

Abstracts



Editors: Niels Bonde, National Museum Copenhagen
Dieter Eckstein, University of Hamburg

The following abstracts are alphabetically listed according to the first author.

[P] Poster [L] Lecture

**Baittinger¹, Claudia, Niels M. Schmidt^{2,3}
and Mads C. Forchhammer³**

¹*NEDL - North European Dendro Lab,
Copenhagen, Denmark*

²*Department of Ecology, Zoology Section, Royal
Veterinary and Agricultural University, Denmark*

³*Department of Population Biology, Institute of
Biology, University of Copenhagen, Denmark*

**[P] Tree-ring research on *Salix arctica*
from North-East Greenland**

In the High Arctic, climate change is expected to strike first and to be most pronounced. Thus, Denmark and Greenland has established the Zackenberg Research Facility in Northeast Greenland in order to monitor the Arctic ecosystem prior to and during climate change, thereby enabling solid predictions about the effects of the climatic change. This project aims at providing retrospective information on the climatic conditions in the Zackenberg valley using dendrochronology.

Salix arctica (Pall.), arctic willow, is one of the most northerly occurring plants. It has a wide geographic distribution, occurring on Greenland, in Asia, North America and sporadic in Northern Europe. In the high Arctic it forms a prostrate shrub with individual plants reaching an age of at least 110 years. *Salix arctica* represents an yet untapped resource for not only climate reconstruction but a whole range of proxy data in the High Arctic.

Salix arctica, however, presents a number of problems for obtaining reliably cross-dated ring-width series because of formation of eccentric pith, and missing and discontinuous rings. The dendrochronological study of *Salix arctica* is therefore rather delicate. Additionally, the growth-rates of woody plants at such high latitudes are very low, and the mean growth rate of *Salix arctica* is around 0.08 mm/yr. Due to these extremely slow growth rates a new approach of microscopic examination was necessary to delineate and measure the rings. This methodology proved very efficient. In 2003 and 2004 approximately 75 samples from

the Zackenberg valley were analysed, and the results are very promising.

The initial analyses conducted on these samples suggest that it is possible to use tree-ring measurements from *Salix arctica* to generate proxy climate-data, and to reconstruct past snow regimes in the valley approximately 100 years back in time.

Bednarz, Zdzisław

*Department of Forest Botany and Nature
Conservation, Agricultural University of Krakow,
Poland*

**[P] Frost desiccation as factor limiting
tree-ring widths in stone pine (*Pinus
cembra* L.) from the Stelvio
National Park (Italy)**

On the basis of the analysis of 26 stone pines from the Martello Valley in the Stelvio National Park (northern Italy), a master chronology was prepared spanning 295 years (1700-1994). Analysis of the relationship between ring-width indices of stone pines with mean monthly air temperatures (1926-1978) in Silandro revealed a strict relationship between radial growth and May-August temperature ($r = 0.30$, $p = 0,05$). The stone pine ring-width data show also highly significant relationship with February and Mart temperature, but this relationship has an indirect character; $r = -0.15$ and -0.30 ($p = 0.05$), respectively. The strong negative growth response of stone pine to February-March temperature is caused by frost desiccation phenomenon.

Beliakov, Andrei, and Kirill Dyakonov
Department of Geography, Moscow State University, Russian Federation

[P] Dendrochronological studies on local landscape transects

Dendrochronologists have for a long time used transect method of site selection for sampling. Transects in global and regional scale have proved to be efficient for dendroclimatological studies, e.g. in reconstructions of zonal climatic parameters. Local transects are usually used to study the variation of tree growth at different elevations in the mountains and by dendrogeomorphologists. We assume it is very useful to study the radial growth of trees at local landscape transects together with solving geographical and landscape ecological problems. We have with success used the dendrochronological method in practical and theoretical geographical research. For the first purpose it was applied in our studies of the influence of reservoirs of hydroelectric power stations and drainage reclamation system (see abstracts by Dyakonov and Beliakov in this book). Among the theoretical and methodological problems in modern landscape studies that can be solved by using the dendrochronological method are studies in landscape evolution, analysis of spatial-temporal rhythms of productivity, synchronous trends in functioning of landscapes on local level etc. Nearly 300 increment cores and stem disks of *Pinus sylvestris* L., *Picea abies* L. (Karst) and *Picea obovata* (Ledeb.) were sampled along the line of an 8125 m landscape transect located in the middle-taiga zone (60°51'N, 43°15'E – 60°54'N, 43°21'E) in the South of Archangelsk region, Russia. The transect passes through the wide range of sites: different forest types, oligotrophic and mesotrophic bogs on plain watersheds, valleys of small rivers and creeks that represent the spatial structure of the region. The vegetation of this research area is characterized by high anthropogenic

pressure and absence of common factor limiting growth.

The line of transect was levelled (points were located at every 12.5 m) and detailed geographical description of its territory was made. This description took place at every 25 m point of the transect and included the study of all layers of vegetation, soils (to the depth of 1.5 m), the depth of ground water table and pH of waters and soil horizons. Holocene evolution of the research area was studied applying palynological method. Tree-ring data sampled along the transect line were used to describe and explain secular rhythms in productivity.

The dendrochronological part of the research showed that the climatic factors that simultaneously affects all the landscapes in the transect are the basics of spatial-temporal synchrony of processes. In-centennial rhythms of increments (productivity) are characterized by their own level of synchrony. The discovered asynchrony is a product of different self-developed trends.

The borders of the zones of synchronous increments are usually not the same as if they were divided based on landforms or their genesis; that is the traditional method for landscape studies. So the new thesis in the discussion on how continuous and (or) discrete is the landscape space was added. And it was for the prevailing of continuous organization due to the important role of biotic material.

At present days the dendrochronological method is one of the most convenient in gathering data on time-series of productivity that controls the volume of biological circulation. The most important item now is to work out the methods in dendrochronology that corresponds to the modern directions in landscape studies and the theoretical basics of modern physical geography. The solution of this problem will be most auspicious for both dendrochronology and landscape studies.

[P] Poster [L] Lecture

Billamboz, André
Landesdenkmalamt Baden-Württemberg
Hemmenhofen, Deutschland

[P] 60 years after the pioneering tree-ring work of B. Huber: the Wasserburg Buchau revisited

Along with its palisade system of bog pine (*Pinus rotundata* Link), the Wasserburg Buchau at Federsee was the first site dedicated to tree-ring investigations on the North Alpine range. On the basis of a large sampling made by H. Reinerth in 1939, B. Huber was able to construct two tree-ring chronologies for both the inner and outer palisades, showing a short time of construction within a few years, respectively. The missing cross-dating implied a time shift of at least 100 years between both building activities.

Since new excavations during the last 20 years (Baden-Württemberg Office for the Protection of Ancient Monuments and Pfahlbaumuseum Unteruhldingen) allowed a resampling, the missing link between Huber's two pine chronologies has been found. Together with larger heteroconnections, it led to the absolute dating of the site and revealed the whole history of its construction. Furthermore, the evaluation of tree-ring data from a paleodendroecological perspective provided consistent information's about the evolution of climate and the environmental changes as well as their consequences for the settlement development during the course of the Late Bronze Age.

Boeren, Ilse, Sabine Remmele and Michael Friedrich
Institute of Botany, Hohenheim University,
Germany

[L] Water and fire: the complex history of a Late-Glacial pine forest

A vast and well-preserved Late-Glacial pine and birch forest (14100 – 13300 Y BP) has

been excavated in a lignite mine in Reichwalde (Germany). The advantageous environmental circumstances for the preservation of wood (inundation and peat-formation) provided us with more than 2000 samples for dendro-ecology, which dates cover a period of about 800 years in the Glacial Interstadial 1.

Since trees were excavated on the whole northern shore of the bog, we could test if there is a connection between the finding place on the shore and the date of dying of the trees. We find that the trees tend to date later from east to west, but it is certainly not the fact that the trees found deeper are the oldest. Actually, the dates are quite mixed. This probably means that the bog (lake) did not fill slowly and continuously. Other explanations could be that the trees grew at another place than where they were excavated or that the geology of the area changed intensively. To further elucidate this problem, we looked at the distribution of the trunks and the logs in the bog, and its connection with the preservation of the Late-Glacial soil.

We also discuss a remarkable die-off in the middle of the Reichwalde chronology, followed by a period of 25 years in which the fire frequency was higher than normal for Reichwalde (once every 3-5 years instead of once every 15-30 years), and almost no new trees generated. This caused many problems for dating and brought forth questions about the actual environment in which the trees grew. Answers can be found in the complex interaction between fire, water and vegetation.

Bonde, Niels
Environmental Archaeology, National Museum of
Denmark, Copenhagen, Denmark

[L] Dendroprovenancing

One of the first spectacular results of a dendrochronological research on a historical shipwreck was made by professor J. Bauch at the Institute for Wood Biology and Wood

Protection, University of Hamburg. In the 1960'ties he succeeded in dating the famous 'Hanseatic Kog' excavated in the harbour of Bremen. Although there were very low number of master chronologies for oak in Europe at that time he managed to date the ship to AD 1378/79 using a chronology from 'Weserbergland' indicating that the trees used in the construction of the ship came from this region app. 300 km or more up the Weser, the river where Bremen is situated. This is one of the first known examples of 'Dendroprovenancing' (the ability through tree-ring studies to identify the origin of timber used in a cultural context).

In the early 1970'ties Dieter Eckstein and Ernst Hollstein, Trier, demonstrated that the timber (staves) from winebarrels excavated in the early medieval town of Dorestad in Holland originated from a region app. 400 km up the river Rhein.

Later in the 70'ties and up through the 80'ties the group in the dendrolab in Hamburg (Dieter Eckstein, Peter Klein and Tomasz Wazny with 'a little help from' Mike Baillie) solved the problem with dendrochronological research on art-historical objects and created the concept 'Baltic timber'.

It is a paradox that no one until around 1990 realised the potential in these results. In the late 80'ties working on a dating project with a shipwreck found in the Danish area the dendro lab in the National Museum of Denmark got hold of nearly all the great regional chronologies for oak in northern Europe and thus started systematically to date and provenance shipwrecks from southern Scandinavia. More than 100 shipwrecks have been examined with great success. And up through the 90'ties we continued with all kind of non-static object types such as barrels, paintings, furniture, altars, chests, book-bindings etc.

To day dendroprovenancing is standard procedure in our lab. Each time we examine an object related to trade and communication the archaeologist or historian always ask: 'how old is it and where does it come from?'

In the research we use the calculation of the t -value (Baillie & Pilcher) as an indicator. We use the chronologies that have been worked out in the lab in Copenhagen along with all the chronologies we have access to from the labs in Lund (S), Warsaw (PL), Berlin (D), Göttingen (D), Hamburg (D), Sheffield (GB) and Belfast (N-IRL). The chronologies have been constructed at different times, for different purposes and in different ways (indexed, non-indexed etc.).

To day the lab in the National Museum of DK are producing new regional chronologies in cooperation with the dendro labs in Hamburg and Lund. The borders between Denmark and Germany, and Denmark and Sweden are frontiers drawn according to national sentiment not reflecting the nature and we expect in the future to have new and transboundary chronologies reflecting the growth regions and not the political situation.

Bräuning¹, Achim, Kambiz Pourtahmasi² and Davoud Parsa Pajouh²

¹*Institute of Geography, University of Stuttgart, Germany*

²*Faculty of Natural Resources, University of Tehran, Iran*

[L] Development of a tree-ring network in Northern Iran

The Elburz-Mountains of northern Iran exhibit an extremely asymmetrical distribution of precipitation and ecological forest types. The northern slope is exposed to the moist air masses from the Caspian Sea that supply the mountain forests of *Fagus orientalis* and *Quercus macranthera* with plenty of rainfall during the whole year. In the rain shadow of the main crest line of the Elburz Mountains, which belongs to the Mediterranean climatic realm, the major part of annual rainfall is brought in as snow from western disturbances. In this summer dry climate, open stands of *Juniperus polycarpus* and *Cupressus sempervirens* form steppe forests on south facing slopes. Along an ecological

[P] Poster [L] Lecture

transect from the montane beach forests and oak forests on the upper tree line on north slopes to Juniper forests on the south slopes, increment cores have been sampled from the different elevational forest types. Chronologies of ring width and wood density have been created, covering the past 200 years (oak, beech) to 400 years (juniper). The climatic forcing of each wood species and wood parameter is shown and the potential of deriving long-term climate reconstructions for this very climate-sensitive area are discussed.

Bridge, Martin C., and D. H. W. Miles
Oxford Dendrochronology Laboratory, England

[L] Dendrochronology of doors

Too often, the historical significance of wooden doors to buildings of all types has been overlooked. Doors have fulfilled many simultaneous roles, having to withstand attack whilst conveying the grandeur and status of the building by their sturdiness and decoration. Their construction was therefore often a demanding task for the medieval carpenter. Today, many ancient doors go unrecognised, as at Chepstow Castle where the old main gates, which were replaced in the 1960s, were threatened with disposal until dendrochronology in the 1990s confirmed that they were made from trees felled in the 12th century.

Whilst it may be possible to measure ring sequences *in situ*, or via photographs or impressions, the development of specialist boring equipment has enabled cores of 5mm diameter to be removed from thicker boards, allowing the accurate dating of many doors for the first time.

It is important to sample all the individual boards in a door as sapwood is rarely available and there may be great variation in the preparation of individual boards from the parent tree. Nevertheless, examples of various doors so far dated, including 11th and 12th century examples, suggest that we are now in a position to date many historic

doors and thus investigate the development of the carpentry used, placing the examples within a proper time framework. The 11th century church door at Hadstock, Essex, has long been studied, its unusual construction often being said to bear more similarities with shipbuilding techniques than those of traditional joinery.

Cedro¹, Anna, and Bernard Cedro²

Faculty of Natural Science, Institute of Marine Science, University of Szczecin, Poland

¹*Laboratory of Climatology and Marine Meteorology*

²*Laboratory of Geology and Paleogeography*

[P] The effect of temperature and precipitation on radial growth of plane (*Platanus x hispanica*)

Platanus x hispanica Mill. ex Münchh.

“Acerifolia” is hybridization between *P. occidentalis* L. (from North America) and *P. orientalis* (from SE Europe). This species is a characteristic element of “Jasne Blonia” Park in Szczecin (NW part of Poland). There are 205 trees with monumental dimensions – the biggest and the most beautiful assembly of this species in Poland.

In this study we present the influence of climatic factors on tree-ring formation of *Platanus x hispanica*. Signature years were used for dendroclimatic analysis and response function. For every signature year a response function analysis of meteorological conditions of the current growth season and the end of the previous vegetation season, was made on the basis of average monthly temperatures and total monthly rainfall. In the response function analysis the influence of climatic factors on tree-ring patterns was examined for 16-month intervals (from June of the previous year to September of the analyzed year).

Local chronology for the species *Platanus x hispanica* is based on 15 dendrograms, representing the period 1932 – 2003. For the local chronology of *Platanus x hispanica* 15 signature years (8 positive and 7 negative) were determined. Negative signature years

occurred in years with cold March and May. Also the average temperature of the year has importance (cold year marked minima in dendrograms). Positive signature years are generally connected with warm winter months and high temperature in spring (March and May). Pluvial conditions of the vegetation season were of lower importance; only in 1960 a noted negative signature year was connected with high precipitation in spring and summer (the highest total rainfall in the period 1948 – 2003). Results of response function are similar to signature years analysis. High value of determination ($r^2 = 54\%$) point out significant relationships between weather conditions and formation of growth rings at the species *Platanus x hispanica*. Formation of annual growth rings is mostly depended on temperatures of March and May (positive correlations and regression).

Cedro, Anna
Institute of Marine Science, University of Szczecin, Poland

[L] Dendroclimatic interpretation of tree-ring width of *Taxus baccata* L. from north part of Poland

The objective of this study is to present the results of dendroclimatic analysis on *Taxus baccata* L., yew, from north part of Poland. Yew was once a common and typical component of Polish forests, occurring in undergrowth of deciduous and mixed forests, but due to high value of its timber it has been almost completely eradicated. Actually, since 1934 *Taxus baccata* L. is a protected species in the whole area of Poland.

Altogether 5 research plots were established; core samples were taken from 150 trees. The Natural Reserve “Old Poland Yews” (Cisy Staropolskie) is located in the Tuchola Forest. Here 3559 old yews are recognized as the oldest trees of this species. Reserve “Old Poland Yews” is ranked to be the

oldest and the biggest protected area with yews plots in Europe.

In Western Pomerania this tree species occur in a few sites, among others in Natural Reserves: Rokita Yews, Spas, Tychowo Yews, and Boleszkowice Yews.

The sampling was carried out with Pressler increment borers, measurements of tree-ring widths with 0,01 mm accuracy. Statistical treatment and graphical presentation of data (tree-ring mean width, standard deviation, mean sensitivity, autocorrelation, correlation - r, test - t, Gleichläufigkeit - GI) were made with the computer programs: TREE-RINGS, DendroGraph, and DPL.

Analyses of signature years were performed with the program TCS for local chronologies from all the analysed sites and for regional chronology as well. The signature years were determined from minimum 10 trees, at the minimum convergence threshold of 90%. Statistical analysis of influence of climatic factors on growth of trees was made on indexed averages in order to eliminate other than climatic signals (age trend and autocorrelation); in the program ARSTAN, the measured chronologies were replaced by the residual ones (RES).

In the response function analysis the influence of climatic factors on tree-ring patterns was examined for 16-month intervals (from June of the previous year to September of the analysed year) in the period of 51 years (1948-1998).

Positive signature years are generally connected with abundant precipitation in summer months (June and July). Low temperatures in winter months (January and February) and summer drought resulted in formation of narrower growth rings in the subsequent vegetation season.

Results of response function analysis confirm relationship between climatic factors and tree-ring width obtained from analysis of the signature years. The coefficients of linear correlation and multiple regressions indicate that radial growths were mostly influenced by rainfall in June and July. Apart from drought in summer, the growth of yews may be limited by cold winter.

Chojnacka-Ożga, Longina
Department of Silviculture, Warsaw Agricultural University, Poland

[P] The influence of air temperature and precipitation on the radial increment of beech (*Fagus sylvatica*) in Northern Poland

The paper presents the results of dendroclimatological analyses of beech (*Fagus sylvatica*) in northern Poland. The material has been taken from six locations and represents approximately 500 trees. Research sites were located in fresh deciduous forest and in fresh mixed deciduous forest.

The results of statistical dendroclimatological analyses (using the response function and convergence method) indicate that the radial growth was determined by the thermal and pluvial conditions. This influence was similar in all examined stands. The warm and wet winter (especially February) as well as precipitation above average during the growing season were found to favorably effect the radial growth of beeches growing in this part of Poland. Thermal and pluvial conditions connected with a long-term occurrence of continental air masses, mainly cold and dry February and dry and hot June had negative effect on the radial increment of beech. The influence of thermal and pluvial conditions in the summer and autumn of the previous year was also significant. Dry and hot summer and cold and dry autumn (especially October) had a negative effect.

The results of the study proved that the long-term occurrence of oceanic air masses was found to favourably affect the radial growth of beeches growing in northern Poland. Weather conditions in October of the previous year, as well as in February and June of the year the ring had been formed were significant. Weather effect was similar for all age sub-classes in all stands under study. The main factor affecting radial increment of beech was precipitation, both before and during the growing season.

