DATING OF ARCHAEOLOGICAL WOOD FROM KAUNAS CASTLE BY DENDROCHRONOLOGICAL AND RADIOCARBON METHODS

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Abstract

While performing Kaunas Castle archeological excavations, 2 charcoal samples and 12 archeological wood samples were taken. They were dated according to the methods of radiocarbon and dendrochronology. As different species of wood had been used for construction, it was possible to date 7 samples by the method of dendrochronology. They were dated according to Polpinus and Plpinus – 5 (A. Zielski, 1992) by calculating coefficient (r) and criterion t of correlation. A twenty - one year moving average with one year pace was used for the dating of index for levelling the age curves.

Keywords: Kaunas castle, archeological wood, dating

INTRODUCTION

The dendrochronological method is most useful and has a number of scientific and economic applications. Dating of archeological wood is one of them. To ensure better and more reliable results, the dendrological method is used alongside with the radiocarbon method. The dating of wood enables to assess the age in which different objects were built, furthermore, an accurately dated series of tree rings enables to adjust the previously compiled series and to date other objects.

MATERIAL AND METHODS

For the dating of wood and wood remnants by the dendrochronological and radiocarbon methods, 14 samples were taken from Kaunas Castle territory during archeological excavations. Twelve samples were taken from wooden constructions and two - from charred wood remnants. Samples No. 2208 were taken from canal No. 23, No.2209, 2212,2214,2216 - from canal No. 22, No. 2217, 2219 – from canal No.20, No.2224 – from canal 20(a) and No.2221, 2222, 2223 – from canal No.25. Remnants of charred wood were found in canal 16 and 17.

After preliminary preparation and disclosure of double or missing tree rings, the yearly increment of well preserved wood samples was measured (to 0.05 mm accuracy) and the series of tree rings were compiled. These tree ring series were used for the dendrochronological dating.

Because of the rotten surface of some wood samples, the last tree rings could not be indentified, therefore, when defining the date of the felling of trees, we were guided by

samples from the same period with the outer rings not missing. Sample 2208 had the greatest quantity of rings (211) , but only the first 134 were used for synchronization as the increment of the later period was very small and the outer rings were missing. The youngest tree used for the construction was 77 years old (No.2224). The outer rings of samples 2217, 2222 and 2223 were in good condition or with only 1-3 yearly tree rings missing.

RESULTS AND DISCUSSION

Before synchronization, some of the wood samples and the remains of charred wood were dated by using the radiocarbon method. In order to determine the C 14 quantity (age of samples), they were chemically treated. Scintillators of each sample were made and the quantity of the radiocarbon remains was measured. For the purpose, modern equipment LSC-1220 was used.

After the measurement of the C 14 quantity , radioisotopic dating of the rings was made, and by using the methods developed by M.Stuiver et al. (1993) it was then calibrated and converted to a calendar year. Errors of the radiocarbon measurement were taken into consideration (Table 1).

It should be noted that after fires carbon is usually preserved in the central part of wood, and therefore the date of the wood can be a few decades later than the date of the fire.

Basing on the radiocarbon age of the samples and the archeological dates, tree ring series were cross-synchronized and dated, with the definition of the calendar year of the outer ring of every series. For the purpose, the exactly dated long-term pine tree ring series Polpinus (for the period of 1168-1992) and Plpinus-5 (for 1106-1992) from the northern part of Poland (between Gdansk and Warsaw) compiled by A.Zielski (1992) were used. This kind of comparison is possible as the latest investigations made in the laboratory proved that synchronism of the radial growth of the trees depends rather on habitat conditions than on the distance between the objects of comparison (Kairaitis at al., 1996).

As reported by H.Fritts (1976), a very similar course of growth course was observed in the trees of North America growing thousands of kilometers apart.

