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PIOTR STRZYŻ

ARCHAEOLOGICAL TRACES OF USE OF FIREARMS DURING SIEGES. SELECTED EXAMPLES FROM THE TERRITORY OF POLAND

Abstract: This paper is in attempt at correlating chronologically well-defined assemblages of projectiles and historical events which accompanied their deposition. In order for the relics to be of maximum use such an analysis, it is necessary for them to heave precisely defined find places and cultural context. These are discoveries related to well-datable military activities (sieges) and finds acquired in the course of examinations of masonry objects. We did a comparison with regard to military conflicts which are well-depicted in sources: Bolesławiec and Wieluń 1396, Puck 1464, Muszyna 1474 and Gniewoszów 1428.

Keywords: firearms, medieval siege, Poland, hand held firearms

One of components of military activities in the late Middle Ages was a more and more widespread use of a new type of weapons – firearms. For the territory of Poland, the first mention is related to the siege of Pyzdry in 1383[1], and since then the new weapons appear more and more often on the pages of chronicles describing military activities. In this paper we will deal with finds which are related to the use of firearms during sieges. We will discuss them based on some selected examples. These are: the sieges of Bolesławiec and Wieluń in 1396, Puck during the Thirteen Years War (1454-1466), the conflict with Matthias Corvinus King of Hungary – Muszyna (1474), and the Hussite Wars – Gniewoszów (1428).

Bolesławiec nad Prosną and Wieluń

After ascending the Polish throne, in 1386, Władysław Jagiełło pledged himself to regain the territories which had been lost after the death of Casimir the Great, and to restore the unity of the lands of Polish Kingdom. The same applied to the territories given by Louis I the Great of Hungary to Władysław, Duke of Opole. His landholdings had strategic significance for both economic and defensive coherence of the Kingdom, comprising the north-western part of Cracow Land, a fragment of Sieradz Land, Wieluń and Ostrzeszów Land. Since Jagiełło ascended the Polish throne in 1386, the relationships between him and the Duke began to cool down steadily. In 1391 the Duke pawned to the Teutonian Knights the town of Złotoryja in Dobrzyń Land, which provided cause for a military conflict. The war was waged between the years 1391 and 1396[2].

The main attack was made after September 15th, 1391. Polish troops gathered near Rabsztyn in Lesser Poland and attacked the castle in Olsztyn near Częstochowa, which they won after three days of siege. During further military proceedings the royal army seized Brzeźnica, Wieluń, Wieruszów and Kępno and other fortresses. Consequently, Władysław, Duke of Opole was left only with Bolesławiec and Ostrzeszów. By the end of September or the beginning of October, Wieluń Land had been in the hands of King Władysław Jagiełło The troops set off again for Ostrzeszów and Bolesławiec in winter of 1393. Ostrzeszów was taken over about middle of March, while Bolesławiec resisted the siege, even though Polish army used artillery. The military campaign was suspended until August 22nd, when Polish troops attacked a fragment of Silesian landholdings of Władysław, Duke of Opole. The campaign was interrupted for the winter period and resumed in January 1394, when the army attacked a part of Bytom and Opole Dukedom. This phase of the conflict was concluded by a truce signed in Głogówek on April 10th, 1394[3].

The preparations for the final military attack were taken up in June 1396. The campaign started on July 14th and the army was led towards Opole Dukedom, in the direct vicinity of the capital of the land – Opole. On their way, they managed to conquer smaller centres. At the same time,

[1] Szymczak 2004, 12-14.

[2] Sperka 2003, 29-37.

[3] Sperka 2003, 37-42, 47-52; Strzyż 2011, 78.

	Dulle Griet	*Mons Meg*	Basel bombard	Boxted bombard	Paris bombard	*Michelette* 1	*Michelette* 2	*Faule Magd*
Overal lenght (cm)	501	404	271	240	202	333	365	233
Barel lenght (cm)	346	288	188	156	126	216	267	148
Lenght powder chaber (cm)	155	116	83	84	76	117	98	76,5
Calibre (cm)	64	48	34	34	48	41	51	34,5
Weight of barrel (kg)	16400	6040	-	-	-	3250	5300	1320

Tab. 1. Metrical data of medieval bombards.

a division of the forces was besieging Bolesławiec which was still in the hands of Władysław Duke of Opole. The town and the castle of Opole were bombarded by three cannons, including one heavy bombard, and they surrendered quickly. On August 6th the truce was signed with Polish king. In this situation, the rest of the main forces, including artillery, supported the siege of Bolesławiec, which most probably gave up to Polish king in August[4].

The aforementioned military campaigns were prepared very carefully and the expenditures were high. The artillery played an important role, but not a decisive one, though. The bills of the town of Cracow containing the records of the funds spent on saltpertre, sulphur, gunpowder, cannons and the transport convey the impetus of works related with the siege. In 1391 the town of Cracow purchased saltpetre and sulphur for 380 grivna and assigned another 103 grivna for 5 cannons, lead and projectiles. In the next year another bronze cannon, shooting accessories and gunpowder were bought and the stock of saltpetre and sulphur was topped up which cost 480 grivna. The gunners were paid salary amounting 42 grivna. In the same year, 4 hundredweights of soft copper and 3 hundredweights of hard copper plus 3 hundredweights of iron were bought for the total of 500 grivna. The sum of money spent during two years on weaponry and necessary accessories and materials was huge – 1500 grivna[5].

The material remnant of the military campaign are the stone cannon balls found today. The six projectiles discovered during archaeological excavation at the castle in Bolesławiec on the River Prosna have the following calibres: 15.2 cm (Fig. 1: 2), 26 cm, 29 cm, 31 cm and 44 cm (two bullets). The weight of the heaviest balls was 104 and 108 kilos respectively. Their deposition is connected with the military campaign of the years 1391 to 1396. Another group of bombard balls is located in Wieluń and these are 19 pieces of the following diameters: 44 cm (four pieces), 45 cm (four pieces), 45.5 cm (two pieces), 46 cm (four pieces), 46.5 cm (four pieces), 47 cm (two pieces) and 48 cm (one piece). These projectiles had been made of granite, which allows us to state that they were delivered as ready products to the besieged fortresses, since granite is not found anywhere near to Wieluń or Bolesławiec[6] (Fig. 1: 3-4).

On the basis of their diameters, we can conclude that Polish army disposed of four or five such cannons (bombards). The first one was most probably of 16 cm calibre (in regard to the 15.2 cm ball from Bolesławiec). The second cannon could fire balls of 26 to 29 cm in diameter; or these were two different cannons of the respective diameters (about 26 and 29 cm). The third bombard threw balls of 31 cm in diameter. In case of the heaviest balls we can most probably deduce one bombard, its calibre measuring from 49 to 50 cm[7].

The data concerning the calibre of the cannons can be applied to the approximate reconstruction of their appearance and parameters. The broad spectre of comparison is enabled by the variety of original cannons preserved in the museums in Western Europe, and dated in majority from the 15th century. One of the biggest historical bombards preserved is the *Dulle Griet* from Ghent, of total length of 5 metres, and not less than 16 400 kilos of weight, while its calibre was 64 cm. The relevant ball weighed 340 kilos[8]. The bombard called *Mons Meg*, from the castle in Edinbourgh, Scotland, is somewhat smaller. The calibre being 48 cm, its total length is 4 metres and the weight is 6 040 kilos. Smaller cannons are represented by the Basel Bombard, Boxted Bombards, Paris Bombards, two bombards from Mont St. Michel in France, nicknamed *Michelettes* and *Faule Magd* from Dresden[9] (Tab. 1).

