WOOD ANALYSIS OF CONSTRUCTIONS OF MEDIEVAL VILNIUS CITY

Rūtilė Pukienė

Scientific researcher, VMU Kaunas Botanical Gardens, Dendroclimachronology Lab., Ž.E.Žilibero 6, LT-3018 Kaunas, Lithuania; phone: +370 7 295677; fax: +370 7 390133; e-mail: rutile_pukiene@fc.vdu.lt

Summary

The paper illustrates the potentiality of dendrochronological analysis on historical wood from city constructions. Standard dendrochronological technique was used to examine annual ring sequences of more than 50 wood elements, excavated in Vilnius Grand Duke's Lower Palace territory. Tree-ring series of twenty three pine and oak timbers have been crossdated and dated to calendar years against reference dendro-chronologies from Poland and Britain. 475 year long annual radial growth chronology for Pinus sylvestris, spanning 1037 to 1511, and 201 year long chronology for Quercus robur, spanning 1208 to 1408, have been constructed from the examined Vilnius material. In order to construct continuous tree-ring chronologies covering all the millennium, more material of historical wood, especially from the 15^{th} – 19^{th} centuries, is necessary. Being a source of information old timbers in historical buildings and sites should be respected as an element of heritage and specialists – dendrochronologists should be consulted before replacing and destroying them.

Key words: dendrochronology, historical wood, medieval Vilnius

Introduction

The analysis of old timbers from historical wooden constructions by applying dendrochronological method is often used in Western Europe cities to investigate the history of the constructions and the city development, and for retrospective analysis of suburban land and forest use [1], [2], [3], etc. Such kind of investigations is very scarce in Lithuania and wood in historical buildings is usually not respected as an element of heritage and a valuable source of historical information. This negligence leads to a situation that old timbers are not protected but replaced and destroyed during repairing old buildings. Thus, a lot of information on our history is irreversibly lost. The paper illustrates the potentiality of historical wood analysis by using dendrochronological method and presents the results obtained analysing timbers from medieval Vilnius city constructions.

Material and Methods

Wooden constructions, excavated in Vilnius Grand Duke's Lower Palace territory, were the subject of this study. More than 50 elements of medieval wooden pavements, fences, poles, buildings, etc. have been sampled and analysed by dendrochronological method. Pinus sylvestris was the main species found in the constructions. Several timbers were oaks and some, especially poles, were made from softwoods. Big size and mature trees were often used

for buildings. The timber samples had 134 annual rings on an average, the longest - lived pine tree was no less than 293 years old.

Material was examined using standard dendrochronological technique. Most of the specimens were stored and measured in wet condition. The width of annual tree-rings has been measured using a stereomicroscope, on sample cross-sections along radial tracks prepared by a razor blade, normally twice per sample. Three or four radii have been used in several difficult eccentric or partly decayed specimens, but some narrow radial planks had only one measurement radius. The tree-ring series for each radius have been plotted, synchronised and averaged to get a single tree-ring series representing the sample. The sample tree-ring series were then synchronised among themselves and against existing dated reference chronologies in order to establish the annual rings of different specimens that were formed exactly in the same year and to date them. The date of the latest ring of the specimen is the most close, or sometimes coincide, to the date of using that timber in the construction. Synchronisation has been carried out using standard technique [4], by looking for the position of tree-ring series overlap with highest values of statistical correlation and best visual crossmach between the series. Student's t-value of correlation coefficient, calculated according Baillie and Pilcher [5], was the main statistical test for correlation between the series in comparison.

RESULTS AND DISCUSSION

After synchronising the series of annual rings, representing individual trees, several groups of construction elements have been crossdated. One group of pine timbers consisted mainly of pavement planks (timbers No ZP98_36, ZP98_36a, ZP98_22, ZP98_33 and a pole ZP98_11) and was named as an 'early pavements' group. Crossdating revealed two phases of pavements separated by about one hundred years. 346 years long annual radial growth chronology for this group has been constructed by averaging synchronised tree ring width sequences.

