruce (*Picea abies* L. Karst.) populations in Poland

Abstract: The natural stands of Norway spruce in Poland account for about 6% of the total forest area and occur in the southern and northeastern part of the country. Populations from northeastern Poland are located in lowland and belong to the Baltico-Nordic domain of *Picea abies* L. (Karst.) deriving from a refuge situated in Central Russia. Provenances from southern Poland occupy mountain areas and belong to the Hercyno-Carpathian domain of Norway spruce distribution in Europe. A so-called spruceless zone separates the northern from southern locations in the Beskid Mts and in Central Poland. In the present study we continue to investigate the genetic identification of Norway spruce populations with mitochondrial (STS) and nuclear (SSR) markers as a tool.

Four different variants of haplotypes: "a", "b", "c" and "d" are present in the *nad*1 locus of STS markers. Populations from the northern domain of *P. abies* distribution in Poland harbor exclusively haplotypes "c" and "d", except the Białowieża population which has haplotypes "a" and "c". Populations from the spruceless zone contain four types of haplotypes whilst those from the South of Poland reveal the majority of haplotype "a".

A high mean gene diversity is observed for both STS and SSR markers (H_T = 0.529 and H_T = 0.851, respectively). The total genetic differentiation of Norway spruce populations is very low, F_{ST} = 0.088.

Two main groups of populations are readily distinguishable in the dendrogram according to the genetic distances of NEI (1978) based on microsatellite markers data. The distribution of the genotypes is scattered and they do not show any affiliation to any of the ranges of *P. abies* distribution in Poland. The only mtDNA markers differentiate the northern populations of Norway spruce from the southern ones, proving the historical separation between the Baltico-Nordic and the Hercyno-Carpathian domains of *P. abies* in Poland. In contrast, microsatellite data suggest that the genotypes overlap due to the human impact made on the Norway spruce stands in the past.

Key words: genetic differentiation, microsatellite and mitochondrial DNA markers, Norway spruce, *Picea abies* L. Karst

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Postglacial re-colonization of Norway spruce (*Picea abies* (L.) Karsten) in Poland based on molecular markers

Abstract: The study aimed to reconstruct the expansion of Norway spruce in Poland after the last glaciation. A mitochondrial DNA maker was applied to provide evidence on the contribution of the European glacial refugia of Norway spruce to its postglacial re-colonization of Poland, and on the postglacial migration pathways of Norway spruce in the country. The specific goal of this work was to answer the questions related to the origin and characteristics of the Middle Polish disjunction in the Norway spruce range: (i) Did the boreal and southern ranges of Norway spruce meet in the territory of Poland? (ii) Can the suture zone between this ranges be found? (iii) What is the genetic origin of spruce populations located in the so-called "spruceless zone"? To discover more about the postglacial history of the species, genetic variation at mitochondrial *nad1* b/c via PCR-RFLP was assessed in 37 populations distributed across the northeastern and southern part of Norway spruce natural range in Poland and 22 populations from the "spruceless zone".

The results clearly demonstrate that the central Russian refugium formed the northeastern range of Norway spruce in Poland while southern Poland was colonized from the Carpathian refugium. The most interesting results concern the Middle Polish disjunction. Genetic data indicate that spruce in this part of Poland came from both refugial areas. Based on this data, the contact zone between both migration pathways was delineated along the Bug River. The northern natural range of spruce in Poland includes also the Białowieża Primaeval Forest. Surprisingly, a high frequency of southern haplotype was reported from the Forest. Palinological data support the genetic results and suggest that the southern haplotype naturally occurs in this part of Poland. Therefore, the area of the Białowieża Primaeval Forest should be included in the contact zone between the northern and southern migration pathways.

Key words: *Picea abies*, postglacial recolonization, "spruceless zone", PCR-RFLP, *nad1* b/c polymorphism.

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Genetic variation of Norway spruce (*Picea abies* L. Karst) in Southern Germany determined by isozyme and STS markers

Abstract: One of the main objectives of the Bavarian Office for Forest Seeding and Planting at Teisendorf consists in determining the genetic variation of the main tree species in Bavaria (Southern Germany). For these genetic investigations (conducted mainly on adult trees) isozymes as genetic markers were primarily used. For Norway spruce more than 50 populations from Bavaria were analysed at 23 isozyme gene loci. The mean genetic distances between these populations were quite small. Geographical grouping could not be observed, nor discrimination between provenances from high and low altitudes could be identified using this marker type. Spruce populations from South Bavaria differ from those of Northeast Bavaria only in the presence of some distinct rare alleles.

Concerning the genetic multiplicity and diversity the differences between stands were high. The hypothetical genetic diversity (v_{gam}) shows values between 140 and 1296 indicating a wide range. The highest values for the genetic diversity were detected for spruce stands in Northeast Bavaria (Frankonian Forest).