We can draw a conclusion from the specification above that the historical bombards whose bores fit most closely the size of the largest balls found in Bolesławiec on the River Prosna and in Wieluń are: *Mons Meg* and *Michelette* 1. Their bores are contained in the span between 41 cm

[4] Sperka 2003, 66-78.

[5] Szymczak 2004, 213; Strzyż 2007, 85-86.

[6] Poklewski 1979, 22, Fig. 9; Maik 1997, 31-32, Photo 21; Szymczak 2004, 148, Fig. 26; Strzyż 2007, 86-87; Strzyż 2011, 61, 79, tabl. XL: 2-6.

[7] Strzyż 2007, 87; Strzyż 2011, 79.

[8] Goetz 1985, 48; Smith and Brown 1989, 1-3, 11, 13, Fig. 3, 5-14; Strzyż 2007, 88, Fig. 2; Strzyż 2011, 79.

[9] Smith and Brown 1989, 46-50, 52-78, Fig. 25-60; Strzyż 2007, 88-89, Fig. 3-7.

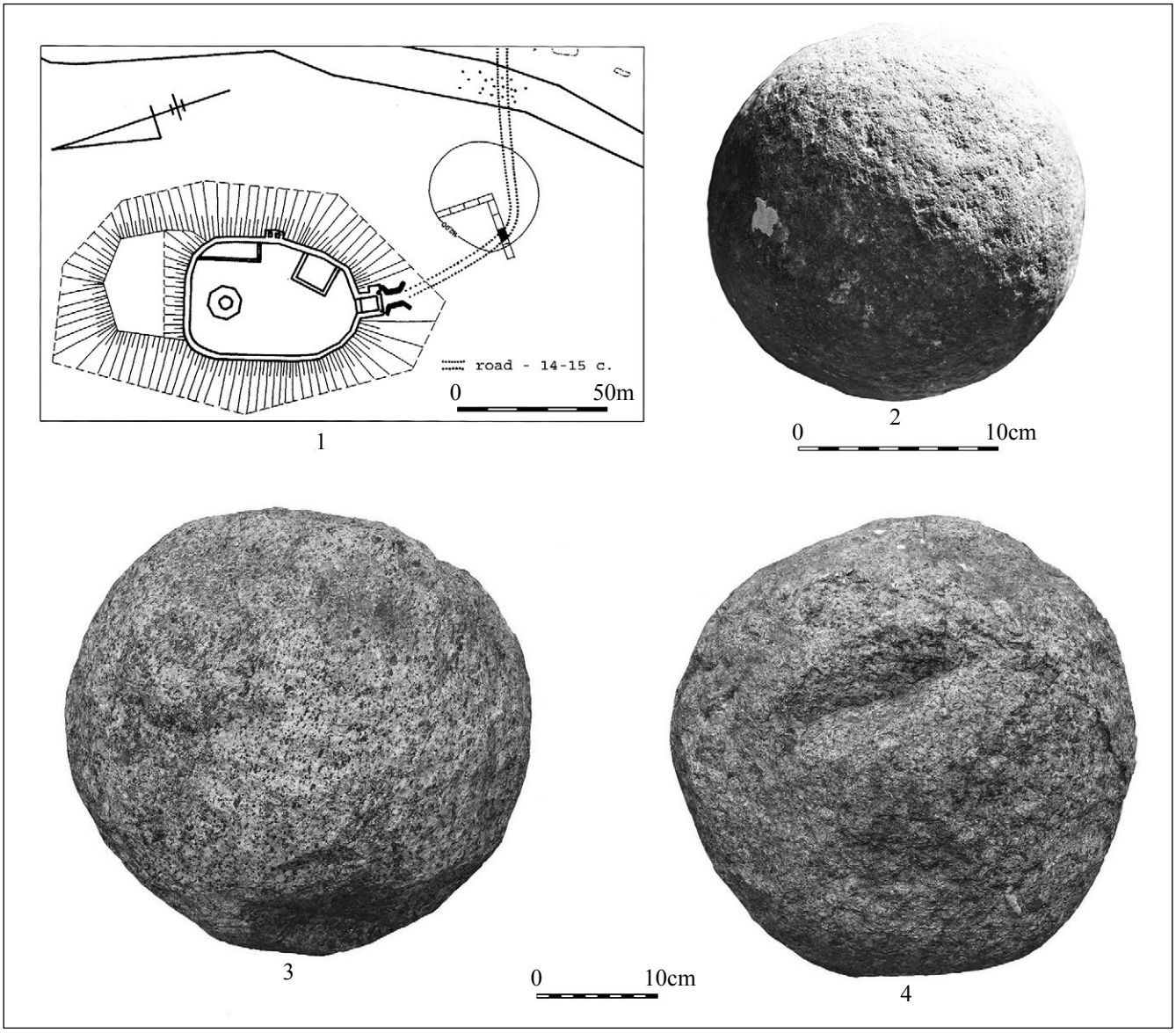

Fig. 1. 1 – Bolesławiec on the River Prosna – location of an earthwork on the background of the castle, general layout. After Strzyż 2007, Fig. 10; 2 – stone ball from Bolesławiec on the River Prosna; 3-4 – stone balls from Wieluń. Photo P. Strzyż (2-4).

(*Michelette* 1) and 48 cm (*Mons Meg*). Therefore it seems very likely that the parameters of the largest cannons used by Władysław Jagiełło's army were similar. We can also state that the heaviest of Polish bombards could be two to four metres long, while weighing maximum three to six tons, depending on the length of the barrel and the powder chamber. Smaller cannons firing balls of 26 to 31 cm in diameter come close to the Basel and Boxted Bombards and *Faule Magd*, that is, they were likely to be two metres of length and weigh one and a half to two tons.

During scheduled archeological works a significant discovery was made which is important for the reconstruction of the strategy of bombardment of the castle in Bolesławiec. An earthwork was found which had been used as a platform for the bombard firing the castle of Bolesławiec. The earthwork was situated on the way from the bridge to the castle, almost directly opposite the castle gate (Fig. 1:1). Unfortunately, the state of preservation of the gun site does not enable the reconstruction of the way in which the it had been fortified. The earthwork was located in the distance of 46 metres from the castle walls, and 72-90 metres from the castle itself[10]. It is the distance in reach of the then artillery, the more if we consider that the best results were achieved by direct fire from a close distance. The location of the artillery required, though, an adequate shield against the firing from the castle, as the defence gun sites were located 15 metres higher than the gun sites of the besiegers. It is probable that the earthwork was fortified with an earth-and-wood construction, and a mobile cover was installed over the bombard, which was opened during the firing, and shut down during the cleaning, cooling down and loading of the cannon. Jan Długosz, the chronicler, noted that Polish troops encircled the castle

[10] Poklewski 1979, 20; Strzyż 2007, 94-95, Fig. 10.

