

# The building of palisades and palisaded castles in Ottoman Hungary – Case studies

Gyöngyi Kovács<sup>1\*</sup>  and Pál Sümegi<sup>2</sup>

Acta Archaeologica  
Academiae Scientiarum  
Hungaricae

73 (2022) 1, 93–106

DOI:  
[10.1556/072.2022.00008](https://doi.org/10.1556/072.2022.00008)  
© 2022 The Author(s)

<sup>1</sup> Institute of Archaeology, Research Centre for the Humanities, Eötvös Loránd Research Network, Tóth Kálmán utca 4, H-1097, Budapest, Hungary

<sup>2</sup> University of Szeged, Department of Geology and Palaeontology, Egyetem utca 2, H-6722, Szeged, Hungary

Received: November 4, 2021 • Accepted: February 1, 2022

## ORIGINAL RESEARCH PAPER



### ABSTRACT

During the period of Ottoman rule in Hungary (1541–1686), palisaded castles of differing sizes were typical elements in the border-castle networks on both sides of the battlefield: the Ottoman and the Christian. Archaeological remains (post-holes, beam structures, parts of palisades) complement the data in the written sources, making perceptible and measurable the great quantities of timber used in the building of castles. In the case of the Ottoman palisaded castle at Barcs and in that of the royal palisaded castle at Bajcsavár (southern Transdanubia), attempts were made – on the basis of archaeological observations and reconstructions of ground plans – to determine the number of palisade stakes used for the walls at the time of building, as well as to establish the number of trees felled in order to make them. By way of environmental history researches, an answer was sought to the question of how much the construction of these palisaded castles impacted on the forests in their respective districts. In the case of Barcs Castle, investigations were conducted into whether forest clearance in its vicinity can be reconstructed on the basis of pollen samples. Other issues examined are how far forest clearance extended from the two fortifications, its intensity, and the approximate quantities of timber yielded by it.

### KEYWORDS

Ottoman Hungary, archaeology, palisaded castles, timber used for fortifications, environmental history

Palisaded castles were characteristic elements in the networks of border castles comprising the basis of the defence systems in Hungary during the time of the Ottoman presence in the country (1541–1686). Strongholds of this kind were erected by the military leaderships on both sides – the Hungarian/Christian and the Ottoman – since they could be built quickly and relatively inexpensively. It was not just smaller castles that featured palisading: larger ones did as well. Some strongholds were completely new earth-and-timber edifices; others were built around a stone structure of some kind from the Middle Ages, in most cases a castle, a manor house, a church, or a monastery. In the early 20<sup>th</sup> century, based on the written sources, three types of palisading were identified by Sándor Takács: simple palisading, filled or lined palisading, and strengthened palisading.<sup>1</sup> Practical considerations meant that when repairs to castles were needed, palisading was installed at stone-built strongholds, too.

The written sources refer more than once to the amounts and the types of timber used for particular fortification assignments. According to a datum from 1583, Ali, pasha of Buda, asked Archduke Ernest for ‘3000 sleepers, 1000 rafters, and 10,000 sawn planks; the sleepers

\*Corresponding author.  
E-mail: [kovacs.gyongyi@abtk.hu](mailto:kovacs.gyongyi@abtk.hu)

<sup>1</sup>Takács (1915) 31, 43, 44. Simple palisading (in Hungarian ‘*latorkert*’): fencing consisting of a line of sharpened stakes close to one another; filled or lined (‘*töltött*’ or ‘*bélelt*’) palisading: twin rows of strong oak posts dug into the ground at a greater or lesser distance from one another, the posts being held together by ties and woven with wattle, the space between the two rows being filled with clay, and on the outer surfaces being with covered with clay; strengthened (‘*rótt*’) palisading: twin rows made up of posts set close to one another, the two rows being connected to one another with ties and the space between the rows being filled with earth.

should each be 25 *sings* long [i.e. approximately 15 m long]<sup>2</sup>. A sultan edict of 1665 lists the quantities and types of timber necessary for the rebuilding of Szécsény Castle captured by the Ottomans two years before, in 1663: ‘...the fire-damaged castle at Szécsény needs to be rebuilt; ...the following are necessary: for the castle’s inner and outer tower (*burdž barusu*), 10,000 palisade posts (*palanka kazuği*)...; for its four sides, 5000 barrier posts (... *kazuği*)...; for walkways inside, 4000 planks (*pāsbān gezedžek tahta*)...; for the rebuilding of the burnt bridge (*şokağ köprüsü*) in the inner part of the castle, 1000 large logs (*balvan*)... and 4000 bridge planks (*köprü tahtası*)...; for the moat to be dug on the four sides..., pales for the making of sharpened stakes in sufficient number; and for the platforms for the cannons in the towers, 500 large logs (*balvan*) and 1000 planks...’<sup>3</sup> Our study seeks to determine whether such written sources, and similar ones, can be matched with the archaeological data and with calculations based on surveys and ground plans. Our purpose is not the analysis of the written and pictorial sources; rather, it is to contribute to investigation of the issue with just some of data based on archaeological findings.

A starting point for a precise calculation of the number of wooden posts used for the walls of a castle is the ground plan of the stronghold in question. With regard to palisaded castles, however, authentic ground plans from the time have generally not survived, and when they have, they and their accuracy are open to doubt. Archaeological data that can be set against written and pictorial sources are by and large rather in short supply.

## THE CASTLE AT SZOLNOK

Utilising 18<sup>th</sup>-century surveys in the absence of archaeological data, Zsigmond Károlyi and Gerzson Nemes made, in the mid-1970s, calculations relating to the quantity of timber required for the building of Szolnok Castle. Subsequently, they compared their findings with data contained in a 17<sup>th</sup>-century description. In a work on geography, the 17<sup>th</sup>-century Ottoman scholar Behram Dimişki wrote about this edifice, mentioning that Szolnok ‘has a stronghold resting on 3600 posts’,<sup>4</sup> which, according to Károlyi and Nemes’s interpretation, may have meant that 3600 oak posts were used in its palisade walls. Since no creditable, precise, contemporary ground plan of Szolnok’s castle was available, the two authors reconstructed the lengths of the walls of the one-time castle using maps made by János Litzner and József Markmüller in 1787 and 1819 respectively. On Litzner’s map, the total length of the castle’s walls is 1223 m; on Markmüller’s, it is 1110 m. (On a drawing made of the site in 1882, the total length of the castle’s walls comes to 1165 m.)

<sup>2</sup>Takáts (1915) 83. (Buda, 5 January 1583.) See also Takáts et al. (1915) 275, no. 249. (Original Hungarian: ‘*harom ezer talpakat, ezer szaru fatt, tiz ezer fűreszeolt lecseöt, de az talpak huszon eöt eöt singeöseök legyenek...*’).

<sup>3</sup>Order to the beglerbey of Egri (Eger). Fekete (1929) 90, no. 252.

<sup>4</sup>Fekete (1930) 16.

Reckoning with a total length of 1223 m and hypothesising posts 40 cm in diameter, approximately 3000 posts were needed for the outer row of posts in the castle walls, plus, according to their thinking, one-fifth of this number – around 600 posts – for the inner row and to connect the posts together. The number arrived at, 3600, therefore accords with the data in the contemporary report. Based on the measurements of the posts in question, the volume of timber used may be estimated at 10,000 m<sup>3</sup> and the volume of earth used in the walls at 100,000 m<sup>3</sup> at the minimum.<sup>5</sup>

As mentioned above, the archaeological data in regard to remains of walls of palisaded castles and of the wooden buildings that once stood inside them are very scarce, across the whole country. That is to say, excavations hitherto have revealed parts of them merely;<sup>6</sup> in more than one case, though, these parts have yielded important information.

## BEAMS, POSTS, PALISADE STAKES, PLANKS, WATTLE

In what follows, some remains documented in the course of archaeological excavations are presented which tell of the multifarious applications of the posts, beams, and palisade stakes used in the construction of castles; of frameworks of beams used for strengthening, of palisade walls; and of different solutions and practices. These remains tangibly underpin the data in the written sources, giving a sense of the quantities of timber used.

In castles – principally in marshy environments – frameworks made of beams were used to create strong foundations. They were intended to firm up damp earth, thus enabling construction operations and ensuring the viability of buildings and other structures erected.<sup>7</sup>

Kanizsa Castle (Nagykanizsa, southwestern Transdanubia) passed into Ottoman hands in 1600. Before this, in the period 1568–1587, major efforts to strengthen it were made following a decision by the Aulic War Council in Vienna.<sup>8</sup> Large quantities of timber were used there even earlier, at the time of the medieval castle’s construction. Because of the marshy ground, framework consisting of beams had been used; significant remains of this were uncovered in the course of the archaeological researches;<sup>9</sup>

<sup>5</sup>Károlyi and Nemes (1975) 43–45 (A ‘reconstruction’ of the ground plan and measurements of Szolnok Castle). Litzner’s map of 1787 shows castle walls that are relatively intact, while Markmüller’s portrays the outlines of decaying ruins.

<sup>6</sup>It is not our purpose here to present the historical and archaeological research conducted into building operations using palisading and into palisaded fortifications. For these topics, see, for example, Takáts (1915), Mordovin (2011), and Tolnai (2011), with summaries of earlier researches and further literature. With regard to recent researches, a number of studies can be found, for example, in issues of the periodical *Castrum*, namely vol. 19(2016/1–2) and vol. 20(2017/1–2).

<sup>7</sup>Méri (1988) 38.

<sup>8</sup>Vándor (1994) 304–312.

<sup>9</sup>Méri (1988) 20–31, pls. IV–XII.

