RADIOCARBON DATING OF THE ZAGREB UPPER TOWN PREHISTORIC SETTLEMENT

BOGOMIL OBELIĆ,[1] MARIJA ŠMALCELJ,[2] NADA HORVATINČIĆ,[1] ROMANA BISTROVIĆ[1] and ADELA SLIEPČEVIĆ[3]

ABSTRACT. During the 1989–1994 renovation of the Zagreb Town Museum, it became obvious that the area was inhabited in prehistoric times. We ^{14}C dated 40 samples to determine various settlement periods. The ages of the samples span a much longer time than expected, from the Early Iron Age (Hallstatt period) to the 19th century AD. ^{14}C dates on charcoal samples placed the remains of dwelling pits in the Hallstatt period, 8th to 4th century BC. A late La Tène settlement dated between the 4th century BC and the 2nd century AD. Medieval fortifications were identified in the western part of the complex, consisting of a well-preserved wooden structure used for construction of the royal castrum. ^{14}C measurements on wooden planks and posts date the construction of the fortification between the 13th and 15th centuries AD and branches, beams, and tools found below the basement of the Convent of St. Clare span the 16th to the 19th century AD.

INTRODUCTION

The Zagreb Town Museum was completely renovated for the 900th anniversary of the capital of Croatia. The Museum is located in a historical complex on the northeast corner of Gradec Hill (167 m asl) and includes the 13th century watchtower Popov Toranj, a former Convent of St. Clare and the Old Town granary (Fig. 1). Following preliminary archaeological excavations in 1989, M. Šmalcelj supervised systematic investigations from 1991–1994. Archaeological finds showed that the Gradec hilltop was inhabited during the Hallstatt (Early Iron Age, 8th–5th century BC), La Tène (Late Iron Age, 3rd–1st century BC) and the Middle Ages.

The toponym Zagreb is mentioned for the first time in a document related to the foundation of the diocese and the erection of the first cathedral on the Kaptol hill by Hungarian King Ladislas (1040–1095) in AD 1094. Another important date is AD 1242, when Hungaro-Croatian King Bela IV briefly stopped in Zagreb on his escape to the Adriatic Sea, fleeing the advancing Tartars. After Gnengis Khan's death, King Bela IV, in a proclamation known as the "Golden Bull", freed several towns that offered shelter during his exile, including Zagreb. The town developed on top of Gradec Hill, surrounded by ramparts, which were strengthened during the time of danger from the Ottoman Turks (15th–17th century). The canons of the Zagreb Chapter built a watchtower and owned several houses at the northeast corner of the hill. The danger from the Ottoman Turks being over, the canons' property was given, according to the decision of the Croatian Parliament in AD 1635, to the Order of St. Clare, who built a convent *ca.* AD 1650. Following the secularization proclaimed by Austrian Emperor Joseph II, the convent was converted into barracks and a post station and finally, during this century, into the Town Museum.

ARCHAEOLOGICAL INVESTIGATIONS

The excavations at Gradec Hill revealed the remains of a relatively large Early Iron Age (Hallstatt) settlement. The remains of older dwelling pits are partly overlain by houses with stone basements and fireplaces. A well-preserved furnace for bronze melting found on this site probably belongs to this period. A late La Tène settlement was built on the same site just before the Roman conquest of the Illyricum. Well-preserved fortifications show a construction technically unknown to this part of

[1]Rudjer Bošković Institute, P.O.B. 1016, 10001 Zagreb, Croatia
[2]Faculty of Philosophy, Department of Archaeology, Ivana Lučića 3, 10000 Zagreb
[3]Faculty of Veterinary Sciences, Department of Physics, Heinzelova 55, 10001 Zagreb