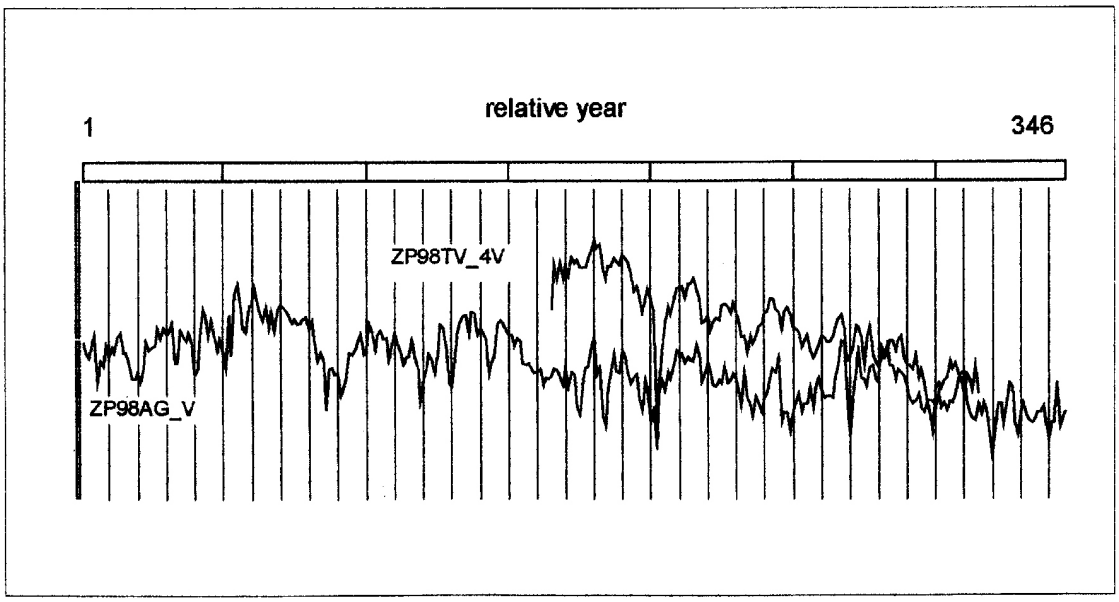

Fig. 1. Relative position of the radial growth chronologies for "early pavements" (ZP98AG_V) and "fence planks" (ZP98TV_4V) groups of crossdated timbers.

Another group was composed of plank samples No ZP98_24, ZP98_24a, ZP98_30, ZP98_49 and was named as a 'fence planks' group. The mean chronologies for the 'early pavements' and 'fence planks' groups were crossdated relative to each other (see figure 1). Tree ring series of two more timber samples (beams No ZP98_18 and ZP98_05) have been crossdated against the samples of the above mentioned groups. Annual radial growth sequences of all these crossdated timbers have been combined to construct a mean 379 years long radial growth chronology 'ZP98-07v'.

Six pine timbers from a wooden construction close to the basement of the Grand Duke's Palace (No ZP99_03, ZP99_04, ZP99_05, ZP99_06, ZP99_08 and ZP99_12) and a pole above the 'Wooden construction' No ZP99_01 have been crossdated relative to each other. Their annual ring sequences have been dated to calendar years against Polish reference chronology PLPINUS (author A.Zielski). Calendrically dated tree ring sequences of the timbers from the 'Wooden construction' helped to date the chronology ZP98-07v and all the timbers this chronology encompasses. Basing on all the dated Pinus sylvestris timbers, 475 year long annual radial growth chronology, spanning 1037 to 1511, was constructed.

Five oak beams from the 'Wooden construction' (No zp98_34, zp98_35a, zp99_09, zp99_10 and zp99_11) formed a group of oak timbers. Tree ring width series of these timbers have been crossdated and an average 201 years long chronology of annual radial growth for oak has been constructed. Tree ring series of the beams and the chronology have been dated to calendar years against reference oak chronologies from England BALTIC1, BALTIC2, WINCHCOL (authors J.Hilliam, I.Tyers, D.Mills). These reference chronologies are built up using oak timbers that were imported to England from the Baltic region in medieval times. A good agreement of ring width fluctuations in these chronologies to those in tree ring series of our oaks confirms the provenance of those imported timbers. The last year of our chronology is dated to 1408 and all the chronology for Vilnius oak covers the years 1208 to 1408.

All the calendar dates of the dated Pinus sylvestris and Quercus robur timbers from examined constructions of medieval Vilnius city and the position of their annual tree-ring sequences in a time scale are presented in figure 2.