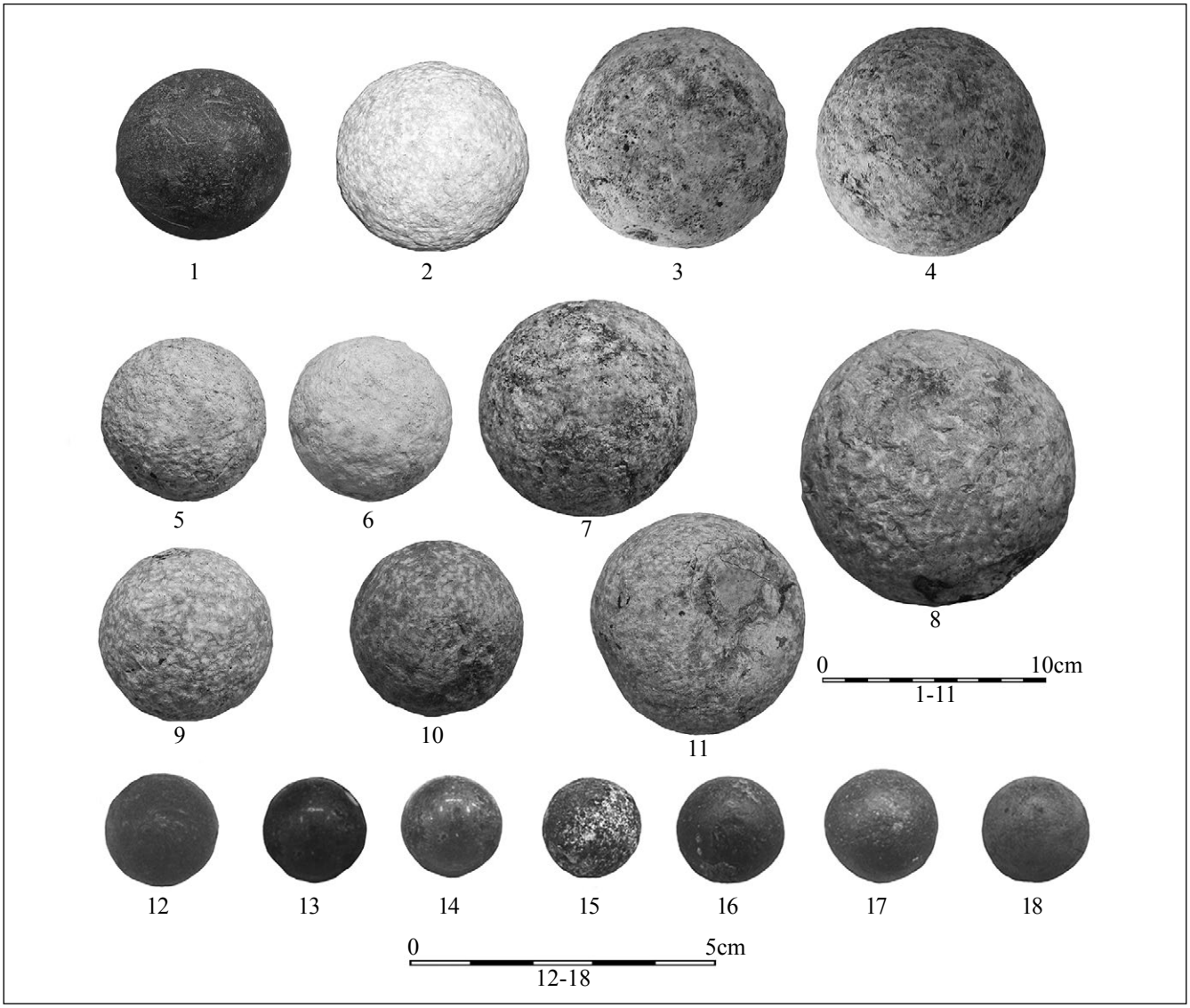

Fig. 2. Puck castle: 1 – lead ball; 2-11 – stone balls; 12-18 – handgun projectiles. Photo P. Strzyż (1-18).

of Bolesławiec with small "mottes" which provided shelters for artillery[11]. Those "mottes" could be the earthworks exactly – the artillery sites, and the information may indicate that the castle was bombarded from multiple sides or sites at a time. The accessible documents contain no detailed description of damage done by the Polish army's artillery. On the basis of archaeological excavation, we can only cite the general damage of the castle tower and the castle itself, including the Duke's Assembly Hall.

Puck

The castle in Puck was built in the first years of the 15th c.[12] The building which was later referred to as the tower was the strongest defensive point of the premise, which was not an object of military activities during the Polish-Teutonic wars in the period of reign of King Władysław Jagiełło. During the Thirteen Years War (1454-1466), already on 20 February 1454 the town and the castle passed under the rule of the Prussian Union[13]. In 1457 the castle became the residence of Karl Knutson Bode, the Swedish king on exile, to whom the City Council of Gdańsk pledged this estate [14]. Puck returned under the Teutonic rule in the night of 13-14 October, when the Swedish garrison left the walls of the fortress. In 1464 Puck was taken by Gdańsk troops. Without waiting for Polish forces, the Gdańsk burghers laid siege to the fortress. The town and the castle were blocked with bastilles and earth fortifications from the side of the land, and with armed vessels from the side of the bay. The Teutonic garrison defended bravely from 23 April to 24 September 1464[15], but as they saw no chance for relief, they decided to surrender the castle.

[11] *Annales*, 215.

[12] Kruppé and Milewska 1997, 43; Kajzer et al. 2001, 408.

[13] Kruppé and Milewska 1997, 45.

[14] Kruppé and Milewska 1997, 45; Haftka 1999, 258.

[15] Biskup 1967, 667-668; Kruppé and Milewska 1997, 45; Haftka 1999, 259-260.

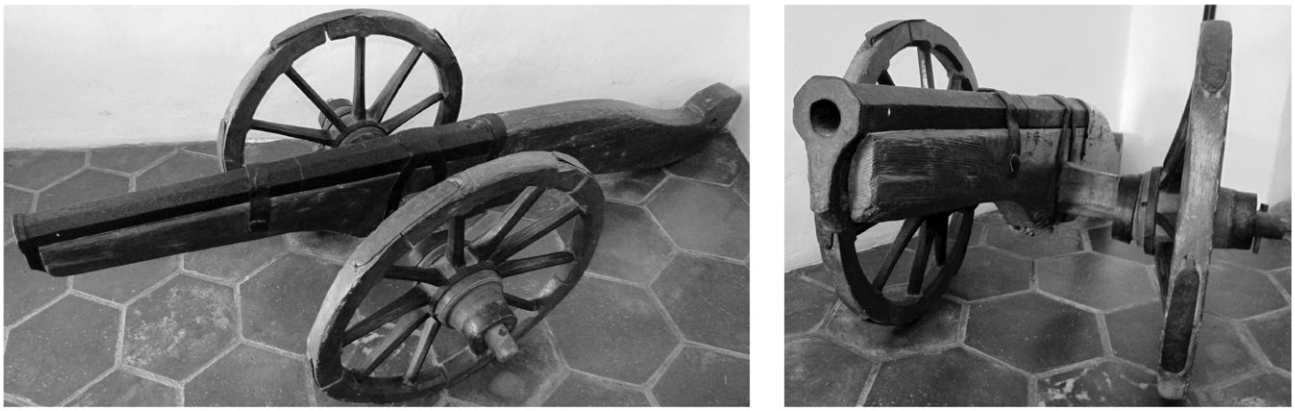

Fig. 3. Terrace-gun from Český Šternberk castle, the 15th c. Photo P. Strzyż.