Christensen, Kjeld
WM-Trædateringslaboratoriet, Højbjerg Denmark

[L] Dendrochronological dating of Bronze Age oak coffins from Denmark and Schleswig-Holstein

In the Early Bronze Age, c. 1700 – 1000 BC, funeral ritual in Northern Germany and Southern Scandinavia called for the burial of the dead in coffins of hollowed-out oak trunks. In Denmark alone, around 40.000 burial mounds from the Early Bronze Age are known, but in the vast majority of the investigated mounds, the organic material had decayed totally within a short time after its interment. Occasionally, however, special natural and chemical conditions in the mound ensured the survival of the oak coffin and its content to the present day. These oak coffins, over 3000 years old, are among the most notable finds from the Nordic Bronze Age. In the most famous mounds, the coffins contained not only the dead persons their everyday clothes but also a lot of grave gifts as weapon, jewellery, wooden bowls and furniture. The majority of the well-preserved coffins are found in a rather limited area in Northern Schleswig-Holstein (D) and Southern Jutland (DK). When dendrochronology was firmly established in Northern Europe in the end of the 1960'ies, not at least due to the work of professor Dieter Eckstein, a co-operative effort between German and Danish museums was started to date the Bronze Age oak coffins. The archaeologist, prof. Hermann Schwabedissen in Köln, initiated the project and Dieter Eckstein (Hamburg) and Burghart Schmidt (Köln) worked out the dendrochronological analysis. Since 1990, the present author has continued the work.

A total of 28 coffins from Schleswig-Holstein and Denmark – all the coffins found in the museums today - have been investigated; 25 of the coffins have been dated. For 8 coffins with preserved bark-ring, the precise felling-year of the tree has been determined; for 11 coffins, where the

sapwood is partly preserved (3 coffins) or the youngest preserved tree-ring is assumed to be near the sapwood border (8 coffins), the felling year has been determined to within a short period. For the remaining 6 coffins, only a *terminus post quem* dating has been obtained.

The dendrochronological dating show that the oldest coffin was buried c. 1400 BC or shortly thereafter, while the youngest – whose year of felling is unfortunately rather uncertain – probably date from 1300 - 1250 BC. Thus it appears, that all the dated coffins were buried within a span of only 150 years. Even more surprising is the fact, that the trees used for most of the coffins - 22 of 25 dated coffins – were certainly or probably felled between 1410 and 1360 BC, i.e. within a period of only 50 years, though the custom of burying the dead in oak coffins prevailed in a period of about 700 years.

Crone¹, Anne, Ian Tyers², Orla Hylleberg Eriksen³ and Didier Pousset⁴

¹*AOC Archaeology Group, Scotland*

²*Dendrochronology Laboratory, Archaeology Graduate School, University of Sheffield, England*

³*Environmental Archaeology, National Museum of Denmark, Copenhagen, Denmark*

⁴*Dendrochronology Consulting Sheffield, England*

[P] A tale of three tuns

Since the Roman period when coopered barrels were first manufactured they have been used to transport all manner of goods around Europe. They often ended their lives as linings for wells and are a relatively common feature of many urban Roman and medieval excavations. As most barrels will have had a long life before their final re-use in the well the archaeological value of a tree-ring date from the staves is lessened, and it is further reduced as the sapwood will usually have been trimmed from the stave. The value of tree-ring dating barrels lies more in the evidence they can provide for trading networks than in the *termini post quem* dates

they can provide for the construction of the well.

Tree-ring analysis of 3 oak barrels, all re-used as well-linings, from Denmark, England and Scotland has provided material evidence of trading connections during a period for which there is little documentary evidence.

Analysis of 8 staves from the barrel found during excavations in the HIGH ST. PERTH, SCOTLAND produced a 158-year chronology dated AD 964 – 1121.

Analysis of 6 staves from a barrel found during excavations at the GUILDHALL, LONDON, ENGLAND produced a 131-year chronology dated AD 998 – 1128.

Analysis of 9 staves from the barrel found during excavations at PRAESTEGADE 13, RIBE, DENMARK produced a 187-year chronology dated AD 963 – 1147.

All 3 barrel chronologies display highly significant correlations with each other indicating that they probably originated in the same region. Comparison with other European chronologies has identified this region as north-eastern France, probably Burgundy. One of the staves in the Ribe barrel had retained a few rings of sapwood allowing us to calculate a felling range of AD 1151 – 1179. The barrels were probably manufactured in the latter half of the 12th century.

It seems most likely that the barrels carried wine. Although wine was produced throughout Europe by the early Middle Ages the commercial production of wine had become concentrated in a handful of regions, Poitou, Gascony, the Rhineland and Burgundy. This period saw a rapid expansion of economic activity across Europe and the barrels were a reflection of that activity. They were all found in towns, which were major trading ports during the medieval period.

The purpose of this poster is to alert fellow dendrochronologists to this group of early barrel chronologies and elicit information about similar chronologies, if they exist.

[P] Poster [L] Lecture

Čufar, Katarina, Martin Zupančič, Jožica Gričar and Martín de Luis Arrillaga
Department of Wood Science and Technology
University of Ljubljana, Slovenia

[L] Oak and beech local chronologies in Slovenia - some new results on teleconnection and heteroconnection

In some parts of Slovenia historic constructions are often made of oak (*Quercus robur* L., pedunculate oak, or *Q. petraea* Liebl., sessile oak) or beech (*Fagus sylvatica*) wood. Due to lack of adequate reference chronologies it is still difficult to dendrochronologically date them. After one decade of research at the Department of Wood Science and Technology we only have several up to 150 years long local chronologies of oak. They are based on living trees because we have not managed to prolong them with chronologies from 'historic wood'. Among the main obstacles for development of a longer regional oak chronology is the absence of old trees, great variability of tree ring patterns among trees from the same site and poor teleconnection. The beech has until recently not been sufficiently investigated, nor have we explored the possibilities to heteroconnect oak with beech. In the recent period we have taken more samples of oak and beech wood and constructed new chronologies for localities where dendrochronological dating is a problem. The objective of our presentation is to show the main results related to new chronologies. The preliminary results indicate that there exists greater similarity among tree-ring chronologies of beech from different locations than among oak chronologies. It seems to be possible to teleconnect beech chronologies from Slovenia with those of neighbouring countries. In some cases it is possible to heteroconnect beech and oak chronologies from different locations in our region. We also found out that it might be possible to teleconnect oak chronologies from some locations in Slovenia with oak chronologies from some distant sites. We present how the quality of chronologies affects statistical

parameters of matching. These results give hope for future progress in constructing regional oak and beech chronologies and for increased likelihood and quality of dendrochronological dating in the region.

Daly, Aoife
Institute of History and Civilization, University of Southern Denmark, Denmark

[L] Towards a new dendrochronological tool for the determination of the provenance of ancient oak objects

More than 30 years of dendrochronology in Northern Europe means that an enormous amount of ancient oak timber has been analysed and dated. This tree-ring data has been assembled into large regional "master chronologies" for dating additional oak timber, and has proved useful in the determination of the region of origin of mobile oak objects, objects like for example ancient shipwrecks and ancient barrels. These large regional master chronologies have been built for dating purposes, while timber from buildings or archaeological sites, which have been included in the chronologies, can have grown outside of the region, which the chronology represents. I am currently carrying out a Ph.D. study entitled "Timber and Traffic: Maritime trade in the Viking and medieval periods. A dendrochronological analysis of oak, with a view to documenting and describing trade of timber and wooden objects." For this research I am analysing tree-ring data from Northern Europe to build a better tool for the determination of the provenance of oak objects. For my paper here I will outline the methodology for the analysis and describe some of the problems that need to be considered. Particularly the problem of using building timber from historical buildings as the geographically fixed reference for determination of provenance of moveable oak objects, when that building timber has its own history; a history which might in some instances have included the transport

of oak, some distance from the place the oaks grew.

I will illustrate the types of results, which I can already present, showing connections that emerge from the analysis of barrels and showing how the development of certain medieval shipbuilding technology/tradition can have spread from a particular geographical region.

Deslauriers, Annie, Tommaso Anfodillo and Vinicio Carraro
Dipartimento Territorio e Sistemi Agro-Forestali, Università degli Studi di Padova, Italy

[P] Dynamics of radial growth and climatic response of *Picea abies*, *Larix decidua* and *Pinus cembra* from dendrometer analysis at the alpine treeline (Italy)

Daily stem radial growth of *Picea abies* (L.) Karst., *Larix decidua* Mill. and *Pinus cembra* L. was studied between 1996 and 2003 at the alpine treeline (Italy), using automated bands dendrometers to investigate meteorological influence. Dendrometers have the advantage of providing continuous time-series of stem growth reflecting mostly cell enlargement of the xylem and the phloem. Growth extractions were performed by dividing the diurnal growth pattern into three phases of (1) contraction, (2) expansion and (3) stem radius increment (SRI). The entire cycle (4) was considered as a fourth phase. For each year, similarities in SRI variations were observed between each trees and species. The mean weather conditions of each phase were compared with the SRI using response function analysis. For each year, results were more or less similar for all species. From 1996 to 2003, sap flow and relative humidity during the expansion and SRI phases had a positive impact on stem radius increment while vapour pressure deficit had a negative one. These results showed the importance of low VPD and sap flow during the night, increasing the possibility water absorption and radial growth. Other factors like air and

soil temperature showed weak positive responses despite their importance on cell enlargement at night. Although substantial differences between radial growths of various years, the trees response to daily weather changed slightly.

Dyakonov, Kirill, and Andrei Beliaikov
Department of Geography, Moscow State University, Russian Federation

[L] Dendroindication of zones of influence of hydro-technical systems on the landscapes of adjoining territories

Hydro-technical systems such as reservoirs of hydroelectric power stations, drainage reclamation and draining-moistening systems are facilities that include technological objects, artificially constructed natural sub-systems and natural landscapes of river basin. The systems of this kind are controlled and include units of monitoring and management. On the other side they significantly influence (usually negatively) on the landscapes of adjoining territories. For example the total square of flooded shores of large and middle reservoirs in Russia is nearly 1.3 millions of hectares. The climatic influence zone is much wider but reservoirs affect only the local climate.

The geographical aspect of studying the influence of this kind includes the determination of its area and the division of trends caused by this influence and of natural landscape dynamics and functioning. We applied dendrochronological method to solve these problems studying the influence of Rybinskoye, Ivankovskoye, Bratskoye, Kamskoye, Novosibirskoye, Sheksninskoye reservoirs located in forest and forest-steppe zones and drainage reclamation system located in Meschera lowland (all sites are in Russia).

The 2-3 km length transects were laid in typical coastal landscapes athwart to shore (or to border of drained territory). The lines of transects were levelled and detailed

[P] Poster [L] Lecture

geographical description of their territories was made. This description also included studying of the depths of water table (up to 3 m). Cores and stem-disks were sampled in the most representative sites (> 12 samples per site). The method of spatial-temporal correlations of increments was implemented. The current increments (5-year means) in zone of estimated flooding (drainage) were compared with increments out of this zone. Only the sites with the same forest type and age of trees (usually not less than 60 years) were compared. The mean periodical increments before and after creation of reservoir or drainage system were also compared.

The width of zones of flooding and of influence at all varies in different regions because of the differences in their geological and geomorphological conditions, geometrical forms and total squares of affecting objects. However the dependence of annual increment on annual water level regime was detected at all research areas. It's influence on the adjoining landscapes decreases while the distance growing. Studying of zone of negative influence of local drainage system showed the difference in reaction of different species on draining process: the width of a belt of growth reduction of *Pinus sylvestris* L. exceeded 170 m from the border of the system while the zone of negative reaction of *Picea abies* L. (Karst) was nearly 120 m.

Finally the principles of spatial-temporal organization of zones of hydrogeological and climatic influence were stated. These practical and theoretical results are being widely used during the evaluation of possible influence at planning and projection stages of new hydro-technical systems construction.

Eggertsson¹, Ólafur, and Hjalti Gudmundsson²

¹*Icelandic Forest Research, Reykjavik, Iceland*

²*Office for the Environment, The City of Reykjavik, Iceland*

[P] Tree-ring study on Holocene forest remains unveiling a major Jokulhlaup in South Iceland

The Mýrdalsjökull ice cap overlies the highly active Katla central volcano in South Iceland. Large-scale flooding (Jokulhlaup) are associated with the volcanic eruptions of Katla as great amounts of ice is melted. The melt-water formed is drained via the various outlets of the ice cap depending on the subglacier topography and location of the volcanic activity within the caldera. The main flood paths of the Jokulhlaup during historical times (last c.a.1000 years) have been to the south and east forming the Mýrdalssandur outwash plain. The last eruption occurred in 1918 and the next Katla eruption is now overdue according to historical eruption rates and seismic observations.

Previous investigations have identified at least four main sedimentary units that are associated with prehistoric flood activity in the critical north western sector of the ice cap. These findings are important because they indicate that west of the ice-cap has been an active Jokulhlaup route with associated hazard implications.

Forest remains have recently been unveiled on an outwashed plane 35 km west of the ice cap. The place is named Drumbabót and is characterized by hundreds of logs sticking 20-60 cm up from a sandur plane. The area is estimated to be 100 hectares. All the investigated logs were *Betula pubescens* and most of them are inclined towards southwest. The average diameter of the logs is 18 cm and the thickest ones more than 30 cm.

The sub-fossil trees are “*in situ*” with their root system sitting in a 40-70 cm thick sandy peat soil. Disks from the logs were sampled for tree-ring studies. The average number of tree rings in the logs was between 70-100

years. The tree ring pattern of the different logs could be cross-dated giving the same "felling date" for all logs, signifying that the trees were killed simultaneously (during the same event). The outermost ring was fully formed, indicating that the trees were killed during wintertime.

Because most of the logs are inclined towards southwest and all the logs were killed during the same event it can be assumed that this old forest was destroyed during a Jökulhlaup event from the Mýrdalsjökull icecap probably because of a volcanic eruption in the Katla central volcano. This must have been a catastrophic event because the forest remains are situated 35 km from the nearest outlet glacier of Mýrdalsjökull. The forest was probably killed during the last major Jökulhlaup that went over this region, which had its source in the north-western part of the Myrdalsjökull ice cap. It can be estimated that the flooded area of this Jökulhlaup was 600 km².

Samples from the logs were sent to a high-precision 14C wiggle-match dating. A preliminary result gives the age 1400 BP, calibrated to c. AD 600, or 200 years before Iceland was colonized.

**Eilmann², Britta, Pascale Weber¹,
Andreas Rigling¹ and Dieter Eckstein²**
*¹Swiss Federal Institute for Forest, Snow and
Landscape Research - WSL, Birmensdorf,
Switzerland*

*²Institute of Wood Biology, University of Hamburg
Germany*

**[P] The influence of drought on the
wood structure of *Pinus sylvestris* L.
and *Quercus pubescens* Willd. in
Valais, Switzerland**

In Valais, an inner-Alpine dry valley in Switzerland, the lower Scots pine (*Pinus sylvestris* L.) forests are in change. While pine shows high mortality rates, deciduous species, in particular downy oak (*Quercus pubescens* Willd.), are spreading. Increasing drought is one potential factor for the pine

mortality, besides land-use change, insect pests, pathogens and natural succession. To study the growth reactions of pine and oak to drought on extreme dry sites, earlywood, latewood and ring-width chronologies of 26 oaks and 22 pines were built. These dendrochronological investigations showed a decrease in the mean ring width of both species, oak and pine, in dry years. Oaks displayed a higher mean sensitivity and a lower autocorrelation than pine. The correlation between mean ring width and an annual drought index were higher for oak than for pine.

In the period 1970-1985 the drought years of 1972, 1974 and 1976 were additionally analysed using wood anatomical methods. For oak the lumen areas of earlywood and latewood vessels were measured. In dry years mean vessel-lumina area decreased in earlywood and increased in latewood. The increase of mean vessel-lumina area in latewood is a result of a lower number of small vessels due to reduced latewood width. The frequency distribution of latewood vessels did not vary between dry and mesic years - the number of vessels increase in mesic years but the fragmentation in the groups does not vary. The frequency distribution of dry and moderate years in the Valais is equivalent to the frequency distribution in very dry years on mesic sites. For pine the anatomical measurements were focussed on the radial diameter and the number of tracheids. The number of tracheids decreased with increasing drought. Surprisingly the radial tracheid diameter did not show a uniform reaction to dry years, which stays in contrast to literature (e.g. PARK 2000 *Schr.reihe Freibg forst. Forsch.*) and is not yet understood in detail.

While the results of the dendrochronological investigations are according to expectations, both species show different reactions to drought on the wood anatomical level than described in other studies. This is probably due to the extreme dry conditions whereby the growth rate is strongly reduced. The climatically caused reduced wood production can additionally affect the formation of cells. Accordingly the cell size is not only directly

[P] Poster [L] Lecture

(e.g. by water availability) but also indirectly (e.g. by reduced cell division) affected by dry climatic conditions.

What we learn from this study is, that the process of wood formation and cell functionality on dry sites is not yet completely understood. Therefore the influence of climate warming on tree growth and tree survival on extreme dry sites is not predictable.

Eißing, Thomas

*Institut für Archäologie, Bauforschung
Denkmalpflege, Universität Bamberg Germany*

[P] Timber rafting and the interpretation of dendrochronologically dated roof constructions and frameworks in Thuringia and the southern part of Saxony-Anhalt

Historic building timber was mostly used immediately after a tree was felled. This fact is proved for many historic buildings by written sources. On the other hand the rafting and trading of timber shows, that timber wasn't used immediately after felling. More than 30% of the 140 investigated historic roof constructions and the frameworks in Thuringia and the southern Saxony-Anhalt were built with rafted timber. In most cases the dated last annual ring range between 2 and 4 years for one building unit. For 5% of the building units the difference varies between 6 and 12 years. This fact is important for the interpretation of dendrochronologically dated timber constructions. The poster shows how to recognize rafted timber, how to select the sample cores and to discuss the consequences of rafting for the building of master chronologies in the middle and southern part of Germany.

Elferts, Didzis

Faculty of Biology, University of Latvia, Riga, Latvia

[L] Relationship between North Atlantic Oscillation Index and radial growth of Scots pine (*Pinus sylvestris* L.) near Kolka horn in Latvia

Climatic conditions change during time and they can influence the growth and distribution of trees. There is a need for more information about the influence of climatic factors on tree growth (Scots pine). There are some common features in climate across large areas, for example, North Atlantic Oscillation (NAO) that influences climate in North Atlantic hemisphere. The aim of this study is to determine relationship between North Atlantic Oscillation index and radial growth of Scots pine in Latvia. Samples of tree-rings from pines were taken in six sampling-sites near Kolka horn in north-western Latvia. Tree-ring series were dated; from the dated tree-ring series seven chronologies were made: six for sampling-sites and one common chronology. Correlation analysis and multiple regression analysis were performed between tree-ring series, climatic factors and NAO indexes. Separate analysis was made for 50 years periods.

Analyses show that there is statistically significant correlation between NAO monthly indexes and average monthly temperature in Latvia (for period 1925-2000), except May, July and August. Correlation analysis shows that winter NAO have the most statistically import impact on the growth of pine in Kolka horn but summer NAO indexes have no statistically import correlation with chronologies. There are differences in significant NAO indexes in different time periods.

According to multiple regression analyses North Atlantic Oscillations explains only small part of variations of pine radial growth and there are some time periods when NAO does not explain radial growth at all. NAO explains less variation in tree growth when

relationship is studied for long time period compared to shorter time periods. Conclusion is that there is a relationship between North Atlantic Oscillations and radial growth of pines in Latvia but this relationship is not as strong as the relationship between temperature and growth. NAO index could be used as an estimate of temperatures for time periods when temperatures data are not available.

Elling, Wolfram

*Department of Forest Science and Forestry,
Weihenstephan University of Applied Sciences,
Freising Germany*

[L] Damage, decline and recovery of Silver fir

It is widely recognized that the damage and decline of Silver fir (*Abies alba* Mill.), observed on wide areas since the second half of the 19th century, is a consequence of the complex interaction of different partial causes. Frequently, however, confirmed or only assumed partial causes were named without consideration of its complex interaction in a linked-up system. Extensive dendroecological investigations at our department increased knowledge and understanding in this context. It was shown by tree-ring analyses that sulphur emissions play an important role in the complex system of damage and decline of Silver fir (Elling 1993, Ellenberg 1996).

