RESEARCH ARTICLE – VÝZKUMNÝ ČLÁNEK

Medieval grain from Křivoklát Castle in Central Bohemia: An emergency food store from 1422

Středověké obilí z hradu Křivoklát ve středních Čechách: Nouzová zásoba potravin z roku 1422

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As a crucial food staple, grain was stored in castles in medieval and Early Modern Bohemia in granaries or in sections of farm buildings designated and adapted for storage purposes. However, during periods of conflict, other spaces intended for different purposes were also occasionally used for storage. During research into the palace complex in the north-western part of Křivoklát Castle in Central Bohemia, a large find of burnt grain and other crops from the 1421 harvest was uncovered. The results of an archaeobotanical analysis provided a completely new perspective on the creation of emergency food supplies during times of conflict within the context of medieval castles, both in terms of the composition of these food supplies and their location on castle grounds.

Middle Ages – castle – Křivoklát – bulk find – cereals – field crops – rye (*Secale cereale*)

Jako klíčová základní potravina bylo obilí ve středověkých a raně novověkých Čechách na hradech skladováno v sýpkách nebo v částech hospodářských budov určených a upravených ke skladovacím účelům. V obdobích konfliktů však byly ke skladování příležitostně využívány i prostory původně určené k jiným účelům. Během výzkumu palácového komplexu v severozápadní části hradu Křivoklát ve středních Čechách byl objeven rozsáhlý soubor zuhelnatělého obilí a dalších plodin pocházejících ze sklizně roku 1421. Výsledky archeobotanické analýzy přinesly zcela nový pohled na vytváření nouzových zásob potravin v době válečných konfliktů v prostředí středověkých hradů, a to jak z hlediska složení těchto zásob, tak z hlediska jejich umístění v rámci hradního areálu.

středověk – hrad – Křivoklát – hromadný nález – obiloviny – polní plodiny – žito (*Secale cereale*)

Introduction

Křivoklát Castle in Central Bohemia is one of the most prominent castles in the Czech Republic, not only due to its architecture and history, but also to a thorough excavation campaign led by Tomáš Durdík (e.g. *Durdík 1982*; *1996a*; *1997*; *1999*, 299–303; *2001*; *2002*, 50; *2008*). The castle's north-eastern sector features the abandoned palace complex, which is interpreted as the 'vassal house' (*Durdík 1988*; *1991*; *1992*; *1995a–g*; *2002*; *2003*; *2010*). This site was used as accommodation by the castle's vassals from the ranks of the nobility while fulfilling their obligations at the castle. On 18 March 1422 this vassal house was damaged by an extensive fire, which spread from the horse stables and virtually engulfed the castle. The vassal house suffered the greatest degree of fire damage and collapsed. Unique Pompeian-style archaeological contexts have been preserved on its premises. In addition to an extensive assemblage of artefacts dating from around 1400–1422, archaeological

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Fig. 1. Křivoklát Castle. Aerial view of the castle site from the south-west. A – outer ditch; B – the palace complex, the 'vassal house'; C – the narrow communication corridor defined by the walls (photo archive of J. Hložek).

excavations revealed an unusual concentration of 230 kg of charred grain and other field crops, which ranks among the largest assemblages of its kind from the medieval period in Bohemia. A preliminary interpretation associated this grain with a small brewery of the castle serfs presumed to have been part of the 'vassal house' (*Durdík 1995g*). However, this was based only on a macroscopic examination of the grain.

The current text presents a new, detailed archaeobotanical analysis of the grain find that refutes the original interpretation. We consider the stored crops to be an emergency food store from the period of the Hussite Wars. This uniquely well-preserved find allows us to address questions relating primarily to 1) the choice of the storage location on the castle grounds; 2) a reconstruction of the significance that the discovered assemblage of field crops held for the inhabitants of Křivoklát Castle; and, last but not least, 3) the possibilities of reconstructing agricultural practices in the cultivation and harvesting of field crops in the Middle Ages.

Historical context of the events at Křivoklát Castle in 1422

Křivoklát Castle (*Fig. 1*), which had been loyal to the Catholic side since the start of the Hussite Wars, suffered a fire on the afternoon of 18 March 1422 (*Benešovská – Žižka 1987*), destroying the extensive palace complex situated in the north-western part of the castle grounds. This catastrophic fire also affected other parts of the castle, especially the wooden galleries of the castle fortifications and other burnable parts of the buildings. Křivoklát probably remained inhabitable to some extent, but was extremely limited in terms of defensibility. Immediately afterwards, it was therefore abandoned by the Prague burghers, who were hiding there and later found safer refuge within the walls of the Catholic town

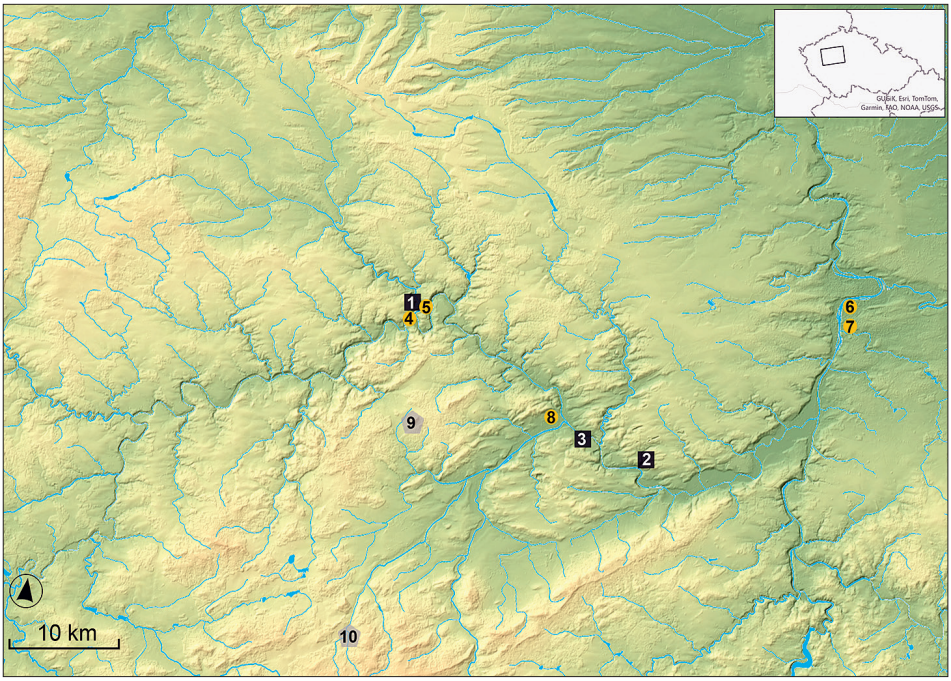

Fig. 2. The situation around Křivoklát Castle at the beginning of the Hussite Wars. Castles: 1 – Křivoklát, 2 – Karlštejn; 3 – Tetín; Settlement agglomeration: 4 – Roztoky u Křivoklátu; 5 – Křivoklát-Městečko; 6 – Prague–Old Town; 7 – Prague–New Town; 8 – Beroun; ecclesiastical sites: 9 – provost's residence at Velíz; 10 – Svatá Dobrotivá Monastery (edited by K. Hanáková).

of Plzeň (*Sedláček 1891*, 22–23; *Durdík 1988*, 295). In April 1422, the damaged castle was captured without much difficulty by Hussite troops led by Absolon Bělbožek of Chříč, who, however, was unable to hold it. In August of the same year, probably without great trouble, the damaged Křivoklát was conquered by Hanuš of Kolovrat, who left only a small garrison there. This circumstance was taken advantage of by Absolon's brother, Žibřid of Chříč. In the months that followed, the castle was seized three more times, once by Hussite forces and twice by the Catholic side (e.g. *Sommer – Razím 1988*, 54).