Indices of tree ring were calculated for the series of samples rings as in most series age curves were expressive. For the purpose, a 21 year moving average with one year step was used. Analogical indices were calculated for the tree ring series Polpinus and Plpinus-5. The calculated indices of certain sample tree ring series were used for cross synchronization and dendrochronological dating.

Synchronization and dating were made by using two methods:

- by calculating the percentage of similarity (T.Bitvinskas, 1974)
- by calculating correlation coefficients (r) and their reliability (t).

Table 1. Dates of wood samples and charred wood from Kaunas castle. The dating made by the radiocarbon method

Current No.	Object	Dated tree rings	Radiocarbon age since 1950	Calibrated age	Calendar year
1	KP sample No. 2208	124-132	303 ± 35	421 – 478	1519 - 1576
2	KP sample No. 2215	76 - 125	324 ± 49	397 – 486	1511 - 1680
3	KP sample No. 2224	68 -77	424 ± 35	509 – 561	1436 - 1488
4	KP sample No. 2223	21 - 84	289 ± 35	430 – 476	1521 - 1567
5	Charred wood No. 1	_	691 ± 36	689 – 714	1283 - 1308
6	Charred wood No. 1	_	649 ± 39	606 – 652	1345 - 1391

As wood of different species (pine, spruce, oak) had been used for the construction, and as the trees had grown in different habitat conditions, only part of the samples could be adequately synchronized: No. 2208 (canal 23), 2212 and 2215 (22), 2217 (20), 2224 (20a), 2222 and 2223 (23). High cross-synchronization was observed between sample tree ring series No.2217 and 2224 (Fig.1), and therefore in the next stage of synchronization this average tree ring series was used. All the above mentioned sample series were dated dendrochronologically.

When the first and the last year of the cross-synchronized tree-ring series coincided best with the same difference of years in Polpinus and Plpinus-5, the date of the tree felling could be established. The scheme of dendrochronologically dated samples is presented in figure 2.

The derived coefficients of correlation (r) and significance (t) with regard to the series from Poland are presented in table 2.

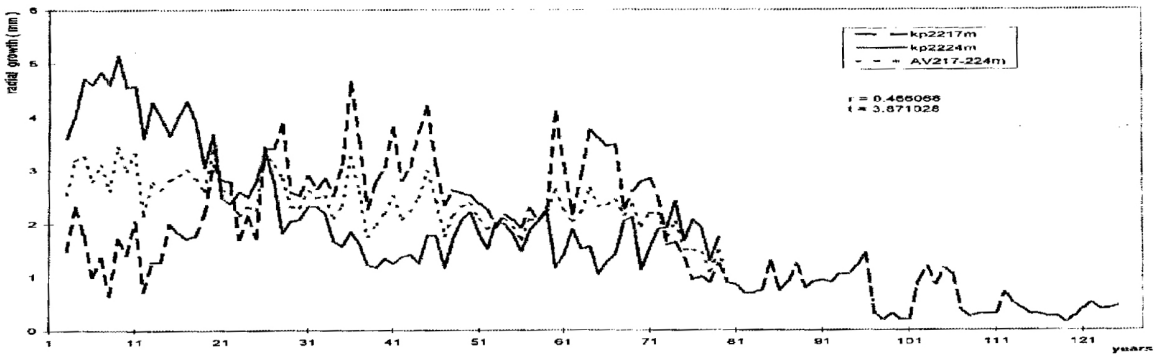

Figure 1. Individual and average radial growth dynamics of cross synchronized samples 2217 and 2224

