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Dendrochronology and Environmental History: The Difficulties of Interpretation

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The study provides insights into questions concerning forest management and timber use by drawing on case studies in the dendrochronological research which has been underway over the course of the past couple of decades in Hungary. The essay refers to natural resource-use and historical and demographic questions which arose in analyses of the wooden materials. The study questions some of the topoi of historical research, such as the immense forest loss traditionally associated with the Ottoman wars.

Keywords: dendrochronology, Hungary, forest resources, Ottoman wars, environmental history

The dendrochronological research which has been underway in Hungary for more than two decades now has brought to light a number of environmental history (related) data which goes beyond the use of the method in dating. If one takes a closer look at these data, several questions arise many of which remain unresolved. This study discusses some (if not all) of these questions.

In 2017, Gergely Rákóczi, associate of the Dobó István Castle Museum of Eger, excavated a wooden sluice bridge structure in Eger in the bed of the Eger Stream.[1] Based on the four samples, the earliest year in which the oak trees which were used for the construction could have been cut was 1798. Analyses of the beams showed that the trees were considerably older than what is considered the ideal age for cutting (90 to 120 years), as the samples had 242, 257, 117, and 168 consecutive rings. Thus, these four samples offered a dataset which spanned a long period and could be used for dating and other investigations.

A relatively new and increasingly used method in dendrochronology which has yielded important insights is dendro-provenancing. By using many regional chronologies, researchers try to identify the original habitats of the trees used for timber and thus offer a spatial comparison.[2] As Fig. 2 shows,[3] the tree rings

1 Rákóczi, "Zsiliphíd."

2 Bridge, "Locating the origins."

3 From the statistical data marked on the map, "t" is the result of the t-test. This text, which is frequently used in archaeology, demonstrates the extent to which the values in two datasets could be said to match

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Figure 1. Structure of the sluice bridge in the bed of the Eger Stream
(Photograph by Gergely Rákóczi)

in the samples from Eger fit best with the chronology from trees in present-day Slovakia, which means that their original habitat was probably there.

This conclusion seems logical, as the Archbishopric of Eger had significant land holdings in this region. Furthermore, it harmonizes with the familiar topoi concerning the Ottoman Empire's use of Hungary for its timber and the

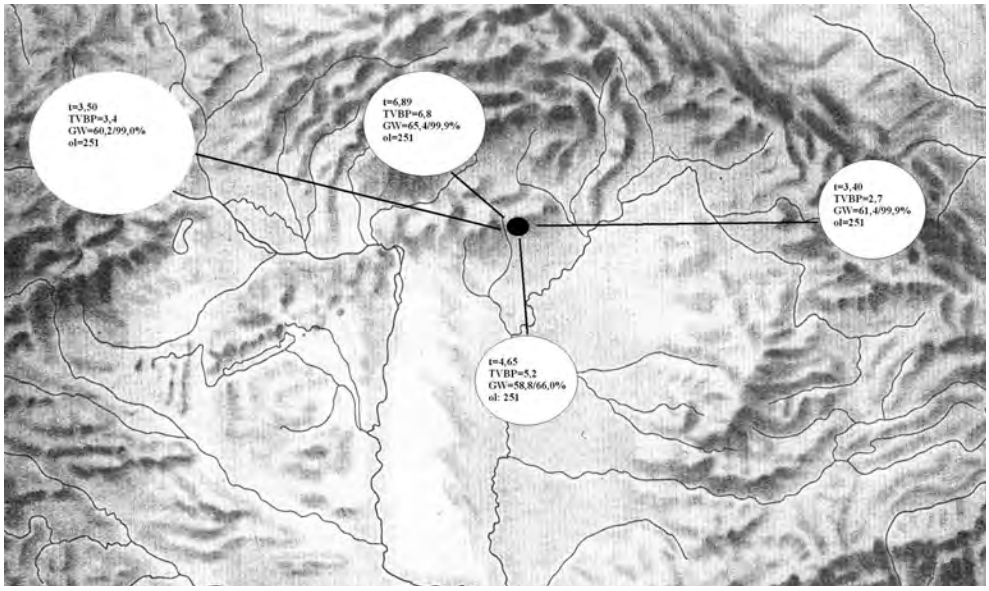

Figure 2. The relationship between the data from Eger and chronologies of different areas

each other. TVNP is the Baillie-Pilcher's t-value and GW is *Gleichlaufigkeitswert* (correlation), which indicates the correlation in the running of two curves. The fourth data (ol) marks the number of overlapping tree rings. On the statistical methods used in dendrochronology, see Schweingruber, *Der Jahrring*.