Military actions at the outset of the Hussite Wars impacted life not only at the Křivoklát Castle itself but also in the wider region. Between May and November 1422, the other important royal castle – Karlštejn – was besieged, and the nearby Tetín Castle probably suffered some damage as well. However, this siege was preceded by a military campaign in November 1421, which was aimed at capturing Karlštejn's supplies stored in buildings under the castle (*Sedláček 1889*, 47, 81). In 1421, the Hussite army conquered the town of Beroun (*Kuča 1996*, 100), while the provostry at Velíz and the monastery of Svatá Dobrotivá in Zaječov were burnt down (*Vlček et al. 1998*, 320–321, 691). As a result, Křivoklát remained a relatively isolated structure at the beginning of 1422, as other key royal towns in the wider area had been held by Hussite unions from 1421 (*Fig. 2*). These events likely led to the creation of extensive grain stores in places that were not primarily designated for storing grain and other foodstuffs.

Material and methods

Archaeological excavation at the palace complex

As part of the unusually large-scale excavation of the Křivoklát Castle complex, which commenced in 1973 (e.g. *Durdík 1988*, 285; *1992–1996*; *1996b*; *1996–2001*; *2008*; *Razím 2010*, 101), the area of a late Gothic bulwark in the north-western part of the castle grounds was excavated in 1983–1987 (*Durdík 2008*, 182; *Durdík 1999*, 70–71). Here, the remains of a vanished palace complex were excavated beneath the late Gothic fortification. They consisted of a rectangular palace, a square donjon, and a narrow sloping courtyard secured on both sides by gates (*Durdík 1988*; *Durdík 1999*, 354–355; *1995a–g*; *2002*; *2003*; *2010*). This area, interpreted by T. Durdík as a vassal house (*Figs. 3–6*), was built as part of the extensive reconstruction of the castle by the Wenceslas IV, King of Bohemia in 1378–1419 and Holy Roman Emperor in 1376–1400 (*Durdík 1979–1985*; *Durdík 1996a*, 246; *Durdík 2010*, 292). The house thus reflects an extensive vassal system that was associated with the castle, originating likely in the time of the King John of Luxembourg (reigned 1311–1346) (*Laštovka 1995*, 46; *Šimicová 2004*; *Razím 2010*, 66–68; most recently *Hložek 2018*, 85–86).

The choice of the construction site of the palace complex, which has the dimensions of a small castle, fell on a rocky ridge in the central part of the northward sloping spur of the castle promontory, surrounded on three sides by the Rakovník Stream (*Fig. 1*; *Fig. 5*: A). This part of Křivoklát was separated on the outer side by a wall and ditch with a wooden bridge leading to the first gate (*Fig. 1*: A). The inner courtyard of the vassal house was enclosed by another gate. From the south-east, the palace complex was accessible via a gate and a narrow passage from the first castle courtyard (*Fig. 1*: C; *Figs. 2–6*). After the destruction of the vassal house, Huderka Tower was erected during the Jagiellonian reconstruction on the site of the former gate between the vassal house and the first castle courtyard (*Durdík 2008*; *2010*, 292; *Fig. 6*: B). A lighter, presumably domestic building was attached in the Middle Ages to the north wall delimiting the narrow passageway to the vassal house, and the mortar floor of this domestic building has been preserved (*Fig. 3*; *Fig. 4*). The core of the vassal house complex consisted of a rectangular palace, ending on the north-western side with a square donjon. The ground floor of the palace contained a large storage room with a smaller partitioned space, and a portal connected the palace basement with the lower level of the donjon.

Context of the grain samples

The grain samples that the study focuses on come from three segments of the preserved stratigraphy. The first segment is the interior of a square donjon uncovered in the area of trenches LXI A and B. Here, a concentration of burnt grain was recorded within the black burnt layer 11 below the eastern wall of the donjon (not captured on the profile documentation) and layers 8 and 9 (*Fig. 3*; *Fig. 7*). The greatest concentration of burnt grain was found at the entrance to the donjon basement (*Durdík 1979–1985*; *1985–1987*). According to the documented 1985 profile of the lower parts of the donjon's ground floor oriented in the NW–SE direction, black burnt layer 9 was 4–20 cm thick. It was superimposed on the modified bedrock, which was partially overlain by reddish, locally grey to brown ash layer 8 containing daub, bricks, and tiles. This was overlain by layer 7, up to 180 cm thick,

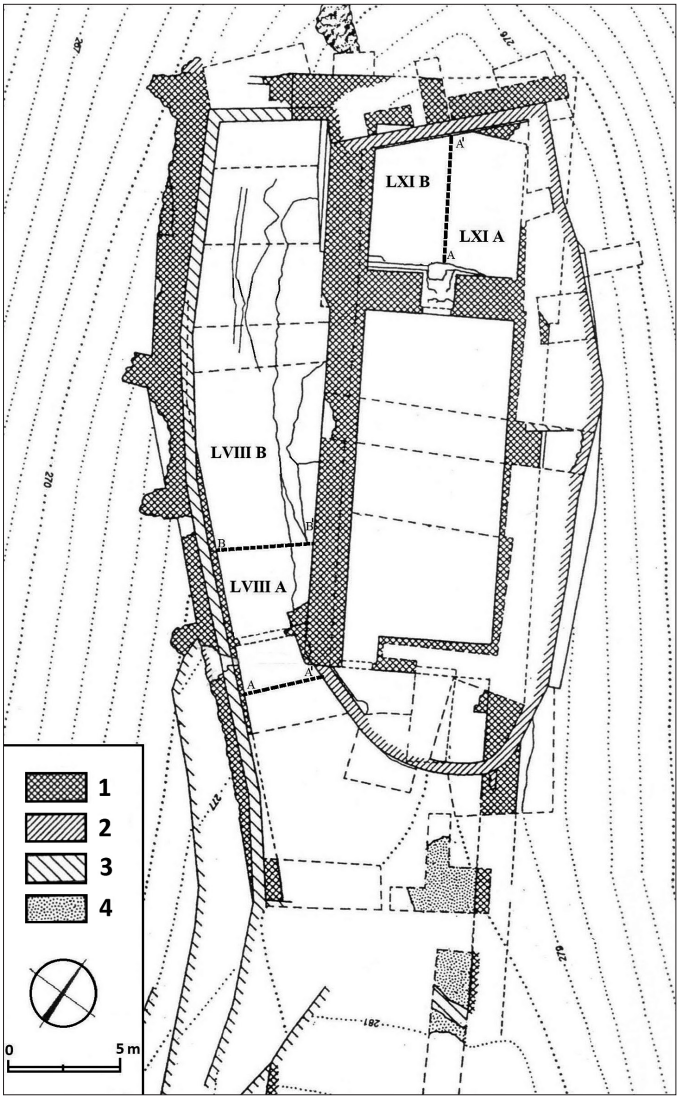

Fig. 3. Křivoklát Castle. 1 – masonry of the vassal house and fortification (around 1400); 2 – masonry of the late Gothic bulwark; 3 – masonry of the modern park arrangements; 4 – mortar floor of the building in the communication corridor. Thick black dashed lines mark the excavated profiles (drawn image according to *Durdík 1999*, 254, edited by J. Hložek).

consisting of coarse whitish rubble, covered by an equally thick layer consisting of black organic burnt layer 4 with abundant slag and layer 3 consisting of yellowish clay-mortar debris.

