DENDROCHRONOLOGICAL INVESTIGATION OF WOOD FROM VARAŽDIN OLD CASTLE

DENDROKRONOLOŠKA ISTRAŽIVANJA DRVA IZ STAROGA GRADA U VARAŽDINU

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SAŽETAK

Tijekom arheoloških istraživanja na Starom gradu u Varaždinu, a iskopavanja su provedena kao dio Projekta BASTION u sklopu međunarodnog INTERREG III A programa, otkriveni su dijelovi dviju drvenih konstrukcija. U sjevernom jarku bili su pronađeni ostaci mosta ili prilazne rampe, koja je vodila prema vratima srednjovjekovne četvrtaste kule, a u zapadnom unutarnjem jarku otkriveni su ostaci drvene obrambene ograde - palisade. Na osnovi raspoloživih povijesnih podataka bilo je procijenjeno da drvo pripada konstrukcijama s vremenskim rasponom nastanka od 13. do sredine 16. stoljeća. Nakon vađenja iz zemlje drvo je bilo odgovarajuće pohranjeno u podrumu muzeja u Varaždinu pa se nije osušilo niti je doživjelo oštećenja. Prema uputama Odsjeka za drvnu tehnologiju Univerziteta u Ljubljani, pripremljeni su manji uzorci koji su poslani na dendrokronološku analizu u Ljubljanu. Tamo je drvo fino obrađeno te su provedeni identifikacija i dendrokronološko datiranje u skladu s važećom metodologijom (ČUFAR et al. 2006).

Rezultati istraživanja su sljedeći: (1) uzorci iz pristupnog mosta u sjevernom jarku (sonda VII) bili su: daska (VAR1A i VAR2A) iz jelovine (Abies alba) dendrokronološko datirana u god. 1406., dva pilota iz hrastovine (Quercus sp.) datirana u 1374. (VAR12A) i 1394. (VAR13A) te mali komad drva hrasta (VAR14A) datiran u 1400. godinu. Uzorak pilota ili ostatak debla od drva pravoga kestena (Castanea sativa) s očuvanom korom nismo mogli datirati jer je imao premalo godova.

Uzorci VAR5A i VAR8A iz zapadnog jarka (sonda VIII) bili su iz aksialno raskoljenih trupaca hrasta i predstavljali su dijelove drvene obrambene palisade te su bili datirani u 1415. i 1404. godinu. Datacije su bile provedene s referentnim kronologijama laboratorija u Ljubljani.

Nijedan od uzoraka nije imao sačuvanu bjeljiku niti koru te zato navedeni datumi predstavljaju godinu nastanka krajnjeg perifernoga goda, sječa stabla i postavljanje konstrukcije u svim su se slučajevima dogodili nakon navedenih datuma. Most je bio podignut nakon 1406., a palisada poslije 1415. godine. S obzirom na procijenjeni broj godova koji nedostaju, pretpostavljamo da bi obje konstrukcije mogle biti sagrađene istodobno ili pak u kratkom razmaku, poslije 1415. i prije 1445. godine. U tom je razdoblju Stari grad bio u vlasništvu grofova Celjskih. Izvori spominju da je 1446. Janko Hunjadi napao i spalio Varaždin, a utvrdu nije mogao osvojiti jer je bila dobro branjena drvenom ogradom.

Dendrokronološko datiranje i interpretacija s povijesnim izvorima pokazuju važnost interdisciplinarnih istraživanja. Datacija drvenih konstrukcija sa Staroga grada u Varaždinu je, uz datiranje nalazišta Torčec-Gradić (ČUFAR i SEKELJ-IVANČAN, u ovom broju), među prvim uspješnim aplikacijama dendrokronologije u arheologiji u Hrvatskoj s uporabom referentnih kronologija iz Slovenije.

Ključne riječi: Varaždin, Stari grad, arheološko drvo, dendrokronologija, datiranje, projekt BASTION

Key words: Varaždin, Old Castle, archaeological wood, dendrochronology, dating, BASTION project

INTRODUCTION

Renaissance Varaždin Old Castle has been the subject of historical, archival and architectural research for over a decade, because of its well preserved elements of fortification, such as the embankment, bastions and ditches (e.g. HORVAT 1993: 119,193; ILIJANIĆ 1954; KRUHEK 1995: 141,240; ŽMEGAČ 2000, 28, 160 etc.). Archaeological excavations with small trenches were conducted in the 1960s and 1970s. The trenches were dug mainly near the walls close to the building, so they provided us with new knowledge about its architectural characteristics, but not with sufficient data about the archaeological layering of the complex. In the fall of 2006, archaeological research was conducted on several locations at the Varaždin fort within the framework of the biennial BASTION Project, part of the International INTERREG III A Program (see ŠIMEK, article in this issue). The Bastion Project was accepted and partly financed by the EU. The main goal of the project was to investigate two renaissance fortresses, in Maribor and in Varaždin, that were thought to have been constructed for protection against Ottoman attacks in the 16th century.

