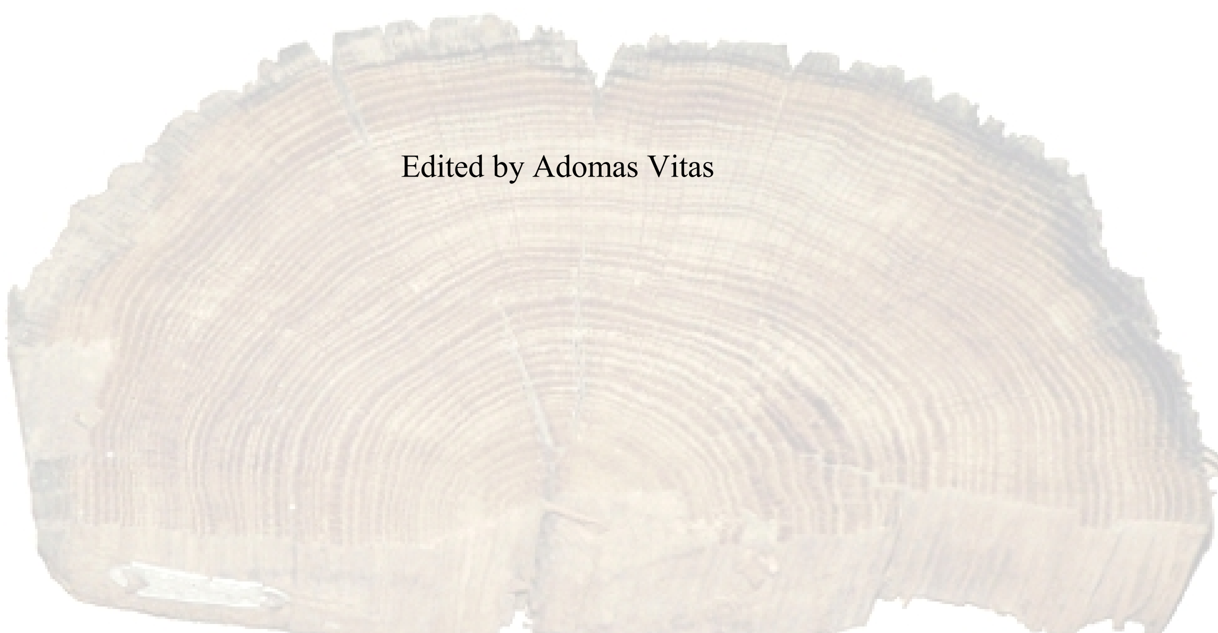
BALTDENDRO 2012

Materials of the 2nd International Conference of Baltic States Dendrochronologists

Šventoji, Lithuania
30th August – 2nd September, 2012

Organized by:

Group of Dendroclimatology and Radiometrics
Environmental Research Centre
Faculty of Nature Sciences
Vytautas Magnus University



Edited by Adomas Vitas

Scientific committee:

dr. Adomas Vitas, Vytautas Magnus University, Lithuania
dr. Iluta Dauškane, University of Latvia, Latvia
dr. Didzis Elferts, University of Latvia, Latvia
dr. Alar Läänelaid, University of Tartu, Estonia
dr. Rūtilė Pukienė, Vytautas Magnus University, Lithuania
msc. Kristina Sohar, University of Tartu, Estonia
dr. Māris Zunde, Institute of Latvian History, University of Latvia, Latvia

Organizing team:

dr. Adomas Vitas, Vytautas Magnus University, Lithuania
msc. Agnė Duobinienė, Lithuania

Contents

Programme

Thursday, 30.08.2012. Arrival and Registration

17:00 Dinner

Friday, 31.08.2012. Conference presentations

8:00-9:00	Breakfast
9:00-9:10	Opening of the conference
9:10-9:35	Māris Zunde “Remarks about some problems and tasks in tree-ring research”
9:35-9:50	Rūtilė Pukienė “A new dendrochronological data standard TRiDaS”
9:50-10:05	Didzis Elferts “Use of program R in dendrochronology”
10:05-10:30	Adomas Vitas “*Phytophthora* fungi – primary pathogens of plants”
10:30-11:00	Coffee break
11:00-11:15	Jēkabs Dzenis, Didzis Elferts “First steps in climate reconstruction from tree-rings of coniferous tree species in Latvia”
11:15-11:30	Āris Jansons “Influence of meteorological conditions on height increment of Scots pine in young and mature stands”
11:30-11:45	Roberts Matisons “Wood formation of oak in relation to climatic factors in Latvia”
11:45-12:00	Juris Rieksts-Riekstiņš “Influence of meteorological conditions on height increment of lodgepole pine in Latvia”
12:00-13:00	Lunch
13:00-13:15	Kristina Sohar, Alar Läänelaid, Dieter Eckstein “Climatic signal in tree-ring widths of pedunculate oak (*Quercus robur* L.) in Estonia”
14:00-17:00	Arbotom demonstration
17:00-18:00	Dinner
19:00	Evening of songs around the fireplace

Saturday, 01.09.2012. Conference presentations

8:00-9:00	Breakfast
9:00-9:15	Adomas Vitas “Trends of climate change in Lithuania”
9:15-9:40	Maxim Yermokhin “Dendrochronology zoning of pine stands (*Pinus sylvestris* L.) in Belarus”
9:40-9:55	Alar Läänelaid, Sjoerd van Daalen, Māris Zunde, Rūtilė Pukienė “Dating a pine sculpture of Jonah and whale”
9:55-10:10	Madara Petrova “The first dendrochronological research of wooden heritage in historic city of Jelgava, and its results”
10:10-10:25	Maris Hordo, Heiki Valdaru “Annual variation in the Scots pine diameter growth and its relation to weather variables in Järvselja thinning experimental plots”

10:25-10:55 Coffee break
10:55-11:10 Marietta Pruuli “Dendroecological case study in Käsmu peninsula”
11:10-11:25 Linda Robalte “Characteristics of forest structure in wet spruce stands in forest reserve "Gruzdovas meži"
11:25-11:40 Adomas Vitas “Are the faster growing trees resistant enough to air pollution and pests?”
12:00-13:00 Lunch
13:00-14:00 Final discussions and closing
17:00-18:00 Dinner

Sunday, 02.09.2012. Departure

8:00-9:00 Breakfast

First steps in climate reconstruction from tree-rings of coniferous tree species in Latvia

Jēkabs Dzenis, Didzis Elferts

Faculty of Biology, University of Latvia, Kronvalda Blvd. 4, LV-1586 Rīga, Latvia; jekabsdzenis@inbox.lv; didzis.elferts@lu.lv

During the last decade, many dendroclimatological studies have been conducted in Latvia. However, so far none of them have involved climate reconstruction from tree-rings. Aim of this study is to evaluate the possibility to reconstruct the past climate from tree-rings of coniferous tree species in Latvia. Wood samples of Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* (L.) Karst.) have been collected in two distinct sampling plots near to Mērsrags in west-north Latvia. To determine which climatic factors (monthly and seasonal mean, maximum and minimum temperature and amount of precipitation) have the strongest effect on both pine and spruce growth, the correlation analysis has been performed. Tree-ring width chronologies of spruce and pine had the strongest correlation with amount of summer precipitation and mean winter temperature, respectively. However, climatic factor that had the strongest correlation with tree-ring widths of both coniferous tree species was the amount of precipitation in May – June of current growing season. Linear regression models were used as transfer function for reconstruction of climatic factors that showed the highest correlation with tree-ring chronologies. 1934 to 2003 was used as calibration period and 1897-1933 as a verification period for all reconstruction models. To assess the fit and validity of transfer models, reduction of error (RE) and coefficient of error (CE) were calculated for calibration and verification periods, respectively, as well as coefficient of correlation and coefficient of determination for both periods. First results indicate that, although according to RE and CE statistics transfer models containing both spruce and pine tree-ring chronologies are statistically significant and valid for climate reconstruction, single species models are more reliable.

Use of program R in dendrochronology

Didzis Elferts

Faculty of Biology, University of Latvia, Kronvalda Blvd. 4, LV-1586 Rīga, Latvia; didzis.elferts@lu.lv

In recent years, R (R Core Team, 2012) has become an important tool in data analysis and graphical presentation. The two main reasons for that are: R is a freeware and users have flexibility to develop their own tools, functions, and assemble them in packages to distribute to other users. At present, there are more than 3800 packages additionally to base R program. The implemented methods cover almost any science field.

Special packages have been developed also for use in dendrochronology – package dplR (Bunn, 2008) and bootRes (Zang, 2012).

bootRes package implements bootstrapped response and correlation functions, as in the program Dendroclim 2002.

dplR package implements standard methods of tree-ring analysis in R – importing of different raw tree-ring width measurement formats, cross-dating, detrending, and chronology building. With dplR, it is possible to perform similar procedures as with CASE, COFECHA, and ARSTAN.

The main advantage of program R is that using only one software you can do cross-dating, chronology development, data analysis (correlation, response analysis, regression analysis), and make publication quality graphics.

References

Bunn, A.G. 2008. A dendrochronology program library in R (dplR). *Dendrochronologia*, 26: 115-124.

R Core Team. 2012. R: A language and environment for statistical computing. *R Foundation for Statistical Computing*. Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/

Zang, C. 2012. bootRes: Bootstrapped Response and Correlation Functions. R package version 1.2.2. http://CRAN.R-project.org/package=bootRes

Annual variation in the Scots pine diameter growth and its relation to weather variables in Järvselja thinning experimental plots

Maris Hordo, Heiki Valdaru

Department of Forest Management, Institute of Forestry and Rural Engineering, Estonian University of Life Sciences, Kreutzwaldi 5, 51014 Tartu, Estonia; maris.hordo@emu.ee

Tree growth changes caused by silvicultural treatments can be similar to variations resulting from climatic variation (Mäkinen, 1997). It is difficult to separate growth variation caused by human activities from those caused by other factors without detailed knowledge about the timing and intensity of silvicultural treatments (Mäkinen et al., 2002).

The aim of study was to create chronologies (early- and latewood) of Scots pine (*Pinus sylvestris* L.) for three different thinning experiment plots in Järvselja Research Station and to analyze the effect of weather and thinning on the radial growth of trees.