The second segment of the stratigraphy with a recorded concentration of grain is trench LVIII A situated in the palace complex courtyard (*Fig. 3*; *Fig. 8*). The trench uncovered a part of the palace courtyard wall, the area of the upper (south-eastern) gate and a part of the steep passageway embedded in the bedrock, which connected the palace complex with the path under the castle leading through the Rakovník Stream valley. A concentration of charred grain was recorded in layer 5. In the surveyed area, greyish clay layer 6 with sharp-edged gravel representing the original walked-on level of the courtyard was

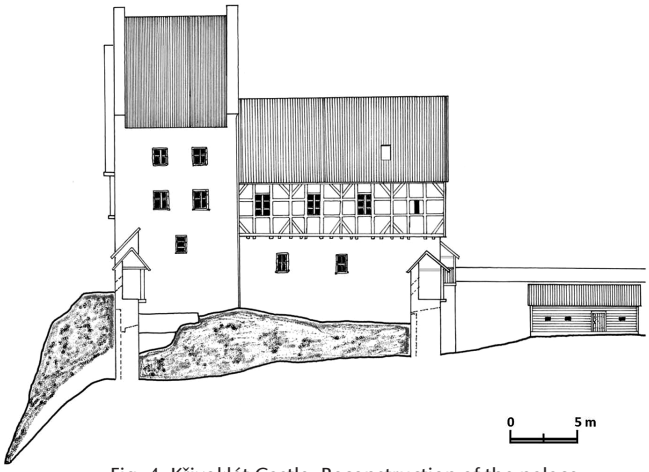

Fig. 4. Křivoklát Castle. Reconstruction of the palace complex of the vassal house (drawing by J. Hložek).

Fig. 5. Křivoklát Castle. 3D reconstruction of the palace complex of the vassal house at the National Museum in Prague (photo by J. Hložek).

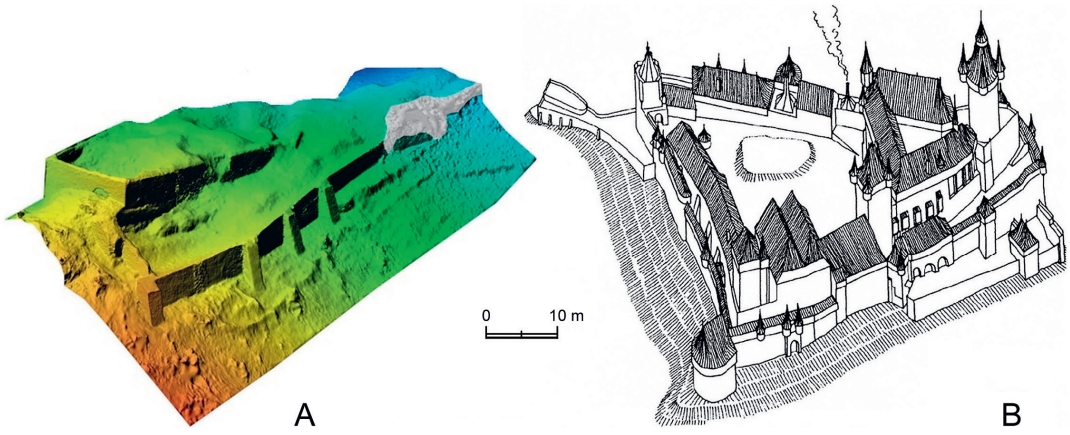

Fig. 6. Křivoklát Castle. A – 3D model visualising the current state of the site where the vassal house stood; B – drawn image of the castle after the Wenceslasian reconstruction with a bulwark built on the site of the abandoned vassal house (3D visualization by P. Hlavenka, drawn image according to *Durdík 1999*, 303).

superimposed on the sloping, north-west-facing bedrock. This layer was overlain by burnt layer no. 5, which resulted from the fire in the vassal house and filled almost the entire width of the yard area behind and in front of the upper gate. This layer was overlain by yellow mortar layer 4 with stones, on which thin greyish clay layer 8 with sharp-edged gravel was deposited. On top of it was layer 3, consisting of coarse stone rubble.

The third segment is trench LVIII B, which was also situated in the courtyard of the palace complex (*Fig. 3*; *Fig. 9*). This trench likewise captured a part of the palace courtyard wall, the course of the passageway leading through the courtyard, and the inner face

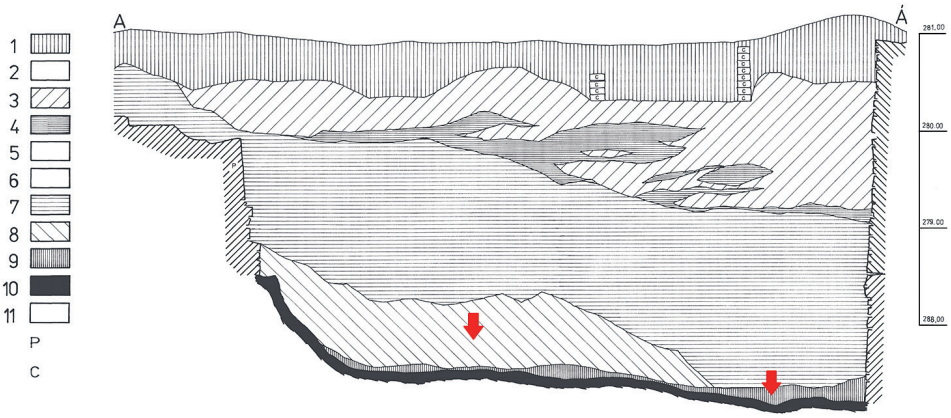

Fig. 7. Křivoklát Castle, trenches LXI A and B (section through the basement of the residential tower of the vassal house). 1 – turf and garden humus; 2 – dark grey loamy infill in a recent pit; 3 – yellow loamy layer with mortar rubble; 4 – black burnt organic layer with abundant slag; 5 – brown loamy layer between 1 and 3 at the south-western corner; 6 – brown loamy layer between 1 and 3 at the eastern profile; 7 – brown whitish rubble layer; 8 – red ashy layer with daub, brick, and tile, locally grey to brown layer; 9 – black burnt layer; 10 – rock; 11 – black burnt layer with grain below the eastern wall (LXI-B). Between layers 1 and 3, brown clay layers 5 and 6 were present in the area of trench LXI B, which were not captured on the profile documentation. Contexts with grain finds depicted in the profile are marked with an arrow (drawing by J. Durdíková based on the original by T. Durdík).

of the south-eastern line of the fortification. In this part of the examined structure, layer 11 consisted predominantly of red burnt daub blocks and was overlain by layer 3, which featured coarse yellow lime rubble. Its upper part contained lentils forming darker loamy rubble represented by layer 9. This was overlain by light-brown loamy layer 10 with pebbles.