destructive impact on forests of the war to liberate the country from Ottoman occupation, as it suggests that there was a dearth of suitable trees in the Great Hungarian Plain and timber had brought in from the north. However, data referred to by Eszter Magyar concerning the valley of the Hron (Garam) River (a river in Slovakia was a tributary of the Danube) are frequently cited in support of the contention that the region of present-day Slovakia was not used for timber mining.[4] In Magyar's words, "as is clear from a lawsuit in 1544, […] the dynasties of charcoal burners who had been working in the easily accessible forests of the area since the death of King Matthias I [1490] cut down and charred the forests for the second or third time in little more than 50 years."[5] The finds from Eger, however, shed light on this conclusion, as the trees felled in the late 1700s at the age of 200 to 250 were already about 100 to 150 years old at the end of the Ottoman period. This suggests that during the period of the Ottoman presence in the Carpathian Basin, the forests in present-day Slovakia were never completely timbered or burned.

In 2012, during the construction of the new gym of the Saint Elisabeth High School in Esztergom, Edit Tari, an associate of the Balassi Bálint Museum, excavated a number of timber-framed Ottoman-period wells.[6] The most "beautiful" and elaborate structure was no. 60, the timber of which was cut during the winter of 1584–1585.[7] The builders used trunks cleaved in two, so in each case it was possible to measure the full series of the tree rings, while in most of the samples, both the bark and the sapwood were removed. Fortunately, in eight cases, they were not accurate enough, and in three cases not even the bark was removed decently. If one looks at the relative age of the timber used for the well, it is clear that very young trees were used. Thus, the well supports the conclusion concerning timber mining by the Ottomans in the forests of the Carpathian Basin.

However, when applied in these cases, dendro-provenancing yields surprising conclusions. The timber of the well can be best dated according to the chronology valid for the Vienna Basin. In other words, the timber used in

4 Magyar, *A feudalizmus kori erdőgazdálkodás*.

5 Ibid., 82.

6 The official name of the site was Esztergom-Szent Erzsébet iskola udvara (Víziváros) [Esztergom–Saint Elisabeth High School Yard (Víziváros)]. Only a preliminary report of the excavation has been published so far: Tari, "Az Esztergom-vízivárosi," 195–210.

7 The reference chronology is the Viennese dataset gathered by Michael Grabner and his colleagues. The statistical values of the comparison: t=5,62; TVBP=5,2; GW=71,4/99,9%; overlap: 64 tree rings. The values of the Hungarian dataset: t=3,87; TVBP=4,9; GW=69,8/99,0%; overlap: 64 tree rings.

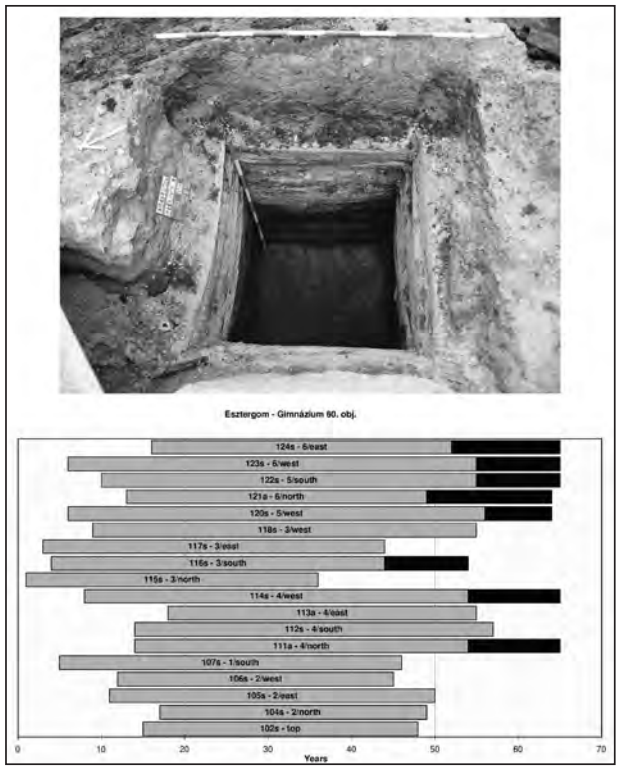

Figure 3. Well 60 (image by Edit Tari). Relative age of the beams (the light fields on the diagram mark the hardwood, while the dark fields indicate the sapwood of the tree rings)