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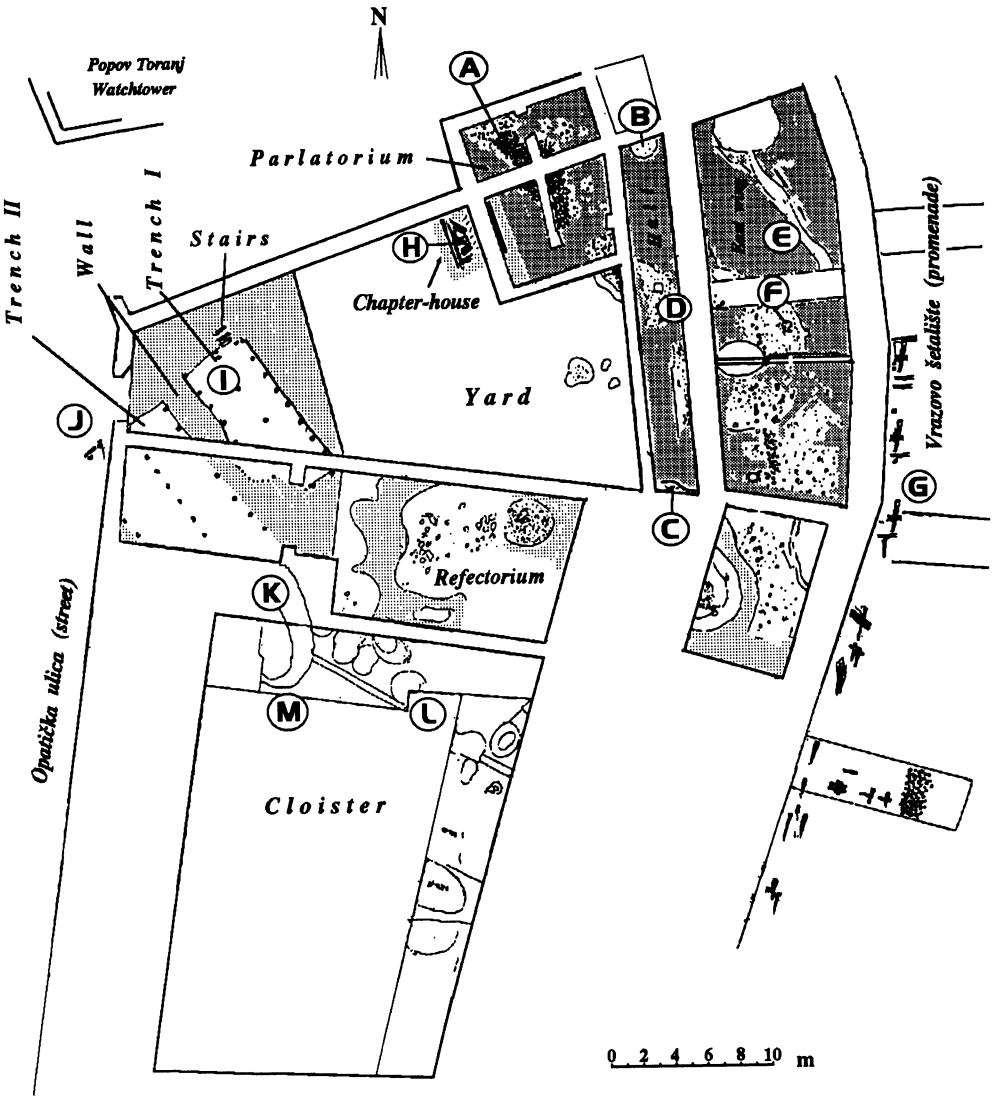

Fig. 1. Site plan of the former Convent of St. Clare, Zagreb Upper Town. Letters denote ^{14}C sampling sites. **A–G**: prehistoric sites; **H–M**: medieval sites. *Parlatorium* = parlor, room in a monastery (or convent) where visitors can speak with monks or nuns; *Refectorium* = refectory, dining room in a monastery.