Methodology of the archaeobotanical analysis

A total of 230 kg of charred grain and other field crops originating from the area of the 'vassal house' at Křivoklát Castle became the subject of archaeobotanical analysis. The concentration of grain and other field crops from Křivoklát Castle ranks among the largest finds of this kind from the medieval period in Bohemia. While the original volume of grain samples collected at the site in the 1980s cannot be reconstructed today, the possibility that it represents all the material collected during the archaeological excavation cannot be ruled out. Thanks to the high concentration and purity of the find, charred plant macroremains (PMR) were extracted directly from the original samples. Twenty-four subsamples were collected in the laboratory from each sample taken in the field and analysed. It was possible to analyse these subsamples without prior preparation (e.g. by floating or sieving). The PMRs were directly selected under a stereomicroscope at a magnification of 7–90×. The archaeobotanical material obtained was determined using a comparative collection of plant diaspores in combination with basic literature on identifying plant macroremains (*Bertsch 1941*; *Beijerinck 1947*; *Katz et al. 1965*; *Schermann 1967*; *Berggren 1969*; *1981*; *Anderberg 1994*). The botanical nomenclature is provided according to *Kubát* (*2002*). The results of the analysis are stated using the abundance of the PMRs of each species; the weight of the analysed components of the samples was not determined.

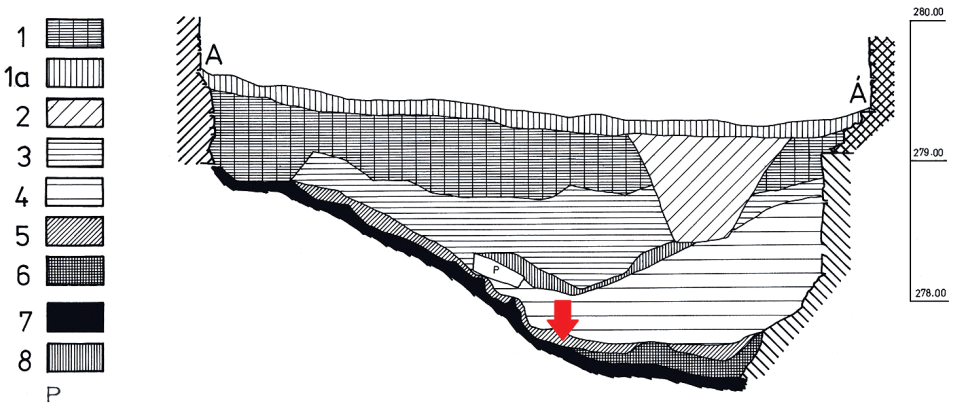

Fig. 8. Křivoklát Castle, trench LVIII A (section through the south-eastern part of the courtyard of the vassal house behind the upper gate). 1 – brown organic layer, 1a-turf; 2 – brown organic layer; 3 – coarse stone rubble; 4 – yellow mortar layer with stones; 5 – burnt layer; 6 – greyish loamy layer with sharp-edged gravel; 7 – rock; 8 – greyish loamy layer with sharp-edged gravel. Contexts with grain finds depicted in the profile are marked with an arrow (drawing by J. Durdíková based on the original by T. Durdík).

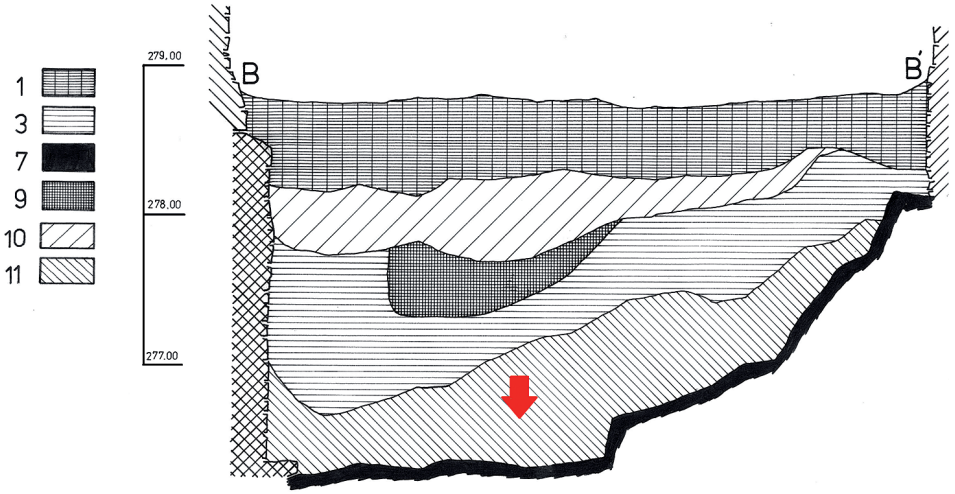

Fig. 9. Křivoklát Castle, trench LVIII B (section through the south-eastern part of the courtyard of the vassal house). 1 – brown organic layer; 3 – coarse yellow limey rubble; 7 – rock; 9 – darker loamy rubble; 10 – light brown loamy layer, loose with pebbles; 11 – red blocks of burnt daub. Contexts with grain finds depicted in the profile are marked with an arrow (drawing by J. Durdíková based on the original by T. Durdík).

Seed cleaning after harvest was reconstructed from the characteristics of weed diaspores contained in the samples (*Jones 1984*; *Van der Veen 1992*). In particular, the following properties of weed seeds are monitored using the following method:

- relative seed size: B – big seeds, S – small seeds
- tendency to form clumps: F – single seeds (free), H – seeds forming clumps (headed)
- relative weight: L – light seeds (light), H – heavy seeds (heavy)

Traditional grain cleaning was carried out in a relatively simple way in several steps, always eliminating diaspores of weeds with certain characteristics. The first step is the winnowing of the crop, which mainly removes small, single and light weed seeds (SFLs), i.e. wind-dispersed seeds. In the second stage, the pre-cleaned product is stripped via the coarse sieving of all the seeds forming clumps (all 'headed' categories of SHH, SHL, BHH) on the basis of size (everything larger than the grains is removed). In the third stage, small heavy non-clumping seeds (SFHs) are removed and can be separated on the basis of size (everything smaller than the grains is removed).

Results

A total of 77,571 PMRs were analysed, among which 45 plant species were identified (*Tab. 1*; *Tab. 2*). All the analysed samples were very similar in composition, except for sample 19, 23, and 24. The proportion of the main crop of rye (*Secale cereale*) in most samples was on average 97.7% (22 very similar samples, *Fig. 10*). The admixture of other crops was minor and averaged only 0.7%. The following field crops were found to be admixed: common wheat (*Triticum aestivum*), emmer wheat (*Triticum dicoccon*), oats (*Avena sp*. and *Avena sativa*), millet (*Panicum miliaceum*), common barley (*Hordeum vulgare* subsp. *distichon*), hemp (*Cannabis sativa*), and peas (*Pisum sativum*, *Pisum*/*Vicia*).

A higher proportion of wheat grains was found in two samples, sample 19 and 23. In sample 19 from the LVIIIA-5 context, wheat makes up 9.6% of the PMRs. In sample 23 from context LVIII/B-11, wheat was the main crop (98.6%). An admixture of rye (1.3%) and a marginal weed admixture (0.04%) were also recorded. Peas in sample 24 from context LXI/B-8 were the dominant crop and accounted for 80% of the PMRs, mixed with rye 19% and a weedy admixture (less than 1%).