Increment cores were collected in 2011 from Järvselja thinning experiment plots. Early- and latewood widths were measured with an accuracy of 0.01 mm using LINTAB tree-ring measuring table with the computer program TSAP-Win Scientific Version 0.59. The measured series were visually cross-dated by comparing the graphs of tree ring-widths. Cross-dating and data quality were assessed using the computer program COFECHA. The measured series were standardized by ARSTAN. The analyses were performed to test the influence of annual variation in climate on growth as a confounding factor when quantifying growth releases (Stan and Daniels, 2010). Correlation analysis was used to test the relation between each residual chronology and monthly mean temperature and amount of precipitation data. Furthermore, the radial-growth averaging method and sensitivity analysis were applied.

References

Mäkinen, H. 1997. Reducing the effects of disturbance on tree-ring data using intervention detection. *Scandinavian Journal of Forest Research*, 12: 351-355.

Mäkinen, H., Isomäki, A. 2004. Thinning intensity and growth of Scots pine stands in Finland. *Forest Ecology and Management*: 201 (2–3): 311–325.

Stan, A.B., Daniels, L.D. 2010. Calibrating the radial-growth averaging method for detecting releases in old-growth forests of coastal British Columbia, Canada. *Dendrochronologia*: 28, 135-147.

Dating a pine sculpture of Jonah and whale

Alar Läänelaid[1], Sjoerd van Daalen[2], Māris Zunde[3], Rūtilė Pukienė[4]

Abstract

A pair of painted wooden sculptures called *Jonah exiting from the whale*, stored in the Estonian History Museum, were investigated for their dendrochronological dating. Only one statue was accessible for tree-ring measurement. It appeared to be made of pine, while the counterpart statue was made of spruce. The pine statue was dated, and the provenance of the wood was determed: most probably the pine has grown in Karelia. Tree species and manufacturing features refer to a possible different origin of the two statues.

Key words: dendrochronological dating, Jonah exiting from the whale, pine wood

Introduction

Dendrochronological dating of art pieces has become a common practice during the last half a century. In the 1960s the first successful attempts of dating oak panels of paintings were carried out in Germany (Bauch and Eckstein, 1981). Later on, dating of oak panels and sculptures was widely practiced in Europe and the United States (Klein, 1983; 2003). In the recent decades

[1] Department of Geography, University of Tartu, Vanemuise St. 46, 51014 Tartu, Estonia, alar.laanelaid@ut.ee

[2] Bergsingel 81-85, 7411CN Deventer, the Netherlands, s.vandaalen@baac.nl

[3] Institute of Latvian History at the University of Latvia, Akadēmijas laukums 1, Rīga LV-1050, Latvia, zunde@lanet.lv

[4] Group of Dendroclimatology and Radiometrics, Environmental Research Centre, Faculty of Nature Sciences, Vytautas Magnus University, Ž.E. Žilibero 6, LT-46324 Kaunas, Lithuania; National Museum, The Palace of the Grand Dukes of Lithuania, Scientific Research Centre, Katedros a. 4, LT-01143 Vilnius, Lithuania, r.pukiene@gmf.vdu.lt

dendrochronological dating of oak artifacts has been applied in several countries (e.g. Zunde, 1998–1999; Läänelaid and Nurkse, 2006; Pukienė, 2011).

Dating of wood other than oak art pieces has been not so common. Partly, the reason is that oak has been the most common wood for painting panels in Europe in 17th century. Within non-oak tree species, artefacts of pine and spruce wood are datable since long pine and spruce reference chronologies are available. The success of dendrochronological dating is related to the species-specific character of the tree-ring sequences. While oak and pine tree-ring series usually contain a high portion of common variance over a geographically wide area, spruce tree-ring series are often characterized by a notable portion of site-related variance alongside with geographically common variance. For other non-oak species like lime, birch, and alder, no long reference chronologies for dating exist. We can assume the species-specific character of their ring-width series is one of the reasons.

In the Estonian History Museum in Tallinn, a pair of peculiar wooden sculptures of little-known origin is preserved. The two horizontal painted sculptures depict Jonah departing from the whale (Fig. 1). The sculptures have no basement. They were to be hung on a wall and only one side is fully coloured. Although they depict the same scene, it can be noted that there were certain differences between the statues, possibly referring to different origins. We do not deal with the art-historical characteristics of the sculptures here. It is known that these sculptures served as shop plates. One of them hang inside Florell shop at Old Market neck in Tallinn in the 19th century (Peets, 1938), the other decorated a shop at Müüriku Landstelle near Väike-Maarja in North Estonia in 1817 (Leimus et al., 2011). The latter sculpture was presented to the Estonian History Museum in 1938.

The Estonian History Museum requested Alar Läänelaid to dendrochronologically investigate the Jonah-whale statues to establish their date. The question arose because up to that time, the art-historical assessments of age of the sculptures varied more than one century.

Material and methods

Two horizontal painted sculptures of *Jonah exiting from the whale*, both nearly two meters (170 and 180 cm) long, were dismounted for investigation and restoration. As there was no basement with cross section of wood, it was problematic to find a surface to measure tree rings. The whole surface of both sculptures was covered with paint. It appeared that in one of the sculptures (the sculpture from Müüriku shop, registration number AM K-2381) the figure of Jonah and the figure of whale were elaborated from separate pieces of wood, connected with iron nails. The parts of Jonah and the whale of the sculpture were taken apart by restorers. This left the mouth of the whale open for dendrochronological investigation. This was a cross section of a conifer trunk with many narrow tree rings. The cross section was sanded with fine-grade sandpapers using an electric drill (Fig. 2). Three longest radii of the asymmetric cross section were chosen for tree-ring measurement. Ring widths were measured in 0.1 mm units along these radii using an Eschenbach 10× measuring lense with surmounted LED light. The measurements were written down on a sheet of paper by a research assistant (Fig. 3). Beside this, the radii were photographed by partly overlapping sections with a Canon PowerShot S2 IS digital camera. Visual assessment shows the whale statue is made of pine wood.

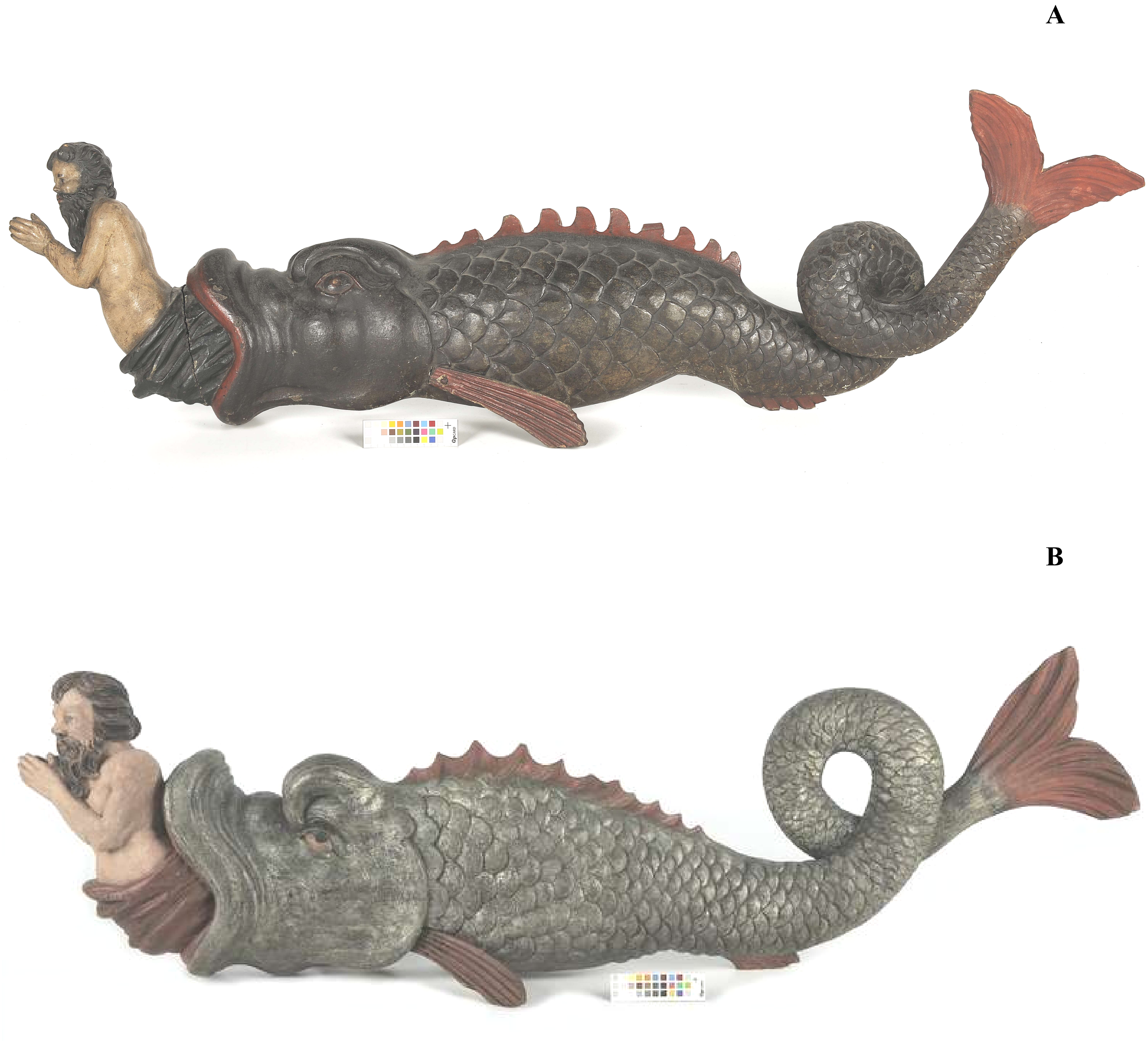


Figure 1. The two sculptures Jonah exiting from the whale: A – from Müüriku shop near Väike-Maarja, B – from Florell shop in Tallinn. Photos Pia Ehasalu

The ring-width measurements of the three radii of the sculpture were typed into a computer in program Catras (Aniol, 1983), and the series of the three radii were synchronized in the same program. An eight-character code was attributed to each series (Läänelaid, 2000). Synchronization was checked by linear graphs in the program TSAP-Win (Rinntech). The synchronized series were averaged into a mean ring-width series of *Jonah exiting from the whale*, coded as *2epjon01*, with length of 254 years. The mean series was synchronized with Estonian pine and spruce averages. After that the mean series was sent for checking to the coauthors.