Europe. The circumvallation was built by burning the massive wooden construction filled with marly clay. The remains of buildings with walls made of thin wooden posts were found inside the fortification. This settlement was abandoned and the remains were leveled during construction of a medieval fortification during the 11th and 12th centuries. The remains of a well-preserved wooden structure that supported the earthwork of the royal *castrum* (fortification) were discovered in the northwestern section. Two square trenches, 1.0–1.5 m deep, separated by a clay wall 2.5 m thick, were probably used for collecting rainwater and were parts of the town fortification (probably guardhouses near the town gate).

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The rectangular trench on the east side (Trench I, Fig. 1), 8.50 m long and 4.50 m wide, containing three rows of vertical pilings driven into the clay, probably served as a cistern. A set of horizontal tongue-and-groove boards supported the clay wall. Wooden steps leading down to the trench and the remains of a wooden door and door frame were also found. The door probably served as a gate during high water level in the cistern.

Trench II (Fig. 1) consists of three rows of posts running northwest-southeast, as in Trench I, and is located at the extreme west wall of the convent under which the cistern runs. A continuous row of tongue-and-groove boards, as clearly seen in the first trench, was not found here. Over the centuries, mud was deposited within the system of trenches. The finds include large amounts of building material, coarse household ceramics, iron tools, stone catapult balls and a relatively large number of organic remains, including peach pits, nuts, a *Sorghum* broom, and bones of mammals and poultry.

This part of the Old Town, which had belonged to the Zagreb Canons since the 13th century, was destroyed at the beginning of the 15th century when the building of the stone circumvallation was finished. The evidence for this is coins of the Hungaro-Croatian King Sigismund of Luxembourg (1368–1437) minted in 1427 found in a layer of clay beneath the structure. Some wood from the town was reused in a smaller building nearby.

At the convent *parlatorium* (a "parlor" or meeting-room) were found two beams and some boards in the cellar of a wooden house, constructed in 15th century, which belonged to the Chapter. The cellar was half-open toward the south. It seems that the boards, all *ca.* 1 m long, were used as roof shingles, taken from the older, destroyed fortification, and that they were thrown into the trench during reconstruction. During excavations at the present-day cloister, pits were found under the existing foundations. Some of the pits were probably used for local industry, such as leather tanning, and later were filled with waste. In one pit, the remains of a colored eggshell were found. Pit No. 3 contained a ceramic jug with the inscription, AD 1615, in baroque letters.

METHODS

Excavations

Excavations were done by strictly demarcating separate, successive layers. We took special care to identify the levels at which individual diggings were done for both houses (La Tène houses excavated in the Hallstatt layer) and postholes or pits. Both horizontal (planum) and vertical sections were prepared for each layer.

Most of the 40 samples dated at the Ruđer Bošković Institute were wood from beams and boards, and charcoal. Samples of charcoal were taken exclusively from complete, intact layers. One bone sample and one sample of *Sorghum* from a broom were also analyzed. Due to the influence of groundwater, the wood samples were well preserved, most of them showing individual tree rings, which enabled dendrochronological dating.

Radiocarbon Dating

Charcoal and wood samples were pretreated by standard acid–base–acid procedures. The collagen fraction of the bone was separated following the Longin method (1971). Further processing included sample combustion, catalytic hydrogenation of CO_2 to CH_4, and measurement in a proportional counter for 24 h following methods published previously (Srdoč, Breyer and Sliepčević 1971). After preparation, samples were stored for at least 14 days to allow radon to decay (Horvatinčić *et al.* 1995). Samples were measured at least twice. Mean values and standard deviations were calculated using standard uncertainty propagation methods (Obelić 1990). Results are given in uncalibrated

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"years" BP using the Libby half-life, 5568 yr. No ^{13}C measurements were performed, but $\delta^{13}C$ corrections were applied according to Stuiver and Polach (1977). The ^{14}C ages were dendrochronologically calibrated based on a 68.3% confidence level (1 σ), using the probability method (B) of the Stuiver and Reimer (1993) CALIB 3.0.3 program.

The reliability of the measurements was tested by three successive intercomparison studies (Scott *et al.* 1990). These studies show that our results are, in all cases, equivalent to median values for participating laboratories (Krajcar Bronić *et al.* 1995).