If tree-ring sequences of stronger damaged, dominant fir trees are investigated, a more or less high number of missing rings can be detected during the 1960s until the 1980s in highly SO₂ polluted regions of Southern Germany (Eckstein et al. 1983). By contrast sites in the Bavarian Alps are not (or only less) affected by SO₂ emissions, no (or only a few) missing rings occur in this time span. A high significant correlation was found between the local SO₂ load and the percentage of trees affected by missing rings (Elling 1993). Local studies confirmed that

this has to be seen not only as statistical but causal relationship (Elling 2001).

The law for the reduction of S emissions of power plants, passed in 1983, caused a strong decrease of SO₂ pollution until 1988. Additionally effective for Bavaria was the stop of extraction of charcoal with high S-content used until the 1970s and 1980s for single power stations. During the 1980s radial growth of Silver fir recovered after a long lasting and during the last 500 years unique growth depression (Wilson and Elling 2003). This recovery is especially pronounced in the influence sphere of local emission sources (Elling 2001). In order to understand the regional and temporal patterns of damage and decline, in interaction with SO₂, however, other important influences on vitality and growth of Silver fir have to be considered.

Especially the effects of extreme winter frost and drought as well as an increased sensitivity against these or other natural influences must be taken into account, included and carefully evaluated in dendroecological investigations; for example by regional and temporal comparisons. Examples show that with respect to responses to different natural influences unpolluted and SO₂ affected fir trees react like two different tree species.

After the decreased SO₂ pollution in the 1980s an ambiguous development of fir condition in Southern Germany can be observed. Depending on the degree of damage and its consequences (e.g. the amount of root destructions) trees recover, continue declining or decline after a temporary recovery. However the clear and convincing recovery of Silver fir at many sites is an encouraging signal. With view at future risks in connection with climate change, for example, this tree species is given an important role for stable and sustainable forests. In conclusion, the demonstrated relations allow a more optimistic than pessimistic conclusion for the future use of Silver fir in our forestry.

[P] Poster [L] Lecture

Fonti^{1,2}, Patrick, Andreas Rigling³, Gregory Biging² and Paolo Cherubini³
¹Swiss Federal Institute for Forest, Snow and Landscape Research - WSL, Sottostazione Sud delle Alpi, Switzerland.

²Dept. of Environmental Science, Policy and Management, University of California, USA

³Swiss Federal Institute for Forest, Snow and Landscape Research - WSL, Birmensdorf, Switzerland

[P] Stand dynamics and competition processes in abandoned chestnut coppices in Southern Switzerland

Chestnut (*Castanea sativa* Mill.) forest ecosystems are one of the most important landscape characteristics in the Mediterranean mountain regions and the Alps. Widely propagated and intensively managed since ancient times as an important source of both food and wood, chestnut forests became neglected after the Second World War when socio-economic changes caused declining interest in forestry.

Regularly short rotation coppices (< 20 years) were abandoned and for the first time they were left to evolve naturally.

In order to meet management demands, it is of vital importance to improve the understanding of stand dynamics in these stands. How do chestnut coppice forests react to abandonment? Which competition processes take place in such a dynamic and dense stands? How rapidly are these processes occurring? Are some patterns recognisable? Which succession trajectories are being delineated?

Here, we propose that tree rings can be used as indicators of past competition processes within the stands, and therefore may help in understanding how these stands may develop in the future.

Difference in “competitive power” among species has been analysed by comparing how the growth and mortality of chestnut, beech (*Fagus sylvatica*) and oak (*Quercus cerris*) have been differently affected in the immediate neighbourhood surrounding individual trees. Analyses were carried out on selected target trees embedded in a 60-year-old abandoned

chestnut coppice from the Southern Switzerland. All living and dead trees within 7.5 m radius from the target tree have been mapped and tree ring width measured. Analyses were performed by taking into account changes in time and space. Results show that in the early stages individual chestnut tree growths rates, with regard to neighbouring trees, were higher in comparison with those of beech and oak. However about 25 years after the coppicing a shift in competitive power occurred: the growth ratio between chestnut and its neighbours remained steady whereas it increased in oak and beech. By projecting these trajectories into the future we can put forward the hypothesis that, whereas abandoned chestnut coppices grow close to competitors as oak and beech, chestnut will be outcompeted and a new succession will be initiated.

Francuz, John
 Aussenstelle Unterwasserarchäologie,
 Archäologischer Dienst des Kantons Bern,
 Switzerland

[P] Dendrochronological studies of sub-fossil wood from submerged Neolithic and Bronze Age pile-dwellings at Lake Biemme, Switzerland: an overview of datings and chronologies

Since 1984, underwater archaeological explorations of endangered prehistoric settlements around lake Biemme (Bielersee) and the dendrochronological studies of their well-preserved posts have revealed many interesting and elucidating results. During the last 20 years over 40 000 sq. metres of lake bed have been excavated and over 28.000 sub-fossilised wooden posts of mixed species have been documented and sampled from these lake-side dwellings dated between 3840 and 850 BC. From the documented posts oak, ash, silver fir (*Quercus*, *Fraxinus*, *Abies*) and some hazel (*Corylus*) were selected for

dendrochronology. This has amounted to more than 13.000 samples that have been studied at the on-site Tree Ring laboratory located at Sutz-Lattrigen. Fortunately for the dendrochronologist over 50% of the rescued timbers are of oak wood (*Quercus*) and a further ca.15% of ash and silver fir. Most dated timbers are from the Stone Age period. The first (known) settlement at the Bielersee was built from trees cut at 3838 BC whilst the youngest of the lakeside villages from this epoch is dated to 2626 BC. Early Bronze Age villages also existed between 1763 BC and 1572 BC, and the youngest of the settlements discovered in this lake are of the Late Bronze Age period falling between 961 BC and 850 BC. As an example, one of the most unique and satisfying results came from 858 *Quercus* and 11 *Abies* posts measured from the submerged excavation site of Lattrigen-Riedstation. Here the exact building history, year by year, of a complete two-rowed village consisting of 19 houses could be reconstructed. This ancient lakeside village covered an area of approximately 6000 sq. metres. The first two-pioneer houses were built in the spring of 3393 BC, a year later in 3392 BC another building was added. In 3391 BC came seven more. The last major group of eight buildings were constructed at 3390 BC. To round off, a further house was erected in the winter of 3389 BC. However, dendro-datings indicate that within a few years the site was abandoned, most likely because of lake-level increases that eventually flooded the village. As to the chronologies, the replication of the number of samples within chronologies varies. Some excavation areas have over 200 individual wood sample measurements integrated into their chronological-sequences, others have less than 10. Generally, the average site-chronology has a replication of around 50 samples. Experience has shown that after about 30 samples have been averaged together and integrated into a site-chronology little changes occur in the ring-width patterns even when further samples are integrated, so more samples does not necessarily mean better defined ring-width patterns. Only

samples reaching a certain criteria of reliability are used for site-chronologies. There are 36 individual absolutely dated site-chronologies from Bielersee excavations (27 oak, 5 ash, 3 silver fir and 1 hazel) as also many mean-curve groups that are as yet still floating, i.e. undated.

From the oak series, representative individual excavation site-chronologies have been averaged together to form five main local-chronologies (A-E below). Hopefully the gaps of 18 and 42 years between chronologies A & B, and B & C respectively will soon be closed, thus forming a single Bielersee oak local-chronology of 1386 years extending from 4011 BC - 2626 BC.

A-	4011 - 3770 BC	242 rings	Stone Age
B-	3752 - 3532 BC	221 rings	Stone Age
C-	3488 - 2626 BC	868 rings	Stone Age
D-	1800 - 1578 BC	216 rings	Bronze Age
E-	1051 - 856 BC	196 rings	Bronze Age

García González¹, Ignacio, Antonio Martínez Cortizas² and Elvira Díaz Vizcaíno¹

¹*Departamento de Botánica, Escola Politécnica Superior (Lugo), Univ. de Santiago de Compostela*

²*Departamento de Edafología e Química Agrícola, Facultade de Bioloxía, Univ. de Santiago de Compostela, Spain*

[L] Climatic response of the earlywood width of oak (*Quercus robur* L.) in the North-Western Iberian Peninsula

A dendrochronological analysis of fourteen oak chronologies has been carried out in North-western Spain, using separate measurements of earlywood and latewood width. Earlywood width series showed a much lower common signal and year-to-year variability than latewood width, but this signal was in most cases still acceptable for further dendroecological analyses, so that these series were used to establish their response to climate.

[P] Poster [L] Lecture

When response functions were computed using both previous latewood width and climate, most of the variance was explained by the prior growth variable, indicating a strong dependence of earlywood on previous growth. Climate-growth relationships for the earlywood chronologies were therefore established using residuals from a regression on previous latewood. The analysis of residual series mostly showed a significant negative response to temperature at the end of the previous growing season, mainly during September. This indicates that a high temperature could be increasing the respiration rate that causes the degradation of stored carbohydrates, making them unavailable for the formation of new earlywood vessels at the beginning of the following growing season. In some cases, a weaker response to conditions at the moment of vessel growth was also observed.

Gärtner, Holger, and Otto Ulrich Bräker
*Swiss Federal Institute for Forest, Snow and
Landscape Research – WSL, Birmensdorf,
Switzerland*

**[L] 3D-Laserscanning as a tool for
estimating root biomass and tree
stability**

In recent years multifaceted modeling approaches have been developed to estimate the role of root systems in the CO₂ budget of Swiss forests. These models are based on a rather small amount of existing data to assess the root spread of different tree species. More recently new models were developed to estimate root biomass. Nevertheless the obtained results still show a wide range in the percentage of root biomass related to above ground biomass. This wide range also applies to existing conversion factors that include root biomass estimations into the computation of total biomass. Comparable problems exist concerning the analysis of tree stability. Whereas the dimensions of the above ground parts of a

tree are more or less easy to determine, the measurement of root dimensions and especially their spread are rather difficult. The new approach presented here, aims on investigating exposed root systems of wind thrown trees (European beech and Norway spruce) using a 3D-Laserscanning system. In contrast to common approaches like measuring length and diameter of single roots or digitizing their length and bifurcations using magnetic fields, a laser system enables the accurate representation of a whole root system in a scatter-plot showing a resolution of 0.5 mm. The scatter-plot data is then compiled into a digital 3D-model of the root system. This model allows the determination of the length, number of bifurcations or the volume of single roots as well as the volume of the whole root system. The time needed to acquire the data needed for the model lies in the range of several hours. Consequently, data sampling for tree-ring analysis can start immediately after the scanning procedure. All samples taken from the root system can be tagged within the scatter-plot and transferred to the 3D-model thereafter.

The same procedure can be used to analyze the dimension of stem and branches of the respective tree. The detailed representation of whole tree dimensions using a 3D-Laserscanner opens new perspectives in analyzing growth of root and stem regarding research on biomass distribution as well as on tree stability.

Gebrekirstos¹, Aster, Martin Worbes² and Ralph Mitlöhner¹

¹*Institute of Silviculture, Sect.II: Tropical Silviculture, Georg-August University of Göttingen, Germany*

²*Institute for Agronomy in the Tropics, Georg-August University of Göttingen, Germany*

[P] Climate and growth relationship of *Balanites aegyptiaca* and *Acacia senegal* from semi arid savannah woodlands in Ethiopia

The presence of growth boundaries and the relationship between tree ring patterns and precipitation data of two tree species were investigated in the Acacia Woodland of the upper Rift valley Lakes region in the central Lowlands of Ethiopia. The evergreen *Balanites aegyptiaca* (Balanitaceae), and deciduous *Acacia senegal* (Fabaceae) are economically important species found all over Africa in arid, semi arid and sub humid savannah.

Samples were taken from 10 trees at 1.3m height using standard increment borers. Six stem discs from fallen trees of known cutting age were taken for each species as well. All samples were sanded to increase the visibility of the growth zones. The wood anatomical structure was examined macroscopically for presence of growth zones and ring boundaries. Ring width was measured to the nearest 0.01mm. The trees were dated optically by ring counting and then a mean chronology was built to correlate tree ring patterns with rainfall data. The pointer years were used to verify the formation of periodical rings.

The result shows that both species form annual growth boundary. Tree rings in *Balanites aegyptiaca* are separated by vessels surrounded a thin parenchyma band and the growth boundary of *Acacia senegal* is characterized by thin parenchyma bands. The annual growth rhythm was correlated to precipitation patterns, and therefore, it seems to be one growth period per year (annual rings), paving the way for using tree ring measurements in understanding the growth dynamics of savanna woodlands.

Grabner, Michael, and Rupert Wimmer
Department of Material Sciences and Process Engineering BOKU - University of Natural Resources and Applied Life Sciences, Vienna, Austria

[L] How heartwood extractives in larch influence densitometric analysis

Wood density is a prominent parameter in dendroclimatology as well as in wood quality and it correlates with a number of various wood properties, i.e. mechanical strength, workability or swelling and shrinking. The most common method to determine density profile across tree rings is the determination through x-ray densitometry. With x-ray densitometry care needs to be taken relative to sample orientation, moisture content or thickness tolerances. In addition, altering chemical composition and the existence of non-structural substances in wood, such as resin, lignans or extractives, are influencing densitometric results.

In this work we focused on larch, which is known for its high content of extractives in the heartwood, with the dominating component of extracellular arabinogalactan found abundantly in the cell lumens. Extractive contents and wood density was determined on samples from 100 European larch and hybrid larch trees (*L. decidua* Mill., *L. decidua x L. kaempferi*). Total amount of extractives in heartwood varied between 5 and 30 % of dry mass. We have found that extractive content went hand in hand with wood density, which means that wood density determined through x-ray absorption dropped significantly at the heartwood-sapwood boundary. However, this drop disappeared after extraction with acetone and hot-water. A strong relationship was found between hot water extractives and the density reduction caused by extraction. As arabinogalactan is primarily located in the earlywood the effect of extractives on wood density was higher in earlywood than in latewood.

Arabinogalactan in larch heartwood has effects on wood quality, one aspect being the shift in wood density due to high

[P] Poster [L] Lecture

extractive contents. Our finding was that especially with larch a careful hot-water extraction is needed prior x-ray densitometry in order to obtain reliable density data.

Gričar, Jožica, Primož Oven, Martin Zupančič and Katarina Čufar
Biotechnical Faculty, Department of Wood Science and Technology, University of Ljubljana, Slovenia

[L] Seasonal dynamics of annual xylem growth ring formation in Silver fir (*Abies alba*)

The dynamics of the current annual xylem growth ring formation in silver fir (*Abies alba*) was studied during one growing season. Blocks of intact tissue, i.e. phloem, cambium and outer xylem, were taken weekly from two apparently healthy silver fir trees growing at Ravnik (elevation 500-700 m), Slovenia in the vegetation period 2003. The formation of new tracheids was determined by examination of transverse sections stained with safranin and astra blue under a light microscope with polarised light. The duration of the cambial cell divisional activity was four months; from the end of April till the end of August. The process of the radial postcambial growth of undifferentiated tracheids started at the end of April and ceased at the beginning of September. The rate of the radial postcambial growth was the highest from mid-May to mid-June. The deposition of the multilayered secondary cell wall and the lignification of the earlywood tracheids started in mid-May. First mature earlywood tracheids matured by the end of May. Transition from earlywood to latewood took place at the end of July. After the cessation of the cambial cell divisions (end of August), the secondary cell wall formation and lignification of the latest formed terminal latewood tracheids continued for more than two months; until the beginning of November. The intact tissue sampling method proved to be useful in investigating the process of current xylem growth ring

formation. In the future studies, the influence of the climate factors on the beginning, cessation, duration and dynamic of the individual phases of the xylogenesis should be taken into consideration.

Groves, Cathy, and Christine Locatelli
Dendrochronology Laboratory, Archaeology Graduate School, Sheffield University, England

[P] Imported conifers in England

In recent years there has been a discernible rise in awareness of the way precise dendrochronological dating evidence can affect management and conservation issues relating to the historic environment. This, combined with an increasing recognition of the importance of understanding our more recent cultural heritage, has been the driving force behind the broadening of dendrochronological horizons in England to incorporate the analysis of conifer timbers. In post-medieval England, in both rural and urban structures, there was a dramatic escalation in the utilisation of conifer timbers. Conifers may be routinely used for dating purposes elsewhere in Europe but those used in England are generally imported which adds another layer of complexity to the successful dating of such timbers.

Although small quantities of conifers are thought to have been imported for over 600 years it is in the mid-17th century when the conifer trade expanded rapidly, with Norway initially playing the role of leading exporter. However by the mid-18th century the structure of English imports had changed considerably with regard to both the sources of supply and the types of timber. Ports on the Baltic and White seas began to rival Norwegian ports and baulks suitable for general construction work, as opposed to specialist requirements, formed a significant proportion of the exports. By the 1820s North America had become England's main timber supplier, though northern Europe

still provided timber of a more specialist nature.

This paper reports on the recent development of this project, which has not only enhanced the understanding of the buildings but also increased our understanding of the north European timber trade during the post-medieval period. We also examine possible reasons for some of the problems encountered in our attempts to date imported conifers.

Grynaeus, András
*Hungarian Dendrochronological Laboratory -
Cince'r Bt., Hungary*

**[P] Recent results of dendrochronology
in Hungary**

As a result of Hungarian dendrochronological research started more than a decade ago we have elaborated an oak-chronology with more absolute dates. These dates cover up the early centuries of Pannonia in the Roman Empire, a section of the late Middle Ages and the period from the early Modern Ages up to present-day history.

As a result of recent years, the institutional background of the research has also broadened – beside Hungarian Dendrochronological Laboratory, in 2001 Budapest Tree-Ring Laboratory at the Department of Paleontology of Eötvös University, Budapest (Hungary) was formed, and they want to fulfil regular and systematic dendroclimatologic research, partly with the use of dendro data from archaeological-monumental researches, partly by own research.

In summer 2003, together with two of my students we have started regular and systematic research in Transylvania extending over years, hoping to start an autonomic Transylvanian laboratory in the future.

There is a group for underwater archaeology established with the help of the Office of National Heritage. Their work is very special

and it not only broadens the number of sites but also results in remains of wood (bridges, ports, ships) in several cases.

Our research and its results have been published in several national and international periodicals therefore the Hungarian archaeologists' former rejections and condescension have been successfully turned into support and that means more and more regular and further collaborations.

Haneca¹, Kristof, and Hans Beeckman²
*¹Laboratory of Wood Technology, Ghent University,
Belgium*
*²Laboratory for Wood Biology and Xylarium,
Africamuseum, Tervuren, Belgium*

**[L] Tree rings and quality of oak
timber: growth patterns from
Roman, Medieval and modern trees**

Stand structure and development are known to be reflected in the growth-ring pattern of individual trees. This implies a strong correlation with the wood quality when trees are cut, seasoned and put into practice. In Europe, ever since the Middle Ages, wood has been selected and graded according to its end-use (e.g. regulation of medieval wood carver associations). Especially oak (*Quercus robur* / *Q. petraea*) was highly appreciated for construction and durable applications. As forests were altered in their structure and composition, the quality of the oak wood must have changed as well.

Nowadays three main forest regeneration types can be distinguished: high forest, coppice and coppice-with-standards. Analysing growth patterns from such stands provides parameters characterising their structure and dynamics. The uniformity of the wood, presence of a pronounced age trend, occurrence of abrupt changes in growth rate and the amount of sapwood are all characteristics easily derived from tree-ring series. These parameters, in turn, can be related to the expected wood quality.

The question arises if it is possible to distinguish between forest types based on a

[P] Poster [L] Lecture

thorough study of the tree-ring pattern. According to the stand structure, differences in growth pattern will occur and determine the wood technological features as well. The relevance of parameters characterising the growth-ring pattern according to the resulting wood quality will be assessed. Tree-ring series from medieval and roman forests and woodlands will be confronted with characteristic modern stands with well-known structure. This allows evaluating the apparent changes in wood quality of oak timber through time.