Esztergom came from the Danube River valley or the surroundings of Vienna.[8] This means that the timber mining was not "Ottoman" but rather "Ottoman period." In other words, it was done on the other side of the border.[9] One is also confronted with the rather surprising fact that, among the three (hostile) polities that shared the territory of the medieval Kingdom of Hungary, there was considerable trade. This somewhat contradicts the traditional view.[10]

In 2015, Gábor Wilhelm and Máté Varga, archaeologists from the Katona József Museum, excavated two "barrel wells" in the center of the town of Kecskemét (Nagykörösi Street 7–9), i.e. two well structures in which, within the timber frame, there barrels, one in each (objects 19 and 26).[11]

8 Other reference chronologies used in the comparison were oak chronologies from Slovakia and the central part of Hungary.

9 See Vadas and Szabó, "Not Seeing the Forest"; Ágoston, "Where Environmental"; Szabó, "Erdők a kora újkorban."

10 See Várkonyi, *Ünnepek és hétköznapok*.

11 Molnár, "Kecskemét–Nagykőrösi utca 7–9," 129–55.

Figure 4. Structure of well no. 19. Photograph by Máté Varga

Similar structures are familiar from the Roman period (e.g. from Ménfőcsanak) but are unique in late medieval contexts.[12] The timber material is well suited for analysis, and it turned out they were cut at the earliest in 1486 and 1484.[13] As there was no way to provide a more precise dating for the samples, it cannot be determined whether they made their way to Kecskemét in the late Middle Ages and the barrels, which were considered useless, were re-used in this manner or whether they were brought to the town in the period of the Ottoman occupation and were recycled as "rolls." Unfortunately, there is no way to resolve this question, which is regrettable, as the timber originates from Transylvania. More precisely, they best match the chronologies of Biertan (Berethalom) and Târgu Mureş (Marosvásárhely).[14] This means that they made their way Kecskemét by trade. The question of what was originally stored in them is fascinating, if still unanswered, and it would be similar interesting to know whether the barrels also testify to trading activities across the borders in the Ottoman period similar to the practices observed in the context of the site at Esztergom. The uncertainty lies in the fact that, because of the *post quem* dating of the barrels, it cannot be determined whether they were brought to the town in the last years of the unified Kingdom of Hungary or only after the tripartition.

12 I know of only one other example from the Middle Ages, from ca. 1380 from the market town of Mohi/Muhi.

13 The reference chronologies were gathered by the Anno Domini Laboratory in Miercurea Ciuc (Harghita county, Romania, by Boglárka Tóth and István Botár). Statistical values of comparison: t=4,67; GW=64.7/95%; overlap: 119 tree rings, and: t=5,28; GW=68.5/99,9%); overlap: 130 tree rings.

14 There was no observable potentially relevant correlation with other chronologies (Vienna Basin, central territory of Hungary, Maramureş region, present-day Slovakia).

In Budapest, at Kacsa Street 15–23 (in the second district of the city), Katalin Éder and Tibor Hable (both of whom were associates of the Budapest History Museum at the time) found wooden wells the trees for which were felled around 1584–1585. These Ottoman-period objects also testify to "transborder" trade (certainly present towards the Kingdom of Hungary and presumably towards the Principality of Transylvania) in the life of the country after the fall of the medieval kingdom, as the material of the well can be best dated according to the Viennese chronology.[15]

As a method, dendrochronology bears surprises for scholars of significantly earlier periods as well. In 2011,[16] Katalin Sebők and Gábor V. Szabó (Institute of Archaeology, Eötvös Loránd University) unearthed a well that be dated to the Late Bronze Age (Urnfield culture) at Pusztataksony–Ledence.[17] Most of the timber in the well (twenty of the twenty-two pieces) was of ash *(Fraxinus sp.)*. The difficulty of interpreting the finds lies in the fact that one cannot draw a distinction among the three species of ash that are indigenous to the Carpathian Basin, the European ash *(Fraxinus excelsior L.)*, the flowering ash *(Fraxinus ornus L.)*, and the narrow-leaved ash *(Fraxinus angustifolia subsp. pannonica)* on the basis of the image of their tissues.