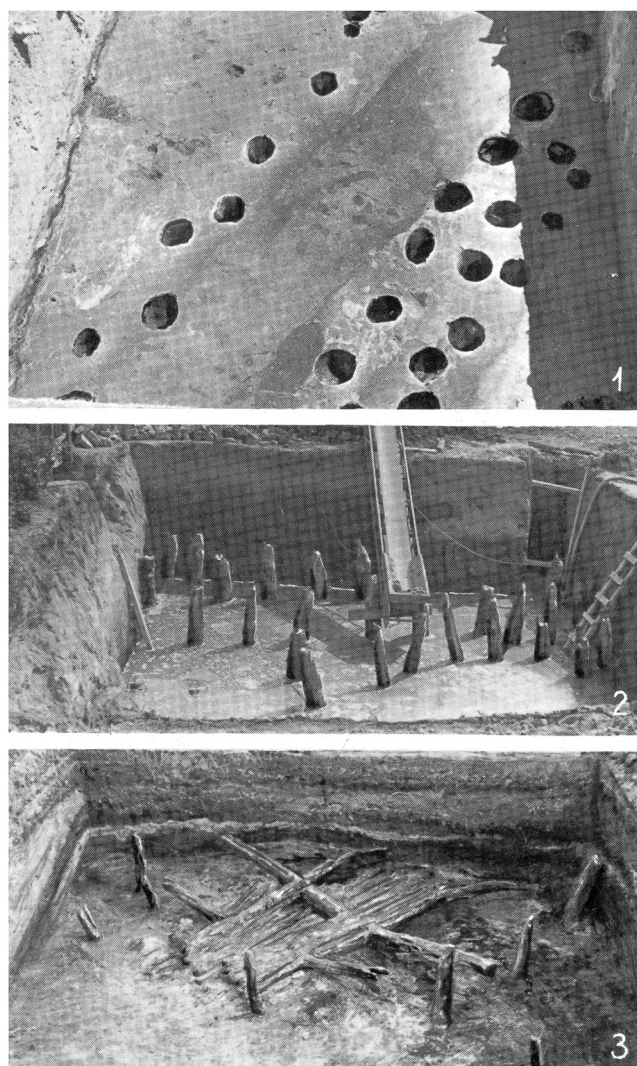


among these remains were rows of posts woven with wattle.<sup>10</sup> The parts excavated allow estimation of the number of posts used to underpin the medieval castle, approximately 2400, although – as István Méri wrote – ‘along with others used in the edifice and in its immediate surroundings [the total number of posts] can be put at twice that, namely at 4800–5000’.<sup>11</sup> Even so, this number would have been sufficient only for a single palisaded bastion of the large-sized castle (which included the earlier castle, too) shown on Ferabosco’s reconstruction plan of 1572, and then only for the base of its outer edge (reckoning with posts 30 cm in diameter arranged, according to the plan, in triple rows). In other words, for the large timber-frame castle constructed in the 16<sup>th</sup> century, many tens of thousands of tree trunks were needed, a number that increased on account of the continual renewals and repairs effected before and after the Ottoman takeover.

Only very small sections of the large-sized castle could be excavated; some featured posts used in the castle walls, some belonged to a bridge roadway in the Outer Castle and to the corduroy road that was later created from it (Fig. 1), and some were as-yet unidentified parts of buildings inside the stronghold.<sup>12</sup>

In the late 1520s, under Bálint Török, the medieval castle of Szigetvár (southern Transdanubia) was strengthened significantly: it was turned into a three-part stronghold with palisaded bastions and walls.<sup>13</sup> Heavily damaged in the Ottoman siege of 1566, the earlier palisaded bastions were rebuilt in stone and brick by the Ottomans. Additionally, a unitary system of defence was created by them through their lengthening of the western and northern castle walls and their filling in of the inner moat. In the course of the archaeological researches, traces of a framework of beams were observed at the walls of the northwest bastion of the new Ottoman-era stronghold (which was formed from the earlier inner and middle castles), as well as reinforcing posts under the walls of the northeast bastion. Also from the Ottoman period were beam and post structures intrinsic to the bastions that were brought to light by archaeological excavations in the 1960s on the areas of the northeast, southeast, and northwest bastions (Fig. 2). These structures in themselves show the enormous amounts of timber used in construction operations at the castle.

Excavated parts at Gyula Castle (southern Great Plain) attest to huge fortification operations there that were continual before, and following, the Ottoman capture of the stronghold in 1566. These parts are in accordance with



**Fig. 1.** Kanizsa, castle. 1–2: Rows of posts belonging to the palisaded wall of the 16<sup>th</sup>-century, large-sized castle; 3: An excavated part of the bridge roadway. After Méri (1988) pl. XIV, Fig. 2. I, Fig. 2. III, and Fig. 1. A

depictions and written data from the time. During excavations of the medieval castle and its surroundings over many decades (from 1956 up until 2016), many details were successfully clarified. In the period prior to its capture by the Ottomans, posts 70–80 cm in diameter formed the framework of a wall of packed clay 8–9 m wide. On the other hand, palisade stakes used in repairs during the castle’s Ottoman years (1566–1695) were 25–50 cm in diameter; the width of the castle walls in this period may have been 3 m (Fig. 3).<sup>14</sup> In 2015, rows of vertical posts belonging to the palisading’s internal, carpentered framework came to light on the north side of the brick castle; so, too, did remains of supporting beams placed horizontally. In 2015, southwest of today’s palace, at the Outer Castle’s southwest bastion, it was observed that vertical posts in a double row were supported

<sup>10</sup>Méri (1988) 27, pl. IV. 3.

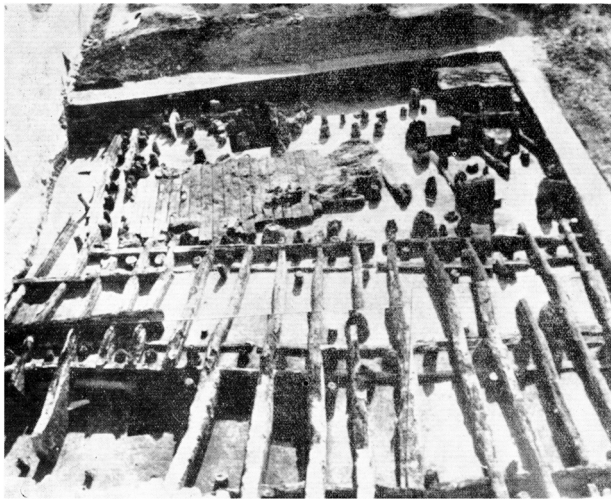
<sup>11</sup>The number of posts encompassing the building was roughly 2000, the number of split posts counting as single posts (i.e. posts split in two lengthways whose two halves had then been bound together) in front of the building’s south façade roughly 100, and the number of posts there up to the outer edge of a slanting pillar roughly 300, making a total of approximately 2400. Méri (1988) 39.

<sup>12</sup>Méri (1988) 29–30, pls. XIII–XV.

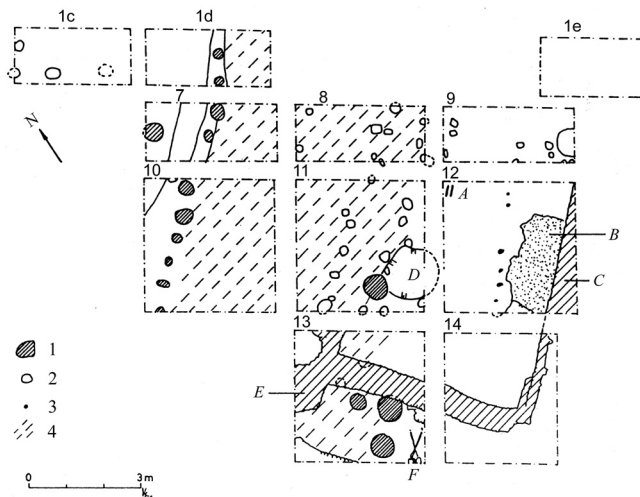
<sup>13</sup>Kováts (1966) 234.

<sup>14</sup>Gerelyes (1996) 114–120.





**Fig. 2.** Szigetvár, castle. Ottoman-era beam structure to firm up the ground (with cannon emplacement) inside the northeast bastion. After Kovács (1966) 234, Fig. 23



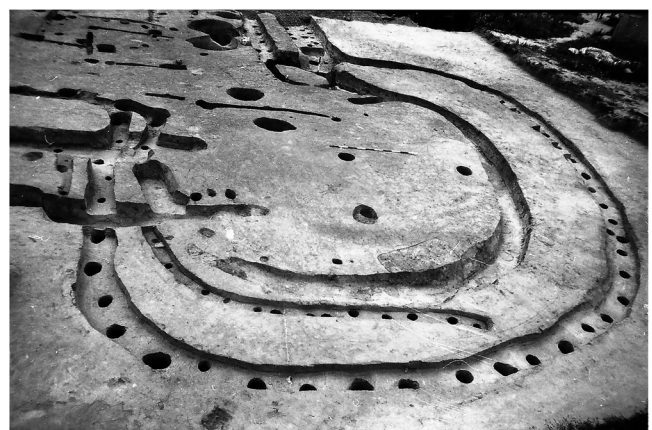
**Fig. 3.** Gyula, castle. Details of pre-1566 palisading and Ottoman-era palisading. After Gerelyes (1996) 115, Fig. 5. 1. Key: 1: Posts from pre-1566 palisading; 2: Posts from Ottoman-era palisading; 3: 17<sup>th</sup>-century post-holes; 4: Tamped-down clay. A. Bones, B. Ottoman-era flooring, C. Modern-era building, D. Refuse pit, E. Modern-era building, F. Skeleton

by a double row of obliquely placed beams in parallel with each other. Also documented were 40–60-cm-long iron nails used to attach the beams to the posts.<sup>15</sup>

The palisaded castle at Egerszeg (Zalaegerszeg, western Transdanubia) was built in 1546 to oppose the Ottomans; after 1600, it was a stronghold in the captaincy facing Kanizsa. On 7 September 1657, it suffered fire damage. For purposes of making good this damage, János Ákosházi Sárkány requested assistance from Zala County: “The noble county should order approximately one thousand palisade

stakes and wattle sufficient for them.”<sup>16</sup> During excavations conducted in 2001–2002,<sup>17</sup> the northeast fortification of the Outer Castle (*presidium*) was discovered. This was a semi-circular bastion 9 m in diameter, and built from posts 15–30 cm in diameter that were placed at an average distance from each other of 30 cm. The bastion’s outer side may have consisted of 25–30 stakes. On the inner side, additional posts came to light; they were not attached to one another but clearly served to reinforce the structure. The curtain walls proceeding from the bastion were made from twin rows of posts; in each row, the posts were set close to one another. Other sections of curtain wall were sometimes a single row of posts, sometimes a twin row of posts.