Heinrich¹, Ingo, Holger Gärtner² and Michel Monbaron

¹*Laboratory of Dendrochronology, Department of Geosciences, University of Fribourg, Switzerland*

²*Swiss Federal Research Institute - WSL, Birmensdorf, Switzerland*

[P] Wood anatomy and geomorphology: calibration and verification of growth reactions in trees in response to geomorphic processes

In the light of the discussion regarding effects of the predicted global warming on magnitude and frequency of natural hazards such as mass movements, the development of existing and new methods to record and quantify past and recent geomorphic processes is required. In this context, dendrogeomorphological methods become increasingly important in the field of dating and reconstructing such processes in geomorphology.

This study intends to contribute to a detailed understanding of tree reactions on growth stresses induced through various kinds of geomorphological forces, such as mass movements. Central focus is set on the calibration and verification of dendroecological methods used in geomorphology and related research areas. These are macroscopic analyses of ring-width variations, *eg*, sudden growth reductions, eccentricity caused by the appearance of reaction wood. Macroscopic changes in

wood formation (growth variations in trees) as reaction to external impacts have often been used for dating catastrophic events in those research areas. Microscopic examinations of wood samples have revealed a wide range of structural reactions in response to different growth stresses. However, the wood anatomical features caused by events such as debris flows or landslides have rarely been analysed on a microscopic scale in detail. Moreover, the accurate timing of growth reactions essential for exact dating purposes has been neglected so far. A better understanding of cell development in reaction-wood zones is hence of basic interest and scientific importance. Besides pure dating of events, dendroecological methods offer qualitative and quantitative information that may potentially be used to reconstruct type, size and intensity of past hazardous impacts on tree growth.

Therefore, our research aims to calibrate and verify existing macroscopic dendroecological techniques by comprehensively analysing (microscopic) wood anatomical features related to geomorphic events. To study the plant-growth / disturbance interactions we conducted a range of experiments on seedlings in natural environments and sampled trees influenced by geomorphic processes from different study sites. All samples were analysed microscopically, and a catalogue of wood anatomical features was developed. The analysis of growth reactions on macro- and micro scale in correlation with detailed stress impact data offer the opportunity to characterise cell variations and attribute them to specific impacts. The calibration of specific dendroecological signals on such known growth stresses is a new interdisciplinary approach. We are not intending to reconstruct geomorphic processes but calibrate and verify wood growth reactions on (i) treating experiments and (ii) well documented (known) geomorphic events.

The extraction of qualitative and quantitative information stored in trees allows us to improve the knowledge of natural hazard processes as well as the understanding of

strategies of plant adaptations to their environment.

Heußner, Karl-Uwe
*Department for Natural Sciences, German
 Archaeological Institute, Berlin*

**[P] The other species (*Fagus sylvatica*,
Fraxinus excelsior and *Alnus
 glutinosa*)**

Most of the investigations made to date buildings and finds of the last millennium are based on the chronologies of oak trees or conifers. In the lowlands between the rivers Elbe and Oder the most common timber are oak and pine. This is dependent on the availability in this region. Still there are far more species of wood in those forests. Furthermore historical sources, such as the customs-lists, prove the trade of beech, ash and alder in this area.

In constructions, which are preserved until today, it is most likely to find ash. In the region of the Altmark and seldom in the region of Brandenburg or Mecklenburg one can find roof trusses, which are either completely or partly made out of ash. In some cases this even applies to half-timbered houses. A special feature is buildings made of alder, which can be found in the region of the Spreewald.

Complete investigations of wood out of excavations show a bigger spectrum of species of wood. One can regularly find beech, ash and alder in all areas.

Beech was usually used to build wells, wooden shafts and furthermore for the bases of structures of stilts or to strengthen dykes and similar things.

Ash was used together with oak. The use of ash in buildings, which are mainly made out of oak, does not follow a clear system. Ash seems to be the favoured timber for parts, which are mechanically stressed.

Alder was used for all constructions, which are in contact with water, e.g. pipes, bridges, structures on stilts. Small Stems out of ash are common, too. However, most of those

cannot be dated because there are not enough tree rings on them.

To set up chronologies all the available pieces of wood of this species were recorded and examined. A problem in these chronologies appeared to be in the modern period. Despite the fact that our laboratory usually does not work with living trees, it is problematic that the industrial wood-trade started in the 19th cent. This means that the long-established species of wood were driven out.

Beech appeared to be the easiest to set up a chronology. Those trees get very old and the series show a big similarity among them. It has been possible to set up a long and representative series. Right now this row reaches from 521 until 2003.

In many aspects the ash is similar to the oak. Sometimes it is even possible to synchronize some complexes with the prevailing regional oak-chronologies. Still there are lots of irregularities along the rivers. A complete row for ash trees reaches from 786 until 1836. It is securely dated via oak trees. Right now there are investigations going on to connect this row to the row of the present. Alder showed up to be a very difficult species for dating. If the tree rings of the alder are wide they rarely show any information and dating is quite hard.

Nevertheless you do get useful information's out of the alder if its rings are tight. The problem with these tree rings is that they are difficult to measure. A lot of times alder is not very well preserved and the rings show lots of irregularities. For alder a complete row from 1090 until 2003 exists. Alder trees show a very striking pointer interval around 1200.

Right now the extension of the rows is in progress. On a long-term basis those rows are not only supposed to be a basis for dating but a basis for comparing the species of wood among themselves and to provide a wider basis for climatically investigations and growth investigations.

[P] Poster [L] Lecture

Hoshino¹, Yasuharu, Takumi Mitsutani²,
Koh Yasue³ and Yoshihiro Nobori⁴

¹*Graduate School of Human and Environmental
Studies, Kyoto University, Japan*

²*Independent Administrative Institution, National
Research Institute for Cultural Properties, Nara,
Japan*

³*Faculty of Agriculture, Shinshu University, Japan*

⁴*Faculty of Agriculture, Yamagata University,
Japan*

**[P] Dendrochronological study of beech
(*Fagus crenata* Blume) in the north-
eastern region of Honshu Island,
Japan**

We will introduce our recent results of dendrochronological research on beech (*Fagus crenata* Blume) growing in the north-eastern Japan. Beech is one of the dominant species growing in the cool-temperate zone of Japan distributed from about 31.5°N to 42.5°N. We sampled 75 disks from 8 sites in the north-eastern region of Honshu Island, Japan. Ring widths and maximum densities were measured by soft X-ray densitometry and cross-dated visually and statistically. The effects of climate on the radial growth of beech were analyzed by calculating simple correlations. Ring-width chronologies are correlated positively with the summer temperature of the previous year and the spring temperature of the current year. The result suggests that beech is a useful species for reconstructing of temperature in north-eastern Japan.

**Jalkanen, Risto, T. Aalto, Margus Pensa
and H. Salminen**

*Finnish Forest Research Institute, Rovaniemi
Research Station, Finland*

**[P] Ring shakes between the 1790 and
1791 tree rings in *Pinus sylvestris* at
the northern timberline**

Long-term chronologies driven from trees are most often taken from breast height or another part maximizing the number of tree

rings. Concentrating on breast height results pay less attention to the stem and its properties. In this study we applied whole-stem analysis to Scots pine (*Pinus sylvestris* L.) by sampling every annual shoot of the lower stem from breast height upwards. Five 220–250-year-old trees per site in two Finnish (Laanila and Muonio) and two Swedish (Kiruna and Torneträsk) locations next to conifer tree line were felled for our multi-proxy studies.

In all four sites wide lengthwise cracks were found inside the stems of most sample trees. These cracks were ring shakes, formed when the earlywood of the 1791 tree ring had been ripped from the latewood of the 1790 tree ring. Additionally in one younger Torneträsk tree a ring shake was found between the tree rings of the years 1821 and 1822. Vertically the ring shakes were 3–4 m long, extending to 20 to 35 successive annual shoots from breast height up to the top shoot in 1790, when DBH was on average 10 cm. The shakes covered three quarters of the ring. In all damaged trees, the shakes were between two neighboring tree rings; the older tree ring was narrow including an exceptionally thin latewood, suggesting a cool summer and a poorly developed tree ring in 1790. The tree ring in 1791 looked normal or a wider-than-normal earlywood. No resin had been produced due to the rip, indicating that the separated tree rings were already in the dead heartwood at the time of the damage. In two Muonio trees, bark and cambium of the stem from older shoots to the newly developed 1849 shoot had suffered from mechanical damage. At that time trees were up to 8 m tall.

Geographically wide occurrence of the shakes from Laanila to Torneträsk (320 km apart) indicates a large-scale phenomenon behind the damage. Whether the phenomenon occurs also south from the northern timberline in old trees, is unknown. Further, whether these shakes are common, cannot be answered at least based on coring because cores quite often split into pieces also due to other reasons. Most probably the summer 1790 did not favor proper tree-ring - or especially its late-wood formation, and

this alone (or together with the structure of the 1791 tree ring) was the stem's weakest point to meet an extreme mechanical stress decades later. This stressor may have been a strong wind, of which there were signs in Muonio trees from the year 1849. A provincial storm occurred in the 1860s. Similar ring shakes were recorded in pines damaged during the big storm in Lapland in 1982. Snow load is doubtful in such a large and far-north area. Frost or rapid temperature changes normally cause radial cracks.

EC Environment and Climate Research Programme (contract: EVK2-CT-2002-00136, PINE) supported this research in part.

Kagawa¹, Akira, Atsuko Sugimoto² and Hisashi Abe¹

¹*Wood Anatomy and Quality Laboratory, Forestry and Forest Products Research Institute, Japan,*

²*Division of Geoscience, Graduate School of Environmental Earth Science, Hokkaido University, Japan.*

[P] Carbon-13 pulse labeling and intra-annual high-resolution carbon isotope analysis in relation to tree-ring isotope studies

This paper describes a combined method of pulse-labeling trees with non-radioactive ¹³CO₂ through photosynthesis and analyzing detailed distribution of ¹³C tracer in tree rings by serial tangential sectioning with rotary microtome. In order to clarify how photoassimilates on a given day with temporal isotope signatures is then recorded in tree ring formed afterwards, a branch of a four-year-old *Cryptomeria japonica* D.Don tree growing in Tsukuba, Japan was fed with ¹³CO₂ on May 29 and Sep 18, 2001. Two disks, taken immediately under the branch (0m) and one meter below (-1m) respectively, on March 4, 2002, were subjected to detailed carbon isotope analysis. Thin cross sections were taken from the disks and then subdivided to see rough ¹³C

distribution two dimensionally. Blocks were taken from where the highest ¹³C concentrations were detected and serial tangential sections covering the whole tree ring were prepared from the blocks. Two peaks were observed over the tree ring, corresponding to each ¹³C marking date. Quick surges in radial ¹³C distribution curve suggested clear separation of tracheids formed before and after the ¹³C tracer reached the cambial zone. ¹³C tracer fed in May and Sep from the branch reached tangentially different parts at -1m, reflecting seasonal orientation change of sieve cells in the phloem due to pseudotransverse divisions of fusiform cambial initials.

Kasatkina¹, Elena A., Oleg I. Shumilov¹, G. Jacoby² and A.G. Kanatjev¹

¹*Institute of North Industrial Ecology Problems, Kola Science Center RAS, Russia*

²*Tree-Ring Laboratory, Lamont-Doherty Earth Observatory, Palisades, USA*

[L] Nature of 33-year climatic variation in tree-ring data

We present results of spectral analysis of more than 20 tree-ring series sampled at different Arctic regions (Northern Siberia, Kola Peninsula and Northern Lapland). A multi-taped method (MTM) was applied to tree-ring records. Spectral analysis of the data reveals significant (90% level or higher) peaks at around of solar cycles 11, 22, 30-33 years. The 33-year (Bruckner) cycle, the physical nature of which currently remains unknown has only been identified in a limited number of regions: Northern Finland, Tasmania, Chile, Mexico, North America. Some features of Bruckner cycle manifestations in solar and geophysical parameters and as well in climatic records are discussed. It is shown that manifestations of solar signal in tree-ring records are spatially inhomogeneous depending on the internal structure and location of so-called standing thermobaric waves induced in the atmosphere. Another

[P] Poster [L] Lecture

interesting peculiarity identified in tree-ring spectra is that solar signal is more pronounced in polluted zones of Kola peninsula (around of Monchegorsk nickel plant). These results may be helpful in using tree-ring chronologies as a proxy of external factors including solar and volcanic activity action. This work was partially supported by Russian Foundation for Basic Research (RFBR) (grants N 03-04-96168 and N 03-04-48769).

Katoh, Terutaka

Department of Public Health, Toyama Medical and Pharmaceutical University, Japan

[P] Relationship between mast fruitions and tree-ring width of *Fagus crenata* and the number of Asian black bears captured in Toyama Prefecture, Central Japan

It is well known that the mast fruitions of *Fagus crenata* are tend to synchronize in a large area, *eg.*, almost whole area of Central Japan and/or Northeast Japan. In generally, beech trees show extremely narrow annual-rings in the mast years. Therefore, ring width of individual trees of *Fagus crenata* are fluctuating in a similar pattern within a wide area. The national distribution of beech is overlapped with the habitation range of Asian black bear (*Selenarctos thibetans*) and the nuts of beech trees serve as an important energy source for the bears during the autumn season. During the autumn of a lean year, a number of Asian black bears go down to mountain villages and infest the field and/or the farmyards. Some of them may be shoot as a harmful mammal. In this study, annual-ring width of a total of 20 trees of *Fagus crenata* growing in two natural forests in Toyama Prefecture, Central Japan, were studied with special reference to mast fruiting and the number of Asian black bear, captured as a harmful mammal. Individual beech trees showed a similar fluctuation pattern of ring-width index and the mean ring-width index for the

two forests were quite similar. Typical narrow rings were observed in almost all the mast years. The annual trend for the number of captured bear was revealed to be a similar pattern with those of the mean-ring width index. According to a sign-test, synchronized fluctuations were shown between the mean ring-width index of *Fagus crenata* and the number of captured Asian black bear ($p < 0.05$). It was suggested that these two observations were mutually related through the mast fruiting of *Fagus crenata*.

Kirchhefer, Andreas J.

Department of Biology, University of Tromsø, Norway

[P] Pine chronologies from Vesterålen and Senja, coastal North Norway, as climate indicators for the “Little Ice Age” and Medieval times

During the project “Climate from tree rings of Scots pine in northern Norway - towards millennial series” (Research Council of Norway, KlimaProg, project.nr. 148791/720), three existing pine chronologies from coastal North Norway were supplemented by new samples. Thus at the west-facing slope of Forfjorddalen, Vesterålen (FF2, AD 877-2001), the internal chronology replication during the period 1350-1700 was raised from previously 9-11 to now 25-30 trees. Meeting the EPS 85% level (expressed population signal) with 8 trees since 1151, this chronology now has the potential for an 850-year climate reconstruction, i.e. the longest continuous tree-ring based palaeoclimate record in Norway. This chronology can be regarded as truly millennial as soon as serious dating problems in the late 11th century are solved. The chronology from the east-facing slope of Forfjorddalen (FF1, open-canopy stand) was prolonged back to 996. In its present version, the EPS 85%-criterion is fulfilled back to 1532 (11 trees). The Stonglandseidet chronology (STO) from Senja was extended

back to ca. 1161, with its significant part back to 1498 (9 trees, EPS 85%). All three chronologies mainly reflect July-August temperatures. During the 20th century, winter climate seems to represent a secondary growth control in Forfjorddalen, whereas the Stonglandseidet chronology is affected by linear growth releases, especially after the heavy growth depression around 1900. In Forfjorddalen, prolonged cool periods occurred in medieval times during 1280-1330 and 1380-1480, as shown by FF2. After ca. 1500, growth at the three sites were (FF1, FF2, STO) were generally similar, with cool periods from 1670-1750 and 1880-1910, and warm summers 1550-1600 and around 1800. However, comparing the chronologies from Forfjorddalen reveals the lack of the 1690s' depression at FF2, followed by a growth maximum around 1700. This could support the hypothesis of 17th century logging at FF2. This site also includes Norway's oldest known living pine (ca. 675 years). A rough estimation of the pith dates at FF2 indicates even pine recruitment before 1400 and after ca. 1675, but a more disrupted pattern between 1400 and 1675, which could be interpreted as climate and/or logging effects. After combining the tree-age data of FF1 and FF2, however, the stepwise patterns observed at the individual sites are smoothed out.

Krapiec, Marek
Polish Geological Institute, Carpathian Branch,
Cracow, Poland

[P] Dendrogeomorphological analysis of landslides (an example from the Polish flysch Carpathians)

The annual rings of trees growing in unstable terrains usually exhibit variations induced by the reaction of trees on sudden movements of the ground. The trees, being inclined due to sliding or flowing of the ground, at regaining vertical position produce characteristic, deconcentric ring patterns. In effect, many coniferous trees

growing in sliding areas display sharp reductions of ring widths in the slope-facing part of their trunks and simultaneous widening of rings in the opposite side. Characteristic shape of dendrograms, with a sharp "divergence" determined by sudden changes in dimensions of the same rings in two opposite parts of the trunk, proved to be diagnostic for mass movements, permitting for identification of not only the onset of the movement but its intensity as well.

The presented study was performed on one of the dated landslides from the Szymbark region (so-called Sawicki's landslide) in the flysch Carpathians. Morphology of the landslide, formed prior to 1784, was reshaped by catastrophic movements in July 1913. L. Sawicki carried out the first detailed study of the landslide in 1917. Currently the landslide area was mapped. For dendrogeomorphological analyses samples were taken with a Pressler coring borer from the slope-facing and the opposite side of over 50 trunks of various tree species (fir, pine, larch, sycamore). The trees were exactly located with the GPS.

Dendrochronological analyses carried out enabled to date with the year-to-year accuracy movements of the ground in various parts of the landslide. The most intensive movements, noted for the years 1957-58, 1980, 1990, and to the end of 1990s, should be related to more intensive rainfall in these periods.

The study was financially supported by KBN, project no 4T12B 025 26.

Krause, Cornelia, and Hubert Morin
Université du Québec à Chicoutimi, Canada

[L] Survival strategies of Black spruce and Balsam fir in the boreal forest of Quebec, Canada – the importance of adventitious root development

The dynamics of the boreal forest is influenced periodically by two principal natural disturbances: fire (Cogbill 1985) and

[P] Poster [L] Lecture

epidemics of insects (MacLean 1984, Baskerville 1986). Spruce budworm (*Choristoneura fumiferana* Clem.) is one of the most important in this ecosystem and can progress to tree mortality, like fire (Blais 1965). The main conifer tree species, black spruce (*Picea mariana* (Mill.) B.S.P.) and balsam fir (*Abies balsamea* (L.) Mill.), are well adapted to these disturbances. After insect outbreaks, balsam fir forest rely on the seedling bank whereas black spruce, less affected, to layering. After fire, black spruce survival is assumed by cone opening and seedling production in comparison with balsam fir that needs survival trees to regenerate.

Our study investigated the reaction of the root system to these disturbances and examined the spatio-temporal dynamics by comparing this tree part with the stump and the stem parts. Thirty black spruces and thirty balsam firs were selected from six different sites located in the boreal forest of Quebec, Canada. Stem discs were sampled every meter, the stump part excavated as well as the woody root system up to a diameter of 2 cm. Each root system was mapped to get an accurate picture of the location in space and afterwards root sections were taken every 15 cm starting the closest from the stump part towards the periphery. As with stump sections, they were sampled every 5 cm in order to precisely date the germination year as possible. All sections were sanded and measured with a precision of 0.01 mm, cross-dated and verified by the program Cofecha.

The age of the 60 trees ranged from 90 to more than 250 years. The radial growth within the stem, the stump and the roots showed periodically abrupt reductions due to spruce budworm outbreaks. The growth reductions registered in the roots were more pronounced, compared to the stump and less visible in the lower stem part.

Furthermore, the number of absent rings was much higher in the root part in comparison with the other two parts. As a whole, the root system exhibited in all trees an adventitious character and showed an important dynamics of renewal. Some

development patterns occurred in new root installation such as massive length growth in the first five to 10 years after initiation. The installation of new roots and the abrupt increase of length root growth were related to spruce budworm outbreaks in the surviving trees. A synchronicity was observed with radial and height growth release in the stem part. The root system appears to play a significant role in the surviving of trees after major disturbances like spruce budworm outbreaks and reveals its plasticity by generating the formation of adventitious root.