The admixture of other crops in the predominant rye can be understood as a consequence of crop rotation on cultivated land or as a secondary admixture during storage. The admixture indicates the cultivation of rye in a three-field system with alternating winter crops, spring crops and fallows. Although there are several possible crop combinations in this field system, the most likely crop is a winter one consisting of rye and wheat, a spring crop of barley and oats and a fallow partially sown with intensively cultivated crops, i.e. crops requiring hoeing and weeding (millet, peas, hemp).

The weed admixture in the samples was low and averaged 1.6% of the PMRs analysed. Weedy (segetal) communities have a relatively strong link to habitat conditions and periodic disturbances caused by agrotechnical interventions (*Deyl 1956*; *Chytrý et al. 2009*, 75). This relationship between weed species and habitat/habitat management has been used to indicate habitat conditions and past agricultural practices (e.g. *Kaiser et al. 2005*).

The weeds from the examined samples demonstrate medium habitat conditions without obvious extremes common in the Czech uplands (e.g. medium fertile cambisols). The grain was not grown on fertile loamy land (brown earth, chernozem), nor did it come from the outright infertile soil conditions of the soils of the higher forest areas (e.g. podzol, pseudogley).

The weed admixture seems to indicate a common agricultural technique for rye in the High Middle Ages. However, weed species diversity seems to be relatively high and allows for further agro-technical considerations. Rye was grown as a winter crop, as evidenced

Context			DONJON INTERIOR								PALACE COURTYARD			Total
Sample number			LXI/A-9	LXI/B-11	LXI/B-8	LXI/B-9	LXI	LXI-9	LXI-8	LXI/B-8	LVIII-5	LVIII/A-5	LVIII/B-11	
Agrostemma githago	d		16	58	11	22	16	2	4		8	34	1	172
Agrostemma githago	d	fr	2	8	0	3	0	1	0		1	1		16
Allium sp.	d		1	1	0	0	0		0		2	0		4
Anthemis arvensis	d			1	0	0	0		0		0	0		1
Apera spica-venti	d			5	0	1	6		0		0	0		12
Atriplex patula	d		1	0	0	0	0		0		0	0		1
Avena sp.	d		1	1	1	2	0		0		0	0		5
Avena sativa	d			1	0	0	0		0		0	0		1
Avena sativa	d		1	0	0	0	1		0		0	0		2
Bromus secalinus	d		5	18	11	9	1		1	1	9	21		76
Bromus secalinus	d	fr	1	5	4	0	2		0		1	2		15
Bromus cf. arvensis	d		3	7	0	5	2	1	3		1	1		23
Cannabis sativa	d			0	0	5	0		0		0	0		5
Cannabis sativa	d	fr		0	0	2	0		0		0	0		2
Camelina microcarpa	d			0	0	0	1		0		0	0		1
Centaurea cyanus	d		11	39	10	15	9	2	4		2	5		97
Centaurea cyanus	d	fr	1	6	3	4	1		2		0	0		17
Cerealia	nd	fr		0	0	0	0		0		0	1		1
Cirsium vulgare	d			0	0	0	0	1	0		0	0		1
Consolida regalis	d		3	38	30	6	11	5	0		0	0		93
Convolvulus arvensis	d		1	2	0	0	0		0		0	0		3
Corylus avellana	d	fr		1	0	1	0		0		0	0		2
Echinochloa crus-galli	d		1	0	0	0	0		0		0	0		1
Fallopia convolvulus	d			0	0	0	1		0		0	0		1
Fallopia convolvulus	d	fr		0	0	0	0		0		1	0		1
Galeopsis tetrahit	d		1	2	1	0	0		0		0	0		4
Galium aparine	d		19	48	23	14	17	2	2	2	1	0		128
Galium spurium	d		17	28	12	13	9	3	4	1	5	1		93
Hordeum vulgare distichon	d			1	2	1	0		0		1	1		6
Chenopodium album	d			1	0	0	2		0		0	1		4
Knautia arvensis	d			1	0	0	1		0		0	0		2
Lapsana communis	d		1	23	4	21	10	5	1		0	0		65
Lolium temulentum	d			1	0	0	1		0		0	0		2
Matricaria chamomilla	d			0	0	1	2		0		0	0		3
Malva neglecta/sylvestris	d			0	1	0	0		0		0	0		1
Panicum miliaceum	d			1	0	0	0		0		0	0		1
Pisum sativum	d			0	0	6	0		3	76	0	0		85
Pisum/Vicia	d	fr		0	0	6	0		14	852	0	0		872
Plantago lanceolata	d			0	0	0	0		0		0	1		1
Ranunculus repens	d	fr		1	0	0	0		0		0	0		1
Rumex crispus	d			1	1	1	0	1	0		0	0		4
Rumex obtusifolius	d			0	0	0	1		0		0	0		1
Secale cereale	d		3378	14235	5549	19422	6876	3378	3618	223	7480	6273	56	70283
Secale cereale	d	fr		0	0	0	0		0		0	0	4	4
Securigera varia	d		1	1	0	0	0		0		0	0		2
Sinapis sp.	d			2	1	2	0		1		0	0		6

Sinapis sp.	d	fr		0	0	1	0		0		0	0		1
Stachys arvensis/annua	d		1	2	1	0	0		0		0	0		4
Stellaria graminea	d		1	0	1	0	0		0		0	0		2
Trifolium arvense	d			1	0	0	0		0		0	0		1
Triticum aestivum	d		10	19	15	13	4	5	1		4	297	3528	3896
Triticum aestivum	d	fr		0	0	0	0		0		0	0	980	980
Triticum dicoccon	d			0	0	0	0		0		1	0		1
Valerianella dentata	d		17	34	21	4	7	5	1		2	0		91
Vicia hirsuta	d		14	28	6	26	8	4	7	1	32	36		162
Vicia hirsuta/tetrasperma	d	fr	4	12	14	9	3	4	2		7	22		77
Vicia tetrasperma	d			0	0	0	0		0		0	0	1	1
Viola arvensis	d			1	0	0	0		0		0	0		1
Indeterminata	d		4	4	2	1	3	1	0	1	0	3		19
			3516	14638	5724	19616	6995	3420	3668	1157	7558	6700	4570	77562
Volume (ml)			140	590	230	805	285	140	150	35	310	260	1000	3945
Rodent excrement				4	0	0	0		0		0	0		4
Textile	ch			1	3	0	0		0		0	0		4
Textile	uch			1	0	0	0		0		0	0		1

Tab. 1. Křivoklát Castle, the vassal house. Results of archaeobotanical analysis. d – diaspora; nd – non diaspora; fr – fragment; ch – charred; uch – uncharred.