Well preserved parts of wooden constructions were discovered during the archaeological excavations in the northern and western moats. Wooden pillars, three beams around 2 m long and a few smaller elements such as boards and ledges were found at the bottom of the northern moat. All parts were found in the moat in front of the entrance to the medieval northern tower. On the basis of the characteristics of the wooden elements and their positions in the layers, we concluded that they were the remains of a bridge or an access ramp - which led to the entrance gate of the square medieval tower.

A 135 m long wooden construction was discovered in the second excavated location, in the western inner moat. It was buried in the alluvial layer of Drava river gravel below the bottom of the moat. Although, the upper part of the construction was missing, presumably because it was

Figure 1.: Wooden board from trench VII with indication of how the sample for analysis should be taken.
Slika 1.: Drvena daska iz sonde VII i opis uzimanja uzorka za analize

destroyed during renaissance reconstruction of the castle, it was still possible to deduce its function. The parts found were probably the remains of wooden defence palisades. A wide range of dating of the discovered findings was proposed. According to historical information about the object and the stratigraphic location of the finds, it was assumed that the wooden configuration was built after the 13th century (time of the oldest building phase of the castle) and before the 16th century (time of major adaptation of the building). In October and November 2006, samples of wood were taken at both locations. They were sent to the Department of Wood Science and Technology, Biotechnical Faculty, University of Ljubljana for analysis to determine the wood species and the age of the wood. Exact dendrochronological dating of the wooden defence elements would be very important for establishing the building phases of Varaždin Old Castle.

MATERIALS AND METHODS

From the northern ditch (trenches VII + A + B), samples were taken of different wooden elements of the same wooden construction, as assumed from where the wooden parts were found. Only sample VAR9A did not appear to belong to the construction. All parts were located in the dark layer of mud at the bottom of a ditch and in the gravel layer, at the transition from the ditch towards the bulwark.

Well-preserved samples with a sufficient number of tree-rings for dendrochronological analysis were selected for analysis. Two samples (VAR1A, VAR2A) originated from a board (Fig. 1, Fig. 2) which was a part of the construction. Other two samples were wooden pillars (VAR12A, VAR13A), which had been pounded into gravel and were found at their original location. One sample (VAR14A) was a part of a small wooden artefact.

Two samples (VAR5A, VAR8A) were chosen from the western moat (trench VIII B). They were taken from axially split beams, from the alluvial gravel (below the bottom of the trench). The beams were 1.5 to 4.5 m long and were the remains of a defence palisade, presumably older than the ditch and the clay defensive embankment.

During the scraping of a large piece of wood (VAR9A) in trench VII A, well-preserved bark was found. Since it did not seem to be processed (by wood working tools) the archaeologists assumed that it did not belong to any of the wooden constructions. Nevertheless, they took a sample of the trunk to determine the wood species and the date that the tree was felled.

The context of the finds indicated that the wooden elements from the northern moat (except sample VAR9A) belonged to the same construction - the bridge or access ramp, and that all samples from the western trench belonged to palisades.

After excavation, the wooden elements were kept in the cool, wet basement storeroom of the museum. In order to prevent desiccation and damage, they were wrapped in »geotextile«, which was remoistened every 3 to 4 days by sprinkling with water. Permanent control of the relative humidity in the room and wetting the geotextile helped ensure that the samples retained their moisture, volume and form and that they remained undamaged.

Since the excavated samples were too big for transport and analysis, they were photographed with identification labels. The photos helped the Department of Wood Science and Technology in Ljubljana to give instructions on where and how smaller samples for analysis should be taken (Fig. 1). These smaller samples were sent to Ljubljana, where they were cut to final size and their cross-sections were smoothed (Fig. 2).