Figure 2. Sandpaper helps to reveal the tree rings of the whale

Figure 3. Ring widths were measured from the mouth of the whale to the nearest 0.1 mm by the Eschenbach 10× measuring lense

Results

Synchronization of the mean ring-width series of *Jonah exiting from the whale* (from Müüriku shop) *2epjon01* (254 years) with Estonian pine averages yielded the dendrochronological date AD 1764 (Fig. 4). The highest Student's t-value 6.08 occurred with Estonian residual pine chronology.

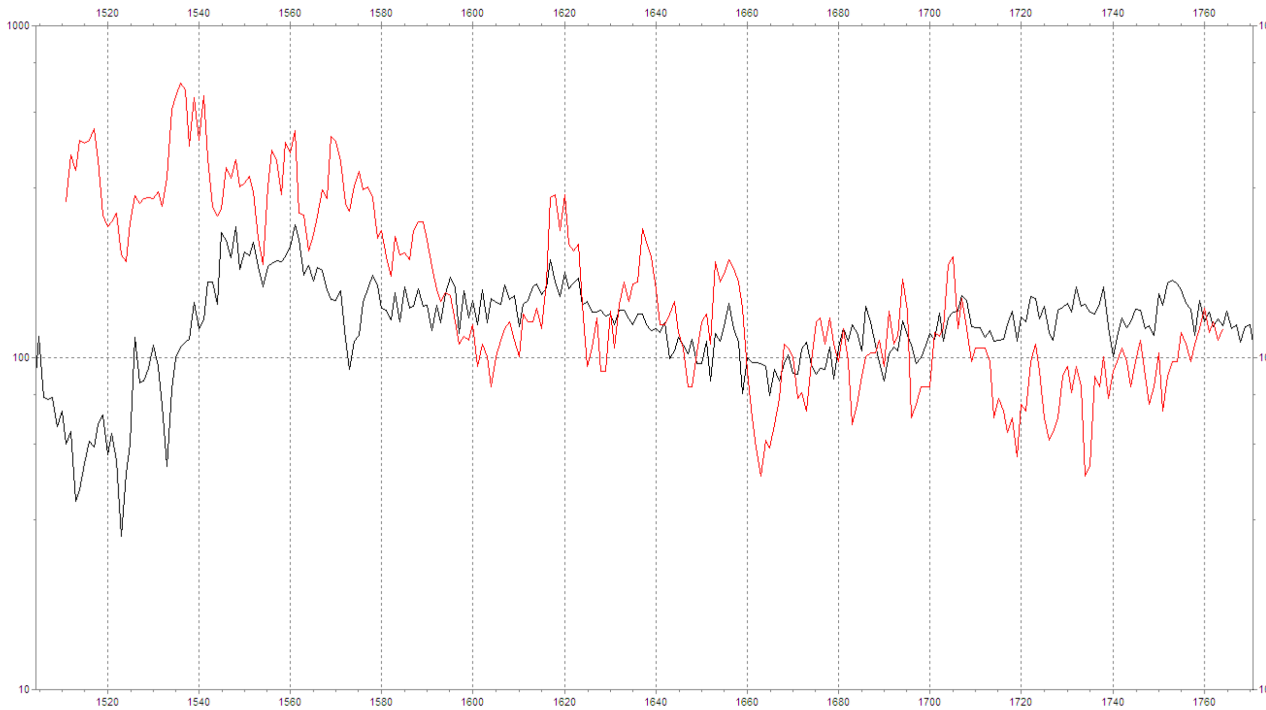


Figure 4. Mean ring-width series of the whale *2epjon01* in the synchronous position with Estonian pine chronology *3epalaja* (Student's t=5.40, Gleichläufigkeit W= 62.5 at 99.9 significance level; overlap 254 years). Abscissa – calendar years, ordinate – ring widths. The graphs are vertically adjusted to each other

Māris Zunde confirmed the date 1764 by synchronizing the Jonah-whale mean series with his references. In this position w-values (*Gleichläufigkeit*) with the chronologies Dans1758 (C. Tyers, pers. comm.), AHA_1750, RCUV1649, RCUV1689, Rutp1800 (R. Pukienė, pers. comm.), VPPT1668, as well with a new chronology Kopa1690 are in a range from 61% to 68%. However, in all cases, the trends of the compared chronologies still could be a little more similar. It is interesting that in some cases a quite good t-value with some Lithuanian and Polish chronologies corresponds to date 1507, but presumably that is a purely statistical similarity and is incorrect.

Rūtilė Pukienė confirmed the date 1764 for the Jonah-whale series with her references. The Jonah series *2epjon01* fits well in the position 1764 with her chronologies. The highest t value occurred with the average millennium pine chronology zpMLps9c: t=5.20.

Sjoerd van Daalen put a valid interval from ring 1 to 117 of the series *2epjon01*, so he checked both the whole series and that interval. There are some good matches and enough replications (Table 1). He would say 1764 is the correct date. He threw the crossdate results in GIS, and it is tempting to say the wood is coming from Finland (Karelia? Fig. 5). It is probably pine. All matches are with ITRDB-chronologies, except NLPISY, which is S. van Daalen's own chronology that is still under development.

Table 1. Synchronization of the Jonah exiting from the whale ring-width series *2epjon01* with some reference pine averages (made by S. van Daalen)

interval 1511-1628

Sample	Reference	DateS	DateR	Ol	Gl	SL	TBP	THO
2epjon01	FIN002	1764	1993	118	66.9	###	5.98	5.31
2epjon01	FINL034	1764	1732	118	67.4	###	5.27	5.27
2epjon01	SE006	1764	1888	118	60.2	#	5.79	5.17
2epjon01	FINL031	1764	1744	118	69.5	###	5.83	5.08
2epjon01	SWED305	1764	2002	118	61.9	##	5.11	4.94
2epjon01	FINL030	1764	1816	118	71.2	###	5.47	4.76
2epjon01	FINL033	1764	1742	118	69.5	###	5.12	4.76
2epjon01	FIN003	1764	1850	118	69.9	###	4.85	4.32
2epjon01	FIN016	1764	1815	118	69.5	###	4.85	4.28
2epjon01	FINL026	1764	1772	118	69.5	###	5.43	4.27
2epjon01	FIN005	1764	1718	118	66.1	###	5.15	4.25
2epjon01	LATV001	1764	1739	118	66.5	###	4.01	4.21
2epjon01	FINL036#2	1764	1831	118	66.9	###	4.35	4.03

whole series

Sample	Reference	DateS	DateR	Ol	Gl	SL	TBP	THO
2epjon01	FIN002	1764	1993	254	60.4	###	5.03	5.34
2epjon01	FINL026	1764	1772	254	62.8	###	4.57	4.71
2epjon01	SWED305	1764	2002	254	59.8	###	4.8	4.58
2epjon01	NLPISY_v1.3	1764	1692	182	62.1	###	4.7	4.46

Notes: DateS – date of the first series, DateR – date of the second series, Ol – overlap of the series, Gl – Gleichläufigkeit, SL – significance level, TBP – t-value of Baillie-Pilcher, TBO – t-value of Hollstein.

Discussion

After matching the *Jonah exiting from the whale* (from Müüriku shop) ring-width series with pine chronologies of the region in our possession, the coauthors found the same date AD 1764 for the whale series. There was still another position of the whale series with some Lithuanian and Polish chronologies pointing to date 1507, but this was rejected by M. Zunde as being incorrect.

It is important to say that the similarity of the three measured radii of the whale mouth was very high: between radii 1 and 2 t=7.67; between radii 1 and 3 t=23.90 and between radii 2 and 3 t=8.41. This similarity confirms the correct measurement of the radii. The dates of the three radii are AD 1764 for radii 1 and 3 and AD 1758 for radius 2. It means that the latter radius has 6 rings less in the outer surface. There remains the question if the outermost ring of two radii, 1764, is the last ring under the bark? When we look at the silhouette of the cross section at the 1st radius (Fig. 6), we see a section of outer surface parallel to the ring borders, while the silhouette at the location of 2nd radius does not follow the ring borders (Fig. 7). So it is probable that radii 1 and 3