Kyncl, Tomáš

Institute of Botany, Academy of Science of the Czech Republic, Pruhonice, Czech Republic

[P] Dendroclimatological analysis of shrubby *Pinus mugo* from Krkonoše Mts.

Relation between radial and apical growth of shrubby *Pinus mugo* and climatic factors has been studied along altitudinal gradient in Krkonoše Mts. Six standard chronologies of *P. mugo* have been constructed on the gradient between the alpine timberline (1360 m a.s.l.) and the upper limit of *Pinus mugo* distribution (1550 m a.s.l.). The climate-growth relation of *P. mugo* has been compared with reaction of *Picea abies* from sites at the timberline.

The dwarf *Pinus mugo* shows an excellent potential for dendroclimatological analysis. It was possible to construct more than 200 years long standard chronologies for most of the sample plots. The reaction on climatic factors is changing along gradient. The radial growth at upper parts is limited by temperature in summer (June, July). There is no apparent relation to climate in lower parts of the gradient. The only factor, which has influence on growth of *Pinus mugo* along the whole altitudinal gradient, is high temperature in previous October, probably associated with the improvement of needle frost hardiness in winter season. The

comparison with growth reaction of *Picea abies* from plots at timberline shows that growth of this species is more limited by climate than growth of *Pinus mugo* from the plots at the same altitude. *Picea abies* react similarly to populations of shrubs at the highest altitude but the seasonal shift in reaction to temperature is apparent. Analysis of apical growth of *Pinus mugo* shows the increasing growth in length in last decades. This reaction is apparent especially at the highest altitudes. But there is no clear explanation for this phenomenon yet.

Läänelaid, Alar
Institute of Geography, University of Tartu, Estonia

[P] Temporal extension of the tree-ring series in Estonia

Tree-ring research in Estonia has concentrated mainly to dating of historical buildings, panel paintings and determining the age of single remarkable trees in parks. Alongside, climatic relations of pines have been studied in co-operation with Dieter Eckstein. A new topic has been initiated to assess the influence of underground oil shale mining to the increment of trees growing on the downfall areas.

The selection of tree species important in tree-ring research in Estonia involves Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* Karst.) as the two main construction timbers through centuries; pedunculate oak (*Quercus robur* L.) has proved to be perspective in dating old painting panels, while introduced larches (mainly *Larix decidua* L. and *L. sibirica*) show very distinctive and sensitive tree rings. Determination of age of remarkable trees by curves of cumulative increment has been used for oaks, pines, spruces, and limes (*Tilia europaea* and *T. platyphyllos*). Other tree species have been of minor importance for tree-ring study in Estonia.

The temporal extension of dated tree-ring series of the two main construction timbers, pine and spruce, depends on the preserved, discovered and availability of old

constructions. At present, the dated pine average series cover the periods AD 1528-1998 (471 years) and AD 1111-1448 (338 years), with a 80-year gap between them. The averaged tree-ring series of growing pines cover the period AD 1707-1998 (292 years).

The dated spruce average series cover the periods AD 1575-1998 (424 years) and AD 1355-1448 (94 years), with a gap of 127 years between these two periods. The averaged tree-ring series of growing spruces cover the period AD 1767-1999 (233 years).

Pedunculate oak is a native tree species in Estonia, growing dispersedly over the whole territory. It occurs more often in the western sea islands and western continental part of the country, characterized by milder maritime climate. In few cases oak grows as an oak forest. Oak is a beloved tree in the parks. Ancient Estonians honoured oak as a holy tree. There are some oak trees of remarkable size growing in Estonia. The most famous and probably the oldest one is the Tamme-Lauri oak in South Estonia (girth 830 cm). Method of cumulative increment showed its probable age about 500-600 years (the trunk is hollow inside), although there are only 192 tree-rings in a core. Several oak cores contain even more tree-rings, e.g. Puhtu oak has 303 rings in the core (AD 1698-2000).

The tree-ring series of oak of dated painting panels have yielded an average sequence of 338 years (AD 1264-1600).

The oldest sampled growing larch (*L. sibirica* in Tallinn) has shown 188 tree rings (AD 1816-2003). There is one case where larch timber has been used as construction timber in Estonia.

The oldest sampled lime (*T. europaea* in Tallinn) contains 110 tree rings (AD 1890-1999).

[P] Poster [L] Lecture

Lageard, Jonathan G.A., and Ian B. Drew
Manchester Metropolitan University, Crewe, England

[P] An investigation of salt subsidence and industrial pollution using oak ring-widths

Cheshire has a long history of salt extraction. Archaeological evidence for this dates from the Roman Period (1st to 5th centuries A.D.) with discoveries of lead salt pans (for brine evaporation) and more recently significant salt processing sites at Middlewich (Roman Salinae, 'Saltworks') and at Nantwich. Early extraction probably centred on natural springs, but nineteenth century pumping technology enabled human-assisted solution of underground salt strata. This unregulated 'Bastard' and 'Wild' brine pumping continued into the late twentieth century and resulted in un-supported underground cavities. Subsidence associated with these large caverns in the Cheshire Saltfield has been significant, with sudden collapses in towns such as Northwich and in the study area for this research, subsidence rates were as high as 11 cm per annum between 1950 and 1975. This research focuses on the Elton area between Crewe and Sandbach where large lakes 'flashes' have developed, particularly in the late twentieth century. Tree ring-width data (*Quercus robur*) from Elton and from a control site are compared with brine pumping records, historical records of the surrounding brine-utilising industry and meteorological data in order to test the suitability of tree ring-widths for reconstructing the timing and scale of environmental impacts of the salt industry in Cheshire.

Lavier, Catherine
CNRS : UMR 6565 and University of Franche-Comté, Besançon, France

[P] Technical evolution of wooden craft during the last millennium in Western Europe

Making of wooden objects are mainly subdued to cultural, economical, political and religious wills of the human societies. It is also constrained by mechanical aspects and due to materials. 4 examples will illustrate these relationships in space and in time: painting panels, brabantine altar pieces, wooden covers of manuscripts and medieval furniture. They show that evolutions are visible, that the rhythms are definable, that processes can continue longer than historical dates tell and that know-how can sometimes stop and appear again later.

Leal¹, Sofia, Thomas M. Melvin², Michael Grabner¹, Rupert Wimmer¹ and Keith R. Briffa²

¹Department of Material Sciences and Process Engineering BOKU - University of Natural Resources and Applied Life Sciences, Vienna, Austria

²Climatic Research Unit, University of East Anglia, Norwich, England

[P] Tree-ring width variability in the Austrian Alps and its relation with climate

The annual variations in radial growth rate of several tree species, across altitudinal gradients in the Austrian part of the Eastern Alps and the relationship between tree growth rates and climate over more than one century were studied. Series of mean ring-width measures were created for 1206 trees of five conifer species. Samples were taken from living trees of *Abies alba* Mill., *Picea abies* (L.) Karst., *Larix decidua* Mill., *Pinus cembra* L. and *Pinus nigra* Arn. Measured ring-width data were crossdated using standard dendrochronological methods. Mean series

of ring indices were produced by taking residuals from a 30-year low-pass smoothing spline fitted through the raw measured data. The tree indices for each species from a site were averaged to create species-specific site chronologies. In total 100 chronologies were created. Mean monthly temperature and monthly precipitation measurements from several climatic stations were used to create long series representing regional and seasonal climate variability. The relations between ring and climate variables were analysed using Pearson correlations. Principal component analysis (PCA) was applied to all chronologies and the first principal component, which accounts for most of the variability, is strongly associated with site altitude ($r=0.88$, $p<0.01$, period from 1906 to 1995). A hierarchical cluster analysis was performed in order to group the sites using the first four eigenvectors obtained in the PCA. The chosen solution creates five groups of sites:

- BPine: all the black pine chronologies, located in the submontane zone.
- Sfir: all the fir chronologies, located in the sub- and montane zones.
- MonS: montane spruce (<1400 m) and submontane larch (500 m) chronologies.
- SubAlp: all high altitude (>1400 m) sites, of mixed species mainly from the subalpine zone.
- MonL: montane (900-1300 m) larch chronologies.

The strongest relationship with temperature is obtained for SubAlp sites, when monthly means for June and July of the current year are averaged ($r^2=0.48$, $p<0.05$, period from 1886 to 2003). BPine and SFir are mainly influenced by current year winter temperature. MonS and SubAlp are influenced by summer temperatures from current and previous years. MonL shows weak associations with October temperatures from current and previous years. All chronologies show the influence of March or April precipitation, which in the case of BPine extends from April through July and is stronger ($r^2=0.36$, $p<0.05$, period from 1840 to 1996). The chronologies showing the highest correlations with

precipitation and temperature will be used in the future to study the relationship between climate and tree growth.

Leuschner¹, Hanns Hubert, Thomas Riemer², Mike G.L. Baillie³ and Tomasz Ważny⁴

¹ *Laboratory for Dendrochronology and Dendroclimatology, University of Göttingen, Germany*

² *Systematika GmbH, Czernyring 22/10, Heidelberg Germany*

³ *Palaeoecology Centre, Queens University Belfast, North Ireland*

⁴ *Institute for the Study, Conservation and Restoration of Cultural Heritage, Nicolaus Copernicus University, Torun, Poland*

[L] Long term ring-width variations in European oak chronologies between 900 and 2000 AD

Tree-ring series of European oak trees contain a considerable amount of low-frequency variation. These decadal to centennial variations in the tree-ring series are reflecting both, the internal age trend and the influence of external environmental factors like climate and site-specific factors such as settlement history and changes in forest management. It is difficult to distinguish between these factors and apply a detrending method to eliminate undesired internal and external non-climatic low-frequency variation from the tree-ring series (Briffa et al, 1996).

Riemer (see this volume) developed a new mixed-model approach based on the evaluation of long-term internal growth trends in trees of different cambial age. This model has been applied on tree ring series of European oak spanning the period from 900 to 2000 AD. We have chosen material from five European areas which represent a transect through the main climatic zones from atlantic in Northern Ireland/Scotland to continental in Poland. In between these two extremes three sites from Lower Saxonian (North German) are located: one

[P] Poster [L] Lecture

from the coastal region representing a more atlantic site and one from the Eastern dry heath region with more continental characteristics.

A comparison between the resulting five oak chronologies along the transect shows a large-scale common signal in the low-frequency variations whereby the Lower Saxonian oak chronologies tend to split up into two groups: the chronologies of the western 'atlantic' sites are more similar to the Irish chronologies whereas the chronologies of the eastern, more continental sites are stronger connected to the Polish chronology. When comparing our five European oak chronologies to the temperature reconstructions by Mann et al. (1999) and Esper et al. (2002) a striking similarity can be found. This indicates that low frequency changes in temperature play an important role for the growth of European oaks.

Liphschitz, Nili

Institute of Archaeology – The Botanical Laboratories, Tel Aviv University, Israel

[L] Reconstruction of past arboreal landscape and macroclimate of the Mediterranean region of Israel as evident from dendroarchaeological research

Dendroarchaeology is based on the identification of wood remains, gathered in archaeological excavations up to the species level, thus enabling the reconstruction of the native arboreal climax vegetation and the regional macroclimate during antiquity. According to the first geobotanists, four types of forest and maquis could be distinguished in the Mediterranean region of Israel at the beginning of the 20th century: 1. Aleppo pine forest; 2. Deciduous Mt. Tabor oak forest; 3. Maquis of evergreen Kermes oak; and 4. Maquis of Carob. Comprehensive dendroarchaeological research of more than two decades shows that the arboreal native climax of the

Mediterranean region of the country during antiquity is quite different from that of the recent time. The Kermes oak – Terebinth association, dominated the ancient native arboreal landscape. Aleppo pine was very rare during ancient times. Carob was also rare until recently. The view that Mt. Tabor oak was dominant was also found to be erroneous.

During antiquity native Olive trees were one of the components of the Kermes oak – Terebinth association, but in very small percentages. Since the Early Bronze Age period onwards, after its cultivation by man, the Olive orchards turned to be very prominent all over the Mediterranean region, and constituted very often ca. 70% of the landscape.

In spite of all these changes the macroclimate of the country during the Holocene remained very similar, and all changes of the landscape are the outcome of man's interference with the environment. In the semiarid and arid regions of the country the arboreal cover remained similar during the relevant period.

In previous eras the arboreal cover and the macroclimate were different, and cooler and more humid conditions prevailed in the country.

Lopatin¹, Eugene, Taneli Kolström¹ and Heinrich Spiecker²

¹*University of Joensuu, Finland*

²*Institute for Forest Growth, University of Freiburg Germany*

[L] Long-term growth trends of Siberian spruce (*Picea obovata* Ledeb.) and Scotch pine (*Pinus sylvestris* L.) in Komi Republic, North-West of Russia

Komi is the east-most boreal region of European Russia where large areas of northern European natural forest still exist. The aim of the study is to detect growth trends of Siberian spruce and Scotch pine in Komi Republic for the last 200 years.

It is impossible in today system of forest inventory in Russia to detect forest growth trends on regional scale with decadal or annual resolution. Discs, cores and model trees were collected in 6 stands in 4 forest zones of Komi Republic: south taiga sub zone of boreal forests, middle taiga sub zone of boreal forests, northern taiga sub zone of boreal forests, forest-tundra transition zone. Mature dominant trees without visible signs of damage were randomly selected as sample trees (53 trees of Siberian spruce and 65 trees of Scotch pine). Measuring of annual ring width, earlywood and latewood were done using the Windendro image analysis system. Chronologies covering period from 1774 till 2003 for Siberian spruce and from 1824 till 2003 for Scotch pine were built for 3 forest zones and forest-tundra transition zone. Combination of stem analysis, comparing of raw ring with series using cambial age approach and building chronologies using collected samples showed common increase of growth for the period after 1950 that can't be explained as a usual variability during last 200 years. Standardized tree-ring chronologies showed higher increase in growth in high latitudes and lower in temperate zone. Response to changing environment of Siberian spruce is higher then response of Scotch pine. The highest increase in growth of Siberian spruce and Scotch pine was observed in the northern taiga zone and northern forest-tundra transition zone. The facts of Scotch pine movement to north in northern taiga limit after 1924 were identified. Increase in area of distribution and increase in production results lead to total volume increase. But evaluation of total balance in changes of wood production in Komi due to climate change studies in relation between tree mortality, forest growth and their relation to climatic parameters needs to be done.

Positive long-term trends of Scotch pine and Siberian spruce growth were discovered on the territory of Komi Republic using collected samples. Increase in radial growth of Siberian spruce in the forest-tundra transition zone for last 70 years was 214%

comparing with long-term mean growth for the previous 118 years; in the northern taiga zone 13% (during the last 50 years increased comparing with long-term mean growth for the previous 76 years and on 46% during last 25 years); in the middle taiga zone 115% (for the last 50 years, comparing with previous 178 years). Increase in radial growth of Scotch pine in the northern taiga zone is 116% (during the last 30 years comparing to long-term mean growth for the previous 47 years); in the medium taiga zone is 67% (during the last 50 years comparing to previous 100 years); height growth has increased on 42%. No clear conclusion could be done yet about growth trends in the Southern taiga zone at this stage of analysis.

There is a lower ability of Scotch pine comparing to Siberian spruce to grow in extreme conditions; in the middle taiga zone response of Siberian spruce to changing conditions is higher than response of Scotch pine. Temperature is a limiting factor for forest growth in Komi Republic.

Comparison of forest growth trends in Komi Republic with similar studies in Finland, Norway and Sweden showed difference in growth trends due to continental climate with more strong climatic conditions in Komi.

Lührte, Angela von
*Büro Stadt Wald Fluss, Büro für
Landschaftsplanung und ökologische Gutachten,
Berlin, Deutschland*

[L] The contribution of tree-ring analysis to the ecological monitoring in Berlin forests

Motivated by the observation of expanse forest damage a European-wide twofold monitoring-system on forest health was installed: an extensive monitoring of tree crown condition in 1987 (Level I) and an intensive monitoring at selected plots in 1995 (Level II). This combination of extensively and intensively surveyed plots

[P] Poster [L] Lecture

should foster new insights into cause-effect relation and help to develop protection strategies. The extensive monitoring focuses on defoliation and discoloration, but both are rather unspecific indicators of forest health due to complex interactions and methodical problems. Increment as one expression of tree and stand condition is measured as diameter growth every five years, but tree-ring analysis is only optional on these monitoring plots.

In 1986 the multidisciplinary project “conurban forest ecosystems“ was implemented in Berlin. Different researcher teams investigated more than 20 plots of typical pine- and oak-stands. Intensive surveys took place till 1994, 1995 three of these plots were integrated into the international Intensive Forest Monitoring Programme (Level II).

In this project tree-ring analysis was carried out on all plots. Some trees at these plots have been cored again 10-15 years later. The results of different methodical approaches of dendroecology and dendroclimatology partly have been integrated into the ecosystems analysis, but open questions still remain. Some examples from this project will demonstrate the special contribution of tree-ring analysis to monitoring programmes. Especially the possibility of intensive sampling and objective assessing, the look into tree and stand history, as well as the analysis of climatic and anthropogenic growth factors. This offers a specific insight into tree growth and vitality at ecosystem level. But there are limitations too, as tree-rings have to be interpreted only in combination with other evaluations of tree and stand condition, which requires intensive data acquisition and common survey strategies.

But as benefits distinctively predominate, tree-ring analysis should be applied as an adequate means in forest monitoring programs.

Mitsutani¹, Takumi, Kakichi Suzuki, Takayuki Okochi¹ and Yasuharu Hoshino²

¹*Independent Administrative Institution, National Research Institute for Cultural Properties, Nara, Japan*

²*Graduate School of Human and Environmental Studies, Kyoto University, Japan*

[P] Tree-ring dating of Horyuji, the oldest wooden building in the world

Located in Nara Prefecture, the *Saiin Garan* (Western Precinct) of the Horyuji Temple is composed of the *Kondo* (Main Hall), *Goju no To* (Five-Story Pagoda), *Chumon* (Central Gate), and *Kairo* (Corridor). The structure is famed for being the most ancient piece of wooden architecture in the world.

Although widely believed to have been rebuilt after being burned to the ground due to a lightning-sparked fire in 670 A.D., as recorded in the *Nihon Shoki* (Chronicles of Japan), the precise facts relating to the construction of Horyuji Temple are not known.

The Horyuji *Goju no To* was dismantled and repaired in a restoration project that went from 1941 to 1952. In the process, the central pillar, which was driven deep into the ground, was cut at the base and underpinned with new wood, since the buried portion was badly rotted. A 10-centimeter thickness of disc-shaped sample was taken from the upper, cut portion of the central pillar during this operation, and kept in storage for research purposes. The configuration of the central pillar was octagonal, with a width across flats of approximately 78 centimeters. The tree species of the central pillar was hinoki (Japanese cypress). In a recent investigation, the disc-shaped specimen was imaged using a soft x-ray transmission microscope, and was found to have sapwood remaining in three of its eight angles. The dendrochronological year of the portion containing the largest amount of remaining sapwood was established as 594 A.D. This dendrochronological year is unquestionably the year in which the tree was felled. Before this result was obtained, it

had been a well-nigh established theory that the Horyuji *Goju no To* had been built in 711 A.D. The recent results of dendrochronological analysis of the central pillar puts the age of the pillar at a point about 100 years prior to the established theory.

This new mystery has prompted historians to take the view that the pillar had been taken from another temple, or that the builders had used a tree that had been cut down about 100 years before. Some researchers have voiced doubt in regard to the science of dendrochronology itself. In this way, the results of dendrochronological dating of the central pillar have caused major ripples among Japanese historical scientists. This has served as the catalyst for in-depth dendrochronological investigations on other construction components. It is fairly certain that, at some point in the near future, we will come to know in detail how many years ago the Horyuji *Goju no To* had been built.