	Křivoklát	Horšovský Týn 1	Horšovský Týn 2	Horšovský Týn 3	Horšovský Týn 4	Český Šternberk	Znojmo
Overall length (cm)	148,0	108,7	133,5	124,5	107,0	90,1	108,4
Barrel length (cm)	120,0	103,0	126,0	115,5	-	85,0	99,8
Calibre (cm)	3,8	4,6	4,4	4,3	3,0	2,8	4,0

Tab. 2. Metrical data of medieval terrace-guns from Central Europe.

In the course of archaeological works carried out both at the castle and in the area of the town, 73 firearms projectiles were found altogether. The stratigraphic situation is of crucial importance for their chronology, as these are layers which are dated based on such artefacts as a coin of Kazimierz the Jagiellonian (minted after 1457), or a Teutonic shilling from the period of 1450-1456.

Cannon projectiles are represented by 22 stone finds (Fig. 2:2-11) and one made of lead (Fig. 2:1). The calibres of stone cannonballs oscillate between 5,5 and 13,5cm, while the lead find has a diameter of 6.7 cm. The weight of the stone specimens is between 0,3 kg (calibre 5,5 cm) and 3,5 kg (calibre 13,5 cm), while the weight of the lead projectile is 1,5 kg. All the mentioned finds come from the western side of the castle, from the moat near a wall of the castle's masonry house and from the western gate, which is situated nearby. It is also significant that specimens with larger diameters (9,0-13.5 cm) were found in the area of the castle gate, while those with smaller diameters (5,5-8,5 cm) were discovered near the northern and the central part of the masonry house[16].

Artillery projectiles discovered in the course of research at Puck represent 12 calibres. The largest diameters can be seen in the case of these cut of granite and sandstone (13,5 and 11,5 cm). It is therefore very probable that the main firepower of the besieging troops were a few cannons launching stone projectiles, the so-called *Steinbüchsen*. Cannons with such calibres were used to bombard the western gate of the castle. Smaller stone projectiles (5,5-9,0 cm) and one lead projectile with the calibre of 6,7 cm can be related with considerable probability to light artillery. In the period in question, it was represented by terrace-guns and possibly veuglaires. Cannons with such calibres were aimed at the front wall of the castle's masonry house. What is especially striking is the large quantity of ammunition which can be related to the lightest types of guns, such as terrace-guns (Fig. 3) (Tab. 2).

The calibres of the smallest specimens (3,5-3,8 cm) are to a great degree convergent with the upper limit which is assumed for hand-held firearms, such as heavy types of hackbuts. For such weapons, not only lead projectiles (calibre 6,7 cm), but also stone ones (5,5-9,0 cm) were used. The other fact is hardly mentioned by written sources, which classify smaller cannons as *Lotbüchsen*. In the case of long-lasting sieges, when both resources of war materials (projectiles) and funds were running out, substitute raw materials were made use of. In this case, it was local stone, which was abundantly available in the neighbourhood. The lack of large calibre stone cannonballs (over 20 cm) in the Puck assemblage is also significant. Such cannonballs could be able to break the castle's fortification in case of systematic bombardment. The assortment of projectiles (within the scope of 5,5-13,5 cm) enables us to conclude that the main aim of the besieging troops was rather to destroy the interior buildings and possibly also to raise fires and destroy the manpower of defenders. The main stress was therefore put on the use of light artillery. Although it did not have great destructive power, it was technologically adapted to greater rate of fire. This was of considerable

[16] Strzyż 2011, 92, tabl. XXXV: 2-17.

significance for a possible breaking of the will of fight of the Teutonic garrison.

In the acquired find material there are also 48 specimens of bullets for hand-held firearms (Fig. 2:12-18). In their case, the preponderance of glass specimens is of interest. Altogether 35 finds were extracted from cultural layers dated to the mid-15th c. The diameter of the smallest one is 1,3 cm, and of the largest one – 1,8 cm, with the weight oscillating between 3 and 4 grams. Apart from glass projectiles, there are also bullets made of stone (5 specimens with calibres of 1,6 – 2,7 cm), lead (6 specimens with calibres of 1.1 – 1.8 cm) and iron (2 specimens with calibres of 1,3 – 1,6 cm). The assortment of calibres of discovered projectiles of hand-held firearms falls within the scope of 1,1 – 2,7 cm. However, as much as 85% is within the scope of 1,4 – 1,9 cm[17].

Based on the analysis of available comparative data, i.e., preserved specimens of hand-held firearms from the territory of Poland and Central Europe, it can be seen that the besieging troops were equipped both with *piszczel* guns and hackbuts, possibly with lighter types of the latter. The early 15th c. *piszczel* gun from the Curonian Spit and the hackbut from the first half of the 15th c. (now stored in the National Museum in Kraków) have calibres of 1,7 cm. The weight of the Curonian find is 2,58 kg, while the Kraków one weighs 4,69 kg[18]. The structure of the size allows to state that lighter specimens dominated. However, there was also at least one heavy hackbut with the calibre of 2,8 cm.

The majority of acquired projectiles for hand-held firearms bears evident traces of manufacture. On glass and lead specimens, these traces are represented by remains of cutting a ready product from the mould, and by traces of flanges, i.e., sprues. On the other hand, traces of hammering can be seen on iron projectiles, which enables us to state that such projectiles were forged. All the projectiles for hand-held firearms, analogously to artillery projectiles, were found on the western side of the castle, in the moat and at the north-western corner of the castle's masonry house. Many of these projectiles, first of all the glass ones, bear clear traces of damage, which originated in result of hitting against masonry fortifications of the castle. One more significant detail must also be underlined – namely, almost all bullets for hand-held firearms were found close to not only artillery projectiles, but also such elements of weaponry as crossbow bolts, which confirms their military use.

Muszyna

The capture and destruction of the castle in Muszyna was part of the Polish-Hungarian war for the throne of Bohemia, waged in 1471-1474. On 10-11 January 1474 6000 soldiers under the command of Tamás Tarczay of Lipany crossed the southern border of the Kingdom of Poland. One detachment attacked the road from Bardejov via Zborov. It passed unnoticed through the Beskid Pass to Ożenna, and then, marching through the forest of the Beskidy Mountains. Already on 13 January both the town and the castle were captured. In the course of the following days a considerable part of the present-day Podkarpackie Voivodeship was devastated and such centres as Dukla and on 16 January Jasło were destroyed. Krosno was also besieged, but the attackers were forced back from the walls i. a. by fire of hand-held firearms. The Hungarians marched from Jasło to the north, reaching Pilzno. It was taken on 1 February, with numerous robberies having been done[19]. At the same time, another smaller detachment attacked Muszyna from Bardejov. In Muszyna, there existed a masonry castle of the bishops of Kraków. It was a rectangular premise with the dimensions of about 59 x 29 m, with an angular tower on the eastern side[20]. In the course of the first day of hostilities the castle tower was pulled down, and already on the second day the garrison surrendered.