Table 1 lists the results, which include calibrated age ranges (68.3% confidence level) and dating probabilities (in %) for the corresponding relative areas of the probability distributions. Calibrated ranges with relative areas <15% are omitted.

TABLE 1. ^{14}C Dating Results from the Zagreb Upper Town

Site	Lab no. (Z-)	Sample material	^{14}C age (BP)	Calibrated age ranges* (with relative areas in %)
Prehistoric Samples				
A	2448	Charcoal	2085 ± 100	cal BC 200–AD 28 (94)
A	2449	Charcoal	2040 ± 110	cal BC 185–AD 80 (100)
A	2450	Charcoal	1750 ± 105	cal AD 196–415 (93)
A	2451	Charcoal	1770 ± 95	cal AD 193–389 (89)
B	2452	Charcoal (lower)	2340 ± 115	cal BC 535–344 (57)
				318–204 (30)
B	2453	Charcoal (upper)	2100 ± 90	cal BC 202–AD 13 (96)
C	2454	Charcoal	2375 ± 105	cal BC 760–673 (24)
				559–365 (65)
C	2463	Wooden board	2255 ± 110	cal BC 405–156 (92)
C	2457	Charcoal	2590 ± 130	cal BC 846–515 (99)
D	2458	Charcoal from foundation pit	2450 ± 110	cal BC 760–672 (31)
				562–407 (54)
D	2459	Charcoal	2290 ± 105	cal BC 424–177 (91)
D	2455	Charcoal (upper)	1990 ± 100	cal BC 109–AD 133 (100)
D	2456	Charcoal (lower)	2110 ± 100	cal BC 207–AD 10 (88)
E	2460	Burned oak	1745 ± 135	cal AD 129–433 (100)
F	2461	Round logs	1630 ± 105	cal AD 330–550 (95)
G	2482	Burned trunk	2220 ± 90	cal BC 382–178 (100)
G	2483	Burned trunk	2500 ± 105	cal BC 784–512 (99)
G	2484	Burned trunk	2215 ± 110	cal BC 390–154 (94)
G	2485	Burned trunk	2310 ± 160	cal BC 545–167 (86)
G	2486	Burned trunk	2250 ± 110	cal BC 403–156 (96)
G	2487	Burned trunk	2215 ± 90	cal BC 380–174 (100)
G	2488	Burned trunk	2300 ± 105	cal BC 426–190 (86)
G	2490	Burned trunk	2400 ± 145	cal BC 764–615 (38)
				606–379 (62)
Medieval Samples				
H	2280	Board (Tr. 12)	300 ± 75	cal AD1487–1609 (69)
				1611–1663 (31)
H	2286	Board (Tr. 12)	325 ± 80	cal AD1487–1648 (100)

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TABLE 1. (Continued)

Site	Lab no. (Z-)	Sample material	^{14}C age (BP)	Calibrated age ranges* (with relative areas in %)
H	2285	Board (Tr. 26)	264 ± 105	cal AD 1489–1607 (42) 1612–1683 (29) 1745–1807 (22)
I	2369	Wooden post	765 ± 50	cal AD 1233–1289 (100)
I	2409	Board	605 ± 80	cal AD 1305–1367 (66) 1373–1405 (34)
I	2411	Board, door frame	580 ± 90	cal AD 1306–1365 (55) 1375–1424 (44)
I	2412	Door	795 ± 70	cal AD 1183–1289 (90)
I	2405	Twigs	480 ±115	cal AD 1391–1519 (69) 1573–1626 (20)
I	2407	Bone	540 ± 80	cal AD 1309–1356 (38) 1383–1444 (62)
I	2413	*Sorghum*	430 ± 85	cal AD 1421–1520 (67) 1571–1626 (31)
I	2408	Wooden board	216 ±119	cal AD 1634–1709 (26) 1711–1822 (40) 1834–1881 (15)
J	2410	Wooden post	440 ± 80	cal AD 1413–1517 (77) 1583–1623 (23)
K	2417	Wood below colored eggshell (Pit 1)	330 ± 85	cal AD 1481–1649 (100)
K	2414	Wood (Pit 2)	275 ±114	cal AD 1480–1682 (75) 1748–1805 (19)
L	2416	Wooden post (Pit 2)	280 ± 80	cal AD 1489–1606 (55) 1612–1674 (32)
M	2415	Wood (Pit 3)	375 ± 80	cal AD 1452–1526 (49) 1556–1632 (51)
M	2425	Straw (Pit 3)	120 ± 80	cal AD 1684–1743 (32) 1807–1932 (68)