Nicolussi, Kurt, Peter Schießling, Andrea Thurner and David Zrost
Institute of High Mountain Research, University of Innsbruck, Austria

[L] Current state of the 7k-long Eastern Alpine tree-ring chronology

At the conference EuroDendro 1999 in Malbork, Poland, the first report on the eastern Alpine Holocene chronology project was given. At this time, a couple of floating chronologies had been established for the last approx. 10 000 years. In the meanwhile, we could connect these floating series to an about 7k-year long absolutely dated and continuous chronology for the middle and late Holocene and three floating chronologies for the early Holocene, respectively. These chronologies are based on some 600 subfossil samples from timberline sites (above approx. 2000 m a.s.l.) in the eastern Alps. The species of the great majority of the samples analysed is *Pinus cembra*. Additionally, *Larix decidua* and *Picea*

abies logs have been sampled and integrated into the chronologies.

The mean number of samples per year of the 7k-year long chronology is 15 (before AD 1000). In general, the number of samples found is reduced with sample age. The time period from the early Bronze Age to the middle Iron Age is an exception: at about 1400 BC, 1100/1000 BC and 550 BC the replication of the chronology is below 5. The low number of samples, which has been found from this period, can be explained by intensive human activities in the timberline ecotone of the Alps, which resulted in reduced forest density in wide areas. The eastern Alpine chronology can be used for dating and dendro-ecological reconstructions, respectively. The dating of samples from glacier forefields in the Austrian and Swiss Alps allows the reconstruction of Holocene glacier activity. Logs from a peat bog in the Zillertal Alps can be used for the establishment of a avalanche-event record for long periods within the last 6000 years by means of dating an dendro-ecological analyses. Tree-ring growth of *Pinus cembra* at tree-line sites is mainly determined by summer (June to August) temperature. The new chronology allows the setting up of ultra-long records of summer temperature fluctuations.

Nikolaev, Anatoly N.
Melnikov Permafrost Institute SB RAS, Yakutsk, Russia

[P] Dendroclimatic investigations in a permafrost area (Yakutia, North-Eastern Russia)

The Republic of Sakha (Yakutia) occupies a huge area in north-eastern Russia situated within the permafrost zone. The response of forest vegetation to large seasonal temperature variations, from extremely low temperatures in winter (up to -70°C) to high temperatures in summer, is of considerable interest. Climate is known to be a primary control on the distribution of forest types, as

[P] Poster [L] Lecture

well as on growth and dynamics of woody vegetation. In north-eastern Siberia, the tree species range is closely related to permafrost distribution and thickness. The largest number of tree species occurs in the south-western portion of Yakutia where permafrost is discontinuous or sporadic. The range limits of tree species on the maps show exact coincidence with the permafrost zone boundaries, suggesting the strong effect of permafrost on tree growth. Investigations were carried out in the Spasskaya Pad study area located in Central Yakutia. The dominant tree species here are larch (*Larix Cajanderi Mayr*) and pine (*Pinus Sylvestric L.*), which require different hydrothermal soil conditions for growth. Larch is more tolerant to cryogenic processes and grows on the major portion of Yakutia. This is because its root system is normally within 50 cm depth from the surface. Pine is less tolerant to permafrost conditions. It occupies dry soils with deep seasonal thawing.

The correlation analysis of tree-ring chronologies from larch and pine shows the following: For larch, the best correlation with soil temperature conditions at different depths is observed in the winter season. The higher is the soil temperature, the faster is soil warming, which promotes timely onset of active tree growth in the beginning of the growing season. Summer temperatures impose no limitations on radial tree growth. There is a sufficient amount of heat for rapid tree growth during this period. The radial growth of pine is positively correlated with winter soil temperatures (until late May) at the upper and lower boundaries of the active layer at depths of 20 cm and 120 cm. In the depth interval 40-80 cm, the positive effect of temperature is observed during the spring months. It leads to early thawing of soil and causes growth processes to begin. In contrast to larch, however, a considerable negative effect of summer temperatures on pine growth is observed at some depths. This may be explained by significant moisture deficit in drier soils where warm temperatures have a desiccating effect.

Oberhuber, Walter
Institute of Botany, University of Innsbruck,
Austria

[L] Climate related causes of distinct radial growth reductions in *Pinus cembra* during the last 200 yr

Distinct radial growth reductions in Cembran pine (*Pinus cembra L.*) were studied at the timberline on Mt. Patscherkofel (2246 m a.s.l., Tyrol, Austria). The study area, which is situated in the inner-Alpine dry region of the Central Austrian Alps, is characterized by a continental climate with minimum precipitation in winter and frequent occurrence of warm dry winds (Föhn).

Six timberline stands facing different aspects were sampled and ring width chronologies developed based on dendroecological techniques. Growth-climate relationships between residual chronologies and climate variables were explored using Pearson product-moment correlation coefficients. *P. cembra* growth at the timberline appears to be limited by cool summer (June-August) and previous autumn (September-October) temperatures and low precipitation in late winter (March).

Timberline stands show concurrent growth depressions deviating $\geq 25\%$ from the mean of standardized measurement values and lasting ≥ 5 yr during the periods 1815-1823, 1851-1858 and 1913-1920, whereby growth depressions were found to be steadily decreasing. Additionally, in 1926, 1961 and 1975 growth reductions were determined at all timberline sites. In 1996/97, however, only stands facing south show strikingly reduced growth. West-facing stands were least responsive to unfavourable climate conditions in 19th century.

Evaluation of climate data revealed that growth depressions can only in part be explained by occurrence of cold growing seasons. Also climate extremes do not inevitably induce growth responses as would be expected from growth-climate relationships. These findings are related to synergistic and/or compensating effects of

growth limiting climate variables, preconditioning of tree growth in previous years and evolution of the habitat. Comparison of growth reductions with two other *P. cembra* timberline chronologies from inner-Alpine dry locations in the Eastern Alps revealed that investigated stands show the highest climate sensitivity during the last 200 yr. This difference in growth response to climate variability is most likely related to the special climate situation at Mt. Patscherkofel, which is exceptionally windy throughout the year and frequently exposed to "Föhn"-conditions.

Okochi, Takayuki, and Takumi Mitsutani
Independent Administrative Institution, National Research Institute for Cultural Properties, Nara, Japan

[P] Non-destructive measurement of tree-rings for wooden cultural properties using micro-focus X-ray computerized tomography

This research aims to establish a non-destructive tree-ring measurement technology to measure ring-width and density of wooden cultural properties. The information from ring width and density is very important not only for dating the felling year of a tree but also for reconstructing past environmental change. It is difficult to distinguish tree-ring boundaries of ancient wooden cultural properties with degraded surfaces or colours. In this case, the cutting or sanding process is necessary to observe the rings. But damaging ancient wooden cultural properties is usually prohibited. The micro-focus X-ray CT applied in our research can visualize tree-rings within the samples non-destructively. Moreover, the system can also visualize the wood density by reconstructing the difference of X-ray absorption per volume, instead of preparing thin wooden strips used in conventional soft X-ray densitometry. In this report, we deal with hinoki cypress (*Chamaecyparis obtusa*

Endl.), which is one of the typical conifer species used in Japanese wooden cultural properties. First of all, we compared both images obtained from the micro-focus X-ray CT and the conventional soft X-ray densitometry. It was concluded that the micro-focus X-ray CT has the sufficient resolution to visualize all tree-rings that are wider than 150µm. Wood density can be measured within an accuracy of 0.1g/cm³. Furthermore, we applied the X-ray CT system in order to date a wooden statue of the dimensions of 28cm in height and 17cm in width.

Oven¹, Primož, Jožica Gričar¹, Martin Zupančič¹, Tom Levanič², A. Straze¹ and B. Demsar¹

¹Department of Wood Science and Technology, Biotechnical Faculty, University of Ljubljana, Slovenia

²Slovenian Forestry Institute, Ljubljana, Slovenia

[P] Relevant anatomical markers for research of wood formation in Norway spruce with pinning technique

Anatomical changes in wood induced by wounding a cambium with a pin were investigated in nine Norway spruce (*Picea abies*) trees. All trees were pinned every week during the period from May 10 to September 13, 2002, felled thereafter, and all 19 samples containing wounded tissue removed and processed for light microscopy.

Our research showed that pinning induced desiccation of differentiated xylem, necrosis of undifferentiated xylem derivatives and cambial cells, as well as formation of callus, traumatic resin canals and typical wound-wood. Callus comprising cells of irregular shape with thick lignified walls developed by hypertrophy and hyperplasia of cambial cells, xylem derivatives in the stage of postcambial growth and xylem rays. Cells of solitary files were not involved in formation of callus. They died whereas the anatomy

[P] Poster [L] Lecture

extant at the time of pinning remained unchanged.

The beginning of divisional activity of cambium can be determined by distinguishing among necrotic cambial cells, "swelled" cells of the cambium and first radially expanded thin walled xylem derivatives of the cambium, which were located inside the callus. During the growth season, radial files of xylem cells comprised mature tracheids, necrotic cells in the stage of secondary wall deposition, dead cells in the stage of radial postcambial growth (RPG cells), usually followed by the necrotic cambial cells (C cells). RPG and C cells took place inside the callus in solitary radial files only. The cessation of the regular activity of the cambium could be masked with wound-induced reactivation of the meristem.

Occurrence of traumatic resin canals (TRC) exhibited high variability in the spatial and temporal sense. When present, solitary TRC were distributed diffuse and formed later than callus in earlywood. Temporal coincidence of formation of callus and TRC arranged in tangential series predominated in latewood.

We concluded that border between RPG cells and C cells located inside of the callus represented reliable mark to define the xylem increment realized by the time of pinning. TRC were not confirmed as reliable growth marker in Norway spruce.

Pensa, Margus, and Risto Jalkanen
*Finnish Forest Research Institute, Rovaniemi
Research Station, Finland*

**[P] Predicting past summer
temperatures based on height
growth at northern timberline**

Twenty-five young Scots pine (*Pinus sylvestris* L.) trees, aged from 36 to 57 years, and 5 old trees (228-236 years) were felled in Laanila, northern Finland (68°30'N, 27°30'E). Based on the needle trace method (NTM), retrospective chronologies of height increment were produced. The indexed

height increment of young trees was strongly related to the mean temperature of previous July, which explained nearly 70% of the temporal variation in height-growth series.

This result concurs with the earlier findings, which showed that at northern timberline the mean temperature of previous summer months determines the development of the winter bud of the leader shoot, and the length of the following annual shoot.

The parameters of the regression equation that described the relationship between height growth and July temperature were used to reconstruct past July temperatures from the indexed height-growth series of the old trees. Estimated July temperatures were strongly correlated with the measured temperatures for the period from 1953 to 2001. However, past July temperatures reconstructed from the height growth of old trees correlated only weakly with the July temperatures measured in the 19th century. Strong inter-correlation of individual height-growth series throughout the period covered by the data indicates that also in past there was strong regional factor that affected Scots pine height growth. The amount of common variability was 38% in the old trees data and 51% in the young trees data. However, in case of old trees this regional factor cannot be identified as a mean temperature of the previous year summer months. Further studies are needed in order to reconstruct factors that had affected height growth in the regional scale at northern timberline in the past. Because of the ongoing global warming, information on past height growth would help us to improve predictions about possible changes in timberline ecosystems. EC Environment and Climate Research Programme (contract: EVK2-CT-2002-00136, PINE) supported this research in part.

Pignatelli, Olivia, and Nicoletta Martinelli

Dendrodata s.a.s., Verona, Italy

[P] First results of the dendrochronological investigations of the ancient shipwrecks of Olbia (Sardinia, Italy)

During the excavations (directed by Rubens D'Oriano - Soprintendenza archeologica delle Province di Sassari e Nuoro and Edoardo Riccardi - nautical archeologist) for the construction of a traffic tunnel in Olbia, a town of the north-east coast of Sardinia (Italy), the remains of more than twenty ancient shipwrecks have been found. All these ship have been examined for dendrochronological investigations. The method of sampling has followed whenever possible non-destructive techniques like the direct measurement of the tree-ring series *in situ*, *frottages* and coring. The dendrochronological investigations carried out up to present concerned about 200 wood elements, coming from the different part of 16 shipwrecks (i.e. keels, planks, frames). These investigations allowed us to build 34 mean curves for different species (*Abies*, *Cupressus*, *Fraxinus* sp., *Larix decidua* Mill., *Pinus* sp., *Quercus* sp., *Ulmus* sp.). The mean curves span from the roman to the medieval time.

Pourtahmasi, Kambiz

Department of Wood and Paper Science and Technology, Faculty of Natural Resources, University of Tehran, Iran

[P] Tracing of heavy metals in tree rings - a case study in Karaj, Iran

The Air Pollution is one of the most important factors, which are affecting the trees in areas with high industrial activities. During recent years in Iran, many different type of investigation have been made to evaluate the values of this effect. This study is a way to make a new look to the method

of Air pollution investigation. According to the tree growth process, heavy metals from all around the trees, including from polluted water and/or air will have retentions in tree rings and this could be used as an important index of pollution. 20 trees around a plant oil making company in Karaj, Iran, have been selected. From 10 living trees one core have been taken by increment borers and from 10 dead trees cross sections prepared. All tree rings have been separated year by year. The ash in each ring extracted by using the TAPPY standard. Heavy metals including Fe, Zn and Mg were traced in each rings and the results showed that the amount of retention of heavy metals is high when the factory working hard.

Pousset, Didier

Dendrochronology Consulting Sheffield, England

[P] A reinterpretation of the J. Paul Getty Museum's Renaissance Burgundian Cabinet (71.DA.89), partly revealed by decoding the information recorded in the wood

In September 2002, the oak pieces of the J. Paul Getty's Renaissance Burgundian Cabinet (71.DA.89) were studied by wood analysis and dendrochronological dating. To facilitate the study of tree-rings in this case, non-intrusive techniques were used. Collected samples provided major information about the year when trees were cut down, the origin of wood and about technological conversion wood. In comparison with previous studies carried out on Sambin's cabinets, results prove the authenticity of this Cabinet and its Burgundian origin at the end of the XVIth century.

[P] Poster [L] Lecture

Pukienė, Rūtė
Dendroclimatology and Radiometrics Group,
Vytautas Magnus University, Kaunas, Lithuania

**[L] Historical wood from the Vilnius
 Lower Castle excavation**

In 2009 Lithuania will celebrate a millennium anniversary of the first reference of its name in written sources. One of the major items of the celebration program is the reconstruction of the Vilnius Grand Dukes Palace. Construction works stipulate more intensive investigation of the Vilnius Lower Castle territory.

During the long history of constructing, destructing and reconstructing up to 8 m thick cultural layer has been accumulated in the Castle territory. The upper layers represent a period of brick and stone constructions mainly of 15 – 17th and later centuries. In the depth of approximately 4 m the layer rich with remnants of timber constructions (pavements, houses, piles, etc.) of previous centuries starts. In some places the thickness of the layer of successive timber constructions is up to 4 m. With high ground water level there is a good chance for preservation of wood.

In recent years a big collection of wood samples was collected by the Castle Research Center “Lietuvos Pilyis” in the excavated territory. More than 300 pieces of timbers were sampled in 2002. For investigation of the historical wood in 2003 a dendrochronological laboratory equipped with the Sheffield tree-ring measurement stage and the program Dendro (Ian Tyers) was founded at the Castle Research Center. In this year I started dendrochronological examination of the collected timbers.

The main tree species used in constructions was *Pinus sylvestris* L. Mature trees were preferred. An average length of tree ring sequences of the measured samples is about 130 years. Some samples have more than 200 rings.

From the already measured timbers a 210 years long chronology has been constructed using 18 relatively dated rampart logs. The chronology is dated to 1300 – 1509. Another

157 years long average series dated to 1396 - 1552 was made from three timbers from under palace basement. Good agreement (t value up to 10) of averaged chronologies and some individual series with the chronology of Riga defensive rampart (Maris Zunde) was found. This indicates the provenance of timbers from the region with a similar dendrochronological signal. Dendrochronological investigation of the historical wood is in progress with expectation to construct a well-replicated pine chronology for the first half of the second millennium.

**Pumijumnong, Nathsuda, and Sineenart
 Wanase**
Faculty of Environment and Resource Studies,
Mahidol University, Nakhonpathom, Thailand

**[L] Teak log coffin culture in Northern
 Thailand: dendrochronology and a
 revision of dating theories for teak
 coffins' heads**

The district of Pang Ma Pha in the Mae Hong Son Province in Northern Thailand has many caves that are of great archaeological interest. In certain dry caves, many teak coffins have been found. An interesting feature of these coffins are the carved teak heads at both ends. One type of head can be described as simple – it has no facial features, merely a headlike shape. By contrast, the complex type has animal-like features. Similar coffins have been found at other South-East Asian sites. According to the archaeologists' hypothesis the simple head type predates the complex head type. The cross-dating of simple and complex head types should follow the same pattern. To test this hypothesis, dendrochronological techniques were applied. The objective of this was to compare and examine the growth patterns of teak from various coffins, thereby establishing dating and cross-dating of the coffins. Ban Bo Kri Cave and Ban Rai Rock shelters were the study area. From a large sample of coffins, two cores were collected using an engine increment borer

and the hollows were filled with a small piece of wood to prevent deterioration of the coffin. The samples were measured and the ring patterns analysed.

Analysis revealed that there was a correlation between the samples of the same head type. Moreover, the teak growth patterns revealed that the simple head type and the complex head type coffins were in the same age range. This strongly suggests that in the Pang Ma Pha log coffin culture there was no continuous development from a simple to a complex head type. If these results are confirmed by C-14 dating, we would have to revise our present ideas about South-East Asian log coffin cultures.

Riemer, Thomas

Systematika GmbH, Heidelberg Germany

[L] The mixed-model approach to separate common low-frequency signals from individual ageing trends

The reconstruction of environmental long-term trends by means of tree-ring chronologies is handicapped by the fact, that different growth factors often have similar effects on the patterns within individual tree-ring series, and thus cannot be distinguished by simple methods.

First of all, a quantitative analysis has to separate internal/individual and external/common factors, i.e. smooth variations typical for the individual age, the "ageing trend" and those shown by many trees of different ages, but within the same years, the environmental "signal".

By means of conventional statistical methods and filters, a satisfying estimation of the common signal is impossible. Either this estimation is biased due to insufficient consideration of internal growth factors, or the signal loses its long-term components by a numerical elimination of individual ageing trends.

The only way out of this dilemma is to estimate all relevant effects simultaneously

and to restrict the possible solutions for each factor to a reasonable range. A first step towards a solution has been the "general linear models", which can estimate both, trends and signal within a one-step procedure. But the underlying restriction is usually formulated as: "All trend curves (within a region or site) are the same", which does not hold (as an example) for Central European oak series. As a consequence, much variance due to individual growth trends is erroneously interpreted as part of the common signal.

Better results are promised by "mixed models", which formulate their restrictions less restrictively and thus are more appropriate to true natural conditions. Instead of assigning the same trend curve to all trees within one group, the only restriction is: "The individual trend curves disperse around a common mean trend". The (finite, spatial) variance of these trend deviations as well as the (finite, temporal) variance within the common signal and the residual variance are estimated simultaneously by a "variance component" model. The advantage is, that each variation in the tree-ring series is assigned to the growth factor that offers the best explanation for that type of variation. E.g. trends shown by several trees at the same time, but at different ages, are explained best by an environmental signal, whereas simply age-dependent trends as well as smooth deviations from the mean trend, which are shown only by single series, are explained best by individual ageing trends, and thus do not distort the estimation of the common signal.

The lecture gives a rough overview of the statistical theory and computational practice. It prepares Dr. H.H. Leuschner's presentation of experiences applying this method to several oak data sets.