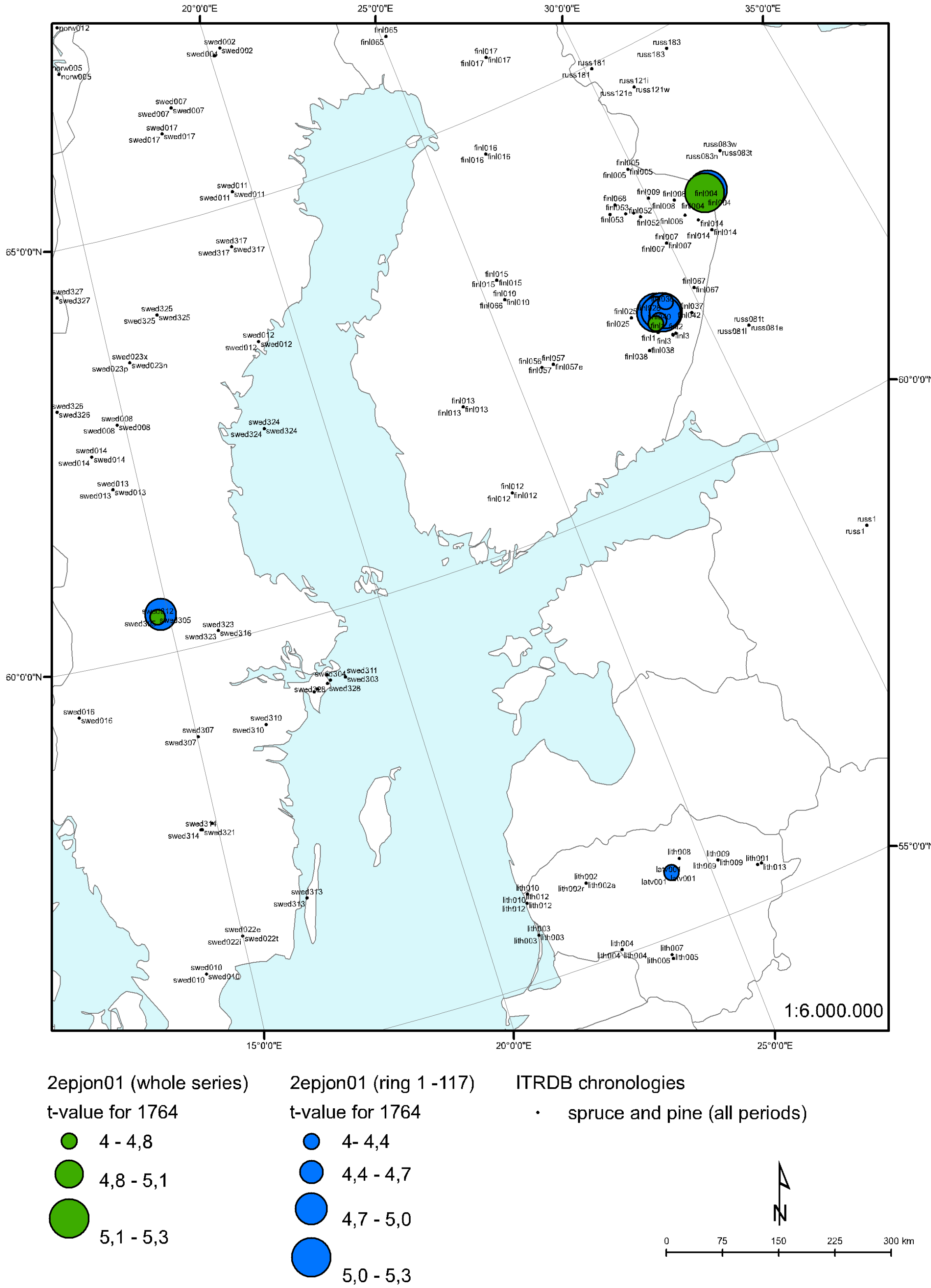


Figure 5. Geographical distribution of high t-values of the ring-width series *2epjon01* with pine and spruce references in the region of the Baltic Sea (S. van Daalen)

extend until the waney edge, while radius 2 misses six outermost rings. This means that the pine for carving the statue of whale was felled probably in winter 1764/1765. As usual for wood for art pieces, the wood was probably seasoned several years before carving the statue. Unfortunately, it was not possible to distinguish heartwood and sapwood border in the cross section.

Figure 6. The outer surface of the cross section of the mouth of the whale at radius 1. Note the parallel surface with the ring borders

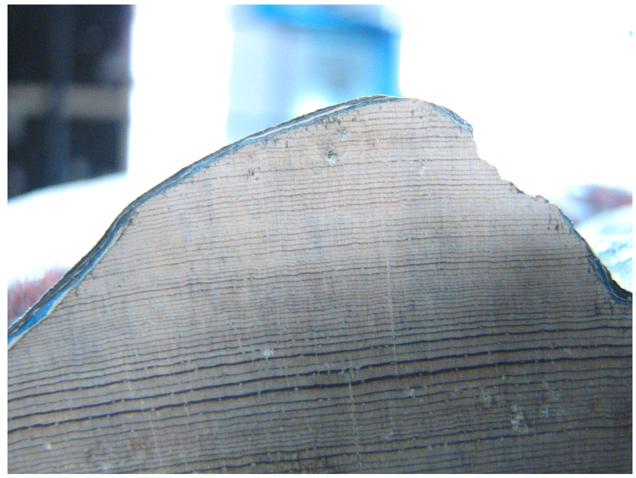


Figure 7. The outer surface of the cross section of the mouth of the whale at radius 2. The silhouette does not follow the ring borders

The possible geographical origin of the wood – eastern Finland or Karelia – is intriguing, but not impossible. Anyway, it is the most probable provenance of this wood, as all other references from the northern Europe gave lower similarity. Unfortunately, a long Novgorod pine chronology does not cover the 18th century. Considering the stressful relations in the Finnish area between Sweden and Russia in the 18th century, it would be more probable that the timber has reached the Baltic provinces of Russia (Tallinn) from the Russian side of the Finnish-Russian border. The story of Jonah is known in both Eastern Orthodox church and Lutheran church, so principally the statue could be manufactured in both Karelia or Estonia. Logically, it would be more reasonable to bring a statue from Karelia than to bring a log from Karelia for carving to forest-rich Estonia.

We did not study the tree rings of the disassembled Jonah, as the ring count was obviously smaller than that of the whale mouth. Therefore, we cannot confirm the contemporarity of the part of Jonah and the part of the whale.

The counterpart of the studied sculpture, the other statue of *Jonah exiting from the whale*, from the Florell shop (registration number AM K-5892), was almost completely inaccessible for dendrochronological investigation. Nevertheless, we were allowed to remove some paint from the hidden side of the whale to reveal tree rings (Fig. 8). Unlike the dated sculpture, the other statue is made of spruce wood. Moreover, the body of the whale consists of several pieces of timber glued together. There are a few wide rings only and floem stripes have been retained between the wood pieces. Although it was impossible to date by tree rings the other Jonah-whale statue, it is clear that its tree species and the manufacturing technique is different from the first one. These features refer to the different origin of the second statue.

Figure 8. Wide spruce rings with bark stripes in the hidden side of the whale statue from the Florell shop

Conclusions

Investigation of the two wooden sculptures of *Jonah exiting from the whale* resulted in dendrochronological dating of one of the statues (from Müüriku shop). The date of the pine of the whale is AD 1764; probably, it is the date of the waney edge. The region of provenance of the wood is probably either eastern Finland or Karelia.

It was also ascertained that the second statue of *Jonah exiting from the whale* (from Florell shop) is made of several pieces of spruce wood. The few and wide rings of the spruce timbers did not enable dating of this statue by tree rings. The different tree species and manufacturing features refer to a possible different provenance of the second statue.

Acknowledgements

We are indebted to Ivar Leimus, Pia Ehasalu for photos and the Estonian History Museum for suggesting an interesting research object for dendrochronology.

References

Aniol, R.W. 1983. Tree-Ring Analysis using Catras. *Dendrochronologia* 1: 45-53.

Bauch, J. and Eckstein, D. 1981. Wood biological investigations on panels of Rembrandt paintings. *Wood Science Technology* 15: 251–263.

Klein, P. 1983. Dating of art-historical objects. In D. Eckstein, S. Wrobel and R.W. Aniol (eds), *Dendrochronology and Archaeology in Europe: Proceedings of a Workshop of the European Science Foundation (ESF), held in Hamburg 28–30 April 1982*, Mitteilungen der Bundesforschungsanstalt für Forst- und Holzwirtschaft Hamburg 141: 209–222.

Klein, P. 2003. Dendrochronological analyses of some paintings by H. Bosch and his followers. In H. Verougstraete and R. van Schoute (eds), *Jerome Bosch et son entourage et autres etudes*, Le dessin sous-jacent et la technologie dans la peinture, Colloque XIV, Bruges-Rotterdam 13–15 septembre 2001, Leuven, pp. 3–8.

Läänelaid, A. 2000. Tree ring data from Estonia collected in 1999. *Conifer growth variability during the Holocene in Northern Europe.* Proceedings of the meeting in Lund, Sweden 16 - 19 March, 2000. Research notes, University of Joensuu, Faculty of Forestry 108: 107-117.

Läänelaid, A. and Eckstein, D. 2003. Development of a tree-ring chronology of Scots pine (*Pinus sylvestris* L.) for Estonia as a dating tool and climatic proxy. *Baltic Forestry* 9: 76-82.

Läänelaid, A. and Nurkse, A. 2006. Dating of a 17th Century Painting by Tree Rings of Baltic Oak. Baltic Forestry 12, 1 (22): 117-121.

Leimus, I., Loodus, R., Mänd, A., Männisalu, M., Raisma, M. 2011. Tallinna Suurgild ja gildimaja. Tallinn.

Peets, H. 1938. Vanu Tallinna reklaam- ja tsunftisilte. Tallinn 2. Tallinn, pp.72-73.

Pukienė, R. 2011. Potential of dendrochronological dating of wooden artefacts. Synthesis of art and science in conservation: trends and achievements. Preprints of the international conference "The 9th Baltic States triennial restorer's meeting". Vilnius, Lithuanian Art Museum, pp. 145-150.

Zunde, M. 1998–1999. Timber export from old Riga and its impact on dendrochronological dating in Europe. *Dendrochronologia* 16–17: 119–130.

Wood formation of oak in relation to climatic factors in Latvia

Roberts Matisons, Guntis Brūmelis

Faculty of Biology, University of Latvia, Kronvalda Blvd. 4, LV-1586 Rīga, Latvia; robism@inbox.lv; guntis.brumelis@lu.lv

Although oak is a widely studied species in Central Europe, there are few studies on growth of oak in the Baltic States. In Latvia, oak is located close to its northern distribution limit and information about climate growth relationships is necessary to predict future growth of oak under changing climate. Furthermore, there have been no living oak chronologies established for Latvia.

In this study material from 42 oak stands distributed across Latvia was collected. In each stand 7 –20 visually healthy dominant oaks were cored with a Pressler borer from opposite sides of the stem. Two proxies, tree-ring width (TRW) and mean earlywood vessel cross-section area (EVA) were measured. Stand and regional residual chronologies and pointer year index time-series were produced. PCA was used to determine similarities of wood formation. Climate-growth relationships (climatic signals) were determined by Pearson's correlation and response function analysis.

Climatic signals of TRW differed even at small geographic distances between stands growing in similar conditions. The PCA showed that high-frequency variation generally differed between western and eastern regions of Latvia, according to continentality. In the western region, the number of stands showing effect of temperature in spring and beginning of summer on TRW was higher, while the effect of August precipitation and July and August temperature in the eastern region in a previous year was more common. EVA showed an effect of temperature in the dormant period and spring in most of the studied stands, but the effect was stronger in the eastern region. This suggests that EVA is a more suitable proxy for temperature reconstruction than TRW.

During the 20th century, a shift of climatic signals was observed for both proxies, likely in response to climate warming. In the western region of Latvia TRW lost sensitivity to October, February and March temperature, while the negative effect of August temperature in the previous year intensified. In the eastern region, positive effect of August precipitation became significant after 1950. The changes in climatic signals suggest that climatic factors related with availability of water are becoming limiting for TRW. With warming of winter temperatures, EVA has lost sensitivity to March temperature and the effect of January and February temperature has weakened.