The remains of Újpalánk Castle (*Yeni Palanka*) (near Szekszárd, southern Transdanubia) have been excavated almost completely,<sup>18</sup> although a ground plan of the facility has still not been published. Photographs taken at the southwest and northwest bastions show the heterogeneity of the bastions as regards shape; they also indicate repairs, ties, and places where palisade stakes once stood (post-holes). According to observations made during the excavations, the (filled) palisade walling was 80–100 cm thick; the stakes constituting the outer row stood 40 cm apart and were each 20–25 cm in diameter. The large and deep pits found within the bastions probably indicate additional construction using wood.<sup>19</sup> On the basis of the photographs (cf. Fig. 4), the outer side of the double row of posts forming the palisade wall of the semi-circular northwest bastion consisted of 55 palisade stakes (including the stakes observable in some places that probably served to reinforce and support the wall). Proceeding from this and picturing – theoretically – corner-bastions roughly identical in size, approximately 220



**Fig. 4.** Szekszárd-Palánk. Northwest bastion of the Ottoman palisaded castle, Újpalánk (*Yeni Palanka*). Photograph: Attila Gaál

<sup>16</sup>Eventually, on 8 November 1657, the county assembly ordered the rebuilding of the castle, drawing on the labour of the men of two districts. Müller (1976) 14.

<sup>17</sup>Vándor (2016) 67–68, Figs. 3–4.

<sup>18</sup>Gaál (1985); Gaál (2003).

<sup>19</sup>Gaál (1985) 187, Figs. 8–9.

<sup>15</sup>Liska (2017) 54–56.

palisade stakes were needed for the outer walls of the bastions alone (at the time of building). In the ditch dug for the posts of the curtain wall joined to the southwest bastion, traces of stakes in multiple rows side by side came to light; at the northwest bastion, on the other hand, traces of single rows of stakes in multiple ditches were seen. Judging from the post-holes, posts were not sited with precision. The southwest bastion's inner row of palisade stakes likewise exhibits an ad hoc solution.

At the end of our brief (and by no means comprehensive or complete) survey, we shall return to Szécsény; timber ordered for rebuilding of the castle in 1665 was mentioned above. The castle and the town together comprised an important stronghold in the Ottoman border-castle system in the Buda area during the periods when they were in Ottoman hands (1552–1593 and 1663–1683). In 2005 and in the course of 2010, the town wall afforded opportunities for research into the stronghold's palisading in the Early Modern Era over several sections on more-or-less connected area.<sup>20</sup> Two construction periods in the fortification work could be discerned: the second half of the 16<sup>th</sup> century and the first half of the 17<sup>th</sup> century. This work could be reconstructed as three-part palisading whose parts were a twin rows of posts on the inside, earthwork on the outside with an outer single or double row of posts to retain it, and a parapet 80–90 cm high on the side facing the town. The excavations uncovered (among other things) a distinctive system of vertical posts and horizontal crossbeams, remains of planks, and traces of a covering made from planks that may have formed part of the parapet.

The amount of timber used in the construction of castle walls – or, more precisely, the number of posts deployed – can sometimes be investigated on the basis of archaeological data merely, and can then, to a certain extent, be deduced or estimated, especially when other kinds of sources – scarce as they are – can be used in the calculations.

In what follows, we shall try to determine in the case of two palisaded castles in Transdanubia – fortunate examples so to say – the amounts of timber used at the time the castles were built, or, more precisely, in the construction of the castles' walls. In the case of the Ottoman castle at Barcs, a schematic, unscaled, 17<sup>th</sup>-century ground-plan sketch and the findings of a partial archaeological investigation were available to us, while for the Styrian-built border castle at Bajcsa no contemporary ground plan was on hand, although following systematic archaeological excavations a rather exact ground plan emerged on the basis of which calculations could be made. At neither castle could timber foundations, timber upper parts, or timber bracing elements be observed. Consequently, our calculations – based on ground-plan reconstructions and archaeological observations – were limited to investigation of the quantity of posts (or 'stakes', 'palisade stakes', 'piles', 'beams' in the language usage of the time) utilised for the first construction of the castle walls merely.

The circumstances in which the castles were built will not be dealt with here. Those employed in the construction of Barcs Castle were probably drawn from the inhabitants of settlements nearby. They may have come from areas beyond the River Drava, perhaps from further afield (also), maybe from among those ordered to participate in construction operations at Szigetvár Castle. The archival material of the Styrian Estates in Graz and the documents of the Aulic War Council (Hofkriegsrat) in Vienna afford substantial data concerning not only the building operations at Bajcsavár, but also the builders themselves. We shall speak of this information later on.

## THE OTTOMAN CASTLE AT BARCS

The Ottoman palisaded castle at Barcs was one of the fortifications comprising the system of Ottoman border castles along the River Drava. Built in 1567, it burnt down twice, in 1595, during the Long War (1593–1606), and in 1664, when it was abandoned for the last time, – during Miklós Zrínyi's winter campaign of January and February that year. This was when the sketch of the castle's ground plan published in Count Pál Esterházy's *Mars Hungaricus* was made.<sup>21</sup> Judging from fieldwalking operations, surface finds, and archaeological researches, the sketch is a more-or-less authoritative depiction from the period, although many of its details are disputable – for example, its showing of Italian-type bastions.

According to the archaeological researches conducted,<sup>22</sup> the castle was built from scratch; it had no medieval antecedent. Judging from the sections of castle walls uncovered, the stronghold was positioned on a northwest–southeast axis, in accordance with the direction followed by the Drava riverbank at that time. In the 16<sup>th</sup> century, the castle was protected by filled palisaded walls that consisted of double rows of posts filled in the middle. The distance between the two rows (the inner and the outer) varied in different sections: the width of the walls was, therefore, not uniform; it was on average 130–150 cm (leaving out of account repair and renovation work). In the 17<sup>th</sup> century, the castle walls – certain sections of them at least – consisted of a single row of posts. Judging from the remains unearthed there, a rondella-type bastion may have stood at the north corner of the castle (in one period anyway).

Reconstructed with the help of computer graphics specialist Zsolt Réti, the castle's ground plan has by and large the shape of a regular square. This was worked out by collating parts that were excavated with the ground-plan sketch made in 1664. Based on the excavated parts of the north bastion and on formal marks characteristic of Ottoman palisaded fortifications, semi-circular bastions – not Italian-style ones – were envisaged for the corners. It should be noted, however, that the original shapes of the bastions are, alas, not known. If the 1664 drawing is to be

<sup>21</sup>Esterházy (1989) 140.

<sup>22</sup>Kovács and Rózsás (1996) 163–182; Kovács and Rózsás (2010) II, 621–642.

<sup>20</sup>Mordovin (2011); Mordovin (2015) 137–138.



believed as regards the number of bastions, the scant archaeological phenomena uncovered at the southeast corner may, perhaps, indicate the place of a bastion stretching towards the river, although it cannot be excluded that they are merely remains of a fourth bastion (Fig. 5).

On the basis of the archaeological remains and the distribution of the surface finds, the unscaled Esterházy sketch of the castle at Barcs was given a scale. According to the archaeological data, the castle extended 90 m in a northwest–southeast direction; on the other hand, in a southwest–northeast direction its length may have been roughly 70 m, after collation of the contemporary drawing with observations made during fieldwalking. It turned out from the archaeological discoveries that the castle's dimensions remained basically the same during its period of service. Accordingly, the calculations below, and the values arrived at, are good for the 16<sup>th</sup>-century castle and for the 17<sup>th</sup>-century one.

Obviously, the areas (and the perimeter) of castle wall hypothesised on our sketch showing the reconstruction cannot be precise, but may approximate to reality. With four rondellas, the outer walls run to 379 m, with five bastions 397 m (on the contemporary drawing adjusted in accordance with the known details the figure is 441 m). Since the castle walls were not too thick, the difference between the length of the outer row of posts and the length of the inner one was almost the same: the inner one was just 1 per cent shorter. The length of the wall sections excavated (measured between the two rows of posts) amounted to 30–31 m, – in

other words, 7–8 per cent of the total length of the walls. On the basis of the post-holes observed, posts were 20–25 cm in diameter (Fig. 6.1–3). The distances between the post-holes exhibited irregularity: they were 40–50 cm generally speaking, 40–60 cm on occasion. In the parts excavated, the distances between the posts in the outer row and the inner one did not differ. The inner row was shorter in length than the outer one; less wood was required for it. The site of the castle entrance may, perhaps, have been 4–5 m wide; this gap would not, according to our calculations, have impacted significantly on the number of the posts used at the castle.

Reckoning with palisade stakes (posts) 20–25 cm in diameter and with distances between them of 40–50 cm, based on our reconstruction and our averaging of the data<sup>23</sup> for the building of the filled castle walls at Barcs Castle approximately 1100–1200 palisade stakes were needed, independently of the number of the bastions. Once again it is stressed that this figure, based on our reconstruction, is a rough guide merely.

When the castle was being built, posts flat at the bottom were placed in deep ditches cut for the purpose. The ditches were then filled in using the earth; this was then tamped down. As regards depth below the surface level back in the day, the ditches varied more than a little; on average their depth was 120–140 cm. As regards the posts, roughly the lower third of each was below ground level and the upper two thirds above it, suggesting walls whose height above the surface was about 2.5–3 m. Reckoning with posts 4–5 m in length and 20–25 cm in diameter,<sup>24</sup> 1200 posts represented approximately 216 m<sup>3</sup> of timber.