Rigling, Andreas, and Matthias Dobbertin

Swiss Federal Research Institute for Forest, Snow and Landscape - WSL, Birmensdorf, Switzerland

[L] Growth reaction to multiple abiotic and biotic stresses of Scots pine growing on dry sites in the Central Alps of Switzerland

The study area included the dry Scots pine (*Pinus sylvestris*) forests of the inneralpine Swiss Rhone valley called Valais, which cover an area of about 12'000 ha (11% of the total forest area). These pine forests are of high importance for the region because i) they protect against avalanches, rock fall and erosion, ii) they are the ecotope for a rich flora and fauna and iii) they are a typical landscape element of relevance for recreation and tourism. Repeatedly in the 20th century and augmented since the early 1990s high mortality rates of Scots pine have been observed and question the various forest functions. The aim of this paper was to demonstrate the use of dendroecological methods to analyse relevant processes of forest dynamics and the growth reaction of Scots pine to multiple biotic and abiotic stress factors.

The extensification of the forest and agricultural management during the past decades has a strong influence on the forest dynamics and the tree species composition of these pine forests. A case study in Leuk demonstrates the dynamics of a reforestation of a former pasture into a Scots pine pioneer forest, which is now, after 150 years changing into a Norway spruce (*Picea abies*) forest. In the forests of lower altitudes the past traditional forest management reduced the proportion of downy oak (*Quercus pubescens*) and other broadleaved species systematically. But now, after changing the forest management practices the shade-tolerant broadleaved trees are coming back and compete more and more with the light demanding pine and they will replace them on a large scale. The Valais has a typical inneralpine continental climate with low precipitation

and high evaporation. Climate-tree growth analysis showed that low spring precipitation and hot summer temperatures are limiting factors for plant growth in dry pine forests. Under consideration of the ongoing climatic warming, pines growing on extreme dry sites will suffer most from increasing evapotranspiration and subsequent drought. In addition the warmer climate creates optimal conditions for insect and pathogen development. According to the estimation of the local forest service damages caused by pine-insects increased significantly during the past decades.

Another effect of climate warming is the shift of about 250 m to higher altitudes during the past 100 years of the temperature sensitive pine mistletoe (*Viscum album*). This semi-parasite deprives water from the pine. This leads, especially in periods with limited water availability, to an additional increase of the host's drought stress and to an increased probability of mortality. Tree rings generally reflect the negative influence of the mistletoe on growth and mortality of pines but in some cases other factors such as e.g. competition or insect attacks can superimpose their growth reaction. Climate warming will also increase the risk of forest fires in this dry environment. One of the driest years of the past decades was 1990 with a maximum of 50 forest fires. Using dendroecological methods the borders of a forest ground fire were precisely reconstructed. The surviving trees could profit from the increased nutrient supply and from a temporary reduction of the root competition and showed a positive growth reaction.

Most of the today extended Scots pine forests must be interpreted as part of an ongoing natural succession, superimposed by effects of climate warming and landuse changes. Dendroecology is a very useful tool to analyse the various processes of forest dynamics and their consequences on future stand structures and mortality rates.

Romagnoli, Manuela, S. Cesetti, E. Bizzarri, F. Anzelmo and M. Sarlatto
DAF – Agriculture Faculty - University of Tuscia, Italy

[P] Dendrochronological perspectives of the wood ceiling in the Palatina Chapel in Palermo (Sicily, Italy) (XII Century)

The wood ceiling of the Palatina Chapel is a very famous art-historical artefact. It is in Palermo town (Sicily) inside the Norman Palace where actually the Sicilian Government is located.

The Palatina Chapel is as such considered a “unicum” for the precious style and the rareness of manufacture of the wood ceiling, paintings, mosaics etc.

The wood ceiling was built in the XII century under the kingdom of Ruggero II. It is mentioned in a historical document in 1143 and therefore the making of the ceiling was likely ended at 1143 or shortly afterwards.

Wood ceiling manufacture is typical arabesque and a lot of questions arise about the wood provenance and the origin of work-people.

Some researches are carried out thanks to the collaboration of the Sicilian Restoration Centre (Director. Arch. Guido Meli) having the imminent restoration in sight of Palatina Chapel.

In spite of the centuries, the wood ceiling is still well preserved even if the most represented species are not durable.

Macroscopic and microscopic analyses make the hypothesis reliable that *Abies nebrodensis* is the species mostly represented (Romagnoli, M. and Terranova, F., to be published). Also *Pinus* elements were found. They belong to the mountain pine group (cf. *Pinus sylvestris*, *P. nigra*, *P. laricio*). The other species represented in the ceiling are so far not suitable for dendrochronological analysis.

A preliminary floating chronology of 120 years was built of *Abies* species. This chronology represents the first dendrochronological point historically located for that period in Sicily and it would

allow dating of Mediterranean objects or artefacts.

Rybníček¹, Michal, Tomáš Kyncl² and Jitka Vrbová¹

¹*Mendel University of Agriculture and Forestry, Brno, Czech Republic*

²*Institute of Botany, Academy of Science of the Czech Republic, Pruhonice, Czech Republic*

[L] Oak standard chronology in the Czech Republic

The majority of historical wooden constructions in the Czech Republic are made from softwood. Hardwood (generally oak) are only found in few cases. However, there are some constructions (e.g. belfry constructions), in which oak wood dominates. Availability of standard chronology for dating of these species is therefore as important as earlier - made standards of coniferous species.

Jitka Dvorská made the base of oak standard chronology in 2001. The standard presents almost 1500 years. The sources of the data were only from archaeological excavations. The young parts, significant for dating of constructions in historical buildings, were based on relatively low amount of samples. In last few years, material from younger wooden constructions were collected and highly replicated oak standard chronology for the period 473 – 1998 was established. In the next time we focus on making more specified local chronologies (Bohemia, Moravia) and on prolonging of the existing standard. Wood of such age can be found in archaeological samples only rarely; therefore the standard can be prolonged only by systematic sampling of subfossil wood explored in large rivers (Morava, Vltava and Labe). Radiocarbon dating of these samples reflects possibility to prolong the standard to the period closely to beginning of Holocene (9000 B.C.).

The standard will be completed using results of research of the sapwood rings number of

[P] Poster [L] Lecture

the oak species in the Czech Republic based on living and historical samples.

Sander, Constantin, Frank Rinn and Andreas Kraft
RINNTECH, Heidelberg Germany

[P] TSAP-Win with new statistical and graphic features

Time Series Analysis and Presentation, or short "TSAP" was developed as a software solution for dendrochronologists more than ten years ago. It covers all steps from measurement of tree-ring series to cross-dating and chronology building. In 2003 it was re-programmed for a Microsoft Windows environment and enriched with helpful new features for dendrochronological analysis. A cross-date check, first programmed by Richard Holmes for the program COFECHA with a text output, is now implemented as a graph supported feature. During this procedure time series are cross-checked segment by segment. The segment length can be adapted by the user (standard: 50 years). This helps to find and correct measurement errors. Alternative, better matches for each single segment and their statistical parameters can be viewed on the screen and edited right away. This improves the reliability and convenience of the cross dating process. The cross-date index, a powerful joint parameter from t-value and Gleichläufigkeit calculation, is used as sorting criterion. The graph library allows graph lists of different kind (line, bar core beams) including one or more references including their replication. Pointer years and periods can be emphasised. An additional feature in preparation is the visualisation of markers for anatomical features. The frequent appearance of resin ducts, fire scars and other peculiarities can be displayed with the time series as a superimposed skeleton plot.

Saß-Klaassen, Ute
Netherlands Centre for Dendrochronology, RING Foundation, Wageningen University, The Netherlands

[L] Tree-ring chronologies of sub-fossil bog oaks – a potential proxy for past and palaeoclimate ?

Ultra-long tree-ring chronologies extending from about 6000 BC to the tenth century AD were derived for sub-fossil bog oaks from different regions in NW Europe (Jansma 1995; Spurk *et al.* 1998; Leuschner *et al.* 2002). These chronologies share a strong common 'signal' implying that the growth pattern of oaks from different wetland woods in NW Europe are probably triggered by a large-scale regional factor such as climate (Leuschner *et al.* 2002). Therefore tree-ring chronologies may provide a continuous proxy record for past climate. Before this can be validated an essential prerequisite to using any proxy data for climate reconstruction is a complete understanding of the ecological background from which the data was collected. Therefore different approaches were used to evaluate the environmental factors reflected in growth pattern of sub-fossil bog oaks. (1) Investigation and comparison of the growth patterns of 'living bog oaks' from modern wetland woods: In NW Europe: no oaks with a growth pattern resembling that of the sub-fossil bog oaks were found; anthropogenic changes of hydrology in wetland woods are considered to be the causal factor. However, preliminary results from oaks at a remote wetland wood in NE Ukraine suggest site hydrology, triggered by both river run-off and precipitation, as the key factor for variations in oak growth. (2) Interpretations based on excavations of two ancient wetland woods complete with sub-fossil bog oaks in the Netherlands: interdisciplinary research provides strong evidence that temporary high groundwater level and inundation brought about by wet climate conditions influenced the growth and population dynamics of the oaks.

(3) The isotopic ($\delta^{13}\text{C}$, $\delta^{18}\text{O}$) composition of sub-fossil oak wood during periods of favourite and depressed growth was studied in order to look for indications of environmental stress. Together with the results derived from high-resolution isotopic profiles we were able to understand shifts in isotopic composition of the wood throughout the growing period of the oak in response to changes of hydrology. The combined results from these different approaches indicate that site hydrology played a key role for the growth of oaks in former wetland woods. Synchronous growth behaviour of bog oaks from different regions in NW Europe, i.e. Germany, The Netherlands and Ireland, suggest a regional climate factor as the causal factor thus implying that tree ring chronologies of bog oaks do provide a potential proxy record for past climate.

**Schmidt, Burghart, and Wolfgang
Gruhle**

*Labor für Dendrochronologie, Institut für Ur- und
Frühgeschichte, Universität Köln, Germany*

**[L] Similar climatic conditions
(teleconnection) between Europe
and Asia, identified by a new
method of tree-ring analysis and
meteorological data**

The dendrochronology - as a very successful dating method - documents indirectly that ring-widths are significantly influenced by the climatic changes from year to year. In Europe, e.g. the degree of growth similarity among trees is not constant through time.

We demonstrate this phenomenon by calculating the similarity between tree-ring chronologies in Western Europe in a gliding time window of 20 and 50 years (Growth-homogeneity).

By the same method we calculated the degree of homogeneity between meteorological data sets (precipitation).

The homogeneity-patterns of trees and precipitation are highly correlated, analysed in the region of England, Scandinavia, Hungary, Germany and France.

First results seem to show that the range of these patterns is ending near the Mediterranean area.

Similar patterns are also identified between Europe and Asia (Nepal/Karakorum).

Schöffbeck, Tilo, and Karl-Uwe Heußner
*Department for Natural Sciences, German
Archaeological Institute, Berlin, Germany*

**[L] Medieval timber in North-East
Germany: building-archaeology and
dendrochronology**

Depending on many well preserved parish churches in the research area, we have been exploring more than 200 objects with medieval roof constructions. As an aim the project should combine building archaeology and art history. Moreover it gives us out of the dendrochronology a detailed impression of the deep change at the beginning of the late middle ages.

As an outstanding result the dates show a clear gap in the building boom between 1330 and 1350/60. This describes exactly the decline of economic prosperity following the colonisation of eastern Germany.

The primeval forests were cut down during the clearings; the best timber was used for shipyards and buildings. The younger roof constructions after the crisis mainly built with timber in average age less than 100 years. Quality of timber and craftsmanship never reaches the former standard for the rest of the middle ages. Dating samples from these late gothic times is much more difficult than examining samples from before.

Beginning in the 1280s, ash was sometimes used in roofs. Not seldom whole construction made of ash. Before this time oak was dominating roofs frameworks, but in the same time pine is appearing as building timber, especially in Pomerania, in Mecklenburg only in towns.

[P] Poster [L] Lecture

Samples from town archaeology demonstrating timber trade beginning in the same time. Beams from the roof of the so called "Kramerkompanie" in Stralsund (dated 1285 d) were shipped from the area around the middle of the river Oder. In a parish church near Stralsund we found a complete roof with timber marks imported from middle Sweden, dated 1383 (d). Some of the earliest monumental roof constructions covering hall churches are preserved from the early 14. century, masterpiece in craftsmen's art, for instance in Anklam, Bützow, Greifswald, Perleberg, Barth and Grimmen. In Greifswald, for example, hundreds of high quality oaks with traces of rafts were used around 1329 (d).

Schweingruber, Fritz H.
Swiss Federal Research Institute for Forest, Snow and Landscape - WSL, Birmensdorf, Switzerland

[L] Distinctness of ring boundaries in deserts

It is well known that the ring distinctness in trees and shrubs decreases from temperate to tropical regions (Worbes 1990, Schweingruber and Dietz 2001). In contrast, the knowledge about ring formation and ring distinctness in arid regions is poor. Therefore I collected wood samples from shrubs and dwarf shrubs from approximately 650 species in the arid regions of the Sahara, Oman, Chile and Australia (Schweingruber 1992). The regions are located between 30° and 22° north (Sahara, Oman) and south (Chile and Australia). The climate is characterized by low precipitation (>300mm per year) and mild winters (January temperatures above 10 °C). The ring distinctness is very low in most regions. 64% have no or indistinct rings in the Sahara, 73% in Oman, 62% at the Australian West Coast and 82% in the Australian Nullarbor Plain. But only 12 % show indistinct rings in the comparable climate of the arid Northern Chile.

We have no proper explanation why the ring boundaries are distinct in the deserts with high winter temperatures (12 –18 °C) in Chile. All analysed shrubs and dwarf shrubs in other arid regions (Australia, Oman, Sahara) grow at dry sites with high winter temperatures. Only a minority shows distinct rings. Fahn 1977 found that low temperature as well as the availability of water control cambial activity. The distinctness of ring boundaries is also determined by genetic factors.

Shumilov¹, Oleg I., A.V. Kuzmin², Elena A. Kasatkina¹, N.-A. Morner³ and E.Yu. Poloskova²

¹*Institute of North Industrial Ecology Problems, Kola Science Center RAS, Russia*

²*Polar-Alpine Botanical Garden-Institute of Kola Science Center RAS, Russia*

³*Department of Paleogeophysics and Geodynamics, Stockholm University, Sweden*

[L] Climatic sensitivity of tree-ring data selected in polluted area: the 4th timberline in dendroclimatology

The climatic response of tree-ring growth was studied both in polluted and ecologically pure regions of Kola Peninsula behind the Polar Circle. Tree-ring series in polluted region were selected around great Monchegorsk nickel plant. Totally more than 30 dendrochronologies were analyzed. The problem is considered in two aspects: selective sensitivity of separate trees and structural organization in different ecological conditions. Inside of forest stands with natural (undisturbed) structure it was detected a homogeneous distribution of different meteorological factor influence on separate forest stands. As "meteorological" factors we considered air temperature and humidity, precipitation, surface temperatures, depths of snow cover). On the contrary, at the polluted forest areas the diapason of continuous action of meteorological factors spreads, and in addition their complex influence on separate

forest trees increases. From all set of meteorological factors studied in unpolluted zones significant correlation between them and tree-ring widths was detected only for two factors compared with five ones in polluted areas. The cumulative character of weather action on forests leads to decrease of plantation stability and increase of competition relative to limitation factors. At natural conditions the level of potential stability is essentially higher and the competition between plants is minimal. The increased sensitivity of the tree-ring data to climatic influence in polluted areas permits us to suggest that together with three other well-known timber-lines, where the climatic effects in tree-ring growth are maximal, there exists the forth “pollution timberline” in polluted zones where climatic phenomena as well may be effectively studied. It is very important for investigation of modern global change effects: global warming, total ozone depletion etc. Very important that modern climatic changes may be studied rather far from usual timberline areas including middle latitudes where the industry concentration and pollution are maximal.

This work was partially supported by Russian Foundation for Basic Research (RFBR) (grants N 03-04-96168 and N 03-04-48769).

Stravinskienė, Vida

Department of Environmental Sciences, Faculty of Nature Sciences, Vytautas Magnus University, Kaunas, Lithuania.

[L] Dendrochronological indication of anthropogenic environmental trends in Lithuania

Tree-rings can be considered as natural monitors, able to record information on impact of natural and anthropogenic stressors. Nevertheless deciphering of this information is rather complicated task, retrospective tree-ring analysis provides very useful long term information and can serve as an appropriate tool for assessment of

general consequences of anthropogenic environmental changes. As the result of long-term dendroindicational studies on tree annual radial increment in stands of different tree species growing in various Lithuanian forest habitats, affected by different management measures and environmental pollution of varying intensity, as well as having analyzed main tendencies of investigated indices, the following conclusions were drawn.

Having analyzed the anthropogenic changes in Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* (L.) Karsten) radial growth in the surroundings of mineral fertilizers plant “Achema” it was found, that until the onset (1965) of pollution tree annual radial increment fluctuations were close to 11 and 22-year Solar activity cycles – increment maximums coincided with favourable for growth warm periods, while minimums – with coolness beginnings of vegetation period, when precipitation is close to norm, as well as with cold and rainy vegetation periods. Since the beginning of pollution three different periods of anthropogenic transformations of tree radial growth were singled out – fertilization, growth depression and recovery period. When “Achema” has started production of mineral fertilizers, emitted nitrogen compounds have a positive impact to tree growth. During the first five-year pollution period tree annual radial increment in the zones of intensive (8-12 km) and moderate (13-24 km) pollution is similar or close to the control, or insignificantly (10-15%) higher. The general impact of increased air pollution became negative and growth depression period started. Permanent negative effect of pollutants on pine and spruce forests, growing nearby the plant started in the second five-year pollution period (1973-1977). The greatest damages to forests were caused in 1977-1981, when in the zone of intensive pollution pine annual radial increment reached only 60-75%, while that of spruce – 50-70%, compared to the control increment. Just then amounts of the plant emissions with prevailing SO₂ were the highest (34-40 thou. tons annually). In 1986-

[P] Poster [L] Lecture

1988 changes in pine and spruce annual radial increment stabilized at the level of 1980-1982, while in 1989-1995 a tendency of recovery and decreasing increment losses is observed. It was a result of essential reduction of environmental pollution. Studies on drainage efficiency of permanently overmoisted and marshy forests have indicated that tree annual radial increment augmentation after drainage is rather dependant on climatic conditions at the time of draining. In the case of drainage of *Pinetum myrtillo-sphagnosum* and *Pinetum carecoso-sphagnosum* forests as well as *Pinetum carecoso-calamagrosticosum* and *Pinetum calamagrosticosum* forests at the beginning of dry period, forest stand adaptation to ground water level changes is shorted. This led to tree annual radial increment augmentation already in the first 5-year period after drainage, while the greatest increment effect was attained in the second and third period after drainage. Later drainage effect was decreasing and after 25-30 years has disappeared, while tree annual radial increment corresponded to the increment of control (undrained) stands. Drainage in rainy period caused the significantly changes in level of ground water, stand adaptation to new ecological conditions takes longer time and tree growth increase is achieved 2-3 years later, as compared to drainage in dry period. It is more rational to drain pine and spruce forests growing on permanently overmoistured and marshy habitats at the beginning of dry periods, because then climatic conditions are more favourable for radial growth. Drainage of black alder forests is inefficient: insignificant radial increment rise is observed in young drained *Alnetum carecosum* and *Alnetum carecoso-calamagrosticosum* forests. Their radial increment is slightly higher in the 3-5 five-year periods, later it does not differ from the increment of undrained forests; in older drained black alder forests negative drainage effect was ascertained, expressed by tree annual radial increment decrease. Results of dendrochronological studies on tree annual radial increment changes due to

fertilization, carried out in 50-year-old pine forests in the vicinity of "Akmenės cementas" indicate, that annual radial increment of trees fertilised by different mineral fertilisers increased as follows. Having fertilized by carbamide (80 kg/ha of nitrogen active substance), pine annual radial increment in the first year after treatment augmented by 20%, in later years it differed from the control by 10-15%. The greatest fertilization effect according to additional annual radial increment was ascertained after treatment with superphosphate (100 kg/ha of phosphorus active substance) in the 2nd and 4th year after fertilisation, when pine annual radial increment augmented respectively by 46% and 30%, compared to control; positive effect of superphosphate was revealed in dry 1992 and 1994 years, when pine annual radial increment augmented by 46% and 30%. The greatest effect of fertilization by double phosphogypsum dose (10 t/ha) – increment rise by 39-47%, compared to the control. Having fertilized with 5 t/ha of phosphogypsum, pine annual radial increment has grown by 11-30%, while with a mixture of phosphogypsum (5 t/ha) and superphosphate (100 kg/ha of phosphorus) – by 18-23%, compared to the control.