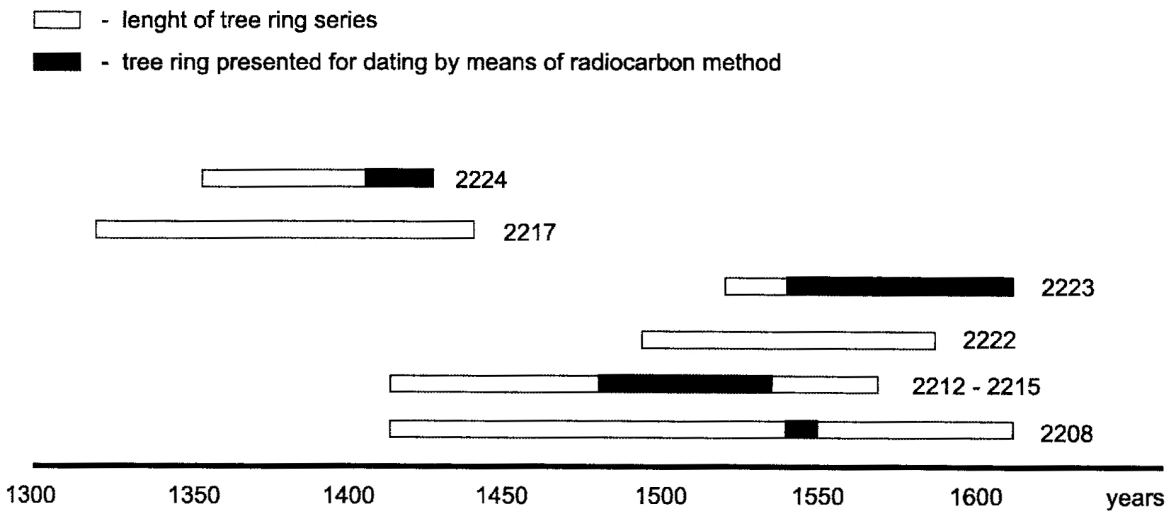

Figure 2. Scheme of dendrochronologically dated Kaunas Castle wood samples

Table 2. Correlation coefficients (r) of dendrochronologically dated Kaunas Castle wood sample tree ring series and their statistical significance (t) with regard to the Polpinus and Plpinus-5 tree ring series

Sample	Date of the last tree ring (indices)	Date of the last tree ring (absolute quantity)	with Polpinus		with Plpinus-5	
Number	year	Year	r	t	r	T
2208	1519	1606	0,23	2,50	0,31	3,47
Average of 2212 and 2215	1556	1566	0,24	2,80	0,18	2,08
2217	1426	1436	0,07	0,77	0,18	1,88
2222	1571	1581	0,26	2,09	0,21	1,69
2223	1597	1607	0,19	1,56	0,22	1,81
2224	1414	1424	0,21	1,59	0,36	2,87

Note: As in the calculations of indices the first 10 and the last 10 tree rings were rejected and in the synchronization of sample 2208 eighty-seven outer rings were not used , the calendar date of the last tree ring should be considered the date of the last tree ring as an absolute quantity.

From the cross-synchronized tree ring series of wood from Kaunas Castle the following correlation coefficients and t values were:

- between 2208 and average of 2212 and 2215 - 0.20 (1.97),
- between average of 2212 and 2215 and 2222 - 0.26 (1.82),
- between 2222 and 2223 - 0.59 (4.41),
- between 2217 and 2224 - 0.46 (3.87).

It should be noted that in certain cases some of the sample tree ring series had better correlation coefficients with the tree ring series from Poland but they could not be cross-

synchronized. This can be explained by the recurrence of increment cycles in the course of time.

CONCLUSIONS

As a result of the evaluation of the sample tree ring radiocarbon age, cross synchronization of tree ring series and synchronization with the tree ring series from Poland, the following dendrochronological dates of the last tree rings of samples were determined: 2208 – 1606; 2212-2215 – 1566; 2217 – 1436; 2222 – 1581; 2223 – 1607; 2224 – 1424.

As the outer tree rings of some samples were rotten and only samples no. 2217, 2222 and 2223 were in complete state, the dates of the felling of the trees for construction should be as follows :

- samples 2208 (canal 23) and 2223 (25) – 1607,
- samples 2212, 2215 (22) and 2222 (25) – 1581,
- samples 2217 (20) and 2224 (20a) – 1436.

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