According to the peace made in 1474, Matthias Corvinus pledged himself to return the castle in Muszyna and he was to support its reconstruction. Numerous militaria were found in the course of archaeological works carried at the castle. These can possibly be related to the afore-mentioned events. Many militaria were found in rubble layers in the foreground of the castle. Among the finds related to firearms, which are of interest for us here, there were two fragments of projectiles cut of sandstone, with their diameters being c. 13 cm (Fig. 4:10), an iron ball with the diameter of 4,8 cm (Fig. 4:6) and iron bullets with their diameters being 2,1 cm (Fig. 4:7-9). The stone projectiles come from the foreground of the tower and in their vicinity, the iron projectile was deposited. Ammunition for hand-held firearms was found both in the interior of the castle, and in its external part[21].

Five fragments of burst barrels of hackbuts deserve a thorough description (Fig. 4:1-5). The first one is an iron fragment with the calibre c. 3,0 cm. The other find comes from a bronze cast barrel, whose calibre was c. 2,1 cm[22]. Therefore, in this case (analogously to finds from the castle in Puck) we have an opportunity for a broad insight into the kinds of firearms which were used for the siege and for the defence. The sandstone projectiles with the diameters of 13 cm can be considered as ammunition coming from the artillery which was bombarding the castle. The iron projectile testifies to the use of terrace-guns (rather lighter types) in these activities. On the other hand, concerning hand-held firearms, both the projectiles which were documented and the two fragments of hackbuts confirm the use

[17] Strzyż 2011, 93.

[18] Szymczak 2004, 43-44; Strzyż 2011, 18, 22.

[19] Plewczyński 2005, 71-72.

[20] Kajzer et al. 2001, 314; Chudzińska 2009, 17.

[21] Chudzińska 2011, 205-207, Fig. 3; Strzyż 2011, 28, 101, tabl. VII: 2-6.

[22] Chudzińska 2011, 205, 207, Fig. 2; Strzyż 2011, 52, 53, 101.

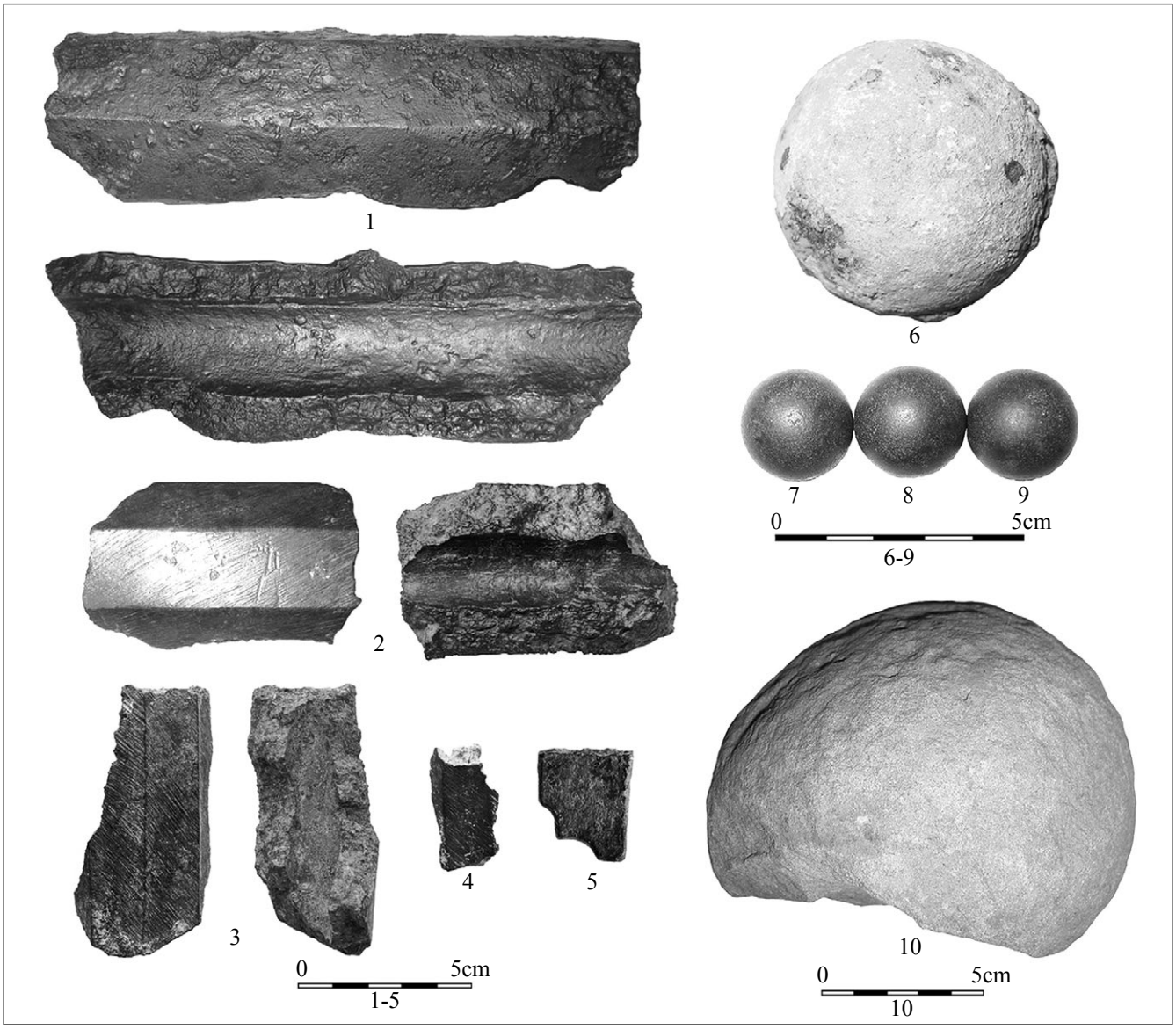

Fig. 4. Muszyna castle: 1 – remains of iron barrel; 2-5 – remains of bronze barrels; 6 – iron ball; 7-9 – iron handgun projectiles; 10 – stone ball. Photo P. Strzyż (1-2, 6-10), A. Ginter (3-5).

of medium and heavy types of hackbuts, with the calibre of 2,1-3,0 cm (Fig. 5:1-3). Regrettably, we are unable to define which specimens that were found belonged to the defenders and which ones – to the troops attacking the castle.

The Hussite Wars in Silesia – Gniewoszów

In the second half of the 1420s, especially in 1428-1429, Hussite troops carried out a series of devastating raids in the territory of Silesia. Vestiges of these actions are finds of stone balls, with the most numerous assemblage having been discovered during systematic examinations of the castle in Gniewoszów. Altogether 32 entire or fragmentarily preserved stone projectiles were found in the remains of the premise which was captured in 1428[23]. On the other hand, it is in eight cases only that we are able to precisely define their original diameters and weights. It seems that the ammunition corresponding to calibres of cannons which were used for capturing the castle had the following diameters: around 12, 15, 17-18 and 20 cm, and their weights oscillated between 3 and 5 kg (Fig. 6:2-5). It is of interest that the projectiles were made exclusively of sandstone, which was light and hardly resistant to breaking. Therefore, there is a considerable quantity of small slivers, which originated when the cannonballs hit the stone walls of the castle. Within the examined assemblage, the greatest number of projectiles was discovered in Building 1, with possibly 17 in Room B, two in Room A and one in Room C (Fig. 6:1). Buildings at Gniewoszów were concentrated in the eastern and north-eastern part of the castle's ward, where the afore-mentioned main gate and Building 1 with Rooms A-D were situated[24].