In the course of development of a new system for proof of identity of forest reproductive material on the basis of genetic comparisons on reference samples, alternative genetic markers need to be found for Norway spruce that are cost-efficient and usable in standard applications. Moreover, they should reveal more significant differences between populations, since a reliable control system is only feasible on the basis of differentiation possibilities between populations. Thus, for *Picea abies* we examined nuclear EST-PCR-markers, which are co-dominant inherited and refer to expressed DNA-sequences. The genetic differences found on the basis of 10 EST-markers between different *Picea abies* seed lots and/or seedling populations are generally 2–3 times higher than those found using isozyme gene markers.

Hence, DNA markers have turned out to be an appropriate and substantial addition or even more a suitable alternative to isozyme markers for analysing genetic variation and testing provenance identity. Their advantages consist in a markedly higher variation as well as in the enlarged genome segments investigated. At present, for *Picea abies* there are about 23 isozyme gene loci available which can be interpreted confidentially; about 30% of them show little or no variation. It may be assumed that the potential of these markers is more or less exhausted. Using EST markers, further genes of the nuclear genome of *Picea abies* can be dealt with.

Key words: Norway spruce, genetic variation, Bavarian populations, isozyme gene loci, EST-PCR-markers, nuclear genome.

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Genetic research on Norway spruce (*Picea abies* (L.) Karst.) from extreme areas of *Spaghno Piceetum* in Slovenia, and Bosnia and Herzegovina

Abstract: By using 10 isoenzyme systems and analysing 16 gene loci from the extreme areas of *Sphagno-Piceetum* occurrence in Slovenia and in Bosnia and Herzegovina, we compared the genetic structure of three different populations of Norway spruce. Based on the available ecological indicators, mainly climate and its effects, we found differences between the populations fairly distant from each other, even though in phytocenotic therms they belong to the communities of *Spaghno-Piceetum*. A number of minor and major differences in the plant content of phytocenoses were noted. The results of the analysis by isoenzyme markers point to the differences between the populations under study but also show an interesting closeness between one Slovenian population and one Bosnian population (Pohorje and Nisici, respectively).

Key words: *Picea abies* (L.) Karst., *Spaghno-Piceetum*, populations, isoenzymes

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Demographic and genetic structure of the native *Picea abies* Karst. population from the Białowieża Forest

Abstract: The research focused on the *Picea abies* Karst. population from the Białowieża Forest. Its demographic structure was characterized on the basis of tree height, DBH, and DBH age of trees selected along linear transects. The genetic structure of the population was assessed by using 7 enzymatic systems. It was found that the Norway spruce population has developed through natural regeneration and is a Białowieża Forest virgin population. This population has a polymorphic character and holds the Hardy-Weinberg equilibrum. Its genetic structure is strongly differentiated: besides 2 genetic subpopulations, few different genotypes were found.

Key words: *Picea abies* Karst., Białowieża Forest, demographic structure, enzymatic systems, different genotypes.

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Genetic changes between age classes of naturally regenerating population of *Picea* abies (Karst.) from Białowieża primeval forest

Abstract: By means of research on the genetic variation of isoenzymes (26 loci) and chloroplast DNA microsatelites (5 loci), the changes in the genetic structure of five age classes in a naturally regenerating population of Norway spruce were studied. According to age, the population was divided into four classes: seedlings 2 years old, individuals 3 to 10 years old, trees aged 11 to 100 years, and trees over 100 years. The genetic structure of embryos from the seeds of two last age classes was also investigated. Each age class was represented by ca. 100 individuals for the purposes of isoenzymatic analysis. A sample for DNA (SSR) study comprised 232 embryos and individuals. The work aimed to determine the changes in the genetic structure connected to the adaptive processes of a population regenerating without human impact on the shape of the stand. The study of both kinds of molecular markers (isoenzymes and DNA) revealed a significant reduction in the number of alleles (by ca. 20%) from embryos do the oldest class of trees, and an increase in isoenzymatic heterozygosity by 25% and haplotic diversity by 35% in the oldest class compared to embryos. The fixation index (F) shows deviations from the Hardy-Weinberg equilibrium in the younger classes of trees and a state of equilibrium in the oldest. The most significant change in the genetic structure of the population occurs between the group of embryos and two youngest groups (2 to 10 years old). The gene flow indices (Nm) indicate that the most prominent age class influencing the genetic shape of the population is the one of individuals 10 to 100 years old. The results of the work show the direction of changes in the adaptive processes in a naturally regenerating population and their dynamics.