With respect to shape, post-holes were round or slightly oval. In all probability, trees were selected whose slenderness was such that they did not require much work, i.e. trees that could be used soon after they had been felled, trimmed of their branches, and cut into lengths. Oak trees were used to



**Fig. 5.** The Ottoman castle at Barcs. Possible reconstructions of the castle's ground plan based on archaeological observations, with the castle walls as shown on the sketch from 1664. Blue: reconstruction; yellow: sections of the palisaded wall (rows of post-holes) discovered; brown: the 17<sup>th</sup>-century sketch. Computer graphics: Zsolt Réti

<sup>23</sup>In the outer and inner rows on a reconstructed ground plan with four bastions (379 + 373 = 752 m), in total:

Reckoning with a diameter of 20 cm and a distance between posts of 40 cm, 1253 posts

Reckoning with a diameter of 20 cm and a distance between posts of 50 cm, 1074 posts

Reckoning with a diameter of 25 cm and a distance between posts of 40 cm, 1157 posts

Reckoning with a diameter of 25 cm and a distance between posts of 50 cm, 1003 posts = average 1122 posts.

In the outer and inner rows on a reconstructed ground plan with five bastions (397 + 394 = 791 m), in total:

Reckoning with a diameter of 20 cm and a distance between posts of 40 cm, 1318 posts

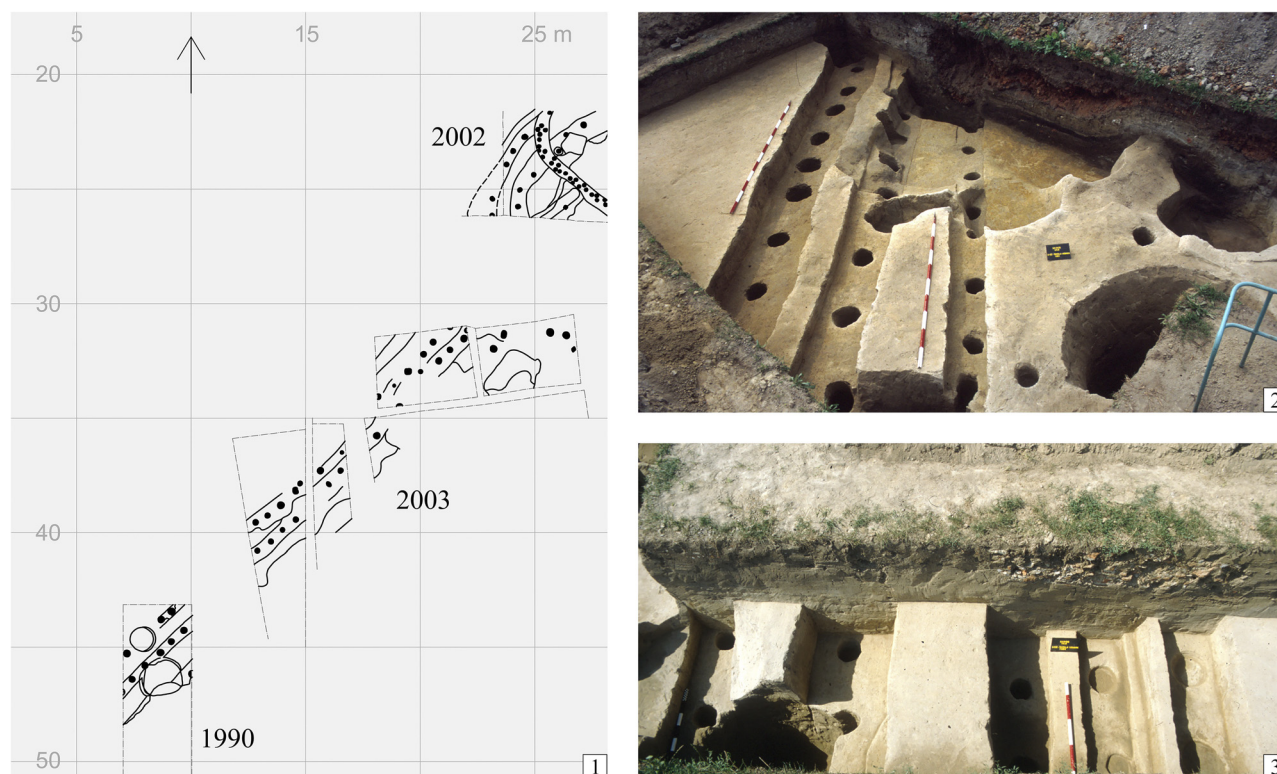
Reckoning with a diameter of 20 cm and a distance between posts of 50 cm, 1130 posts

Reckoning with a diameter of 25 cm and a distance between posts of 40 cm, 1217 posts

Reckoning with a diameter of 25 cm and a distance between posts of 50 cm, 1055 posts = average 1180 posts.

<sup>24</sup>Palisade stake 4 m long and 20 cm in diameter: 0.12 m<sup>3</sup>; palisade stake 5 m long and 20 cm in diameter: 0.16 m<sup>3</sup>; palisade stake 4 m long and 25 cm in diameter: 0.19 m<sup>3</sup>; palisade stake 5 m long and 25 cm in diameter: 0.24 m<sup>3</sup> = average 0.18 m<sup>3</sup>.





**Fig. 6.** Barcs, Ottoman castle. 1: Details of the northwest palisaded wall. After Kovács and Rózsás (2010) 624, Fig. 4; 2–3: Details of palisaded walls close to the southeast bastion. After Kovács and Rózsás (1996) 169, Fig. 8c, 170, Fig. 9a

build castle walls. Since oak trees could grow to heights of 30–40 m, one tree could be used to make more than one post. The height of an oak tree whose trunk was 20–25 cm in diameter is, however, only 9–13 m (oak trees of this height and diameter are 50–60 years old). Only 6–9 m of such a tree could be used; this meant that a single tree of this kind yielded just one or two posts. If we reckon with 1200 posts and two posts per tree, then we can conclude that approximately 600 trees were cut down to build the palisaded castle walls at Barcs. The figure may have been appreciably higher though, since for two posts one tree was not always enough.

According to observations made during the excavation work, in the 17<sup>th</sup> century the castle walls in the castle's southern part (ÁI/1991) consisted of a single row of posts only; at the north bastion (KÜ/2002), signs of later fortification along a line differing from the earlier one appeared in the form of much smaller post-holes (15 cm in diameter), while at a trench (ÁI/1994) cut in the southeast part signs emerged of multiple repairs to the palisading (Fig. 6.3). With regard to the rebuilding work and the repairs, it is clear that the amount of timber used for the castle walls in the approximately 100 years of the castle's operation was a multiple of the amount used when the castle was first put up. Large quantities of timber were necessary not only for posts, but also for fastening elements, for the rows of stakes and posts erected along the edge and bottom of the castle's moat, for the bridge, for the defence of the outer gate (likely to have existed on the basis of the contemporary sketch), for the buildings inside the castle, and for various other uses, too.

From the point of view of the timber used for its construction, the palisaded castle may have relied on the forests of the Drava country round about.<sup>25</sup> On a 1782 map made as part of the First Military Survey of the Habsburg Empire (Fig. 7), forest is absent from a large area to the north of Barcs: a cleared space triangular in shape and 430 ha in extent can be seen directly outside the settlement. This space cuts into a belt densely covered with forest. South of nearby Babócsa can be seen a similar forest-free area, albeit – at 840 ha – a larger one. The road between the two settlements is flanked by a broad cleared area. In historical terms, the explanation for the lack of forest is complex.<sup>26</sup> The forests of the area had served these two settlements in earlier and post-Ottoman periods also; the above map data, recorded in the late 18<sup>th</sup> century, show the results of human activity over a long period. The cleared areas grew bigger from the 16<sup>th</sup>

<sup>25</sup>For the extensive forests of the Drava region, see, among others, the description offered by the Ottoman traveller Evliya Çelebi: 'From Szigetvár we travelled westwards for six hours through hills and then through forests on sandy soil, arriving at the castle of Babocsa (Popofça). [...] We then proceeded southwards for seven hours through forests, reaching the castle of Berzence. [...] From Kanizsa we travelled in a southerly direction for three hours through hills and forests, arriving at the Grand Vizier's encampment and the territory of Ibrahim kethüda. [...] Setting out from the castle [Kanizsa], we went westwards for a day, through forest the whole time, crossing the River Mur with ease at a suitable ford.' Evlia (1985) 552, 554, 571, 577.

<sup>26</sup>For a new summary on the theme, see Vadas and Szabó (2021).



**Fig. 7.** The Barcs area on a map made in 1782 as part of the First Military Survey of the Habsburg Empire. Hungarian Government, Ministry of Defence, Military History Institute and Museum, Military Map Archive

century onwards: as well as castle building and maintenance, other military needs, significant firewood requirements, and an upturn in industrial output all played a part. An additional factor was large-scale cattle breeding, which necessitated the creation and expansion of pastures.<sup>27</sup> Of relevance is the fact that in the 16<sup>th</sup> century cattle intended for sale in Styria and Italy were driven in this area, – along routes that followed the line of the River Drava.<sup>28</sup> The timber needs of shipping on the river – and of crossing places, shipbuilding, and mills along this waterway – similarly merit consideration.

## ENVIRONMENTAL HISTORY RESEARCHES IN THE VICINITY OF BARCS

Environmental history investigations, too, were conducted in the Barcs area within the framework of our 2007–2013 project (by Pál Sümegi and his colleagues).<sup>29</sup> In the course of these, a question emerged: could forest clearance in the

environs of Barcs Castle from the 16<sup>th</sup>–17<sup>th</sup> century onwards be reconstructed on the basis of pollen data; and, if so, how much deforestation was there, which areas did it affect, and approximately how much timber was produced?