Most of the analysed samples of archaeological timber had not complete set of all the annual rings produced by the tree. Last rings were usually lost or undetermined due to wood decay or mechanical deformation of outer layers. In this case it was impossible to establish the date of tree felling and using it in the construction with accuracy of one year. But most of the examined pine timbers had more or less sapwood rings that allowed us to estimate the approximate number of lost rings. The greatest number of sapwood rings found in the examined pine trees was 82 rings. If the number of sapwood rings is close to that, we can assume that not many rings are lost and the tree felling year is close to the year of formation of the last preserved ring.

The last rings of the earliest dated samples are dated to 1275 and 1277 (two pavement planks) and to 1281 (a pole No. zp98_11 with a 'bark ring'). This means, Vilnius had a wood-paved road already at the end of the 13th century. According to archaeologists, there are up to 10 layers of medieval Vilnius wooden pavements conserved in deposits. We hope this unique material will not be destroyed during present day constructions and will be accessible for dendrochronological investigation in some future.

The last rings of most fence and some pavement elements (timbers No zp98_24, zp98_24a, zp98_30, etc.) are dated to the middle – third quarter of the 14th century. These wooden constructions were in use before expanding stone buildings of the Palace around the turn for the 15th century.

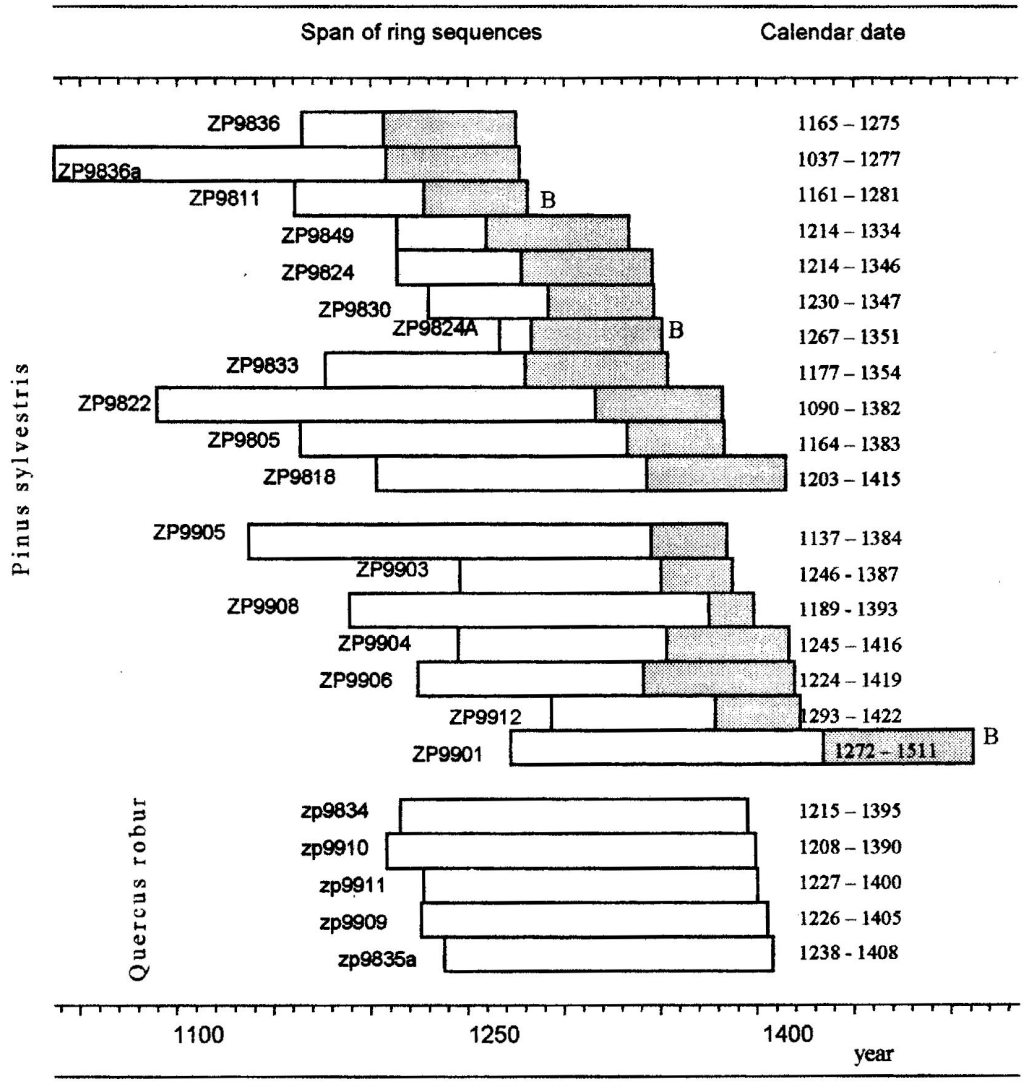

Fig. 2. Bar diagram of years spanned by the tree ring series of dendrochronologically dated timbers from constructions of medieval Vilnius city. Sapwood zone of a timber is shaded. 'B' means the timber has the last ring produced by the tree ('bark ring') preserved.