Sample	Context	Main crop – rye (%)	Main crop – wheat (%)	Main crop – peas (%)	Presence of weeds (%)	Admixture of other crops (%)	Volume of the analyzed sample (ml)
1	LVIII-5	98.8	-	-	1.08	0.13	155
2	LVIII-5	99.2	-	-	0.82	0.03	155
3	LXI/A-9	96.1	-	-	3.58	0.34	140
4	LXI/B-11	97.7	-	-	2.2	0.06	125
5	LXI/B-11	96.2	-	-	3.62	0.19	165
6	LXI/B-11	96.8	-	-	3.01	0.17	140
7	LXI/B-8	98.4	-	-	1.45	0.18	160
8	LXI/B-8	95.2	-	-	4.51	0.32	125
9	LXI/B-9	99.4	-	-	0.43	0.14	115
10	LXI/B-9	98.3	-	-	1.44	0.26	110
11	LXI/B-8	99.1	-	-	0.55	0.31	105
12	LXI	97.9	-	-	1.95	0.16	125
13	LXI	98.6	-	-	1.38	0	160
14	LXI-9	98.8	-	-	1.08	0.15	140
15	LXI/B-9	99.2	-	-	0.69	0.13	125
16	LXI/B-9	98.9	-	-	0.96	0.16	180
17	LXI/B-9	99.3	-	-	0.64	0.11	110
18	LXI/B-9	99.1	-	-	0.87	0.07	165
19	LVIIIA-5	88	9.63	-	2.33	0.04	100
20	LVIIIA-5	97.5	-	-	1.64	0.86	160
21	LXI-8	98.8	-	-	0.75	0.48	60
22	LXI-8	98.5	-	-	0.95	0.5	90
23	LVIII/B-11	1.3	98.6		0.04	0.06	1000
24	LXI/B-8	19	-	80	0.49	0.51	35

Tab. 2. Křivoklát Castle, the vassal house. Overview of main crops and admixtures in the analysed samples.

Fig. 10. Křivoklát Castle. Charred rye grains from the 1421 harvest from a bulk find at the site of the vassal house (photo by J. Hložek).

by the prevalence of winter weeds (*Agrostemma githago*, *Apera spica venti*, *Bromus secalinus*, *Bromus cf. arvensis*, *Camelina microcarpa*, *Centaurea cyanus*, *Consolida regalis*, *Fallopia convolvulus*, *Galeopsis tetrahit*, *Galium aparine*, *Lapsana communis*, *Matricaria chamomilla*, *Sinapis sp.*, *Stachys arvensis/Stachys annua*, *Trifolium arvense*, *Valerianella dentata*, *Vicia hirsute*, *and Viola arvensis*). A smaller proportion of spring weeds was also recorded (*Anthemis arvensis*, *Atriplex patula*, *Avena sp.*, *Echinochloa crus-galli*, *Galium spurium*, *Chenopodium album*, *Lolium temulentum*, and *Malva neglecta/sylvestris*), accompanied by grassland species (*Allium sp*, *Knautia arvensis*, *Plantago lanceolata*, *Ranunculus repens*, *Rumex crispus*, *Rumex obtusifolius*, *Securigera varia*, and *Stellaria graminea*), and an admixture of perennial weeds (*Cirsium vulgare*, *Convolvulus arvensis*). The presence of spring weeds can be explained as a consequence of the wide ecological amplitude of these 'ubiquitous' species.

Nitrophilous species (e.g. *Galium aparine*, *Atriplex patula*, *Chenopodium album*, *Malva neglecta/sylvestris*, *Rumex crispus*, *Rumex obtusifolius*) indicate the use of organic fertilisers, probably manure. In particular, both *Rumex ssp.* are typical weeds whose diaspores pass through the digestive tract of cattle and contaminate manure-fertilised land. Fertilisation in the High Middle Ages usually took place before sowing the main crop (i.e. the winter crop) on the fallow field area. The inclusion of fallow (a short period when a field lies fallow) is indicated mainly by grassland weeds and less specifically by perennial weeds.

Low-growing weed species (e.g. *Anthemis arvensis*, *Galium spurium*, *Matricaria chamomilla*, *Malva neglecta*, *Trifolium arvense*, *Valerianella dentata* and *Viola arvensis*) indicate the harvesting of cereals on low stubble. In the High Middle Ages, the harvesting of field crops with a grain sickle was clearly predominant.

The identified weed species also provide us with information on seed cleaning before sowing. Particularly important are the speirochorous weed species (e.g. the abundant taxa *Agrostemma githago*, *Bromus secalinus*, *Lolium temulentum*). These are highly specialised species of weeds that require the dispersion of diaspores via 'sowing' with the culture

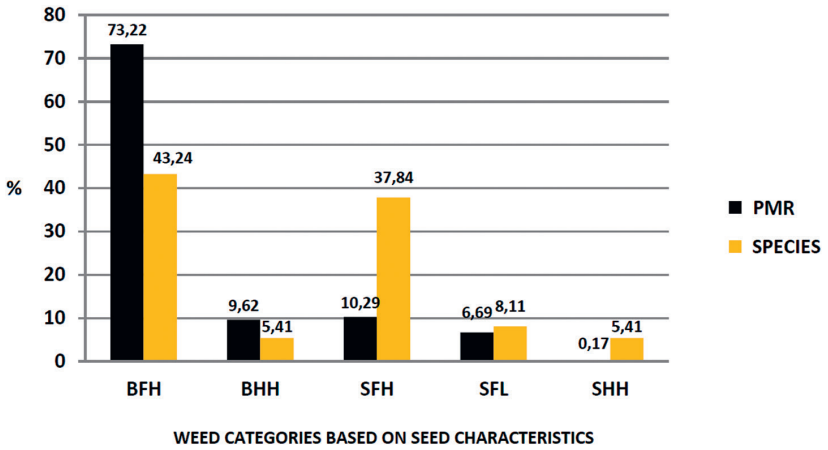

Fig. 11. Křivoklát Castle, the vassal house. Proportions of weeds based on aerodynamic properties of seeds/fruits, determining their distribution during field crop cleaning by winnowing and sieving (*Van der Veen 1992*). BFH – weeds with large heavy seeds not forming clumps; BHH – weeds with large heavy seeds forming clumps; SFH – weeds with small heavy seeds not forming clumps; SFL – weeds with small light seeds not forming clumps; SHH – weeds with small heavy seeds forming clumps; PMR – plant macroremains.

crop (rye). Speirochorous weeds form only a small grain bank (grain supply) in the soil and spread exclusively by grain (*Chytrý et al. 2009*, 75). The occurrence of these species can therefore be used as a good indicator of a low level of grain cleaning before sowing (the weeds must have reproduced using poorly cleaned grain).

Mainly large and heavy weed seeds that do not form clumps (BFHs) and are difficult to separate from cereal grains (in this case rye) remain in the cleaned cereal stock, when in the traditional methods of cleaning are used. A good illustration of rye cleaning after harvesting is provided by an ethnographic description from Wallachia: '*The grain, already rid of larger impurities, was gathered to the edge of the threshing floor, with the farmer scooping up the grain on a wooden shovel and throwing it in a higher arc. The heaviest grain fell furthest; it was also the best grain – the dreck fell closest. The part of the winnowed grain which came into contact with the chaff was winnowed again and then the grain was cleaned up on a sieve, first on a sieve with a coarser mesh and then with a finer one*' (*Šťastný 1971*).