Occurrence of abrupt changes (pointer years) in TRW can be related with climatic extremes. Negative pointer years were observed in years with low temperature in spring and summer, while positive pointer years occurred in years with warm and moist summers. EVA showed mainly negative pointer years, which were caused by inflow of arctic air masses and extremely low temperatures in the dormant period. Two positive pointer years of EVA occurred in the eastern region in the 1980s, but it is difficult to relate these with climatic extremes.

During the past 30 years, changes in wood formation have occurred. TRW has significantly decreased and EVA has significantly increased in the eastern region of Latvia. The beginning of these changes (after 1979) might be related by weather conditions at the end of 1978, when a rapid shift of temperature between an extremely warm November (5^{o}C above average) and extremely cold December (16^{o}C below average) occurred.

The first dendrochronological research of wooden heritage in historic city of Jelgava, and its results

Madara Petrova

The Institute of Latvian History at the University of Latvia, Akademijas laukums 1, LV-1050 Rīga, Latvia; madara.petrova@gmail.com

In 2011, during archaeological monitoring in Jelgava (Mitau) were found a number of wooden constructions: the most significant of these were the wooden remains of the water-supply system (Fig. 1), and a building foundation piles near from the bank of river Driksa, at the current place of Technical Faculty of the Latvian University of Agriculture and in its surroundings. Bank of river Driksa few centuries ago was also known as a residential area for noble and wealthy. There were located, in this place, two of Count von Medem town houses, one of them also known as the "Medem's palace."

Figure 1. The water pipes of water-supply system in Jelgava

The results of dendrochronological dating showed that a 150-year-long Scots pine chronology (*Pinus sylvestris* L.), which was derived from water pipes, refers to the 19th century. Exploring the Jelgava city water system's history, during the second half of the 17th century to 1881/2 in the water system were used wooden pipes. These results suggest further study of the water system, yet the resulting research material is only from two streets.

However, recovered building's foundation piles have been dated back to the end of 18th century. Results indicate to the one of von Medem city property, which was located at Upes street 9 or "Bachstrasse", the building was completed in 1783; the indicated year corresponds to the dating results – 1781. This building's architect was famous Danish architect Severin Jensen, assistant of architect B.F. Rastrelli and also later Courland architect.

Building foundation piles were divided into two groups, that is, according to their species – Scots pine (*Pinus sylvestris* L.) and Norway spruce (*Picea abies* (L.) Karst.). From spruce samples were established 82-year long chronology. Although it is stated that spruce' shallow root system and high sensitivity makes dating very often difficult, in this case with Medem town home was a different situation. The established chronology showed a high Student's t-distribution relative to other chronologies.

Dendroecological case study in Käsmu peninsula

Marietta Pruuli

Estonian University of Life Sciences, J. Hurda 3, 51005 Tartu, Estonia; xmariettax@gmail.com

In order to maintain sustainable forestry and to improve it, one needs to understand how various factors, including natural and anthropogenic disturbances and climatic factors, influence the tree growth. In the fall of 2011, a study was carried out in Northern Estonia (Käsmu peninsula). The aim of the study was to identify and analyse the effect of disturbances (thinning, impact of pine looper moth) and climatic factors on radial growth of Scots pine (*Pinus sylvestris* L.). Sample trees were cored in three distinct study plots; the widths of tree-rings were measured and standardised. Regression and correlation analyses were carried out in order to identify the relationships between climatic variables and radial growth of trees. Climatic data (monthly average temperatures and amount of precipitation) from 1947 to 2007 was obtained from Kunda weather station. Information regarding logging activities was collected from the archives of Sagadi.

Results of the study showed the positive impact of thinning on the growth of the remaining trees. Furthermore, due to the negative impact of pine looper moth, there were some missing tree-rings in cores from one study site. The correlations between climatic factors and tree growth proved to be variable in each study site. However, generally, the influence of temperature and precipitation was not significant.

A new dendrochronological data standard TRiDaS

Rūtilė Pukienė

Group of Dendroclimatology and Radiometrics, Environmental Research Centre, Faculty of Nature Sciences, Vytautas Magnus University, Ž.E. Žilibero 6, Kaunas, Lithuania; National Museum, The Palace of the Grand Dukes of Lithuania, Scientific Research Centre, Katedros a. 4, LT-01143 Vilnius, Lithuania; r.pukiene@gmf.vdu.lt

Different dendrochronological laboratories use different dendrochronological data formats and different software for data processing. Inter-laboratory and inter-national collaboration requires unification of the standards for data sharing. Probably, the most known dendrochronological data format is so-called ITRDB (International Tree-Ring Data Bank) or Tucson format, created for the needs of handling digital dendrochronological data deposited at the International Tree-Ring Data Bank from around the world. The ITRDB was founded by Dr. Harold C. Fritts at the Laboratory of Tree-Ring Research, The University of Arizona, in 1974. In 1990, the ITRDB found its place among the National Oceanic and Atmospheric Administration (NOAA) paleoclimatic databases and became a part of the new World Data Center for Paleoclimatology at the National Geophysical Data Center (NGDC) in Boulder, Colorado, USA. Because of the open-access policy, ITRDB, its data formats and data processing software were adopted by the scientific community. Until now, ITRDB data standard is the most popular format for data sharing, and almost every dendrochronological program has a converter to convert its own data format to ITRDB format.

Since the times when the ITRDB data format was created, computing technologies have made a great advance. The 30-years old ITRDB format is very compact but doesn‘t manage to store much of metadata. For handling larger amounts of digital data descriptions and easier sharing of both data and metadata, a new dendrochronological data standard TRiDaS (Tree-Ring Data Standard) has been recently created.

This universal data standard uses XML schema and was developed by Peter Brewer for the data archiving project DCCD (the Digital Collaboratory for Cultural – Historical Dendrochronology) supervised by the Netherlands Culture Heritage Agency. For converting other formats to TRiDaS, a converter program TriCYCLE was created.

Besides to dendrochronological data (e.g. ring width) values, TRiDaS stores a great amount of metadata. The metadata is organized in a hierarchic way. There are eight data entities: Project, Object, Element, Sample, Radius, MeasurementSeries, DerivedSeries and Value (Jansma et al., 2010). Where appropriate, the TRiDaS uses standardized vocabularies and thesauri in the descriptions.

The universal data standard TRiDaS is implemented in the dendrochronological database program TRiDaBASE (http://vkc.library.uu.nl/vkc/dendrochronology/Pages/Default.aspx; Jansma et al., 2012) and in the digital repository of dendrochronological data for cultural studies DCCD, holding data from more than ten countries (http://dendro.dans.knaw.nl/). More and more organizations adopt dendrochronological database systems (e.g. Tellervo http://www.tellervo.org) based on TRiDaS that shows a potentiality of this new data standard.

References

Jansma, E., Brewer, P.W., Zandhuis, I. 2010. TRiDaS 1.1.: The tree-ring data standard. *Dendrochronologia*, 28 (2): 99-130.

Jansma, E., van Lanen, R.J., Sturgeon, K., Mohlke, S., Brewer, P.W. 2012. TRiDaBASE: A stand-alone database for storage, analysis and exchange of dendrochronological metadata. *Dendrochronologia*, 30 (3): 209-211.

Characteristics of forest structure in wet spruce stands in the forest reserve „Gruzdovas meži”

Linda Robalte, Guntis Brūmelis, Roberts Matisons

Faculty of Biology, University of Latvia, Kronvalda Blvd. 4, LV-1586 Rīga, Latvia; linda.robalte@inbox.lv; robalte.l@gmail.com; guntis.brumelis@lu.lv; robism@inbox.lv

In Latvia, it is important to determine to what extent spruce forests are natural. Forest drainage has led to a loss of most of the natural moist spruce forests in Latvia. Natural forest stands are now rare, and also research on these forests is insufficient. To determine the occurrence of natural spruce forests in Latvia, from the Latvian State Forest register, we selected stands older than 190 years and with an area greater than 4 ha. In Latvia, area of spruce stands older than 190 years is 16.6 ha. From several potential territories, for a preliminary study site, we selected the nature reserve “Gruzdovas meži”, which had spruce age recorded as 192 years and had an area 5.6 ha. In the reserve, we established four sampling plots each with area 20x50 m. The sampling plots were established in a *Myrtillosoi-polytrichosa* stand. The dominant species in the stand were *Sphagnum girgensohnii*, *Sphagnum wulfianum*, and *Pleurozium schreberi*. To characterize the stand, data on tree species composition, age, diameter, and height were collected. Release-suppression analysis was conducted to determine times of major disturbance. The obtained results showed a multi-age structure, which is characteristic of old, natural forests. The oldest spruce was 273 years old with a diameter 31 cm. Spruce trees growing grew in heterogeneous environmental conditions, resulting in a non-significant relationship between diameter and age. High numbers of spruce seedlings indicated that regeneration was evident in the stand. The oldest black alder was 166 years old, which also indicates the naturalness of the stands. This stand is the oldest known spruce forest in Latvia. The age structure and release analysis indicated regeneration after large-scale disturbances in 1853, 1875, 1943, and 1970 (influence of wind, snow, and frost). After these years, regeneration of pioneer tree species was abundant. The amount of dead wood was 82 m^3/ha, which is high in comparison with that in Sweden and Finland.

Climatic signal in tree-ring widths of pedunculate oak (*Quercus robur* L.) in Estonia

Kristina Sohar [1], Alar Läänelaid [1], Dieter Eckstein [2]

[1] Department of Geography, Institute of Ecology and Earth Sciences, University of Tartu, Vanemuise 46, 51014 Tartu, Estonia; kristina.sohar@ut.ee; alar.laanelaid@ut.ee
[2] Department of Wood Science, University of Hamburg, Germany; d.eckstein@holz.uni-hamburg.de

According to the principle of aggregate tree growth, climate is one of the main factors that affect the increment of a tree in any year. Generally, the impact is maximal near the margin of the species' ecological amplitude. In Estonia, pedunculate oak (*Quercus robur* L.) grows close to its northern distribution limit, but dendroclimatologically the species is little investigated so far. Thus, our aims were to construct oak tree-ring chronology, to analyse its response to climate, and explore its potential as a climatic proxy for this region.