The habitats of the three species, however, differ. The first two species are mountainous, while the Hungarian subspecies of the narrow-leaved ash prefers

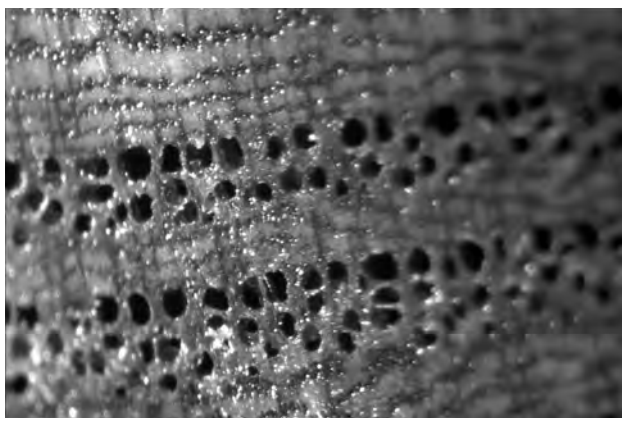

Figure 5. Image of the tissue of one of the ash beams (at a magnification of 20). Photograph by András Grynaeus

15 The reference chronology is the Viennese dataset gathered by Michael Grabner and his colleagues. Statistical values of the comparison: t=5,15; TVBP=4,5; GW=74,0/99,0%; overlap: 51 tree rings. See Várkonyi, *Ünnepek és hétköznapok*.

16 Fülöp, "The Birth of Wells."

17 NKT-01. o:637/s:869.

flood plains.[18] This provides us with an opportunity for further interpretation. One could assume that the trees were transported, in which case one gains valuable data concerning the economic life of a community very far away from Hungary today, both in space and time. However, one can interpret the data from an environmental history perspective. In that case, the data tells of the significantly different composition of species in the flood plain forests back then. Which reading of the data would be correct?[19] The site provides us with one more surprise: young (only 40- to 50-year old) trees were used here again. Why? This question, i.e. the age of the felled trees, is difficult for specialists even at sites on which they have more information.

In the cases of a number of excavation sites, information can be acquired on the ages of the trees used to craft different objects. A telling example is the case of the two Neolithic wells (nos. 629 and 583) that were unearthed at Szalkszentmárton–Táborállás in 2017 by Bernadett Kovacsóczy (an associate of the Katona József Museum).[20] The wells were built of trees felled with an eleven-year gap. For the older well, they used trees which were 200 years old, while for the younger, the trees were roughly 150 years old.[21] This indicates two things: when building wells, there were trees of those ages at the disposal of the community within a reasonable distance, which means that the forests in the territory had been left intact for at least 200 years. However, it also became clear that the newly settled population started to use the forests, so after a decade, they had to "fall back on" the less suitable timber, which was "only" 150 years old.

The use of old trees can be observed at many sites throughout Hungary, such as in the case of a Celtic-period well[22] unearthed at site no. 212 (Center for Heritage Protection, Hungarian National Museum, 2010) by the M3 highway at Pócspetri–Bikarét, where trees which were 100 to 160 years old were built into the well's structure. But the same could be observed at the Sarmatian-period wells found at Püspökladány–Sárréti Csali-tanya (2013)[23] and at site no.

18 Babos, *Fafajmeghatározás*, 58.

19 The two other beams were made of sessile oak *(Quercus petraea (Mattuschka) Lieblein)*. This indicates a mountainous origin if one assumes that all the timber came from the same area.

20 Kovacsóczy, "Előkelő avar férfi," 69–96.

21 In most of the samples, the sapwood was preserved and, in some cases, even the bark could be observed. As the planks were carved out radiately from the trunks, the datasets could be set to the center of the tree, allowing us to measure the width of (almost) every tree ring.

22 The excavation was led by Vera Majerik and Eszter Istvánovics. For a short overview of the excavation, see Larsson and Majerik, "Pócspetri határa," 146–47.