*Calibrated age ranges were calculated using the probability method of Stuiver and Reimer (1993) with a 68.3% confidence level (1 σ). Corresponding relative areas of the probability distributions, if <100%, are in brackets.

Figure 2 shows all the ^{14}C measurements of this study. They span an interval from the 9th century BC to the 18th century AD. No samples with calibrated ages covering the 5th to 11th centuries were found.

DISCUSSION

The remains of a hearth were found below the foundations of the convent *parlatorium* (**A** in Fig. 1). Charcoal found beneath a Hallstatt bowl (Z-2448: 2085 ± 100 BP), as well as another charcoal sample (Z-2449: 2040 ± 110 BP) from the same cultural layer date to the La Tène, thus supporting the archaeological age estimates. However, two samples from the same layer (Z-2450: 1750 ± 105 BP and Z-2451: 1770 ± 95 BP) yielded ages from the 2nd–4th century AD, which were not confirmed by archaeological finds.

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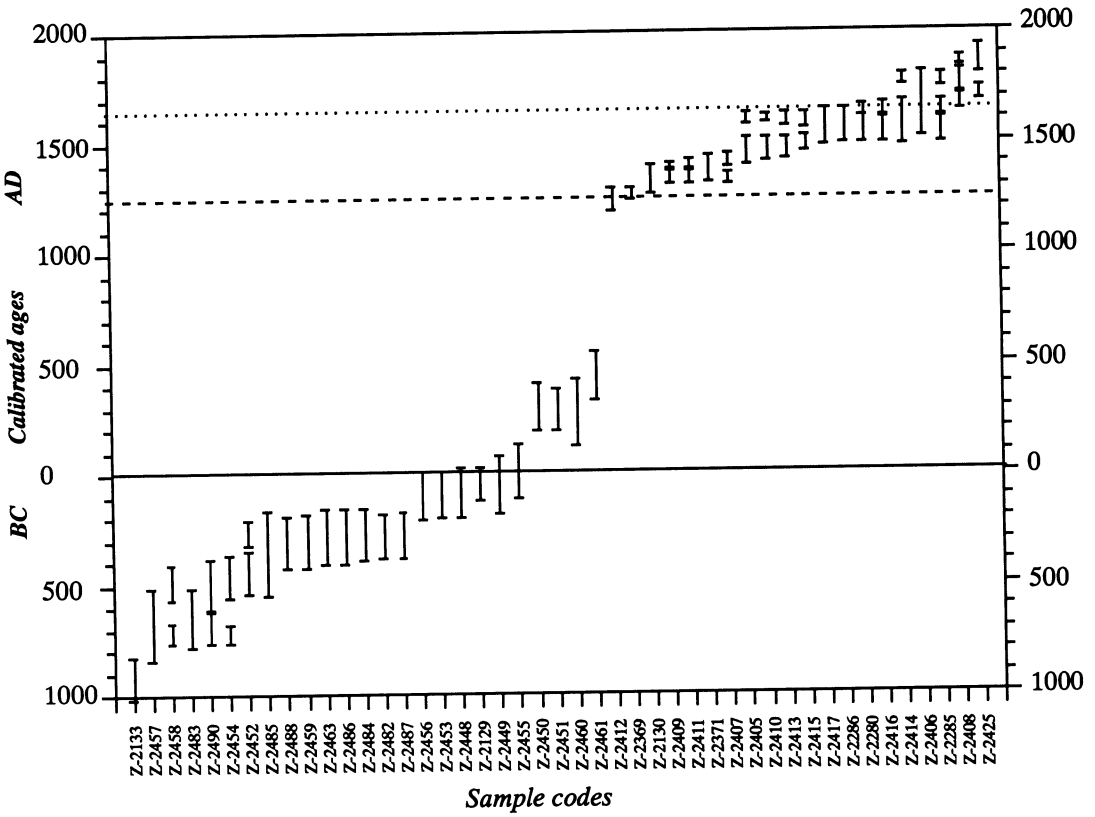