When we consider this cleaning method for the analysed material (*Fig. 11*), we find that the grain from Křivoklát Castle was cleaned using a combination of winnowing and double sieving. The small number of wind-dispersed seeds (SFLs) indicates that post-harvest cleaning by winnowing was probably employed. The relatively high diversity of species with small, loose and heavy SFH seeds (38% of the species), but only a very small proportion of their diaspores in the whole assemblage (10% of the PMRs of the weeds) and the small number of clump-forming weed seeds (SHL, SHH, BHL) indicate that the stored grain may also have been sieved through coarse and fine sieves. In addition, the prevalence of weed species with relatively large free and heavy BFH seeds (e.g. *Agrostemma githago*, *Avena sp.*, *Bromus secalinus*, *Bromus cf. arvensis*, *Convolvulus arvensis*, *Fallopia convolvulus*, *Galeopsis tetrahit*, *Galium aparine*, *Knautia arvensis*, *Lolium temulentum*, *Ranunculus repens*, and *Vicia hirsuta*; 43% of the species) and the marked prevalence of

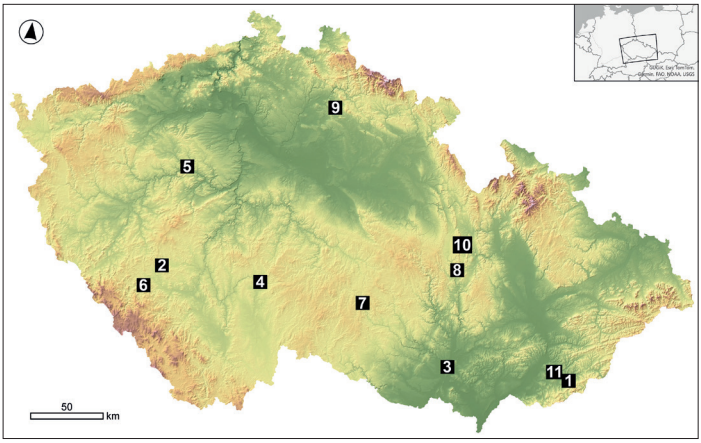

Fig. 12. Castles with cereal finds in the Czech Republic. 1 – Bánov; 2 – Chanovice; 3 – Koválov u Žabčic; 4 – Kozí Hrádek; 5 – Křivoklát; 6 – Rabí; 7 – Rokštejn; 8 – Rumberk; 9 – Trosky; 10 – Udánské Hradisko; 11 – Uherský Brod (map by K. Hanáková and J. Hložek).

their diaspores in the whole study population (73% of the weed diaspores) suggest that the stored cereals were a purified cereal stock. The large and heavy seeds of these species, such as those dominated in our dataset by the seeds of *Agrostemma githago*, the grains of *Bromus secalinus*, and the seeds of *Vicia ssp.*, are only partially removed by this simple cleaning procedure. These remaining seeds may have been the source of further problems. Flour milled from grain heavily contaminated with *Agrostemma githago*, *Vicia ssp.*, and *Bromus secalinus* is greyish in colour, bitter, and poisonous even after baking (*Jirásek et al. 1957*). The examined samples from Křivoklát, however, do not have a high share of poisonous admixtures (total contamination 1.7%), and it can be assumed that they did not cause major difficulties after milling.

Discussion

Purpose of the stored crops

To date, the grain supply found in the area of the north-western palace complex of Křivoklát Castle, interpreted by Tomáš Durdík as a vassal house related to the extensive manor system of Křivoklát Castle, has been considered as a stock of malting material, which could hypothetically be related to the existence of a small brewery of the castle vassals (cf. *Durdík 1995g*). This interpretation, however, was based on a cursory evaluation of the small amount of grain found, which was submitted for analysis to Jelena Majeríková in the 1980s, who evaluated the samples macroscopically and identified them as high-quality wheat with a minor admixture of weeds.

However, the archaeobotanical analysis of the assemblage presented in this study did not reveal any cereal residues that could be interpreted as malt residues. In particular, we lack the remains of germinated grain and a large number of cereal species preferred for malting in the High Middle Ages (common wheat or common barley). Small sample 23 from context LVIII/B-11, with predominance of ungerminated wheat, may have been used for general baking purposes. The rye found is the least suitable of Central European cereals for malting. Cultivated in the territory of the Czech Republic since the Iron Age, rye domi-

	Uherský Brod	Rokštejn	Udánky	Kovalov – Žabčice	Bánov	Kozí Hrádek 1	Kozí Hrádek 2	Kozí Hrádek 3	Rumberk	Trosky	macroresidues (%)	frequency (%)
Cereals	**macroremains (%)**											
Secale cereale	0.34	10.9	8.3	70.3	22.1	91.8	94.04	91.4	94.8	77.8	**56.18**	**100**
Triticum aestivum		63.9	10.3	28.6	74.95				2.9		**18.06**	**62.5**
Avena sativa	82.5	14.7	13.04	0.03	0.18						**11.05**	**62.5**
Hordeum vulgare	2.02	0.99	2.37	0.35	0.003				0.01		**0.58**	**75**
Panicum miliaceum			1.58	0.44							**0.2**	**25**
Triticum dicoccon			0.4								**0.04**	**12.5**
Legumes												
Vicia sativa	6.73		1.19	0.04							**0.8**	**37.5**
Lathyrus sativus			6.32	0.01							**0.63**	**25**
Lens esculenta				0.15	0.72						**0.09**	**25**
Pisum sativum			0.4	0.01	0.02						**0.04**	**37.5**
Vicia faba			0.4								**0.04**	**12.5**
Presence of weeds (%)	8.42	9.44	62.1	?	2.03	8.16	5.96	8.63	2.3	22.2		
Reference	*Tempír 1961*	*Kühn 1977*	*Kühn 1980*	*Kühn – Vrubelová 1983*	*Tempír 1968*	*Tempír 1973*	*Tempír 1973*	*Tempír 1973*	*Kočár 2009*	*Kočár – Kočárová 2013*		

Tab. 3. Proportions of field crops in the bulk finds of plant macro-remains from castles in the Czech Republic.

nated as a staple bread cereal from the 12th century to the late modern period (*Kočár – Dreslerová 2010*). Moreover, one sample contained a predominance of pea seeds, a common legume of the High Middle Ages. This finding again indicates a non-malting function of the stored field crops. The analysed PMRs assemblage can thus be interpreted as a sacked stock of bread grain and a smaller stock of legumes stored for general consumption rather than malt production.

Finds of field crops at castles in the Czech Republic

Archaeobotanical finds of field crops in castle contexts of the Czech Republic have been scarce so far (*Tab. 3*). In particular, there is a lack of systematically sampled sites. The samples examined so far are mostly bulk finds of cereal crops obtained haphazardly during excavations of high medieval castles without a clear sampling strategy or the use of flotation; they were noted for their conspicuousness during standard excavation.