[23] Grünhagen 1872, 143.

[24] Kajzer et al. 2001, 184-185; Marek 2008, 87-88, Fig. 1.

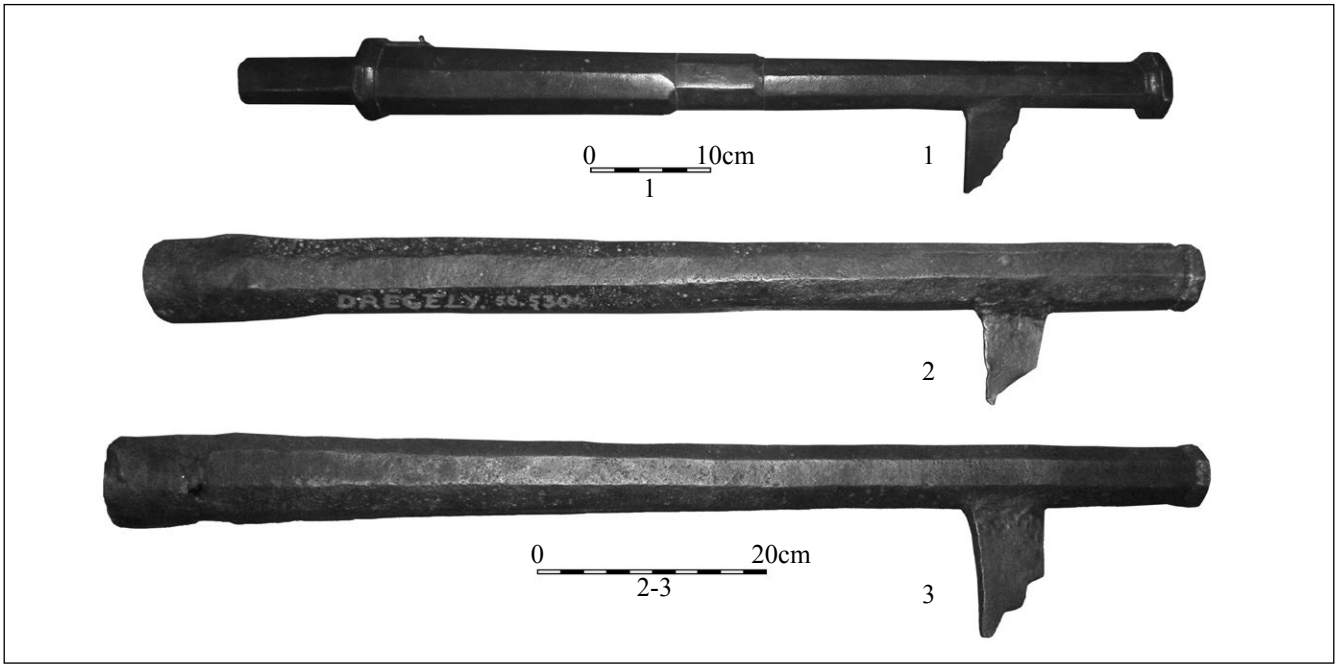

Fig. 5. 1 – bronze hackbut from Poběžovice, the 15th c.; 2-3 – iron hackbut from Drégely castle, the 15th c. Photo P. Strzyż (1-3).

	Kurzętnik	Museum Berlin	Museum Vienna	Nový Bydžov	Museum Murten 1	Museum Murten 2	Museum Murten 3
Overall length (cm)	50,7	80,5	59,5	53,5	48,0	48,0	62,5
Barrel length (cm)	22,5	30,5	-	-	22,0	22,0	32,5
Calibre (cm)	13,5	18,0	16,0	11,0	16,0	16,5	21,0

Tab. 3. Metrical data of medieval *houfnice* cannons.

This means that the castle's gate was bombarded as the crucial point of each defensive premise. The same concerns as well as castle's buildings, with the aim of destroying the manpower and rooms of defenders.

Preserved written sources from this period inform us that Hussite troops had numerous artillery, and each fifth wagon in the trains was to be equipped with a light field cannon: a terrace-gun or a *houfnice*[25].

The lack of finds of projectiles with larger calibres in the examined ruins lets us assume that medium calibre artillery was used for capturing small castles. Bombards with the largest calibres were not applied, as they caused numerous logistic complications and slowed down the pace of the march of troops. Light artillery has less destructive power, but it was completely enough for fighting the manpower of defenders and destroying buildings inside the castle. In this case, the main role was played by the psychological factor. Defenders, being fatigued with incessant fire and deprived of shelter, often decided to surrender the fortress, in spite of the fact that the castle walls were not yet sufficiently damaged.

In all probability, only one specimen of a genuine Hussite *houfnice* can be related to this period (Fig. 7:1-2). It comes from the locality of Nový Bydžov and it is dated to the first half of the 15th c.[26] A similar construction can be seen in the case of a *houfnice* stored in the Berliner Zeughaus, which is dated to the second half of the 15th c.[27] (Tab .3).

It must be stressed that practically all the specimens are remarkable for short barrels. In the case of Murten 3 specimens it is only 32 cm. The case of the Berlin specimen is similar. After the cannon is charged, all that remains is a short distance of a dozen or so cm, within which the projectile is to gain impetus and momentum. These features must have had a considerable impact on the accuracy of fire of *houfnice* cannons. Due to this, the launched projectile lost its contact with the walls of the bore at the very beginning, which resulted in poor accuracy of such cannons. Therefore, the effective range of fire of such weapons hardly exceeded 200 m. Thus, their strength relied in the rate of fire and in small dimensions and weight.

Based on discussed examples, the following conclusions can be drawn. Firstly, if we know the metrical data of ammunition, we can attempt at reconstructing the firepower

[25] Durdík 1955, 131-136, 152; Iwańczak 2002, 381-383.

[26] Drobná and Durdík 1975, 37, 54, cat. No. 281.

[27] Goetz 1985, 38; Smith and DeVries 2005, 310-311, cat. No. 25.