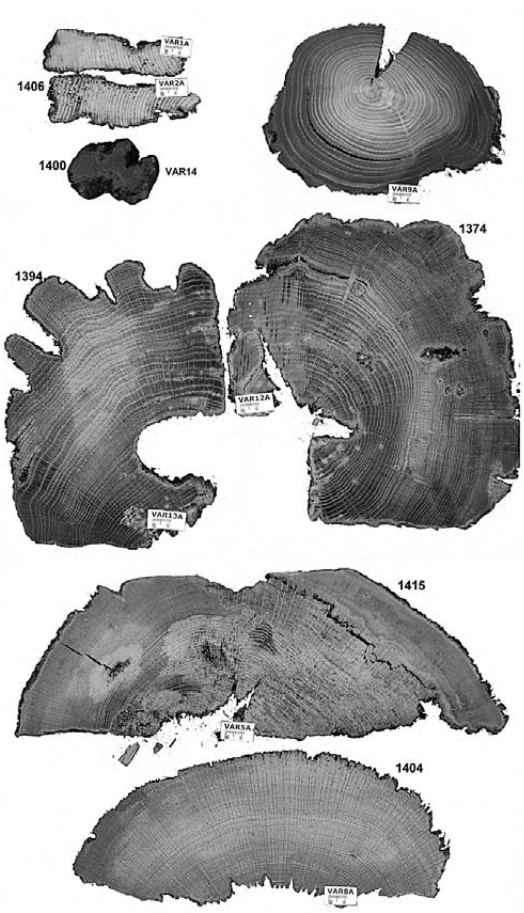

Figure 2.: Samples prepared for wood identification and dendrochronological analysis.
Slika 2.: Uzorci pripremljeni za identifikaciju drva i dendrokronološke analize

We identified the wood species, counted the number of tree-rings and measured their widths to the nearest 0.01 mm using a LINTAB measuring table and TSAP/X and TSAPWIN programmes. The obtained tree-ring series were dated with reference chronologies of the laboratory in Ljubljana. Dendrochronological procedures and interpretation of the results are described elsewhere (e.g. ČUFAR and LOZAR ŠTAMCAR 2004, ČUFAR et al. 2006).

RESULTS AND DISCUSSION

The description of the samples, the results of wood identification and dendrochronological dating are presented in Table 1. Samples from the northern moat (trench VII) belonging to the bridge or access ramp construction were identified and dated as follows. The board (VAR1A and VAR2A) was made of silver fir (*Abies alba*). Its last preserved ring was dated 1406. The oak (*Quercus* sp.) beams from the same construction were dated 1374 (VAR12A) and 1394 (VAR13A). The small wooden artefact (VAR14A) surprisingly also had enough rings for dendrochronology and was dated 1400 (Fig. 2, Fig. 3, Tab. 1).

The unprocessed pole with bark (VAR9A) was made of sweet chestnut (*Castanea sativa*) wood. It contained only 22 tree-rings, which is not enough for dendrochronological dating.

Samples VAR5A and VAR8A from the axially split oak beams of the remains of the palisade in the western moat (trench VIII B) were dated 1415 and 1404 (Fig. 2, Fig. 3, Tab. 1).

The dating of silver fir was done with the Slovenian silver fir chronology, version 2006 (LEVANIČ and ČUFAR 1997, ČUFAR et al. 2006) and verified by the silver fir chronology of the Hohenheim laboratory, Germany (BECKER and GIERTZ-SIEBENLIST 1970, FRIEDRICH pers. comm.). The best matching parameters were GLK= 71*** and t_{BP}=4.9.

The oak samples could be well synchronized and the dating was done with the Slovenian oak chronology version 2007 (ČUFAR et al. 2006b) and verified with the eastern Austria oak chronology (WIMMER et al. 1998, GEIHOFER et al. 2005). The best matching parameters were GLK=63** and t_{BP}=4.2.

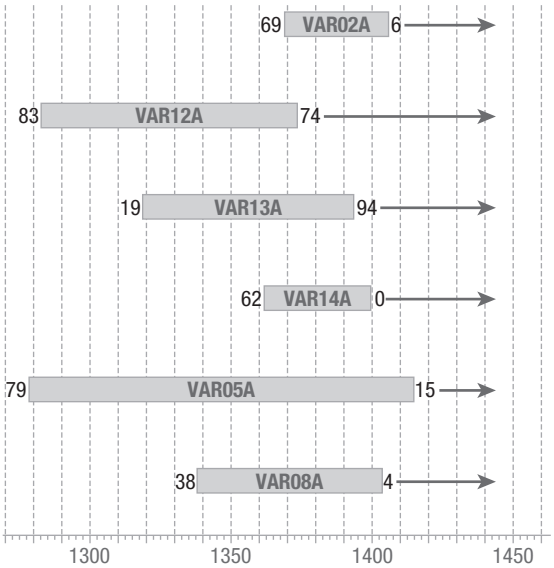

Figure 3. Dating of the last rings of all samples and estimation of felling dates of trees and time when the constructions were built.
Slika 3. Datumi zadnjih godova svih uzoraka i procjene datuma sječe stabala te vremena kada su podignute konstrukcije