Bulk finds of cereals were obtained at the abandoned castle of Kulatý Kopec near the deserted medieval village of Kovalov in South Moravia (*Fig. 12*: 3; *Kühn – Vrubelová 1983*). The analysis confirmed charred stocks of rye and common wheat with an admixture of other cereals. The PMRs come from a large number of contexts of varying dates (from the 13th to 16th century), but were published, unfortunately, in aggregate. A bulk find of wheat with admixtures of other cereals dated to 1468 comes from Rokštejn Castle in the Bohemian-Moravian Highlands (*Fig. 12*: 7; *Kühn 1977*). A mixture of cereals, mainly

oats, wheat, and rye, was identified in a sample from the Udánské Hradisko Castle in East Bohemia (*Fig. 12*: 10), with uncertain dating to the period from the 13th to 16th century (*Kühn 1980*). An unpublished bulk find of rye from the 14th century comes from Rumberk Castle in South Moravia (*Fig. 12*: 8; *Kočár 2009*). The assemblage contains a marked predominance of winter weeds. The 15th-century castle of Kozí Hrádek u Tábora in South Bohemia (*Fig. 12*: 4) yielded, among others, three samples with a predominance of charred rye and a significant proportion of winter weeds, especially corncockle and rye brome (*Tempír 1973*). The medieval castle in Bánov u Uherského hradiště in South Moravia (*Fig. 12*: 1), dated to the mid-13th century, yielded a bulk find of charred wheat and rye with a smaller admixture of other cereals and legumes (*Tempír 1968*). The 14th-century royal castle in Uherský Brod (*Fig. 12*: 11) yielded a bulk find of oats with an admixture of barley and spring weeds (*Tempír 1961*). A smaller unpublished set of macro-remains of rye and winter-indicating rye brome from the 14th and 15th centuries is also documented from Trosky Castle in Central Bohemia (*Fig. 12*: 9; *Kočár – Kočárová 2013*).

In two cases, actual malt remains were probably found at Czech castles (involving bulk finds of germinated grains). Remains of barley malt from the 15th century come from Rabí Castle in West Bohemia (*Fig. 12*: 6); they were excavated directly on the premises interpreted as a medieval malthouse and brewery (*Foster et al. 2013*). At Chanovice Castle in West Bohemia (*Fig. 12*: 2), a bulk find of germinated oats was found in an Early Modern malthouse (*Kočár 2014*; *Kočár et al. 2015*). A bulk find of field crops with a predominance of barley and a significant presence of wheat, rye, and, in some samples, also peas and buckwheat, was made at Rokštejn Castle, situated in the Bohemian-Moravian Highlands (*Fig. 12*: 7; *Havlicová 2018*). The analysis identified a large number of germinated grains, especially barley, in the samples.

Our current understanding of the archaeobotanical material is thus primarily based upon assemblages obtained during earlier archaeological excavations. Nevertheless, it is possible at least to approximate the significance of individual field crops from these data. Leaving aside the two latter bulk finds of germinated cereals, which are very well interpreted given their find context, we can evaluate the remaining finds of unsprouted cereals in the following manner.

Rye is the only cereal crop found at all the studied sites, and it also shows the highest abundance (average 56% of PMRs). The second cereal in order of importance is undoubtedly wheat (63% of the sites and 18% of the PMRs on average), which is particularly important at Moravian sites (Rokštejn, Bánov, Udánské Hradisko, Kovalov), while appearing to be less significant at Czech sites (Kozí hrádek, Trosky, and Křivoklát). This corresponds to the data obtained from high medieval towns, where a similar distribution pattern can be observed (*Kočár et al. 2014*, 136). The third cereal in order of importance appears to be oats, detected at 63% of the sites but with a somewhat lower representation in the set of PMRs (on average, only 11%). Barley was detected at a relatively large number of castles (75% of the sites), but only in a small amount (on average, 0.6% of the PMRs). Millet appears to be the least important cereal, with a low frequency at sites (25%) and very low abundance in macro-remains (on average 0.2% of PMRs per site).

A comparison with other castle sites that have undergone archaeobotanical study shows that the charred cereal stock from Křivoklát, despite being a random bulk find, may reflect the contemporary reality in the preferences of individual types of field crops stored at castles in Bohemia. Both rye and peas seem to have played a leading role among the

consumed field crops of castle sites. The consumption of winter rye as the dominant cereal of the High Middle Ages can be traced, especially in Bohemia, from the lowest levels of society to the nobility.

In terms of its original location, the find of grain and other field crops from Křivoklát Castle is unique. In the medieval and Early Modern periods, we encounter granaries (*Varhaník 2018*) or multifunctional farm sites in Bohemian castle contexts that allowed for the storage of grain and other foodstuffs (*Úlovec 2004*, 216–217). Finds of cereals on the premises of castle breweries are by no means exceptional. In the case of Křivoklát Castle, grain and other crops were stored in extremely unsuitable and undoubtedly damp spaces in the basement of the keep, in the residential areas of the vassal palace, and, last but not least, in the narrow corridor above the second gate in the upper part of the vassal house (*Durdík 1995g*, 6). However, in terms of access to the castle via a turn-off from the road running through the valley of the Rakovník Brook, this was the first accessible part of the castle complex. As it is evident from the historical assessment of the situation at the start of the Hussite Wars, a significant number of the castle's vassals failed to fulfil their obligations to the castle or simply joined Hussite forces. In 1422, some of Křivoklát's vassals directly participated in the siege of the castle to which they were bound by vassalage. With regard to this situation, we can assume that the vassal house did not serve its original purpose at the start of the Hussite Wars, but was a vacant palace complex situated in the lowest-lying part of the castle grounds and directly linked to one of the access routes to the castle. The grain and other crops found in this part of Křivoklát Castle do not, therefore, represent a standard food store. Given the historical circumstances and the location of the deposit, we can assume that this was an emergency store of grain and other field crops from the 1421 harvest, which was held for supply purposes in the most accessible part of the castle grounds.

Grain stores were originally kept in sacks. Samples from the layers LXI/B-8 and LXI/B-11 yielded remnants of coarse textiles, probably sacking, which confirm the storage of grain in these containers. For this reason, the archaeological evidence of rodent infestations of some of the stored grain in the basement of the keep in the form of mouse burrows containing grain is hardly surprising (*Durdík 1995g*, 6–7). The charred excrement of small rodents was detected in samples from context LXI/B-11. The storage of rye in sacks has also been documented at other medieval sites, for example, in the vicinity of the emerging town of Starý Plzenec in West Bohemia (*Kaiser et al. 2005*). The storage of large quantities of flammable material in the form of grain and other field crops in this part of the castle could then have been the reason why the area of the vassal house was damaged by fire the most severely within the entire castle complex and why the majority of the buildings in the vassal palace complex collapsed during the fire.

Conclusion

Archaeobotanical analysis and the interpretation of the assemblage of cereals and other field crops from Křivoklát Castle damaged by fire on 18 March 1422 provide key insights into the possible nature of emergency reserves of field crops and their somewhat unusual location on the grounds of a large royal castle at the beginning of the Hussite Wars. The results of the archaeobotanical analysis of the largest bulk find of crops from the medieval

castle context in Bohemia provide crucial insights into the quality of food available in High Middle Ages and the preferences for certain types of field crops among the castle milieu, where rye and peas in particular played a dominant role among the consumed food staples. The consumption of winter rye as the dominant cereal can then be traced, particularly in the Bohemian context, from the lowest classes of high medieval society all the way up to the highest social strata. The content of weeds in the samples was very low, averaging just 1.6% of analysed plant macroremains. The weed admixture detected in the examined samples reflects the common agricultural technique of rye cultivation in the High Middle Ages, involving selection and location of the land intended for rye cultivation, probably a three-field fallow system, knowledge of organic fertilisation, low stubble cereal harvesting, practices used for cleaning seeds and harvested grain, and the storage of field crops. The content of other crops in the predominating rye can be interpreted as a consequence of crop rotation in the fields, or as a secondary admixture during storage. As such, the earlier interpretation regarding the storage of malting grain on the grounds of the vassal house of Křivoklát Castle and the existence of a small vassals' castle brewery was not confirmed.

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