These questions can be answered, but they are extraordinarily complex.

On the basis of recent studies, pollen accumulation and embedment (taphonomy) takes place according to definite laws; and if we are to investigate issues of this kind, there is a need for a smaller sedimentary basin into which no stream or other watercourse flows. Since there is no such feature on the alluvium of the Drava near Barcs, pollen from a sedimentary site in another area (Lake Baláta, near Szentá in Somogy County) was compared with pollen from oxbow lakes along the Drava and their alluvial layers.<sup>30</sup>

A model was made by taking into account social energy on the medieval technical level (human and animal power) calculated for the production and transportation of timber based on the amount of timber actually produced. The basis of this was on the one hand the so-called Thünen-circle model, a type of analysis used by us earlier in an archaeological model,<sup>31</sup> and on the other hand SCA (Site Catchment Analysis). An area that could be reached gainfully in a day's walk, a so-called 'one-day catchment area', was then delineated. In this way, an area within 5 km of Barcs was traced out, namely an expanse of 75–76 km<sup>2</sup> for the production of timber and its delivery to the palisaded castle.

The validity of our model is weakened by the presence of driftwood in the Drava valley, by the possibility that timber from further afield arrived as driftwood and was utilised. Hence our model is valid only if we do not reckon with the generation of driftwood and its use at the castle.

Clearing areas served a number of purposes: the pastures, ploughland, and meadows that took shape as trees were cut down supplied villages and other settlements. A northwest–southeast cleared area observable on a high bluff to the north of Barcs Castle – a relief rising out of Holocene alluvium that is clearly recognisable on a map (scale: 1:28,800) made as part of the 18<sup>th</sup>-century First Military Survey of the Habsburg Empire – was shown in 1578 already, on a map of Hungary by János Zsámboky (the humanist Johannes Sambucus) based on data from 1571. Between Barcs and Babócsa, this area was approximately 53 km<sup>2</sup> (5300 ha); the area belonged to the two castles and other settlements in the vicinity, but also served the needs of commerce along the River Drava (e.g., the penning of cattle). In the Ottoman period, Babócsa was an important border castle, market town, and commercial centre, namely a place with increased needs.

On the basis of our pollen analysis, this much can be asserted: in the 16<sup>th</sup>–17<sup>th</sup> centuries a mosaic-like coverage can be envisaged on the area around Barcs's palisaded castle with forest vegetation coverage amounting to 30 per cent – and oak forest coverage around 4 per cent – of the whole.

<sup>27</sup>Rácz (2008) 151–154.

<sup>28</sup>Szakály (1973) 55–62; Pálffy (2007) 356–358.

<sup>29</sup>Settlement Archaeology and Environment History Researches in Southern Transdanubia, 1300–1700', National Scientific Research Fund (OTKA) no. K 72231.

<sup>30</sup>See Sümegi (2007); Juhász (2007).

<sup>31</sup>Sümegi (2009) 472–474.



On the other hand, on areas counting as hinterland from the settlement and production point of view (namely Lake Baláta and its environs), in the very same centuries forest vegetation coverage was around 60 per cent, of which oak forest coverage was in excess of 40 per cent. The differences between these two sets of data can be explained by the impact of human activity: deforestation, the creation of cleared areas, and selective timber harvesting.<sup>32</sup>

Accordingly, in the area under discussion, a cleared space of approximately 6500–6600 ha,<sup>33</sup> prior to the building of the two castles and the settlements round about we can reckon with the existence of 3900–4000 ha of forest, of which 2600–2700 ha were oak forest. After clearance though, only 1900–2000 ha of forest cover can be hypothesised, with just 190–200 ha of this being oak forest. Of the 6500-ha area, the 4000 ha of forest (2400–2500 ha were oak forest) were cleared. The parts exploited during the Ottoman period easily provided sufficient timber for building operations at the two castles as well as in the villages and other settlements that supplied them. Through utilisation of a technique employed in the Middle Ages, namely harvesting only some of the trees available, sufficient living trees remained even after the creation of the cleared areas.

In case of annual net growth of 8 m<sup>3</sup> of timber per hectare (a standard figure in forest management), the total volume of timber harvested was, at a very conservative estimate, 800 m<sup>3</sup>, – provided that the oak trees in question were 50–100 years old. Timber in this quantity would – after removal of branches, sawing into logs, and lengthwise splitting or sawing – have yielded approximately 360 m<sup>3</sup> of useable timber.

On the basis of survey work and experiments relating to growth rates within forests, one hectare of oak forest can hold approximately 50–100 oak trees that are 50–60 years old, 20–25 cm in diameter, and 9–13 m tall. In other words, the timber needed for the 1000 or so palisade stakes required for the construction of the castle could easily be harvested from an area of 5–10 ha. As a reminder, the number of posts used in the walls of Barcs Castle has been estimated at 1100–1200, amounting to around 220 m<sup>3</sup> of timber.

On the basis of the above calculations, trees from the cleared areas mentioned (more narrowly, trees from the 430 ha next to Barcs) along with others from forests that had survived plainly yielded sufficient timber for the construction of the Ottoman-era castle, for the different operations connected with the castle's maintenance, and for the needs of the surrounding settlements as well. The significant quantities of timber and other wood products available facilitated the rapid replacement of timber elements of castles and other buildings when necessary on account of fungus, rotting, or possibly fire. At the same time, in the case of Barcs, which was on a riverbank, the use of driftwood and of timber deliberated floated downstream cannot be excluded.

## BAJCSAVÁR (WEITSCHAWAR)

According to a written source from 1567, the Ottoman Drava flotilla hitherto stationed at Eszék was placed under the command of Barcs Castle following the building of the last mentioned. Partly as a consequence of this, the Habsburg side in the negotiations leading up to the Peace of Adrianople (1568) proposed the demolition of the castle at Barcs (as well as of the castles at Babócsa and Berzence respectively). Since the Ottomans did not demolish the said castles, Habsburg military leaders in Vienna and Graz reorganised their defences along the Drava and Mur (Mura) rivers. Built in 1578 with support from the Styrian Estates, Bajcsavár (Weitschawar) became one of the centres of the new defence system in the region. Constructed from scratch, it was the principal stronghold of the Captaincy of Bajcsavár district belonging to the Captaincy of Slavonia (more precisely, to the Wendish-Bajcsavár Captaincy-General). After a short existence, it was evacuated in 1600, before the Ottoman capture of Kanizsa.

As already mentioned, the archive sources in Graz contain relatively ample data regarding the construction of the castle. Under the leadership of the master-builder of castles Geronimo Arcanato (German form: Hieronym[us] Arkhanat), chief architect for the Croatian–Slavonian border area (*Superintendent an der Kroatischen und Windischen Grenze*) and originally from Milan, construction work on the fortification began in the September of 1578. It was undertaken by Styrian loggers and by Hungarian carpenters, smiths, and stonemasons. A datum from 1584 tells that repairs had to be performed using the local inhabitants; another that, on 4 October 1588, the Ottomans attacked loggers who wished to harvest tree trunks for palisading in the forests around Bajcsavár. Between the September and November of 1588, we hear of the work of the master-builder Franz Marbl. Among others, Marbl put in 1500 new palisade stakes, and faulted the castle's commander, Miklós Malakóczy, for his unwillingness to entrust the felling of the timber needed for the fortification's palisading to Hungarian–Croatian soldiers. In 1591, it was again German soldiers who put in new palisade stakes.<sup>34</sup>

Excavations have yielded important data on the construction and measurements of the castle.<sup>35</sup> Its fortifications consisted of palisade walls by and large, but the southern half of the castle moat cutting through the dune on the north side was strengthened by a retaining wall made of bricks, in order to prevent its collapse (Fig. 8). The path followed by the palisading on the castle's north side is unclear; on the other hand, in the eastern and southern parts it could be documented along lengthy sections. On the southern section and at the southwest bastion, the twin rows of posts (discernible by the post-holes) could be followed especially well; in these parts, repairs, too,

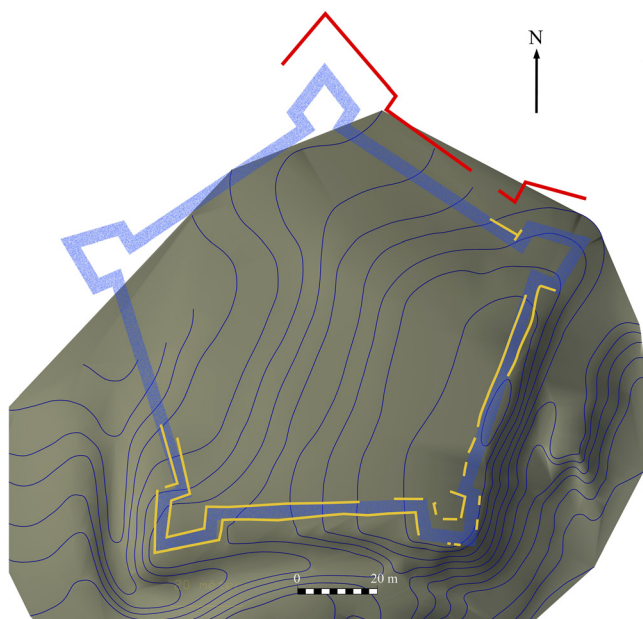
<sup>32</sup>Cf. Sümegi (2010) 295–326.

<sup>33</sup>430 ha next to Barcs + 840 ha to the south of Babócsa + an area of 5300 ha between the two settlements = 6570 ha in total.

<sup>34</sup>Toifl (2002) 28–34.

<sup>35</sup>Vándor et al. (1998/2000) 85–119. See also Vándor and Kovács (2002) 47–62.