Table 1. Description of samples, wood identification, and dendrochronological dating. None of the dated samples contained sapwood or the last tree-ring below the bark, so tree felling and erection of the constructions took place after the given years.
Tabela 1. Podaci o uzorcima i rezultati identifikacije drva i datiranja. Nijedan datirani uzorak nije imao bjeljiku niti zadnji god ispod kore. Sječa stabala i podizanje konstrukcija u svim su slučajevima nastupili nakon datuma zadnjeg goda prikazanog u preglednici.

No. Br.	Code Šifra	Trench Sonda	Description Opis	Wood Species Vrsta drva	Dating of the last ring Datacija zadnjeg goda	Note Primjedba
1 2	VAR1A VAR2A	Trench VII Sonda VII	Part of a bridge Ostatak objekta-most	Abies alba	1402 1406	Parts of the same board Uzorci iz iste daske
12	VAR12A	Trench VII B Sonda VII B	Part of a bridge Ostatak objekta-most	Quercus sp.	1374	
13	VAR13A	Trench VII B Sonda VII B	Part of a bridge Ostatak objekta-most	Quercus sp.	1394	
14	VAR14A	Trench VII B Sonda VII B	Smaller wooden artefact Manji drveni objekt	Quercus sp.	1400	
9	VAR9A	Trench VII A Sonda VII A	Unprocessed sample with bark Neobrađeni uzorak s korom	Castanea sativa	Undated Nedatiran	Too few tree-rings Premalo godova
5	VAR5A	Trench VIII B Sonda VIII B	Part of palisade Ostatak obrambenog zida-palisade	Quercus sp.	1415	
8	VAR8A	Trench VIII B Sonda VIII B	Part of palisade Ostatak obrambenog zida-palisade	Quercus sp.	1404	

- *Abies alba* - silver fir, jela
- *Castanea sativa* - sweet chestnut, pravi kesten
- *Quercus sp.* - oak, hrast

DISCUSSION - INTERPRETATION OF THE DATING

In interpretating the dates given in Table 1, it should be taken in account that dendrochronology provides the calendar years of tree ring formation. The year of the outermost ring on the sample is the most important for interpretation. If this ring is the last one below the bark, it tells the time when the tree was felled (Fig. 4.). None of our dated samples contained visible sapwood (outermost part of oak trunks that can be clearly differentiated from darker heartwood, Fig. 4) or the last ring below the bark (Fig. 2). At least several rings had been removed on all samples during wood processing or they were simply not preserved. The felling dates of the trees and erection of the constructions therefore occurred after the dates given in Table 1. On the basis of the given dates, the bridge or access ramp can be assumed to have been built after 1406 and the palisade was built after 1415. It is likely that the bridge and the palisade were built at the same time after 1415 and not later than 1445.

Historical interpretation of dendrochronological dating to the period between 1415 and 1445 is connected to the history of the Counts of Celje. They were the owners of the Varaždin fort at that time. In 1397, King Sigmund of Luxemburg awarded Varaždin castrum to Herman of Celje. It is almost certain that the Counts of Celje carried out reconstruction of the medieval object (ILIJANIĆ-KAPUSTIĆ 1983, 172) but the extent of such reconstruction is not known.

The *palisade* was apparently built in the time of the Counts of Celje. According to a description in the 'Celje Chronicle', Janko Hunjadi attacked Varaždin in 1446. He and his troops burned down the city, but they could not capture the fort (KRONES 1883), because it was well protected by a wooden palisade. This information from the 'Celje Chronicle' has in fact double importance for interpretating the dating of the wooden architecture: it confirms the presumption that the wo-