23 Szolnoki, "Püspökladány," 41.

14 at Tiszagyenda–Lakhatom.[24] One tends to conclude that the use of old trees indicates an undisturbed environment, while uninhabited territories and the use of younger trees shows a disturbed environment and densely inhabited areas. However, if one has some background knowledge of these periods, one may call into question the accuracy of this reading of the data.

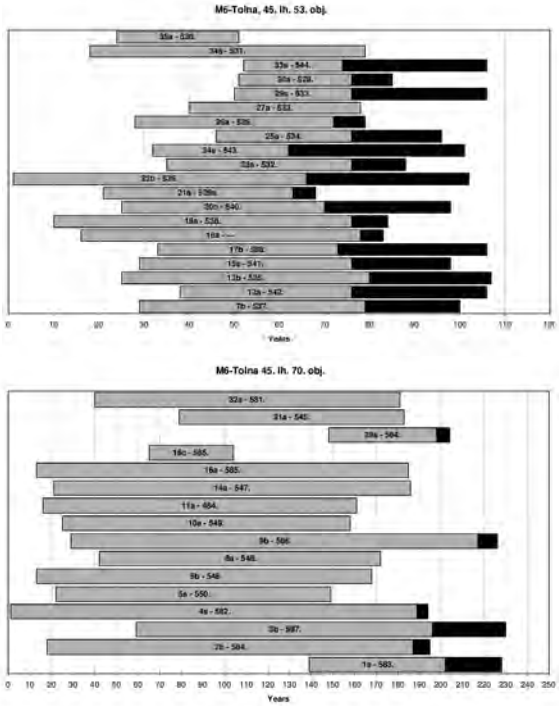

Figure 6. The relative ages of the beams of the wells of Szekszárd (the light fields on the diagram mark the hardwood, while the dark fields indicate the sapwood of the tree rings)

Site no. 45 by the M6 highway close to Szekszárd, which was excavated by János Ódor (Wosinsky Mór Museum) in 2010, prompts one to call into question the above conclusion.[25] Two Avar-period wells (nos. 53 and 70) were also made of timber from trees felled within a gap of eleven years. This is just a coincidence with respect to the aforementioned example, of course, but the interpretation is more problematic, as in this case, the structure of the older well was made of trees felled at about 100 years of age, while in the case of the younger well, the trees used were over 200 years old when felled.[26]

24 Hajnal, "Migration period."

25 Ódor, "Avar szőlő," 22–23, and Grynaeus and Ódor, "Dendrokronológia," 31

26 The planks for the wells were carved out radiately from the trunks in both cases, so we could measure the trees to their centers, and the bark was consistently removed as well. In the case of well no. 53, however,

Is it reasonable consistently to associate the use of older trees with demographic tendencies? Do we really have to assume that there were long periods during which areas were uninhabited and/or periods without forest clearance? Or would it be more realistic to set aside the notion of forests going untouched for generations and consider the possibility that forests were consciously used and cultivated? Could one reasonably make this assumption in the case of the Avars, the Sarmatians, and the Celtic-period populations? Or can one communities inhabited a certain area? The question is clear: should the features make this assumption with regard to periods in which different peoples/of the wood be understood as demographic data or as cultivation data? Do they yield conclusions concerning demographic processes or farming knowledge and practices?

At this point, one must consider methods of forest clearance in historical times. A number of questions and many possible answers arose in the course of an excavation led by Gábor Váczi (an associate of the Institute of Archaeology, Eötvös Loránd University) at site no. 5 at Tiszabura–Bónis-hát. The most important "source" was an Avar-period well. The eight beams studied included trees younger than 100 when felled and older than 200, but only one in between those ages.[27] Why?

Was this the result of clear cutting? This would explain the mixed ages of the trees. However, this may also have been the result of selective cutting, as

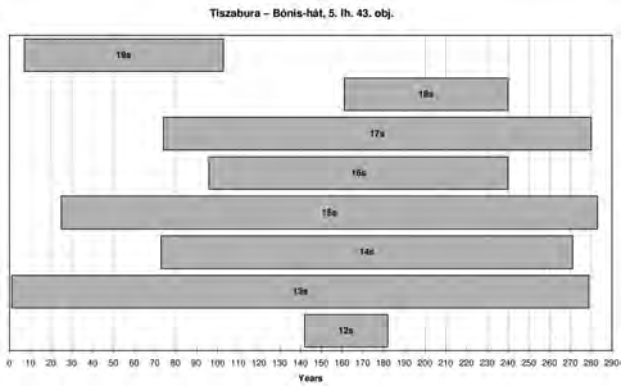

Figure 7. Tiszabura–Bónis-hát, site no. 5, relative ages of the beams of object no. 43 (the light fields on the diagram mark the hardwood, while the dark fields indicate the sapwood of the tree rings)

the sapwood was not removed, and in many cases, all of the sapwood was preserved. At well no. 70, from the sixteen plank samples, fragmentary or full sapwood was preserved in six pieces.