**Fig. 8.** Nagykanizsa-Bajcsa. Reconstructed ground plan of the Bajcsavár (Weitchawar) castle. Blue: reconstruction; red: brick wall; yellow: sections of the palisaded wall (rows of post-holes) discovered. Computer graphics: Zsolt Réti

could be observed. With the help of Zsolt Réti, the castle's ground plan was reconstructed on the basis of surviving parts. It took the form of a relatively regular pentagon approximately 1 ha in area; at the corners of the palisaded castle were bastions of the Old Italian type (Figs 8–9). The castle was flanked by a moat on its north, west, and south sides (Fig. 10);<sup>36</sup> on the basis of the fieldsurvey and of a trench cut through the one-time moat, the last mentioned was 20 m wide at the southern bastions and 4–5 m deep. If we assume an average width of 20 m and an average depth of 4 m, then the digging of the castle's moat required the movement of 20,000 m<sup>3</sup> of earth. (These assumptions yield an approximate volume merely, while at the same time conveying the magnitude of the task.)

The twin rows of posts belonging to the castle's walls were separated by a distance of 4 m on average (in our reconstruction, an average distance of 3.7 m was used). According to the calculations, the length of the outer row of posts was 514 m and that of the inner row approximately 5–6 per cent less, namely 485 m. Some 44 per cent of the palisade walling hypothesised in our reconstruction is covered by sections of castle wall that have been researched archaeologically.<sup>37</sup> On the basis of the post-holes excavated, in the outer row posts 20–25 cm in diameter stood at distances of 30–40 cm from one another while in the inner row posts were spaced at

greater distances from one another: 40–60 cm. The difference (and the regularity, which perhaps reflects the original conception) can be best observed along the south curtain wall. The few empty (stake-free) sections did not influence fundamentally the number of stakes used for the castle walls.

Reckoning with palisade stakes 20–25 cm in diameter at a distance of 30–40 cm from one another in the outer row and 40–60 cm in the inner row (these are average measurements),<sup>38</sup> approximately 1500–1600 palisade stakes would have been needed for the twin rows of stakes making up the castle's walls.<sup>39</sup> The number, which should be understood as an estimate, offers possibilities for the drawing of conclusions, namely it would suggest that by means of the above-mentioned '1500 new palisade stakes' he installed in 1588, the master-builder Franz Marbl practically renovated (or could have renovated) almost the entire castle wall of the fortification erected ten years earlier. On the other hand, if we reckon merely with the 40-cm distance between posts more frequent along the outer row, then the number of posts calculated for the outer and inner rows together is 1506, which accords almost exactly with the data from 1588.

In this castle, too, foundation ditches were dug for the posts, at a depth of 120–150 cm below what was then the surface. Reckoning with 1500 posts each 4–5 m long and 20–25 cm in diameter, we arrive at a figure of 270 m<sup>3</sup> of timber. Since at Bajcsavár every building within the walls was made from timber (possibly from timber and brick), in this castle, too, substantial amounts of timber were needed beyond that required for the palisade walls.<sup>40</sup> Using the above data

<sup>38</sup>In the outer row (514 m):

Reckoning with a diameter of 20 cm and a distance between posts of 30 cm, 1028 posts

Reckoning with a diameter of 25 cm and a distance between posts of 30 cm, 934 posts

Reckoning with a diameter of 20 cm and a distance between posts of 40 cm, 857 posts

Reckoning with a diameter of 25 cm and a distance between posts of 40 cm, 791 posts = average 902 posts.

In the inner row (485 m):

Reckoning with a diameter of 20 cm and a distance between posts of 40 cm, 808 posts

Reckoning with a diameter of 25 cm and a distance between posts of 40 cm, 746 posts

Reckoning with a diameter of 20 cm and a distance between posts of 60 cm, 606 posts

Reckoning with a diameter of 25 cm and a distance between posts of 60 cm, 570 posts = average 682 posts.

In the outer and inner rows (999 m) in total: 1584 posts.

<sup>39</sup>By way of confirmation, the results of the calculation for the southwest bastion using averaged data were compared with the number of post-holes uncovered (Vándor and Kovács, 2002, 52, Fig. 3). The bastion's outer perimeter (outer row of posts) was 48 m in length. According to a calculation assuming palisade stakes 20–25 cm in diameter placed 40 cm apart, the number of stakes needed was 77. The number of post-holes excavated and counted was 72. The difference stems from the circumstance that in certain places no post-holes could be documented. If on the other hand post-holes are assumed in the spaces that were empty, there is almost no difference in the numbers.

<sup>40</sup>For example, elements of the 'patrol path' (*chemin de ronde*) protecting the top parts of the palisaded walls may also be mentioned.

<sup>36</sup>Using a computer, the castle moat shown on a map made as part of the Second Military Survey of the Habsburg Empire (Fig. 10) and the castle moat envisaged on the basis of fieldworking were compared. The two matched exactly.

<sup>37</sup>An average row (perimeter) measured along a line halfway between the two rows in the reconstruction: 501 m; length of the castle-wall sections researched: 220 m.



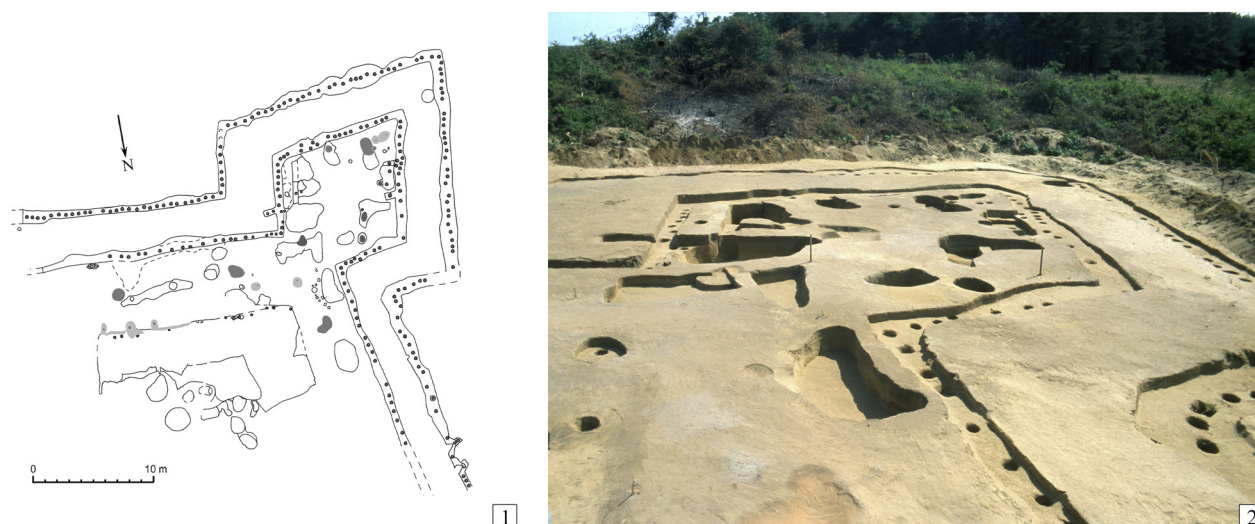


Fig. 9. Nagykanizsa-Bajcsa. Southwest bastion of the royal palisaded castle, Bajcsavár. After Vándor and Kovács (2002) 52, Fig. 3

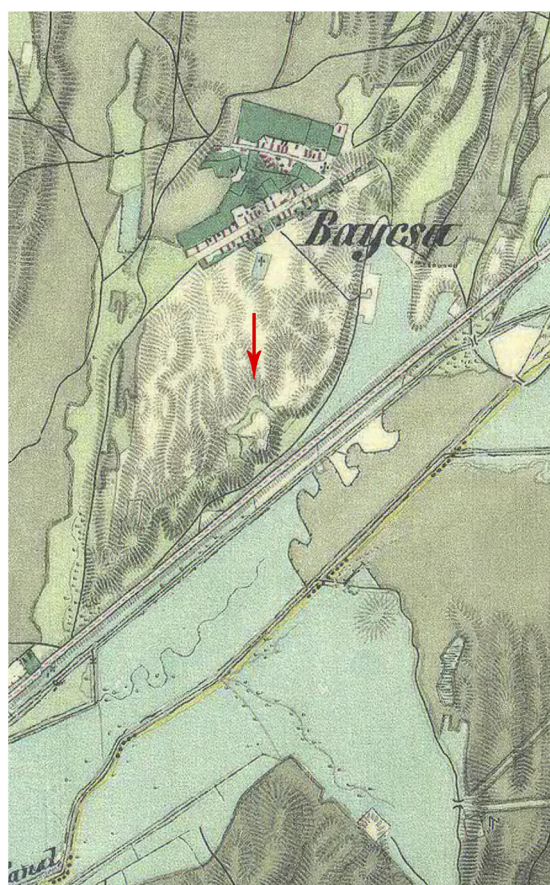


Fig. 10. Bajcsavár's moat on a map made in 1857–1858 as part of the Second Military Survey of the Habsburg Empire. Hungarian Government, Ministry of Defence, Military History Institute and Museum, Military Map Archive

(mentioned at Barcs) and assuming that for two stakes one tree was needed, then approximately 800 trees would have been felled to create the castle's walls. This figure is,

naturally, a rough estimate; in all probability, the number was higher, as not every tree was suitable for the making of two stakes.