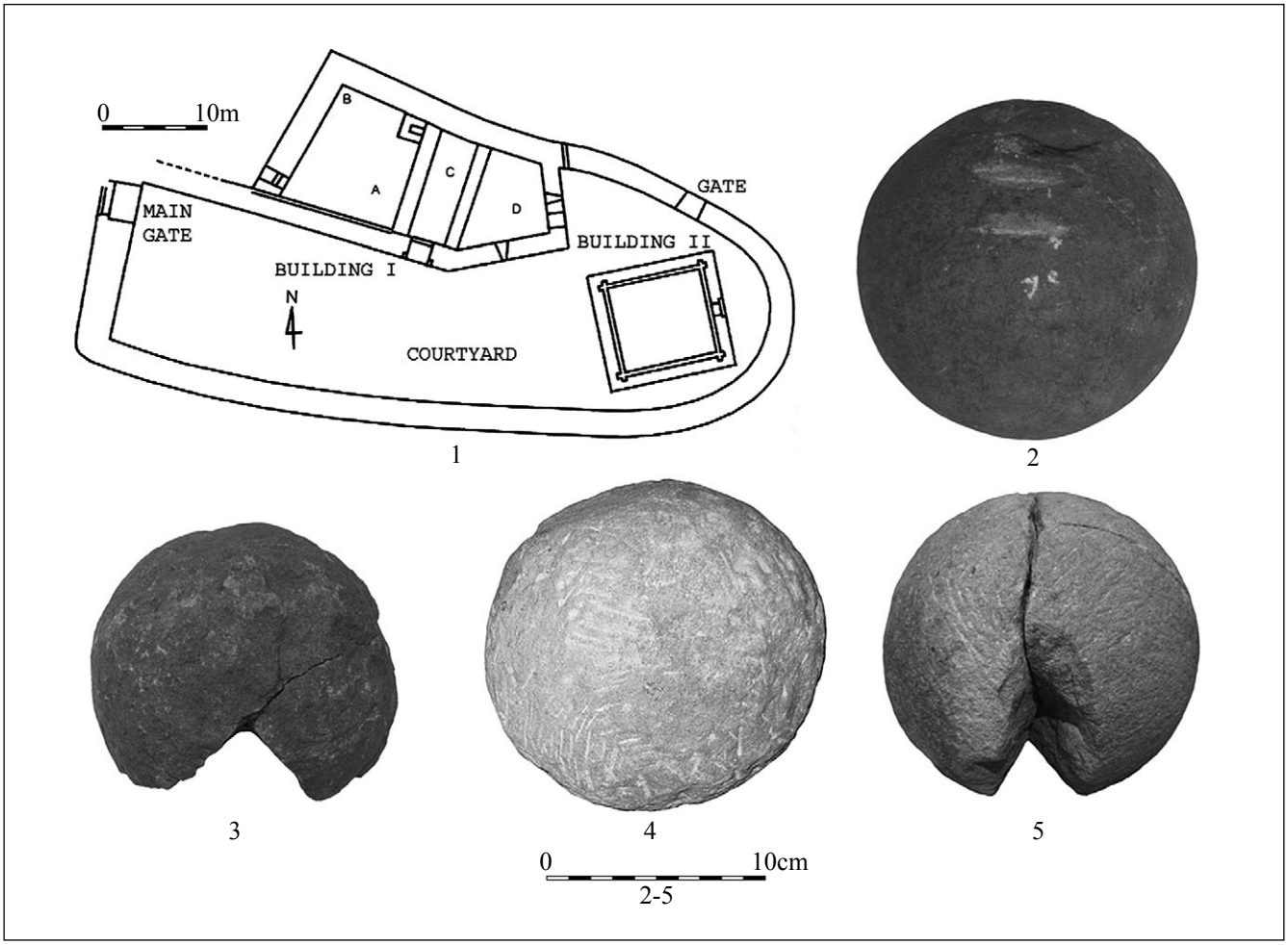

Fig. 6. 1 – Gniewoszów castle layout plan. After Marek 2008, Fig. 1; 2-5 – stone balls from Gniewoszów castle. Photo P. Strzyż (2-5).

Fig. 7. 1 – light field cannon (*houfnice*) from Kurzętnik, early 15th c.; 2 – light field cannon (*houfnice*) from Nový Bydžov, the 15th c. Photo G. Żabiński (1), P. Strzyż (2).

of besieging or defending troops. Another advantage is a chance of completing the information from written sources with new data, e.g., concerning the raw materials used for manufacture of projectiles, especially such ones as glass or clay. Examinations of ammunition also allow to define the technology of manufacture (forging, casting). Precise localisation of finds in the field can also help in defining the places with were bombarded with particular intensity during sieges, such as gates or defensive towers. By paying appropriate attention to these issues, we are able to better learn about medieval techniques of siege of fortified objects.

Sources

Annales – Joannis Dlugossi Annales seu cronicae incliti Regni Poloniae, liber X. Warszawa 1995.

Bibliography

Biskup M. 1967. *Trzynastoletnia wojna z Zakonem Krzyżackim 1454-1466*. Warszawa.

Chudzińska B. 2009. *Badania archeologiczne na zamku w Muszynie w roku 2008*. „Almanach Muszyny" 2009, 17-29.

Chudzińska B. 2011. *Pozostałości średniowiecznej ręcznej broni palnej z zamku w Muszynie*. „Acta Militaria Mediaevalia" 8, 203-215.

Drobná Z., Durdík J. 1975. *Jan Žižka z Trocnova demoktatické a bojové tradice našeho lidu. Výstava k 550. výročí smrti Jana Žižky z Trocnova*. Praha.

Durdík J. 1955. *Sztuka wojenna Husytów*. Warszawa.

Goetz D. 1985. *Die Anfänge der Artillerie*. Berlin.

Grünhagen C. 1872. *Hussitenkämpfe der Schlesier 1420-1435*. Breslau.

Haftka M. 1999. *Zamki krzyżackie w Polsce. Szkice z dziejów*. Malbork-Płock.

Iwańczak W. 2002. *Broń palna w wojsku czeskim późnego średniowiecza*. In: A. Rachuba, S. Górzyński, H. Manikowska (eds.), *Heraldyka i okolice*. Warszawa, 377-386.

Kajzer L., Kołodziejski S., Salm J. 2001. *Leksykon zamków w Polsce*. Warszawa.

Kruppé J., Milewska M. 1997. *Zamek pucki w badaniach archeologicznych 1991-1996*. „Kwartalnik Historii Kultury Materialnej" 45 (1), 43-59.

Maik J. 1997. *Military accesories from Bolesławiec on the Prosna*. „Fasciculi Archaeologiae Historica" 10, 19-39.

Marek L. 2008. *Medieval Armour from Szczeba Castle*. „Acta Militaria Mediaevalia" 4, 87-124.

Plewczyński M. 2005. *Wojny Jagiellonów z wschodnimi i południowymi sąsiadami Królestwa Polskiego w XV wieku*. Siedlce.

Poklewski T. 1979. *Dzieje Bolesławca nad Prosną*. Kalisz.

Smith R. D., Brown R. R. 1989. *Bombards Mons Meg and her sisters*. London.

Smith R. D., De Vries K. 2005. *The Artillery of the Dukes of Burgundy 1363-1477*. Suffolk.

Sperka J. 2003. *Wojny Władysława Jagiełły z księciem opolskim Władysławem (1391-1396)*. Cieszyn.

Strzyż P. 2007. *Artyleria Władysława Jagiełły w wojnie z Władysławem Opolczykiem (1391-1401)*. „Acta Militaria Mediaevalia" 3, 85-97.

Strzyż P. 2011. *Średniowieczna broń palna w Polsce. Studium archeologiczne*. Łódź.

Szymczak J. 2004. *Początki broni palnej w Polsce (1383-1533)*. Łódź.