Fig. 2. Calibrated age ranges for results listed in Table 1, sorted according to ages. Historically relevant dates: - - - - = AD 1242 (drawing up the "Golden Bull" by King Bela IV); ····· = AD 1635–1650 (construction of the Convent of St. Clare).

Remains of older shallow sod houses overlain by dwellings with stone basements and stone hearths were found in the hall of the convent. Samples from this area of the excavation yielded confirming Hallstatt dates. Two fragments of dwelling posts (Z-2452: 2340 ± 115 BP and Z-2453: 2100 ± 90 BP) (**B**), were also dated to the Hallstatt. Charcoal from a fireplace in a closed earth-hut at the opposite end of the hall (**C**) date to an older Hallstatt phase (Z-2454: 2375 ± 105 BP).

The same age was established for a part of a board that covered the fireplace (**D**) (Z-2463: 2255 ± 111 BP). The oldest date (9th to 6th century BC) was obtained for a fragment of a post (Z-2457: 2590 ± 130 BP) from the earliest phase of a dwelling, which—according to the archaeological finds—corresponds to an older Hallstatt phase. A charcoal sample (Z-2458: 2450 ± 110 BP) from the bottom of a pit surrounded by a stone wall and connected to another smaller pit that served as an ash depository dates to the same period. In one pit, a swine skull was found buried in clay. The assumed connection between the charcoal (Z-2459: 2290 ± 105 BP) from an overlying pit (the so-called foundation pit) and sample Z-2457 (2590 ± 130 BP) was not confirmed by the ^{14}C dates. However, this connection is supported by the dates on samples Z-2455 (1990 ± 100 BP) and Z-2456 (2110 ± 100), which were 4 cm apart, lying in vertical positions and separated by a thin, but strong, layer of clay. The older layer seems to have been leveled during the reconstruction of the dwelling. Two samples stratigraphically associated with La Tène were found beneath the East wing of the convent. Sample Z-2460 (1745 ± 135 BP) (**E**) should be the continuation of the beams found outside the

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convent (Z-2482 to Z-2490). The second sample, Z-2461 (1630 ± 105 BP) (**F**), dated to the 4th to 6th century. No archaeological finds exist to support these dates.

The remains of a rampart (**G**) were found along the slope following the East wing of the convent to the promenade Vrazovo Šetalište. The burned layer consisted of up to 50 cm of clay (average 30 cm) overlying a foundation of timber that seems to have been burned deliberately to fire the clay and provide a solid base *ca.* 6 m wide for another clay fill into which the wooden posts of a palisade were driven.

As Figure 3 shows, the calibrated ages range from the 8th to the 2nd century BC, and the most probable period when the trees were felled was between the 4th and 3rd century BC. However, tree-ring dates determined at Cornell University, based on the German Oak Chronology (Becker 1993), gave the best statistical fit at AD 679 (Durman 1994).