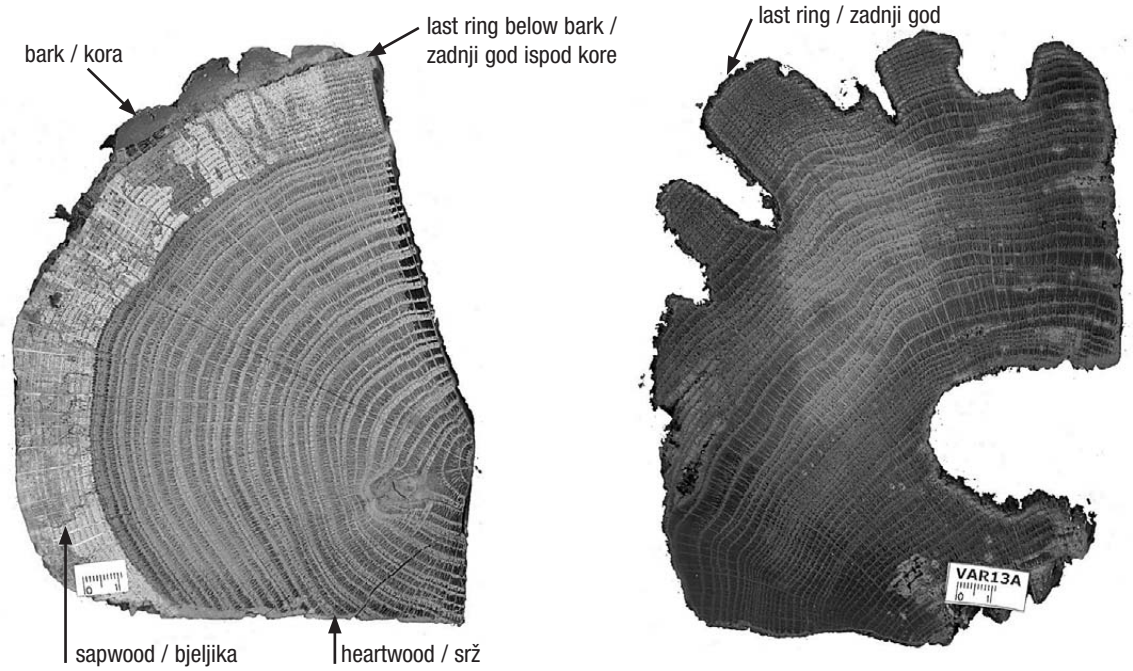

Figure 4. (a) An example of a sample that contains heartwood, sapwood and bark. The year of the last ring below the bark coincides with the last year of wood formation before the tree was felled. (b) Sample VAR13A, in which the last ring was dated 1394. Since the sample does not contain sapwood or bark we can only estimate the date of tree felling by adding a presumed number of missing rings (i.e. 1394 + approx.15-30 rings).
Slika 4. (a) Primjer uzorka koji ima srž, bjeljiku i koru. Godina zadnjeg goda ispod kore sukladna je godini pred sječom stabla. (b) Uzorak VAR13A kod kojeg je datacija zadnjeg goda 1394. Pošto uzorak nema niti bjeljiku niti koru, datum sječe stabla možemo procjeniti tako da zadnjoj godini pribrojimo pretpostavljen broj manjkajućih godova (to je 1394 + pribl.15-30 godova).

oden parts found in the western moat were really elements from the palisade, and that the palisade was complete and already functioning in 1446.

The estimate that the upper limit for dating of the wooden construction is 1445 makes sense, because it agrees with the reports that it was functioning in 1446.

Before application of dendrochronology, we could only approximately date the wooden constructions between the 13th and 16th centuries. This presumption was based on historical data about Varaždin Old Castle, and on the stratigraphy of the finds. We assumed that the oldest architectural elements of the fort and its northern tower originated from the 13th century (ILIJANIĆ - KAPUSTIĆ 1983, 170). This gave the earliest date of the bridge leading toward the object.

The pillars, boards and beams were found at the bottom of a wide moat, which was presumably made in the 16th century, when Domenico de Lalio modernised the medieval castrum.

We also presumed that during the rebuilding of the defence complex, when the older, narrower moat was widened, the old wooden bridge was dismantled since it did not fit into the new concept of defensive architecture.

The main modifications of Varaždin castle were done from 1544 to 1563, when de Lalio died (ILIJANIĆ 1961). Due to new building regulations for castles, the biggest reconstruction took place in the second half of the 16th century, and the old, medieval architectural structures were partly demolished. That is why we presumed that the upper limit for approximate dating of the investigated wooden constructions could be mid-16th century.

The wide range of dating, from the13th to the mid-16th century was considerably narrowed by application of dendrochronology.

CONCLUSION

The information obtained by dendrochronological analysis gave much narrower dating of wooden elements from Varaždin Old Castle than previous estimates obtained by other sources. This shows the importance of interdisciplinary cooperation and the use of dendrochronology in archaeology. The current work, together with the dating of Torečec gradić (ČUFAR and SEKELJ IVANČAN, article in this issue) was among the first successful dendrochronological datings of archaeological wood in Croatia.

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