From the environmental history perspective, in connection with forests and cleared, harvested expanses the same may be said for Bajcsa as was said for Barcs. Looking only at the map made in 1784 as part of the First Military Survey of the Habsburg Empire (Fig. 11), south of Kanizsa expanses of cleared land (harvested woodland) can be seen on the western side of the Kanizsa brook and in the valley of the River Mur (Mura). The emergence of these was in all probability *partly* the result of the building of the nearby Ottoman-era castles (Bajcsavár, Fityeháza, Murakeresztúr) and of military activity along the Habsburg–Ottoman border, i.e. major tasks linked to border-defence endeavours in the late 1570s and in the 1580s. Border defence utilised the natural endowments of particular districts (watercourses, marshes, hills, forests) and the advantages they offered defenders;<sup>41</sup> indeed, it built on these by altering landscapes. In 1577, a military conference in Vienna decided to base the defence of the Kanizsa area on the forested, marshy valley of the Kanizsa brook by making this valley impassable. To this end, watercourses were dammed, on dry terrain obstacles were erected (e.g., by blocking roads with felled trees and rows of posts), and guardhouses were built, in addition to the newly constructed Bajcsavár palisaded castle.<sup>42</sup>

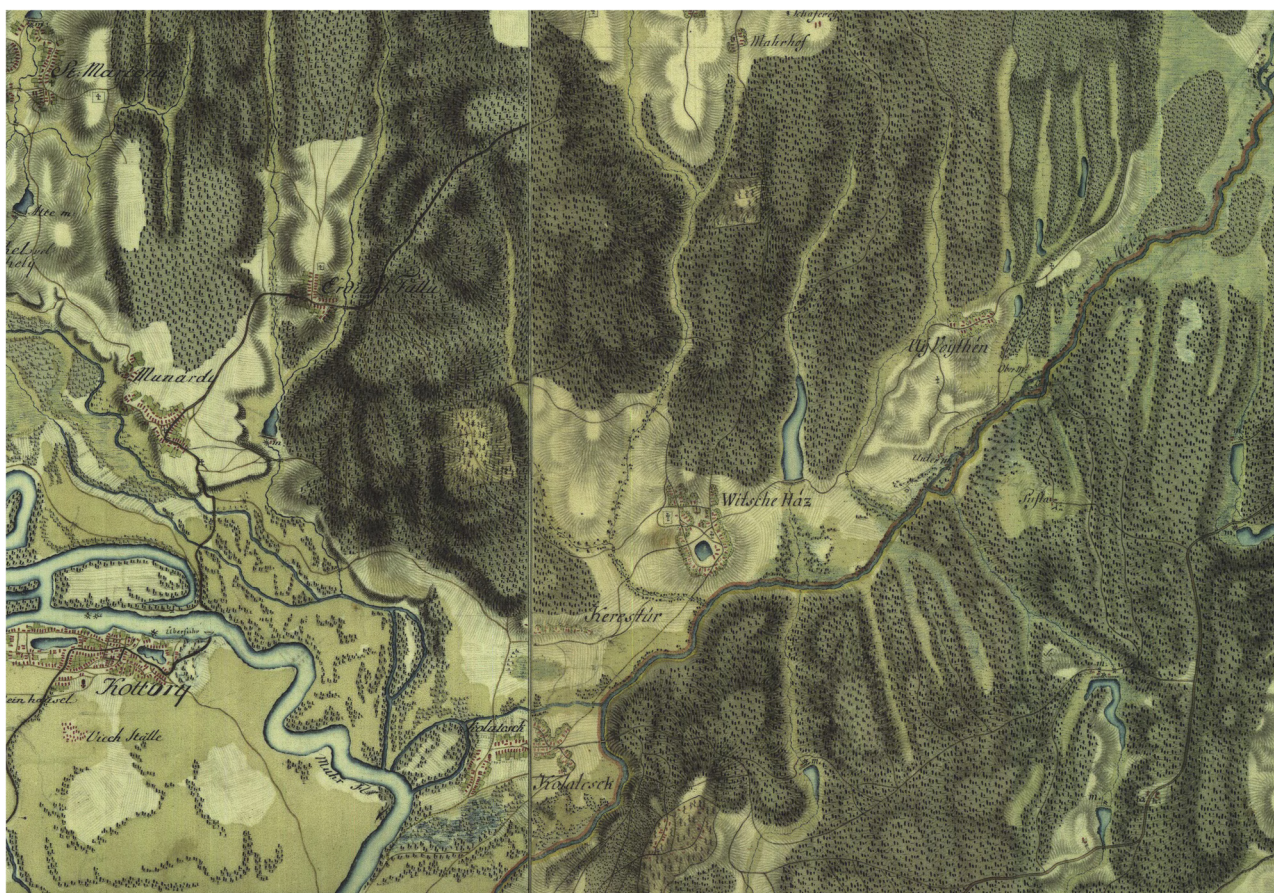
With regard to this large-scale timber production, the question of whether the forests were protected inevitably arises and, if so, how. Since it was known in the Middle Ages already that forests were a finite resource and that their exploitability had limits, such protection was necessary.<sup>43</sup> At present, not much is known about how the forests of the

<sup>41</sup>Cf. Pálffy (1999) 14–20.

<sup>42</sup>Kelenik (1995) 163–174.

<sup>43</sup>Szabó (2008) 336.





**Fig. 11.** The Bajcsa area on a map made in 1784 as part of the First Military Survey of the Habsburg Empire. Hungarian Government, Ministry of Defence, Military History Institute and Museum, Military Map Archive

Habsburg border-castle system were managed and protected, although the written sources do contain data on this. Forests served the defence purposes of castles and of the country, with the result that in many written sources there are references to the enormous attention paid to forest preservation on the very various landscapes of the border-defence system.<sup>44</sup> Forest use was regulated legislatively by the Hungarian Diet.<sup>45</sup> Habsburg rulers systematically forbade the sale of wood into Ottoman territories, although the prohibition could be evaded by way of blackmail and ransom demands.<sup>46</sup> The Ottomans were also

able to acquire timber in the form of tax.<sup>47</sup> An emphasis on protection of forests was manifest on the Ottoman side, too. The decrees and measures were, however, unable to prevent forest destruction. At the same time – as the above-mentioned recently published study by András Vadas and Péter Szabó has pointed out<sup>48</sup> – the building of palisaded castles was just one element in forest use in Transdanubia during the Ottoman period; moreover, the fortification operations did not have a significant impact on the forests.<sup>49</sup>

## REFERENCES

Esterházy Pál (1664/1989). *Mars Hungaricus*. Prepared for publication and translated by E. Iványi, foreword and editing by G. Hauser. Zrínyi-könyvtár, 3. Budapest.

<sup>44</sup>Instructions to castle commanders laid down various different forest-protection requirements, e.g., only trees without value could be felled for firewood and young forests were protected. Castle commanders could be held to account if they tried to benefit personally from the forests. R. Várkonyi (1995) 15.

<sup>45</sup>It was laid down which border castles could use which forests for fortification work. Rácz (2008) 152.

<sup>46</sup>Várkonyi (2008) 50–54. In 1638, the Pasha of Vác was promised shingle boards as a ransom for a captive he held; on another occasion, the Pasha of Esztergom blackmailed the Captain of Érsekújvár, telling that if the last mentioned did not permit the delivery of planks to Esztergom, he, the Pasha of Esztergom, would not allow the delivery of wheat from the Ottoman side of the Danube to the other.

<sup>47</sup>Of the towns on the Great Plain, Nagykörös, for example, supplied palisade stakes as tax on a continuous basis: Fodor (1981) 68; For the building of the palisaded castle wall at Várada in the period following the Ottoman capture of Várada (in 1660), the Ottomans demanded from the inhabitants of Debrecen 1000 timber trees in 1661, 200 palisade stakes in 1664, and 500 large logs (*balvan*) in 1681: Zoltai (1905) 28.

<sup>48</sup>Vadas and Szabó (2021) 163.

<sup>49</sup>The present study is a revised and expanded version of a paper published in Hungarian in 2011: Kovács and Sümegei (2011).