Based on 162 samples from living oaks from 12 sites all over Estonia, we have created three standardised sub-chronologies: AD 1646–2008 for the western, AD 1736–2011 for the northeastern, and AD 1912–2011 for the southeastern part of the country. We correlated the tree-ring width indices with monthly mean temperature, April, May, June monthly minimum temperature, monthly precipitation sums, and monthly North Atlantic Oscillation (NAO) indices. We calculated the pointer years for the sub-chronologies. Finally, the weather variable that most affected tree growth was chosen for the retrospective reconstruction. We validated this reconstruction using the historical extraordinary weather event records.

Our preliminary results show that oak growth in the western region of Estonia is positively influenced by summer (June to August) precipitation; in pointer years the tree-ring width appears to be related to June precipitation. Thus, moisture at the beginning of the growing season is essential to trees on shallow soils, which dominate at the western sites. On the other hand, the growth of the northeastern oaks on thicker soils is mainly limited by June temperature, more evidently during the pointer years. And, in the southeastern sites, both July precipitation and temperature are important to tree increment, but the relationships are weaker.

It appears that occasional frosts at the beginning of vegetation periods do not significantly affect total ring width extension during the growing season anywhere in Estonia. The positive relationship between March NAO-index and tree-ring width is significant and stable only in the northeastern region. Probably, a high March NAO-index stimulates an earlier onset of the vegetation period.

The first attempt to reconstruct the western Estonian summer rainfall is not promising as the model has low predictive skill describing only less than a quarter of the variance in actual precipitation. In addition, the extreme droughts reported in the historical sources coincide only partly with the negative pointer years identified in the chronology. This suggests that extreme events may be local in their character.

***Phytophthora* fungi – primary pathogens of plants**

Adomas Vitas

Vytautas Magnus University, Faculty of Nature Sciences, Environmental Research Centre, Group of Dendroclimatology and Radiometrics, Ž.E. Žilibero 2, LT-46324 Kaunas, Lithuania; a.vitas@gmf.vdu.lt

Phytophthora is a genus of plant damaging *Oomycetes* fungi. *Phytophthora* species are causing economic losses on crops and environmental damage in natural ecosystems worldwide. *Phytophthora infestans*, causal agent of the Great Irish potato famine in 1845-47 was the first described *Phytophthora* species in 1876 (Erwin and Ribeiro, 2005). Because of cell walls constructed of cellulose and diploid chromosomes, *Phytophthora* fungi are resistant to typical fungicides and are highly adaptable to the changing environment. *Phytophthora* infection is transferred through the soil and air. Therefore, *Phytophthora* species are classified into airborne and soilborne. Soilborne *Phytophthora* species are causal agents of root and collar rots, bleeding bark cankers on stems, and diseases of seedlings of many deciduous and conifer species (Fig. 1). Airborne *Phytophthora* species are causing aerial bark cankers, twig dieback and leaf necroses (Fig. 2). So far, more than 100 *Phytophthora* species have been described, and it is likely that worldwide 200-600 species exist being still unknown to science (Brasier, 2009).

Phytophthora fungi invade only healthy plant tissue or fresh wounds and the infection in roots of woody plants starts to be visible only after several years, when at least 50% of lateral roots are lost (Erwin and Ribeiro, 2005). *Phytophthora* infection is responsible for the big amount of crown diseases, collar rots (up to 90%), and fine root diseases (>66 %) of woody plants (Erwin and Ribeiro, 2005; Jung 2005). Different methods have been used for identification of *Phytophthora* infection. They include visual typical symptoms on trees, lateral flow device for in-field testing, morphology of colonies from isolated material, and molecular markers. However, the morphological identification is complicated, because of small morphological differences among species and variable characteristics (Erwin and Ribeiro, 2005). The predisposing factors to *Phytophthora* infection include climatic extremes, infected plant stock, high soil moisture, global climate warming, and reduced vitality of trees (Erwin and Ribeiro, 2005).

So far, 333 trees with symptoms typical to *Phytophthora* have been recorded across 22 districts of Lithuania. At present, the most susceptible tree species in Lithuania are: *Acer*, *Alnus*, *Salix*, and *Betula* genus comprising 51%, 16%, 8%, and 6%, respectively. The young infected trees predominate (51%). Moreover, disturbed trees usually grow near the water sources, e.g. banks of rivers and ponds (Vitas et al., 2012).

Figure 1. A bleeding bark cancer on the stem of young *Acer platanoides*, Kretinga Park, 2011

Figure 2. Leaf necrosis on rhododendron, tentatively caused by airborne *P. ramorum*, Kaunas Botanical Garden, 2012

References

Brasier, C.M. 2009. *Phytophthora* biodiversity: how many *Phytophthora* species are there? In: Goheen, E.M., Frankel, S.J., eds. *Phytophthoras in Forests and Natural Ecosystems*. Albany, USDA Forest Service. General Technical Report PSW-GTR-221, 101–115.

Erwin, D.C., Ribeiro, O.K. 2005. *Phytophthora* diseases worldwide. APS Press, St. Paul, 562 pp.

Jung, T. 2005. Life cycle and pathological importance of the genus *Phytophthora*. Report. *Phytophthora* research and consultancy, Brannenburg, 5 p.

Vitas, A., Oszako, T., Nowakowska, J.A., Sikora, K., Stankevičienė, A. 2012. First records of *Phytophthora* spp. based on DNA analysis in Lithuania. *Folia Forestalia Polonica*, 54 (1): 25-31.

Are the faster growing trees resistant enough to air pollution and pests?

Adomas Vitas

Vytautas Magnus University, Faculty of Nature Sciences, Environmental Research Centre, Group of Dendroclimatology and Radiometrics, Ž.E. Žilibero 2, LT-46324 Kaunas, Lithuania; a.vitas@gmf.vdu.lt

The growth differences of trees judged to be sensitive to air pollution and *Phytophthora* sp. fungi have been investigated. Three experimental pine stands were selected in the vicinity of a nitrogen fertilizer plant 'Achema', approximately 35 kms from Kaunas. The plant was founded in 1965; the composition of aerial emissions in the 1980s was following: carbon monoxide – 26.5%, sulphur dioxide – 12.4%, nitrogen oxides – 10.3%, ammonia – 10.1%, and mineral dust – 37.3%. The first signs of forest damage at the local level were observed in 1972, and the forest damage increased until 1979. The recovery of the severely damaged pine stands located within a 5 km distance from the plant began in the transition from the 1980's to the 1990's when emissions were dramatically reduced (Fig. 1, left).

Samples were taken from 202 mature pines of dominant, codominant, and emergent crown classes. The strongest growth depression period was noticed in 1979-1987. The average tree-ring widths in this period were reduced to less than 0.50 mm per annum. The average decrease in the radial growth of sensitive trees during the 1979-1987 period was 1.6 mm, while the growth of resistant trees decreased by only 0.2 mm. The trees judged to be sensitive to pollution grew much faster in the period before the pollution in comparison to resistant trees – 2.48±0.08 mm and 1.56±0.08 mm, respectively (Fig. 1, right).

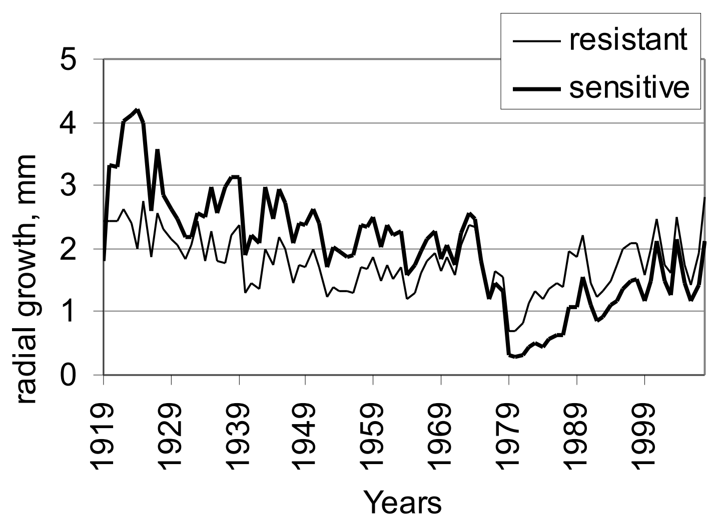


Figure 1. Damaged forest stand located 3.4 kms from the Plant (on the left) and the radial growth dynamics of the most sensitive and comparatively resistant pines to pollution (on the right)

The radial growth dynamics of the infected by *Phytophthora* sp. fungi and healthy black alder (*Alnus glutinosa* L.) trees was assessed in Kaunas Botanical Garden. The alder (Fig. 2, left) is infected tentatively *Phytophthora alni* sp. The radial growth dynamics of both trees are presented in Fig. 2, right. A sharp decrease in the radial growth is seen for infected trees from 2003-2004. It indicates the advanced infection in 2003-2004 with a considerable loss of fine roots. The radial growth of the infected and healthy trees in 1991-2002 was 8.9 and 7.2 mm, respectively (p=0.01). It proves that the infected tree by *Phytophthora* has grown much faster before the infection has spread in it in comparison to the healthy tree.