Stravinskienė, Vida, Regina Erlickyte and Asta Simatonyte
Department of Environmental Sciences, Faculty of Nature Sciences, Vytautas Magnus University, Kaunas, Lithuania.

[P] Growth and condition of Scots pine (*Pinus sylvestris* L.) forests in urban and industrial environment

Kaunas city is covered by Scots pine (*Pinus sylvestris* L.) forests. Urban environment is affected by various environmental factors, including air, soil pollution, soil pressure, land use activities, excavation and trenching, mechanical tree damages. Conifers are especially sensitive to environmental pollution. Annual radial increment can be

used as an anatomical indicator for assessment of climatic and anthropogenic impact.

310 sample Scots pine trees for radial growth and morphological tree crown indicators (crown defoliation, foliage discoloration, the amount of dead branches, state of tops, needle retention, fruiting and damages) analysis were assessed in 17 sample plots distributed in Kaunas city forest parks.

Maximum values of annual increment were detected in 1936-1938, 1947-1950, 1965-1967, 1974-1976, 1983-1985, 2001, which corresponded to warm favourable for growth periods. Minimum increment values were detected in cold periods of 1930, 1940-1943, 1956-1958, 1978-1979 and droughts in 1992, 1994, 1996 and 2002. The tendency of annual tree growth decrease since 1992 until 1996 was observed. In 1998-2001 radial growth have increased again. The most intensive radial growth of 50–69 years-old trees in 2001-2003 was estimated in “Botanical Garden”, the smallest – in “Lampėdžiai” sample plots. The largest increment of the 70-89 years-old trees was estimated in “Petrašiūnai-2” site, the smallest – in “Palemonas-1”. The largest increment in “Panemunė-2” location and the smallest in “Raudondvaris-2” site were estimated in the 90-120 years-old trees. Crown defoliation data showed the best pine trees condition in “Botanical Garden” site and the worst condition in “Panemunė-1”, “Palemonas”, “Raudondvaris-2” and “Vičiūnai” sites. Average crown defoliation in 2001-2003 of Kaunas city Scots pine forests was $25.88 \pm 3.6\%$. Rising emissions from mobile pollution sources contributed to this worsening tendency. The reliable ($P=0.95$) improvement (compared to 1998 data – $32.5 \pm 2.0\%$) of pine forest condition in Kaunas city was established. The worst pine condition was observed in the most polluted Kaunas city districts (Palemonas, Panemune and Petrašiūnai), in the vicinity of high-ways (“Kleboniškis-1” sample plot) and in locations of intensive recreation activities (“Eiguliai” and “Petrašiūnai-2” sample plots). Only symptoms of foliage

discoloration in “Kleboniškis-1” sample plot situated nearby Vilnius-Kaunas highway were noticed. The lowest amount of dead branches has been estimated for Scots pines growing in “Botanical Garden”, “Pažaislis” and “Kleboniškis-2”, the highest one – in “Raudondvaris-2” sample plot ($26.5 \pm 2.3\%$), where the oldest pines were observed. More than 15% of dead branches in Scots pine crowns were detected in “Kleboniškis-1”, “Palemonas-2”, “Petrašiūnai-1” and “Vičiūnai” sample plots. The standard retention of Scots pine needles that indicates an optimal tree growth conditions in Lithuanian forests is 4 years. The longest age of pine needles (3.1 ± 0.03 years) was estimated in “Botanical Garden”, “Kleboniškis-2”, “Pažaislis” and “Romainiai” sample plots. The shortest (1.9 ± 0.04 years) needle retention was estimated in “Kleboniškis-1”, “Palemonas”, “Panemunė”, “Petrašiūnai-1”, “Raudondvaris-2” and “Vičiūnai” sample plots.

Tree ring data of 12 Scots pine stands (280 sample trees) growing 3.5-5.0 km away from the cement plant “Akmenes cementas” in the direction of prevailing, non-prevailing winds and control were used for the indication of annual radial increment response to industrial pollution impact. The analysis of annual radial increment dynamic have indicated, that during period of moderate pollution (1955-1974) the annual radial increment of sample trees growing in the direction of prevalent winds came to 85-90% from control. In period of heavy pollution (1975-1988) due to great amounts of plant emissions annual radial increment have decreased by 40-45% from control. Since 1995 till 2003, due to the decrease of plant emissions, annual radial increment of pines was only 10-15% lower than control. The impact of plant emissions on the pine stands growing in the direction of non-prevalent winds is low. It was ascertained that cold and rainy periods strengthened negative impact of pollution: annual radial increment decreased by 10-12% from control during these periods. Due to decrease of plant emissions in 1995-2003

[P] Poster [L] Lecture

annual radial increment was only 7% lower than control.

Szychowska-Krapiec¹, Elżbieta, Marek Krapiec¹ and Andrzej Zielski²

¹*AGH University of Science and Technology, Cracow, Poland*

²*Nicolaus Copernicus University, Torun, Poland*

[P] The identification of wood origin in the light of new dendrochronological standards

Common usage of oak and, to a lesser degree, pine timber as materials for construction and transport utilities had led to its deficiency already in Middle Ages. Owing to that, wood became a subject of the large-distance trade. Exportation of timber from Poland commenced in the thirteenth century and in a relatively short period of time timber trade developed in the whole of the Vistula river basin, up to Cracow and Przemyśl. Timber delivered to the Baltic harbours was partly used for local purposes as well.

In the last years, thanks to development of a net of Polish local and regional chronologies, it became possible to identify the origin of wood. Some years ago it was NE Poland that was dendrochronologically a relatively poorly recognised terrain. Therefore, with the aim of filling the gap, timbers from that region were gathered in the laboratories of UMK in Toruń and AGH in Cracow. Currently the collected material enabled construction of regional chronologies for pine and oak spanning almost whole of the last millennium. Newly established pine chronologies cover the periods: 1168 - 2000 for the Kujawy-Pomerania region, and 1081 - 1408 AD and 1410 - 2003 AD for the Mazury and Suwalki Pomerania. Two regional oak standards were produced for the Toruń region (1060 – 1665 AD) and for the Mazury and Suwalki Pomerania (1093 - 1665 AD and 1695 - 2003 AD). This completion of the existing net of local and regional chronologies in practice permits for effective determination

of the origin of Polish timbers. As good examples may be presented analyses of wood from archaeological sites and old buildings from Toruń and Gdańsk, especially from the Green Gate in Gdańsk, where the encountered timbers proved to have been of local origin as well as brought from southern, central, and north-eastern Poland. The study was performed as a part of the AGH WGGiOŚ research project no 11.11.140.917.

Treydte¹, Kerstin, Jan Esper¹, D. Frank¹, U. Büntgen¹ and M. Schmidhalter²

¹*Swiss Federal Research Institute for Forest, Snow and Landscape - WSL, Birmensdorf Switzerland*

²*Dendro laboratory Valais, Brig, Switzerland*

[P] A drought sensitive low elevation network for the Alps

The Greater Alpine Region (GAR) provides a great resource in terms of length and spatial density of climate data. Although much work has been done, the potential of these data has not been exploited adequately and systematically. By collecting and homogenizing a huge amount of instrumental and proxy data, the EU-project ALPIMP (multi-centennial climate variability in the Alps based on instrumental data, model simulations and proxy data; co-ordinator: R. Böhm/Vienna) aims to draw a consistent and detailed picture of local to wider-regional climate variability in the region on decadal to multi-centennial time scales and along elevational gradients. Within this framework a tree ring network of dense spatial and extensive temporal resolution has been established. Investigations from selected high elevation sites have yielded detailed local and wider regional temperature reconstructions on annual to multi-decadal time scales (Frank & Esper 2004). Moreover we focussed on the development and analyses of millennial length composite chronologies (recent and historical material), with sufficient sample replication for the application of age-related

standardization techniques to be applied, so that multi-centennial scale variations can be preserved and reconstructed Büntgen et al. 2004).

Investigations on precipitation changes are more challenging because of the spatially heterogeneous nature of precipitation, and additionally, lower tree sensitivity to this parameter. Based on the methodological experiences from the above-mentioned studies, we are focussing on more local levels for reconstructing precipitation using a low elevation network of living and archaeological material. Additionally we will explore the possibility of reconstructing drought metrics, such as the Palmer Drought Severity Index (PDSI), on larger scales, as tree response to drought is likely stronger than that for precipitation alone in the GAR. We present a first 400-year precipitation reconstruction for the southern Swiss Alps (Locarno, Tessin) from *Quercus petraea* and put this in a broader context.

Viellet, Amandine
CNRS : UMR 6565 and University of Franche-Comté, Besançon, France

[P] First dendrochronological synthesis on Neolithic sites of Chalain and Clairvaux (Jura, France) - methodological risks

Absolute chronology of Neolithic sites of French Jura runs from 38th to 26th c. B.C. Since the 80's, archaeological excavations made on these two lakes permitted us to study hundreds of posts. They allow us to describe the development of settlements and villages from their building to the time they were abandoned. The demographic growth was at a maximum during the 31-30th c. and showed an important cultural change at that time with the coming of settlers from others regions. The dendrochronological studies of oak (*Quercus sp.*) and ash trees (*Fraxinus exc.*) help us to define the evolution speed between Horgen and Ferrières

archaeological cultures by observing distinct changes in uses of woods.

Vitas, Adomas
Environmental Research Centre, Faculty of Nature Sciences, Vytautas Magnus University, Kaunas, Lithuania

[L] Dendrochronological investigation on oak timber from gravel pit of Smurgainiai, Western Byelorussia

Dendrochronological investigation on subfossil oak (*Quercus robur* L.) timber from Smurgainiai gravel pit located on the bank of river Neris (Byelorussia) are presented. Collection of oak timber consists of about 100 samples. The biggest part of them was collected in the Soviet period, mainly in 1968-1972. The first radiocarbon datings were accomplished in several laboratories of the former Soviet Union and later re-dated using a liquid scintillation counter LSC-1220. The oldest found oak sample, according to its calibrated radiocarbon date, lived 5557-5336 BC. As a result of visual and statistical crossdating, tree ring series of 103 timber samples were put into eleven floating chronology fragments in the 5557 BC - 1813 AD period: 5557-5336 BC (1 sample), 4664-4491 BC (2), 4199-3838 BC (14), 3555-3110 BC (9), 3987-2877 BC (3), 1377-1294 BC (1), 1173-752 BC (10), 624 BC-277 AD (22), 336-826 AD (14), 829-1376 AD (26) and 1641-1813 AD (1). Because dated reference chronologies for oak are not constructed for Lithuania or Byelorussia, results presented are based only on radiocarbon dates and crossdating among samples.

[P] Poster [L] Lecture

Walder, Felix
Dendrolabor der Stadt Zürich, Switzerland

**[P] Estimating the number of missing
 sapwood rings in *Quercus***

Various dendrochronologists in Switzerland have, for some years now, been using a method to determine the most probable felling date of oak samples that no longer contain its outermost ring or cambium boundary (Waldkante), but still retain some sapwood. Dr. U. Ruoff developed this method and its description has already been published (1). It is based on the observation that the average width of the last heartwood rings preceding the sapwood correlates well with the actual number of sapwood rings of a given sample. A test of this method taken from about 10.000 oak samples, all with inner pith and outer cambium boundary still intact, has verified the accuracy of this procedure. In this context, the average ring-width value is calculated by using the last 9 heartwood rings and the first sapwood ring. This Function is integrated in the current 'DendroPlus' programm-packet used by the city of Zurich's tree ring laboratory. An advantage of this method compared to that of estimating numbers of sapwood rings based on a tree's age is not only in the greater reliability, but also in the fact that these estimations result from values that can be determined from practically every sample.

**Ważny¹, Tomasz, Henryk Paner²,
 Andrzej Golebiewski² and Bogdan
 Koscinski²**

¹ *Institute for the Study, Conservation and
 Restoration of Cultural Heritage, Nicholas
 Copernicus University, Torun, Poland*

² *Archaeological Museum in Gdansk, Poland*

**[L] Early medieval Gdansk/Danzig
 revisited**

Gdansk (German name Danzig) – city and port, located at the Mottlau river, near the swamps of the Vistula delta, is one of the

most important trading ports along the Baltic coast. It first featured on the pages of history in the year 997 when, according to the chronicle *Vita Sancti Adalberti*, Saint Adalbert of Prague stopped in the Gdansk castle on his way to the pagan Prussians, inhabiting the lands east of the Vistula. That year has been accepted as the date of the city's foundation. Post-WW II archaeological excavations, carried out in 1948-1974 in the completely ruined centre of Gdansk, allowed locating the early medieval town with its 17 settlement levels. The wooden constructions were dated to the period between 980 and 1308, based on the stratification of the area, analyses of pottery, coins, and other historical findings. The chronology of early medieval Gdansk has been mapped onto the historic events of the period from the 10th to the 13th century. In 1997, the city organized its millennial celebrations in the year of the 1000th anniversary of its first mention, also related to the anniversary of St. Adalbert's death.

Over the past several years, growing doubts connected among others with new findings regarding pottery and coins from the 10th and 11th centuries, brought about the undertaking of verification excavations in 2003, involving both the wooden constructions already examined and documented in the 50's and thus far unexamined city embankments. Tree-ring analyses have significantly altered the dominant views on the city's development. Of greatest importance are the dating of the oldest construction levels, shifting the city's beginnings to the 50's and 60's of the 11th century. Dendrochronology has also brought new findings concerning the functioning period of the buildings and wood utilization in the early medieval Gdansk. The town turned out to be younger by 70 to 80 years, which gives rise to new questions – first of all what the mention of 997 really refers to and where St. Adalbert really stopped on his mission to Prussia.

Weber¹, Pascale, Harald Bugmann² and Andreas Rigling¹

¹*Swiss Federal Institute for Forest, Snow and Landscape Research - WSL, Birmensdorf, Switzerland*

²*Mountain Forest Ecology, Department of Environmental Sciences, Swiss Federal Institute of Technology, Zürich, Switzerland*

[L] Competition in mixed *Pinus silvestris* L. and *Quercus pubescens* Willd. stands in Valais, Switzerland

Inter- and intra-specific competition in mixed stands of Scots pine (*Pinus silvestris* L.) and pubescent oak (*Quercus pubescens* Willd.) were investigated to better understand the pine decline in the Swiss Rhone valley. The aim was to predict the role that deciduous trees will play in these low-elevation pine-forests in the future.

Besides climatic signals, tree-ring patterns contain information about the individual conditions in which a tree has been growing, including competition. Using dendrochronological methods, we traced the growth dynamics of 500 pines and oaks for the last decades and compared the growth levels of neighbouring trees. The sampled trees belong to 15 stands for which stand dynamics and changing competition regimes were reconstructed. For the analyses, we compared growth trends of pines and oaks on three organisational levels: whole-stand, social class and individual tree. While many pines showed low tree-ring width during the most recent period, some oak trees had increased their actual growth. This observation can be interpreted as an increase in competitive strength of oak, which results in an increasing suppression of pine. To study the competition regime for every single tree, several competition indices were applied.

In a further step, negative pointer years and subsequent recovering phases were distinguished. Although in some extreme (drought) years all the trees were affected seriously, in other years pines faced a stronger growth reduction than oaks, or vice versa. The differences in the occurrence of

pointer years were found to be caused partly by species-specific seasonal growth-strategies. Furthermore, oak usually returned faster to the pre-event growth level than pine. The lag effect in the recovery of pine can be explained by a reduced photosynthetic activity because of needle loss following drought.

Our results suggest that successional dynamics towards deciduous stands are occurring in these low-elevation pine forests.

Weigl, Martin, Michael Grabner and Rupert Wimmer

Department of Material Sciences and Process Engineering BOKU - University of Natural Resources and Applied Life Sciences, Vienna, Austria

[P] Comparison of earlywood width, latewood width, and total ring-width measurements in oak

Oak has been utilized in constructions for its high strength and durability and is therefore often found in historical buildings or archaeological excavations. Oak is also a prominent species in stable isotope studies to understand better climate variability. Due to the ring-porous structure of oak and the limited number of water conducting tree-rings, earlywood width and vessel sizes have been considered in determining climatic-growth relationships. As earlywood is mostly formed with reserve-carbohydrates from the previous year the question of how much information is preserved in the earlywood-width carries information is obtruding. Oak samples from two different sites were measured for earlywood-, latewood- and ring-widths. We also compiled the so-called "transfer ring width", which is defined as the latewood-width of the current year, plus the earlywood-width of the following year $t+1$. Descriptive basic statistics of the four series was calculated and individual chronologies were built with the different parameters. The highest mean series-intercorrelation and mean sensitivity was observed for latewood

[P] Poster [L] Lecture

width. The calculated “transfer ring width” did not show major an improvement. The cross-dating of oak was statistically more significant with latewood-width compared with total ring-width.

Yonenobu, Hitoshi
Naruto University of Education, Japan

[L] Extension of the Hinoki tree-ring chronology and possible climate reconstruction for the last millennium in Japan

Monsoon plays a key role in climatic variability in East Asia. Japan locates at a the Asian monsoon front that divides the coastal mid-latitude Asia into two climatic regimes; the area to the north-west of the front is under a strong influence of the Siberian (continental) air mass, whereas the area to the south-east is governed by the Pacific (oceanic) air mass. We have developed the tree-ring chronology (ca. 250 year long) of the modern living trees of Hinoki cypress (*Chamaecyparis obtusa*), with which the early spring temperature can be reconstructed. The extension of the chronology is undertaken using dead trees that are buried or straddled by living trees (ca. 300 years old). The samples were crossdated simultaneously by visual and statistical assessment on the computer screen. Unfortunately only a few dead samples were possibly crossdated by the modern chronology. However, the resulting chronology spans 1012 years at the sample depths of 8 where the value of expressed population signal exceeds 0.85. AMS radiocarbon dating was performed for some dead samples. The radiocarbon dates were dendro-calibrated using INTCAL98 (Stuiver et al., 1998). The gap of the chronologies was estimated to be ca. 120 years around the late 16th or 17th century.

This study was partly supported by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (grant number 15500685 to HY).

Zunde, Maris
Institute of History of Latvia, Riga, Latvia

[P] Dendrochronological dating of the historical sites in Old Riga

The Latvian capital Riga (founded in 1201) is among those cities whose historic centre has a thick (3–8 m), damp, organic-rich cultural layer, so that historic wood has been preserved up to the present day. Large and medium-sized historic wooden structures have been found here, and in places these are still coming to light: the remains of wooden buildings and spreads of logs that served as street paving (12th–14th cent.), the foundations of timber-frame and masonry houses (13th–19th. cent.), as well as waterfront revetments and elements of them (13th cent. up to the present day). Smaller wooden structures have also been discovered (timber-lined wells, historic ship remains, etc.). The logs incorporated into extant buildings in Riga cover the period from at least the 17th century up to the present day.

In the period up to the mid-1990s, when systematic dendrochronological study began of historic wood in Latvia, the wooden structures at archaeologically excavated historical sites in Old Riga had not been dated, or else most of the wood samples had been lost. During the past 10 years, at the Dendrochronology Laboratory of the Archaeology Department, Institute of History of Latvia, a collection of historic wood from Riga has been created anew. So far, absolute dates have been obtained by dendrochronology for six historic sites in Riga. These cover the period from the 13th up to the 18th century. The results of comparison between the chronologies obtained confirm written historical evidence that up to the 14th century mainly pine timber felled in local forests was used in the buildings of Riga, while in later centuries building timber was supplied mainly along the River Daugava, from the upper reaches of the river and even from more distant areas.