- Evliya (1985). *Evliya Cselebi (török világutazó magyarországi utazásai 1660–1664)* [Evliya Çelebi's travels in Hungary 1660–1664]. Translated by I. Karácson, foreword and re-editing by P. Fodor. Budapest.
- Fekete, L. (1929). A berlini és drezdai gyűjtemények török levéltári anyaga (Második, befejező közlemény) (Türkische Archivalien der Sammlungen in Berlin und Dresden, II., abschliessende Mitteilung). *Levéltári Közlemények*, 7: 55–106.
- Fekete, L. (1930). A hódoltság-kori törökség Magyarországra vonatkozó ismeretei, 1. közlemény [Ottoman knowledge of Hungary in the 16<sup>th</sup> and 17<sup>th</sup> centuries]. *Hadtörténelmi Közlemények*, 31: 1–17.
- Fodor, P. (1981). Bauarbeiten der Türken an den Burgen in Ungarn im 16.–17. Jahrhundert. *Acta Orientalia Academiae Scientiarum Hungaricae*, 35(1): 55–88.
- Gaál, A. (1985). Török palánkvárak a Buda–eszéki út Tolna megyei szakaszán [Turkish palisades on the Tolna-county stretch of the Buda-to-Eszék road]. In: Bodó, S., and Szabó, J. (Eds.), *Magyar és török végvárak 1663–1684*. Studia Agriensia, 5. Eger, pp. 185–197.
- Gaál, A. (2003). Turkish palisades on the Tolna-county stretch of the Buda-to-Eszék road. In: Gerelyes, I., and Kovács, Gy. (Eds.), *Archaeology of the Ottoman Period in Hungary*. Opuscula Hungarica, 3, Budapest, pp. 105–108.
- Gerelyes, I. (1996). Török építkezések Gyulán (1566–1695) [Ottoman building operations in Gyula (1566–1695)]. In: Szatmári, I., and Gerelyes, I., *Tanulmányok a gyulai vár és uradalma történetéhez*. Gyulai füzetek, 8. Gyula, pp. 101–124.
- Juhász, I. (2007). Somogy hills. Paleoenvironmental studies at Baláta-tó. The pollen sequence from Baláta-tó. In: Zatykó, Cs., Juhász, I., and Sümegi, P. (Eds.), *Environmental archaeology in Transdanubia*. Varia archaeologica Hungarica, 20. Budapest, pp. 243–247.
- Károlyi, Zs., and Nemes, G. (1975). *Szolnok és a Közép-Tiszavidék vízügyi múltja, I.: Az ősi ártéri gazdálkodás és a vízi munkálatok kezdetei (895–1846)* [Ancient flood-plain management and the beginnings of hydraulic construction work, I]. *Vízügyi történeti füzetek*, 8. Budapest.
- Kelenik, J. (1995). A kanizsai védelmi övezet és természetföldrajzi adottságai a XVI. század 70-es éveinek végén (Die Schutzzone von Kanizsa und die naturgeographischen Gegebenheiten von dieser am Ende der 70-er Jahre des XVI. Jhr.). In: Petercsák, T., and Pető, E. (Eds.), *Végvár és környezet*. Studia Agriensia, 15. Eger, pp. 163–174.
- Kovács, Gy., and Rózsás, M. (1996). A barcsi török palánkvár (The Turkish hoarding [palisaded] castle of Barcs). *Somogyi Múzeumok Közleményei*, 12: 163–182.
- Kovács, Gy., and Rózsás, M. (2010). A barcsi török vár és környéke. Újabb kutatások (1999–2009) (The Ottoman-Turkish castle at Barcs and its surroundings. New research, 1999–2009). In: Benkő, E., and Kovács, Gy. (Eds.), *A középkor és a kora újkor régészete Magyarországon – Archaeology of the Middle Ages and the Early Modern Period in Hungary, I–II*. Budapest, II., pp. 621–642.
- Kovács, Gy., and Sümegi, P. (2011). Palánkvárak, fák, erdők. Régészeti és környezettörténeti adatok a török kori palánkvárak faanyag-felhasználásához (Palisade castles, trees, and forests. Archaeological and environment history data on the timber used for Turkish-era palisade castles). In: Terei, Gy., Kovács, Gy., Domokos, Gy., Miklós Zs., and Mordovin, M. (Eds.), *Várak nyomában. Tanulmányok a 60 éves Feld István tiszteletére*. Budapest, pp. 113–120.
- Kováts, V. (1966). Sziget várának kutatástörténetéhez (Zur Forschungsgeschichte der Festung Sziget). *A Janus Pannonius Múzeum Évkönyve*, 1966: 207–255.
- Liska, A. (2017). Előzetes jelentés a gyulai vár palánkerődítéseinek területén 2015-ben elvégzett földtani és régészeti kutatásokról [Preliminary report on the geological and archaeological researches conducted on the site of Gyula Castle's palisaded fortifications in 2015]. *Castrum. A Castrum Bene Egyesület folyóirata*, 20(1–2): 45–62.
- Méri, I. (1988). *A kanizsai várásatás. Vázlat a kanizsai vár és város történetének kutatásához (Ausgrabungen auf dem befestigten Schloss Kanizsa)*. Prepared for publication by J. Kovalovszky. Budapest.
- Mordovin, M. (2011). Szécsény városának kora újkori palánkerődítése (A szécsényi Pintér-háznál feltárt maradványok alapján) (The post-medieval palisade fortifications of Szécsény. According to the remains excavated beside the Pintér House). In: Terei, Gy., Kovács, Gy., Domokos, Gy., Miklós Zs., and Mordovin, M. (Eds.), *Várak nyomában. Tanulmányok a 60 éves Feld István tiszteletére*. Budapest, pp. 149–159.
- Mordovin, M. (2015). 'In the shadow of the Crescent...'. The Borderline castles during the Hungarian–Ottoman Wars in the 16th–17th centuries. In: Gutehall, A., and Ödman, Ch. (Eds.), *Castella Maris Baltici 11. Proceedings of a symposium held in Malmö, Sweden on the 27th of May to the 2nd of June 2012*. Malmö, pp. 123–143.
- Müller, V. (1976). *Az egerszegi vár a XVII. században* [Egerszeg Castle in the 17<sup>th</sup> century]. Zalaegerszegi füzetek, 2. Zalaegerszeg.
- Pálffy, G. (1999). *Európa védelmében. Haditérképészet a Habsburg Birodalom magyarországi határvidékén a 16–17. században* [Military cartography on the Hungarian frontier of the Habsburg Empire in 16<sup>th</sup> and 17<sup>th</sup> centuries]. Budapest.
- Pálffy, G. (2007). Magyarország két világbirodalom határán (1526–1711). A magyar gazdaság útjai Európába [Hungary on the border of two world empires (1526–1711). The Hungarian economy's routes to Europe]. In: Romsics, I. (Ed.-in-chief), *Magyarország története*. Budapest, pp. 355–364.
- Rácz, L. (2008). *Magyarország környezettörténete az újkorig* [An environmental history of Hungary up to the Modern Age]. Természet-történelem, 1. Budapest.
- Sümegi, P. (2007). Somogy hills. Paleoenvironmental studies at Baláta-tó. Description of the sampling location at Baláta-tó. In: Zatykó, Cs., Juhász, I., and Sümegi, P. (Eds.), *Environmental archaeology in Transdanubia*. Varia archaeologica Hungarica, 20. Budapest, pp. 239–241.
- Sümegi, P. (2009). Ember és környezet kapcsolata a középső-bronzkorban: az őskori gazdasági tér fejlődése egy bronzkori tell geoarcheológiai és környezettörténeti feldolgozása nyomán (Human communities and their environment during Middle Bronze Age: a model of the evolution of the prehistoric economic space based on the geoarcheological and environmental historical analyses of a Bronze Age tell). *Tisicum*, 19: 457–480.



- Sümei, P. (2010). Az Északi középhegység negyedidőszak végi őstörténete. Ember és környezet kapcsolata a szubkárpati (fel-földi) régióban [The late Quaternary in the North Hungarian Mountains. Links between man and environment in the Subcarpathia (Upland) region]. In: Guba, Sz., and Tankó, K. (Eds.), *‘Régről kell kezdenünk’... Studia archaeologica in honorem Pauli Patay – Régészeti tanulmányok Nógrád megyéből Patay Pál tiszteletére*. Szécsény, pp. 295–326.
- Szabó, P. (2008). Erdők és erdőgazdálkodás a középkori Magyarországon [Forests and forest management in medieval Hungary]. In: Kubinyi, A., Laszlovsky, J., and Szabó, P. (Eds.), *Gazdaság és gazdálkodás a középkori Magyarországon: gazdaságtörténet, anyagi kultúra, régészet*. Budapest, pp. 317–339.
- Szakály, F. (1973). A Dél-Dunántúl külkereskedelmi útvonalai a XVI. század derekán [Trade routes in Transdanubia in the mid-16<sup>th</sup> century]. *Somogy megye múltjából. Levéltári Évkönyv*, 4: 55–62.
- Takáts, S. (1915). A magyar erősségek [The Hungarian strongholds]. In: Takáts, S., *Rajzok a török világból, II*. Budapest, pp. 1–132.
- Takáts, S., Echhardt, F., and Szekfű, Gy. (1915). *A budai basák magyar nyelvű levelezése, I.: 1553–1589* [The Hungarian-language correspondence of the pashas of Buda, I]. Budapest.
- Toifl, L. (2002). Bajcsavár története a stájer levéltári források alapján [A history of Bajcsavár on the basis of material in Styrian archives]. In: Kovács, Gy. (Ed.), *Weitschawar – Bajcsa-Vár. Egy stájer erődítmény Magyarországon a 16. század második felében*. Zalaegerszeg, pp. 28–34.
- Tolnai, G. (2011). *Palánkvárak Magyarországon* [Palisaded castles in Hungary]. *Opitz archaeologica*, 4. Budapest.
- Vadas, A., and Szabó, P. (2021). A fától az erdő? A török-kori háborúk és a dunántúli erdők (Not seeing the forest for the tree? Ottoman era wars and forests in Transdanubia). In: Benkő, E., and Zatykó, Cs. (Eds.), *A Kárpát-medence környezettörténete a középkorban és a kora újkorban – Environmental history of the medieval and early modern Carpathian Basin*. Budapest, pp. 147–188.
- Vándor L. (1994). Kanizsa története a honfoglalástól a város török alóli felszabadulásáig (The history of Kanizsa from the Magyar Conquest till the town's liberation from Turkish Occupation). In: Béli, J., Rózsa, M., and Rózsáné Lendvai, A. (Eds.), *Nagykanizsa. Városi monográfia*. Nagykanizsa, pp. 217–424.
- Vándor, L. (2016). A zalaegerszegi és a keszthelyi palánkerődítések [The palisaded fortifications at Zalaegerszeg and Keszthely]. *Castrum. A Castrum Bene Egyesület folyóirata*, 2016(1–2): 63–72.
- Vándor, L., and Kovács, Gy. (2002). Bajcsavár régészeti kutatása [Archaeological research at Bajcsavár]. In: Kovács, Gy. (Ed.), *Weitschawar – Bajcsa-Vár. Egy stájer erődítmény Magyarországon a 16. század második felében*. Zalaegerszeg, pp. 47–62.
- Vándor, L., Kovács, Gy., and Pálffy, G. (1998/2000). A régészeti és az írott források összevetésének lehetőségeiről: a bajcsai vár (1578–1600) kutatásának újabb eredményei – Archäologische und Schriftliche Quellen im Vergleich: neuere Ergebnisse der Erforschung der Grenzburg Weitschawar (Bajcsavár) (1578–1600). *Archaeologiai Értesítő*, 125: 85–119.
- R. Várkonyi, Á. (1995). A párbeszéd esélyei. A végvárrendszer-kutatások humánökológiai megközelítéséről (Die Aussichten des Zwiegesprächs. Über die humanökologische Annäherung der Forschungen in Bezug auf das ungarische Grenzburgsystem). In: Petercsák, T., and Pető, E. (Eds.), *Végvár és környezet*. *Studia Agriensia*, 15. Eger, pp. 7–31.
- Várkonyi, G. (2008). *Ünnepek és hétköznapiak. Művelődés és mentalitás a török kori Magyarországon* [Holidays and day-to-day life. Culture and mentality in Ottoman Hungary]. Budapest.
- Zoltai, L. (1905). *Debrecen a török uralom végén. A város háztartása 1662–1692* [Debrecen in the last decades of Ottoman sway]. Offprint from the *Magyar Gazdaságtörténelmi Szemle*, 1904. Budapest.