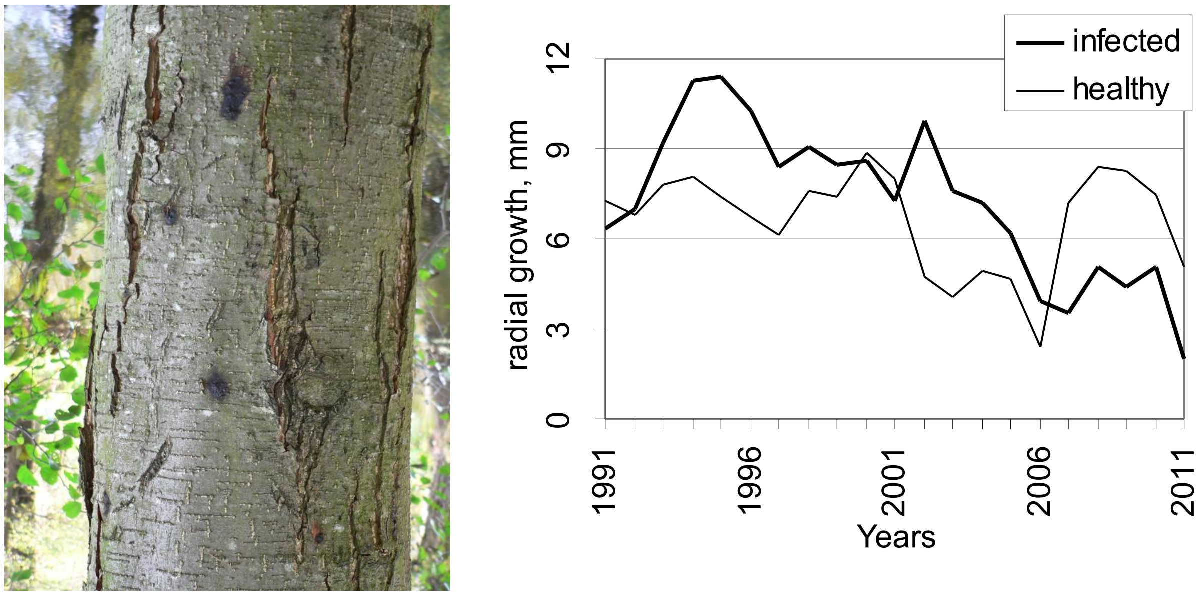


Figure 2. The alder infected by *Phytophthora* sp. (on the left) and the radial growth of infected and healthy tree (on the right)

References

Vitas, A. 2011. Interpopulation variation of individual tree response to pollution: evidence from the Scots pine dendrochronological data. *Polish J. Environ. Stud.*: 20 (1): 215-220.

Trends of climate change in Lithuania

Adomas Vitas

Vytautas Magnus University, Faculty of Nature Sciences, Environmental Research Centre, Group of Dendroclimatology and Radiometrics, Ž.E. Žilibero 2, LT-46324 Kaunas, Lithuania; a.vitas@gmf.vdu.lt

The trends of climate change were assessed in air temperature and precipitation series of Vilnius MS from 1900 to 2011. The variation of air temperatures was studied from daily values of Vaišnoriškė MS from 1976-2011. The increase in air temperature has been evident during all the months according to Vilnius MS, while the increase in winter and spring is the most pronounced. The air temperature for January, March, April, and August have increased by 1.5-1.9°C during 1900-2011 (Fig. 1). The increase in February, July, October, November, and December ranges from 1.0 to 1.4°C, while the increase in May, June, and September was the slightest (0.3-0.4°C).

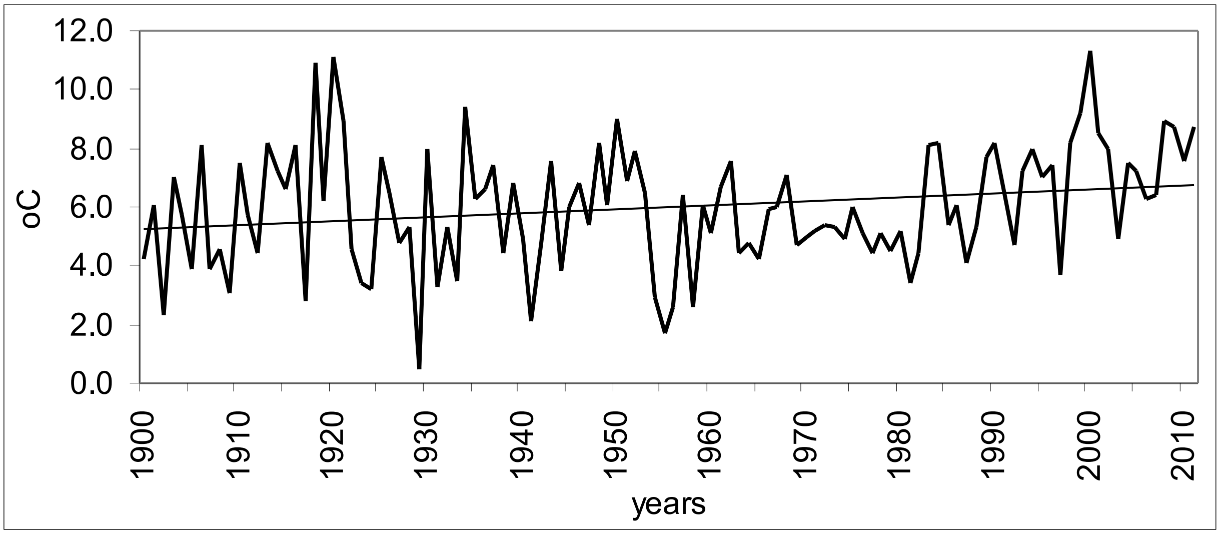


Figure 1. The dynamic and approximated trend-line of April air temperature in Vilnius from 1900-2011

The monthly amount of precipitation is notably increasing for winter and autumn months (8-17 mm per month) according to Vilnius MS, except for November in which the increase in 1 mm is evident. The increase of precipitation in spring is less pronounced (6-12 mm). During the beginning of summer, the amount of precipitation has increased slightly (in June and July by 1-7 mm), while in August the decrease in 26 mm is noticeable (Fig. 2).

The analysis of air temperature daily values in Vaišnoriškė MS from 1976-2011 shows that the temperatures' extremity, expressed in standard deviation, is increasing from 2004-2011 in January, February, May, and June (Fig. 3).

The stability of climate – radial growth relationship was calculated using a program DendroClim 2002. The analysis was accomplished using data of air temperature and precipitation from Kaunas MS and the radial growth of European larch (*Larix decidua* Mill.) from Višakio Rūda forest. The calculations were performed in fifty-years moving intervals. Results indicate the decrease in relationships with air temperature in June because of gradually increasing of air temperature and insufficient amount of precipitation in June (Fig. 4). Therefore, the importance of precipitation in June is increasing and the high temperature in June is already limiting the growth of larch in Lithuania (Fig. 5).

The analysed data demonstrates that the change in several climatic variables, tentatively related to global warming, is already reflected in relationships with the radial growth of trees. So far, the positive relationship with air temperature in spring is stable because the increase in air temperature is compensated by increased precipitation during the aforementioned period.

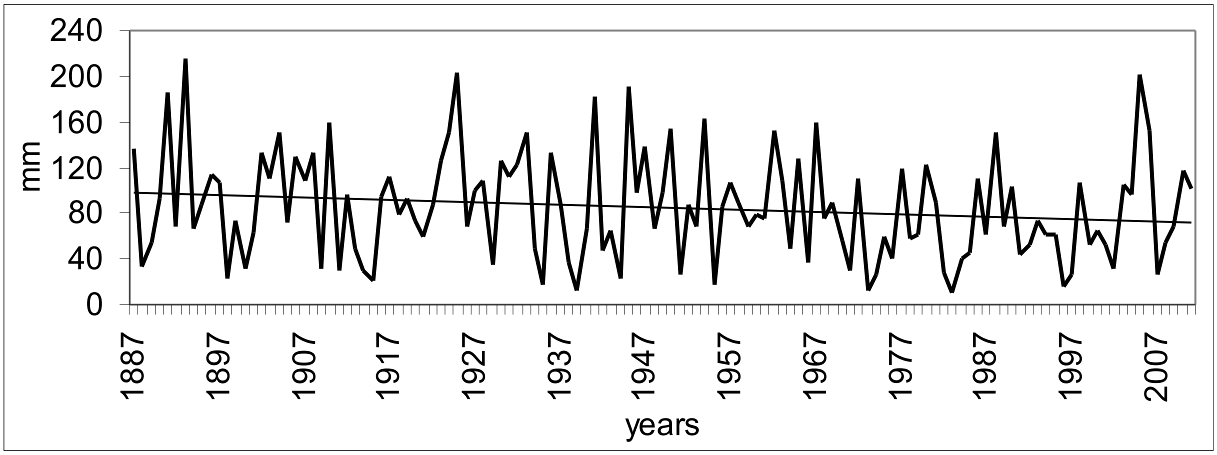


Figure 2. The dynamic and approximated trend-line of August precipitation in Vilnius from 1900-2011

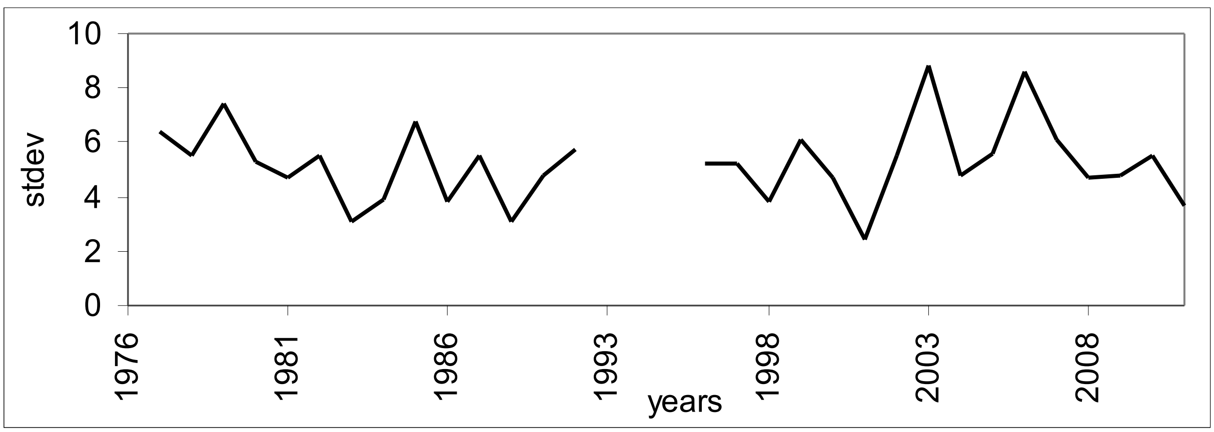


Figure 3. The standard deviation of air temperature calculated from daily values in Vaišnoriškė MS in January from 1976-2011 indicating the increased variation from 2004