Key words: *Picea abies,* isoenzymes, cpDNA, age classes, natural regeneration, adaptation

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Jarosław Socha

Relationship between environmental factors and the potential productivity of Norway spruce in the Polish Beskid Mts

Abstract: The research was intended to explain the relationships occurring between environmental factors and the potential productivity of mountain forest stands of Norway spruce in the West Beskids, Poland. Field data were collected on 295 research sites, round in shape, located in spruce stands in the forest districts of Jeleśnia, Ujsoły, Ustroń and Węgierska Górka. On these sites, the breast height diameter and the height of trees were measured and the age of trees was recorded. In addition, the topographic features of each site including elevation and slope exposure and inclination were measured, and the geological basement complex was determined from geological maps. In order to interpret the site index as a function of elevation, exposure, size of a mountain massif, and geological basement complex of a site, the multiple regression model was used. The model explains 80% of the variation in the spruce site index in the West Beskids. Elevation is the major (53%) factor responsible for and negatively correlated with this variation. The next important factor showing a strong correlation with site index variation is geological basement complex: spruce growing on soils formed from Magura and submagura sandstones strata has the site index ca. 4 m higher than spruce growing on soils formed from Istebna and Godula sandstones. The potential productivity of spruce is also determined by the exposure of the stand. More favourable conditions for spruce prevail on slopes with north-east exposure than on those with south-west exposure. Spruces growing on slopes with north-east exposure have the average site index ca. 1.8 m higher than the others. The potential productivity of a forest site depends to some extent on the size of the local mountain massif: with each 100 m of its height, the quality classification of spruce improves by an average of 0.49 m.

The models developed in the course of the study with the aim of explaining the relationships between the site index of spruce stands and the key topographic and basement complex characteristics may be practically applied to determining the potential productivity of spruce stands in the West Beskid Mts. The models would be particularly useful where traditional calculation methods fail or their use is difficult, i.e. in calculations concerning bare or non-forested areas, or sites on which quite young or mixed-age stands grow.

Key words: *Picea abies*, Long-term storage, cryopreservation, dessication, germination, seedling emergence

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Paweł Tylek

Aerodynamic features of spruce seeds

Abstract: Sorting is one of the possible ways of seed quality improvement. Owing to numerous advantages, it is often based on the differences in the aerodynamic features of seeds, among them critical velocity, drag coefficient and fineness ratio. This paper discusses the results of measurements of those features for the seeds of spruce (*Picea abies*). The sorted seeds were grouped into two classes according to the degree of embryo development (determined by the RTG method). The measurements of critical velocities were made in a vertical aerodynamic channel with a variable cross section area, which was equipped with a channel thermoanemometer and connected to a video-computer set. The results of measurements were presented in tables and histograms.

Key words: critical velocity, distinguishing features, seed sorting

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Preliminary assessment of the genetic structure of Carpathian spruce using terpene markers

Abstract: Terpene polymorphism was studied in 31 plus trees of Norway spruce (*Picea abies* (L.) Karst.) and their generative progeny tested in the family archive area of Istebna spruce located in the Wisła Forest Range. The terpene content of essential oils filling the resin ducts was analyzed using chromatographic techniques. The spruce from Istebna, represented by two stands in forest compartments No. 109d and 108f, exhibited a high level of *camphene*, α-*pinene* and *limonene*. However, no specific terpene markers for the tested population were identified, the terpenes did not show any correlation with morphological traois, either.

Key words: Istebna spruce, plus tree, family, monoterpenes, gene markers

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Isoenzymatic and DNA polymorphism in progenies of spruce stands from some Krutzsch regions of IUFRO 1964/68 provenance test in Krynica

Abstract: The study investigates the genetic structure of 21 provenances of Norway spruce (*Picea abies* (L.) Karst.) originating from four Carpathian regions of Krutzsch: 60 – East Beskid Mts., 62 – West Beskid Mts., Babia Góra, Beskid Sądecki Mts., 63 – Silesian Beskid Mts., Beskid Żywiecki Mts, and 59 – East Romanian Carpathians, and tested in the IUFRO 1964/68 experiment conducted in the Beskid Sądecki Mts. The level of polymorphism was studied using starch electrophoresis and seven allozyme systems coded by ten loci: G-6-PDH-A, GDH-A, NDH-B, SBDH-A, ShDH-A, ShDH-B, DIA-A, DIA-B, LAP-A and LAP-B. Using RAPD and microsatellite markers, 120 random primers and 30 microsatellite primers were initially screened and those generating clear and polymorphic profiles were selected. The intra-population genetic variation was low, as suggested by the low values of statistic parameters such as observed heterozygosity (H_o = 0.130), observed number of alleles (N_a = 1.492) and effective number of alleles (N_e = 1.252). An analysis of the genetic distance between the populations showed that only Romanian populations and population No. 73 Jasina (region 60) are distinguishable from the other provenances tested.