27 The planks were carved out from the trunks radiately, so we managed to include the tree rings to the center, but the sapwood had consistently been removed. As the datasets end at (almost) identical dates, it is likely that only the sapwoods were removed.

based on the sizes and the shapes of the beams, they may have been carefully selected. Or could their placement in the structure of the well be related to their age? There is no substantive data that could support or dismiss this possibility. Do we have so many unanswered questions simply because the low number of samples distort the results? Is this problem aggravated by the fact that parts of the samples have been destroyed (some of the beams and planks), so some parts of the dataset are missing, and some of the external tree rings may be rotten? Of course, one can also interpret the feature as a consequence of a particular method used to shape the beams, because assuming that the wood was cut from a suitably mature tree which was cleaved in half to create two 100 year-old beams, we may have only found one of them. This can also be understood as a special feature of the excavation, which can be traced back to the fact that only the bottom beams survived. The ones above them were destroyed over the centuries.

Can we assume that different methods of wood-cutting were used? I.e., is it possible that people at certain periods could not fell trees of any size? This may seem plausible, but it is unlikely that, if they were able to fell the old trees, they could not deal with the younger ones. Is it possible that the trees preserved traces of demographic processes? Or are both true? Did one of the peoples arriving in the region not know how to or did not want to fell larger trees, and so the trees survived only to be felled and used by later groups? Environmental reasons can also be considered, as for instance younger trees stands could have fallen victim to an ice-flood, while older trees may have proved to be more resilient. And in that case, we have not considered explanations concerning possible rituals or beliefs, such as "sacred oaks" left standing by previous peoples who had lived there.

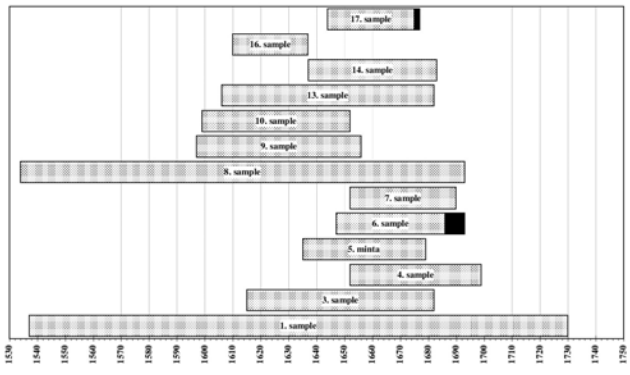

Figure 8. The relative ages of the beams found at Vácszentlászló–Hajta-patak (the light fields on the diagram mark the hardwood, while the dark fields indicate the sapwood of the tree rings)

Which interpretation is correct? How far can an archaeologist/scholar go in interpreting such data? These questions are difficult to answer, but similar features can be observed at late medieval (Vácszentlászló–Hajta-patak[28]) and Árpád Era (Hódmezővásárhely–Kingéc[29]) sites, and these similarities limit the interpretive possibilities to some extent, certainly in connection with ritual practices.

What explanations are the most convincing in such cases? And what methods should researchers use when positing explanations? Should they brainstorm, or should they patiently wait until, at some point in the future, enough data have been gathered to yield definite answers? Should one consider stick to observations of features or should one build theories, which of course involves the risk of error? These questions are not simple to answer.

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28 Excavation led by Zoltán Farkas (Museums of Pest County) in 2011, where a water mill and the related wooden structures of a water mill that can be dated to the seventeenth and eighteenth centuries were unearthed.

29 Well no. 209. Excavation led by Viktor Csányi (Tornyai János Museum) in 2010. See Csányi, *Beszámoló*, Grynaeus, "A 164. számú kút."

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