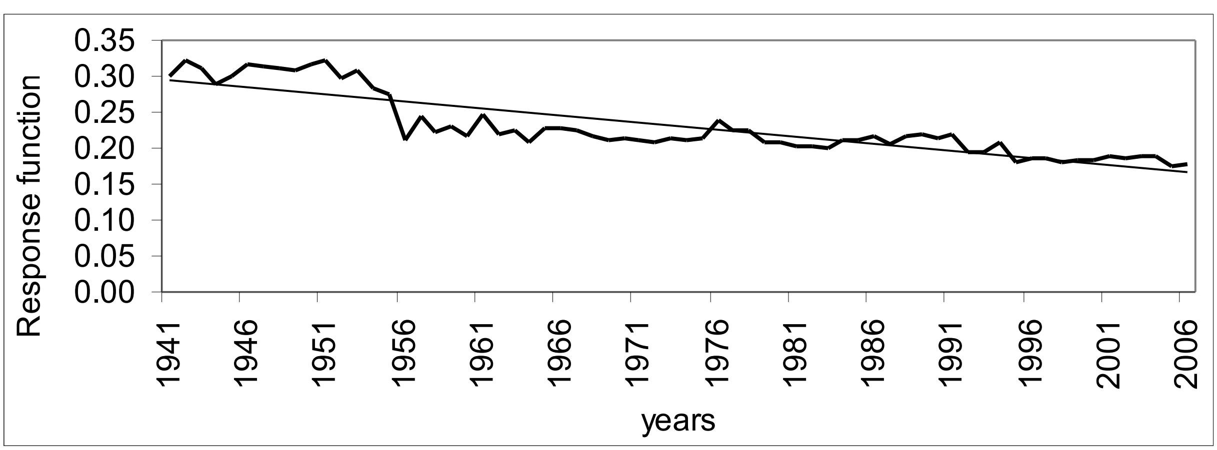


Figure 4. Response function coefficients of fifty-years moving intervals between the radial growth of European larch and air temperature in June and approximated trend-line

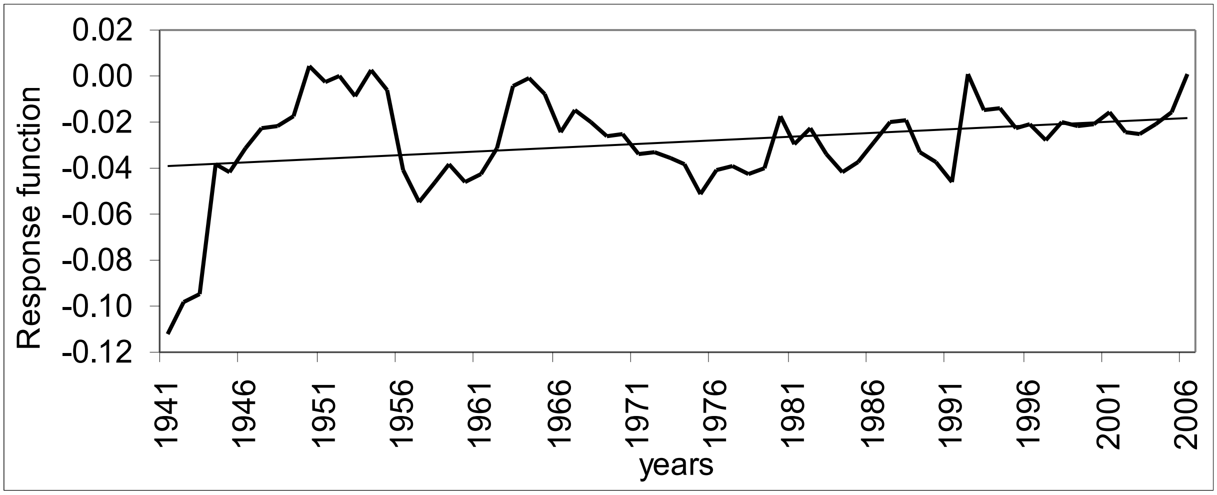


Figure 5. Response function coefficients of fifty-years moving intervals between the radial growth of European larch and precipitation in June and approximated trend-line

Dendrochronology zoning of pine stands (*Pinus sylvestris* L.) in Belarus

Maxim Yermokhin, Vasiliy Saveliev

Institute of Experimental Botany of National Academy of Science of Belarus, 27 Academicheskaya Str., Minsk, 220072, Belarus; yermaxim@yahoo.com

Dendrochronology studies in regions with temperate climate are often difficult due to the absence of clear factors that limit tree growth. The relationship between tree growth and climate data can be very different at various directions from meteorological stations. The problem can be partly solved by constructing master-chronologies from a large number of trees within the region with similar environmental conditions. This allows to eliminate peculiarities of individual stands caused by different damage (windfalls, insect pests, harvesting, fires, etc) and to clearer identify the external signal which is the same for all stands. There is a separate task to select forest type that is the most sensitive to external impact because the reaction of trees on climate strongly depends on soil conditions.

Various studies demonstrate differences in a reaction of trees of the same species to climate factors in different regions of Belarus (Smolyak et al., 1986, Bolbotunov, 1986; 1999; Yermokhin and Sudnik, 1999; Bolbotunov et al., 2006; 2008; Kiselev and Matushevskaya, 2004; Yermokhin, 2008; 2010; 2011). At present, researchers develop the master chronologies based on geobotanical zoning. However, such approach does not always provide a satisfactory result. According to our previous studies, trees of Norway spruce (*Picea abies* (L.) Karst.) located in different geobotanical subzones demonstrate high similarity in growth (Yermokhin, 2008). Therefore, there is a necessity to identify the dendrochronologically homogenous regions. Taking into account that variability of annual growth is significantly determined by climatic factors, we can expect that dendrochronological zoning will be rather similar to the agro-climatic zoning than to the geobotanical.

The paper presents preliminary results of the dendrochronological zoning of Belarus. The tree-ring chronologies of pine (*Pinus sylvestris* L.) from *Pinetum pleuroziosum* forest type were selected for the analysis. This is one of the most common forest types in Belarus. Forty tree-ring width chronologies from the territory of Belarus and three chronologies from the territory of the Ukraine were included in the analysis.

It has been established that significant correlation between pine chronologies is preserved at greater distance in moving from the south-west to the north-east than from the north-west to the south-east. As a result of cluster analysis, two major dendrochronologically homogeneous zones and six subzones have been identified.

Preliminary analysis of climatic data showed that the division into zones is likely related to the differences in summer temperatures, and division into subzones is connected to the temperature regime of the winter months. Further work will be aimed to develop the response functions and to detect the climatic parameters which provide significant impact to the tree growth in different dendrochronologically homogeneous regions.

List of participants

Iluta Dauškane
Department of Botany and Ecology, University of Latvia, Kronvalda Blvd. 4, LV-1586 Rīga, Latvia
e-mail: iluta@lanet.lv

Jekabs Dzenis
Faculty of Biology, University of Latvia, Kronvalda Blvd. 4, LV-1586 Rīga, Latvia
e-mail: jekabsdzenis@inbox.lv

Didzis Elferts
Faculty of Biology, University of Latvia, Kronvalda Blvd. 4, LV-1586 Rīga, Latvia
e-mail: didzis.elferts@lu.lv

Aris Jansons
Latvian State Forest Research Institute "Silava", Rigas 111, LV-2169 Salaspils, Latvia
e-mail: aris.jansons@silava.lv

Maris Hordo
Department of Forest Management, Institute of Forestry and Rural Engineering, Estonian University of Life Sciences, Kreutzwaldi 5, 51014 Tartu, Estonia
e-mail: maris.hordo@emu.ee

Alar Läänelaid
Department of Geography, Institute of Ecology and Earth Sciences, University of Tartu, Vanemuise 46, 51014 Tartu, Estonia
e-mail: alar.laanelaid@ut.ee

Roberts Matisons
Faculty of Biology, University of Latvia, Kronvalda Blvd. 4, LV-1586 Rīga, Latvia
e-mail: robism@inbox.lv

Madara Petrova
The Institute of Latvian History at the University of Latvia, Akademijas laukums 1, LV-1050 Rīga, Latvia
e-mail: madara.petrova@gmail.com

Rūtilė Pukienė
Group of Dendroclimatology and Radiometrics, Environmental Research Centre, Faculty of Nature Sciences, Vytautas Magnus University, Ž.E. Žilibero 2, LT-46324 Kaunas, Lithuania
National Museum, The Palace of the Grand Dukes of Lithuania, Scientific Research Centre, Katedros a. 4, LT-01143 Vilnius, Lithuania
e-mail: r.pukiene@gmf.vdu.lt

Marietta Pruuli
Estonian University of Life Sciences, J. Hurda 3, 51005 Tartu, Estonia
e-mail: xmariettax@gmail.com

Juris Rieksts-Riekstiņš
Latvian State Forest Research Institute "Silava", Rigas 111, LV-2169, Salaspils, Latvia
e-mail: juris.riekstins@silava.lv

Linda Robalte
Faculty of Biology, University of Latvia, Kronvalda Blvd. 4, LV-1586 Rīga, Latvia
e-mail: linda.robalte@inbox.lv; robalte.l@gmail.com

Kristina Sohar
Department of Geography, Institute of Ecology and Earth Sciences, University of Tartu, Vanemuise 46, 51014 Tartu, Estonia
e-mail: kristina.sohar@ut.ee

Bahman Sotoudeh Foumani
Islamic Azad University- Rasht Branch, Lakani, Ata-afarin, 4143664965 Rasht, Iran
e-mail: basofu@gmail.com

Argo Strantsov
Department of Forest Management, Institute of Forestry and Rural Engineering, Estonian University of Life Sciences, Kreutzwaldi 5, 51014 Tartu, Estonia
e-mail: argo.strantsov@emu.ee

Zane Striķe
Latvian State Forest Research Institute "Silava", Rīgas 111, LV-2169 Salaspils, Latvia
e-mail: zza.str@gmail.com

Agita Treimane
Department of Botany and Ecology, University of Latvia, Kronvalda Blvd. 4, LV-1586 Rīga, Latvia
e-mail: agita67@inbox.lv

Adomas Vitas
Group of Dendroclimatology and Radiometrics, Environmental Research Centre, Faculty of Nature Sciences, Vytautas Magnus University, Ž.E. Žilibero 2, LT-46324 Kaunas, Lithuania
e-mail: a.vitas@gmf.vdu.lt

Maxim Yermokhin
Institute of Experimental Botany of National Academy of Science of Belarus, Academicheskaya 27, 220072 Minsk, Belarus
e-mail: yermaxim@yahoo.com

Māris Zunde
The Institute of Latvian History at the University of Latvia, Akademijas laukums 1, LV-1050 Rīga, Latvia
e-mail: zunde@lanet.lv