Key words: isoenzymes, DNA, polymorphism, Carpathian spruce, conservation of gene resources

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Area and volume of Norway spruce (*Picea abies* (L.) H. Karst.) stands in Zawadzkie Forest Division in years 1952–2004

Abstract: For the last centuries Norway spruce (*Picea abies* (L.) H. Karst.) has been one of the most important and precious admixture species in the region of Silesia. Regrettably, due to different reasons its resources are now decreasing. An analysis of the area and volume of Norway spruce stands in the Zawadzkie Forest Division in the period 1952–2004 was intended to show the trend and scale of the phenomenon. All stands with at least 10% proportion of Norway spruce in the species composition were taken into consideration. The analysis was based on the description of stands and the forest management plans from the years 1952, 1958, 1969, 1982, 1994 and 2004.

The total area of the stands decreased from 4114 ha in 1952 and 7149 ha in 1982 to only 617 ha in 2004. Between 1952 and 2004, the average area of a stand decreased from 5.77 to 3.13 ha, the average age lowered from 58 to 29 years, and the average stand volume decreased from 82 to 26 m³. There was also a large fall in the average proportion of spruce in the stand composition: from 50% in 1952 to 10% in 2004.

Key words: Norway spruce, population “Kolonowskie”, area, volume, age

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Spatial analysis of Norway spruce (*Picea abies* (L.) H. Karst.) stands in Zawadzkie Forest Division in years 1952–2004 as a location test of nonexistent motherly population Kolonowskie 0293, IUFRO 1964/68

Abstract: The Geographic Information System (GIS) was used to perform a spatial analysis of the stands of Norway spruce (*Picea abies* (L.) H. Karst.) in the Silesian region. The analysis was based on the data from stand maps and forest management plans of 1952, 1958, 1969, 1982, 1994 and 2004. The spatial changes that occurred in the stands within this period were presented against a background of the newest genetic results as a location test of the nonexistent motherly stand (Kolonowskie 0293, IUFRO 1964/68).

Key words: Norway spruce, population "Kolonowskie", GIS, spatial analysis

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Zawadzkie Forest Division – general characteristics of the region and history of the IUFRO 1964/68 experiment with Norway spruce (*Picea abies* (L.) H. Karst.)

Abstract: The Zawadzkie Forest Division is situated in southern Poland and belongs to the Regional Directorate of State Forests in Katowice. The Division occupies a forested area of about 18 900 ha in the Silesian Lowland, and is divided into three main forest management units: Kielcza, Kolonowskie and Zawadzkie. Due to the habitat structure, the main tree species of the region is still Scots pine (*Pinus sylvestris* L.) growing mainly in pure even-aged stands. Norway spruce (*Picea abies* (L.) H. Karst.) constitutes a precious species and biocenological admixture in stands growing on moist and boggy sites. Forests cover up to 65% of the area.

The IUFRO 1964/68 experiment with Norway spruce was started in 1964 as a part of provenance studies involving about 1100 populations from the whole natural world range of the species. Ninety one populations from Poland were taken into consideration, one of which was the population "Kolonowskie" (No 0293). The first results from 1976 indicated that the population is one of the most valuable ones for silviculture due to its natural development and remarkable growth features in different conditions. Unfortunately, the location of the motherly stand has not yet been recognized.

Key words: Norway spruce, population "Kolonowskie", IUFRO 1964/68

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EVOLTREE - Evolution of trees as drivers of terrestrial biodiversity, project summary.

Abstract:

EVOLTREE is a large EU–funded network of excellence launched in April 2006 to analyze the impacts of climate change on forest ecosystems from an evolutionary perspective. A Better understanding of the evolutionary history of forest trees can help us to predict how they respond to climate change. Forests are complex ecosystems and subsequently forest research needs to apply different approaches to gain a better understanding of how they function. The European forest research community has carried out numerous important studies on forest biodiversity. However, many institutes maintain overlapping research infrastructure and often carry out similar studies without coordination. The main objective of EVOLTREE is the reduction of the fragmentation of European research on forest genetics and genomics, creating the foundations for a new discipline, ecosystem genomics, which investigates linkages between genes and ecosystem functioning, looking at the genetic basis of ecosystem process, by linking various disciplines (ecology, evolutionary studies, genetics and genomics). EVOLTREE's joint research activities focus initially on identifying genes of adaptive significance in the face of climate change in some model species from well studied tree genera (Pinus, Quercus, Populus), phytophagous insects (Limantria) and mycorrhizal fungi (Laccaria and Glomus). Research will be then expanded to include a series of target tree species, including Picea abies.

A total of seven Intensive Study Sites (ISS) in different forest ecosystem have been selected to host multidisciplinary research activities. ISS are large scale ecosystem plots (a few thousands of hectares) where trees and selected associated species will be mapped, genotyped and phenotyped. The sites are comprise entire portions of landscapes where trees are present in different configurations. Data from this network of sites will be exchanged and will allow comparing ecosystem processes in different environmental conditions.

Key words: EU–funded projects, forest genetics, genomics
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