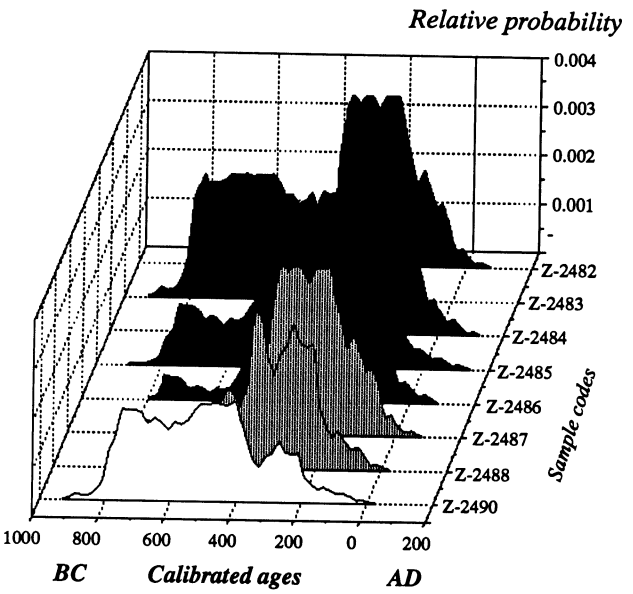

Fig. 3. Calibrated age ranges of the samples from Vrazovo Šetalište

At the site of the convent *parlatorium* a chapter-house (**H**) was standing in the Middle Ages. Boards, probably used as roof shingles, seem to have been thrown into a trench during the reconstruction of the house in the 15th century. Calibrated ages of samples Z-2280 (300 ± 75 BP), Z-2285 (264 ± 105 BP) and Z-2286 (325 ± 80 BP) fit the archaeological stratigraphy. However, tree-ring dates derived from the Cornell Tree-Ring Master Chronology gave the year AD 1171 (Durman 1994).

At the northwestern corner of the convent complex, where two trenches were excavated, several pieces of wood were ^{14}C dated. The top of the central post from the eastern trench was cut and the ^{14}C date of ten outer tree rings (Z-2369: 765 ± 50 BP) ranged from cal AD 1222 to 1279. A tree-ring date from Cornell (Balkans) agrees with this result, giving AD 1290 for the youngest (outer) sapwood ring. A ^{14}C age of a well-preserved wooden board (*Quercus*) found between the two outer posts of the same trench spans from cal AD 1295 to 1400 (Z-2409: 605 ± 80 BP). The earliest medieval result obtained by the ^{14}C method is for the board that was part of the door at the entrance to this trench (Z-2412: 795 ± 90 BP). Between this construction period, which according to both ^{14}C and tree-ring dating should be *ca.* AD 1183–1289, and the construction of the convent in the 17th century,

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trenches were apparently filled with garbage. Twigs, a bone and sorghum from these trenches date from the 13th–16th century, as expected from archaeological observations.

From the western trench (J) a wooden post (Z-2410: 440 ± 80 BP) dated to the 15th century, which is surprisingly young when compared with the tree-ring date (AD 1292) of a tongue-and-groove board found near the same post. Excavations in the convent cloister uncovered several pits (K, L, M) that apparently served as garbage pits. Dates of wood samples from these pits confirm archaeological expectations, but we did not get a confirming date from a piece of straw (Z-2425: 120 ± 80 BP) found in one of these pits. Only one sample was ^{14}C dated from the time of the construction of the convent (AD 1635–1650). This result on a plank from an underground vault dating to the time of construction (Z-2408: 216 ± 119 BP) was not satisfactory due to the large range in calibrated ages caused by the relatively large standard deviation.

Conclusion

Systematic archaeological excavations at the Zagreb Upper Town showed that this site was inhabited much earlier than expected. The series of ^{14}C ages from the Zagreb Upper Town generally confirmed the cultural periods determined by archaeological dating methods. The ^{14}C ages of the Middle Age samples agree well with the historical data and support the archaeological assumption that the first ramparts of the medieval town were constructed in the 12th and 13th centuries. A discrepancy exists for the samples associated with the construction of the rampart at the eastern part of the site (Z-2482 to Z-2490). Dendrochronological measurements gave a best fit in the year AD 678, as opposed to ^{14}C results, which consistently point to the La Tène period. Whether the reason for this discrepancy lies in the use of the South German Oak Chronology for trees deriving from the Pannonian Valley will be tested in the future by further comparisons of ^{14}C and tree-ring dating.

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