Some other timbers and the 'Wooden construction' at the base of the Palace are dated to the first quarter of the 15th century. The latest ring of one pine log of the 'Wooden construction' (No zp99_12) is dated to 1422. One plank from this construction (No zp99_06), with the last ring dated to 1419, has 79 sapwood rings and this means the date of the construction should not be later than some few years after 1419.

Dating of oak beams from the same construction corroborates the dating of the 'Wooden construction' pine timbers: the latest ring of one oak log (zp98_35, no sapwood rings

preserved) is dated to 1408. Seven years should be added to that date as a minimum, because such is determined to be the minimal number of oak sapwood rings [6]. Average number of sapwood rings in oaks differs depending on geographical region [7], but for oaks growing in nearby Poland is estimated as 13 – 19 [8]. So, the most likely felling date for the oak timber from the 'Wooden construction' is after 1421.

The latest dated timber of the examined material is a pole above the 'Wooden construction'. The last ring of it is dated to 1511. This is also the tree felling date, as the last preserved ring of the timber is close to bark ('bark ring').

Conclusions

Pinus sylvestris was the main tree species used in medieval Vilnius constructions. Mature trees, suitable for dendrochronological analysis, were often used in Grand Dukes' Palace territory. The examined samples had on an average 134 and as a maximum 293 preserved annual rings.
Annual ring sequences of eighteen pine samples and five oak samples were relatively crossdated and dated to calendar year against reference chronologies. 475 year long annual radial growth chronology for Pinus sylvestris, spanning 1037 to 1511, and 201 year long chronology for Quercus robur, spanning 1208 to 1408, were constructed basing on the tree ring width series of the crossdated timbers. These chronologies enable us to analyse growth fluctuations of medieval trees and to date wooden constructions and elements of those periods.
In order to build up continuous chronologies of tree growth covering all the millennium, we need more material of historical wood from different periods, especially from the 15^{th} – 19^{th} centuries.
Old wood in historical buildings and sites provides us with historical information and should be respected as an element of heritage. Specialists – dendrochronologists should be informed in a case of finding historical timbers and before replacing and destroying them.

References

1. E. Schia. Dendrochronology on material from medieval Oslo. // Norw.Arch.Rev., Vol.23, Nos. 1-2, 1990, pp. 38 – 42;
2. A.Crone. Source and supply; dendrochronological evidence from Stirling Castle, Scotland. // Dendrochronology and Environmental Trends (eds. V.Stravinskiene, R.Juknys), Kaunas, 1998, pp. 9-17;
3. D.Miles, M.Worthington. The Tower of London. // Dendrochronology and Environmental Trends (eds. V.Stravinskiene, R.Juknys), Kaunas, 1998, pp. 37-45;
4. R.Pukienė. Pinewood growth dynamics in Užpelkių Tyrelis oligotrophic bog during the Subatlantic period. // Summary of doct. diss., Institute of Botany, Vilnius, 1997, 27 P.;
5. Baillie M.G.L., Pilcher J.R. A simple crossdating programme for tree-ring research // Tree-ring Bulletin, 33, 1973, pp. 7 – 15;
6. J.Hillam, R.A.Morgan, I.Tyers. Sapwood estimates and the dating of short ring sequences. // Application of Tree-ring Studies (ed. R.G.Ward). BAR International Series 333, 1987, pp. 165 – 185.
7. T.Bartholin, N.Bonde, K.Christensen, A.Daly, O.H.Eriksen. Dendrochronological dating at the National Museum of Denmark 1992. // Arkaeologiske Udgravninger i Denmark, 1992, pp. 305 – 321;
8. T.Ważny. Aufbau und Anwendung der Dendrochronologie fur Eichenholz in Polen. // Diss., Hamburg, 1990.