Streszczenie

Archeologiczne ślady zastosowania broni palnej w oblężeniach. Wybrane przykłady z terytorium Polski

Jednym z komponentów militarnych działań w późnym średniowieczu była broń palna. Dla terytorium Polski pierwsza wzmianka dotycząca jej użycia pochodzi z roku 1383 i ma związek z oblężeniem Pyzdr. Od tego momentu liczba zdarzeń wojskowych z wykorzystaniem broni ogniowej szybko wzrasta. Przedmiotem niniejszego artykułu są wybrane oblężenia oświetlone źródłami pisanymi, jak również odkryciami archeologicznymi. Jako przykłady wybrano walki o Bolesławiec nad Prosną i Wieluń w latach 1391-1396 r., oblężenie Pucka w 1464 r., zdobycie Muszyny przez oddziały Macieja Korwina w 1474 r. oraz zniszczenie zamku Szczerba w Gniewoszowie przez wojska husyckie w 1428 r.

W każdym z wymienionych przypadków zwraca różnorodność zastosowanej broni ogniowej. W ruinach zamku w Bolesławcu nad Prosną znaleziono sześć pocisków o kalibrach: 15,2 cm, 26 cm, 29 cm, 31 cm i 44 cm. Najcięższe z nich ważą 104-108 kg. Z kolei kule z Wielunia, w łącznej liczbie 19 sztuk, mają kaliber od 44 do 48 cm. Pozwoliło to na stwierdzenie, że podczas oblężeń prócz lekkiej i średniej artylerii w użyciu były też bombardy, strzelające kulami do 50 cm średnicy. W Bolesławcu uchwycono w terenie pozostałości stanowiska artyleryjskiego, oddalonego 46 m od murów zamku, a 72-90 m od jego zabudowy.

Zupełnie odmiennie prezentują się pozostałości po zastosowaniu broni palnej w trakcie oblężenia Pucka przez wojska gdańszczan w 1464 r. W tym przypadku odnalezione kamienne pociski artyleryjskie mają kaliber od 5,5 do 13,5 cm, a jedyna kula z ołowiu ma średnicę 6,7 cm. Ponadto pozyskano liczny (48 sztuk) zbiór pochodzący z broni ręcznej, w tym okazy

szklane, ołowiane i kamienne. Pociski mają kaliber 1,3-1,8 cm. Na tej podstawie można stwierdzić, że stosowano głównie lżejsze rodzaje dział oraz broń ręczna pod postacią piszczeli i hakownic.

Badania archeologiczne na zamku w Muszynie, zniszczonym w 1474 r., dostarczyły zarówno zabytków amunicji do broni ręcznej i artylerii, jak i zniszczonych luf ręcznej broni palnej. Były to zarówno ciężkie hakownice o lufach żelaznych, jak i ich mniejsze odpowiedniki lane z brązu.

Wreszcie w przypadku śląskiego Gniewoszowa odkryta amunicja kamienna pozwala stwierdzić, że wojska husyckie zastosowały tutaj do celów oblężniczych działa polowe w rodzaju hufnic. Ich kaliber osiągał maksymalnie około 20 cm. Zatem potwierdza się niechęć husyckich wojskowych do używania w oblężeniach artylerii najcięższej (bombard), które były mało mobilne i opóźniały marsz armii.

Bazując na powyższych przykładach można z pewną dozą prawdopodobieństwa określić środki, które wykorzystywano do zdobycia twierdz. Ich zakres był każdorazowo dobierany indywidualnie i zależał nie tylko od rangi założenia, ale także od możliwości ostrzału z różnych kierunków.

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PIOTR STRZYŻ, PIOTR CZUBLA, ADAM MACKIEWICZ

CANNONBALLS FROM THE OLSZTYN TURRET

Abstract: This paper discusses an assemblage of artillery projectiles discovered in 2012 in the course of archaeological works in the basement of remains of the Medieval High Turret in Olsztyn (Masuria – north-eastern Poland). 113 cannonballs were found altogether, out of which 89 were made from erratic boulders, while the remaining ones were made from well-fired clay. Apart from a discussion on these finds, a analysis of stone raw material used for their manufacture was carried out. Furthermore, it was attempted at identifying types of cannons stored in this part of Olsztyn's fortifications.

Keywords: cannonballs, Middle Ages, Olsztyn, artillery, ceramic projectiles, rocks used in the production of ammunition

Introduction

Archaeological examinations carried out in the centre of Olsztyn (Allenstein), the Warmińsko-Mazurskie Voivodeship, in 2011-2012 resulted in documenting of remains of the High Turret, situated in the northern part of the Old Town. This site, provided with No. XXIV, was part of the Main Gate complex. This area was of strategic importance in the defensive system of the town's masonry walls. It was originally composed of the gate (the Main Gate) and its neck. They came into existence in the 2nd half of the 14th c., by virtue of a privilege issued by the Warmian Chapter in 1378[1]. In the 2nd half of the 15th c. this complex was enlarged with a defensive turret (the High Turret), which flanked the eastern corner of the premise. It is difficult now to precisely assess the time of construction of this turret. It is possible that it happened only after 1480[2]. In Trench 110 at the examined site of the High Turret, 113 cannonballs were found at the depth of c. 5 m. This assemblage included both stone and clay projectiles[3]. The assemblage from Olsztyn is exceptional for two reasons. First of all, it is one of few assemblages of projectiles in Poland which were found in the context of the room in which they were originally stored[4]. The other reason is a very rare and unique raw material – clay[5].

Stone cannonballs

The group of stone cannonballs includes 89 finds altogether. It is significant that it can be divided into four calibre groups only (Tab. 1). Diameters between 12.9 and 14.0 cm are the most numerous. There are 75 such finds, which is nearly 85% of the assemblage. Their weight is about 3.0-3.25 kg; however, due to a considerable degree of weathering of rocks or mechanical damage, lighter finds are also found. Other sizes are represented in a much more modest manner. Thus, there are only two missiles with calibres of 15.5-16.2 cm (their weight is 4.58-5.1 kg), and six finds are within the range of 10.5-11.6 cm (their weight is 1.77-2.01 kg). The last group are projectiles with diameters between 9.0 and 9.3 cm. It also includes six projectiles and their weight is from 0.94 to 1.09 kg.

Based on our hitherto research it can be said that in the territory of northern Poland (including the former State of the Teutonic Order) local erratic boulders were mainly used for the manufacture of cannonballs. Such rocks were selected which were most useful both with regard to their hardness and weight, possibilities of processing and expected ballistic properties. For this purpose, fine- and medium-grained granitoids were most often used, while granite-gneisses and limestones were less common. Coarse-grained rocks were less often used, and chiefly for the manufacture of large-calibre cannonballs. However, in periods of difficult availability of raw materials, these less useful rock types were also made use of[6].

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[1] Kaczyński and Mackiewicz 2014, 5.

[2] Wojciechowska-Grygo 2014, 38; Lewicka 2014, 51, Fig. 3B.

[3] This paper discusses 113 stone and clay finds altogether. However, preliminary press reports mentioned about 120 stone and 20 clay projectiles.

[4] The following assemblages are of similar nature: 88 stone cannonballs found in the cellar at the castle of Bishops of Warmia in Reszel, as well as 80 projectiles from the ruins of the Town Hall in Elbląg, cf. Strzyż 2007; Strzyż 2011, 115-117.

[5] So far, the only reasonably certain finds of Medieval clay ammunition for artillery in Poland have been known from Jemiołowo, the Warmińsko-Mazurskie Voivodeship, and from Chojnice, the Kujawsko-Pomorskie Voivodeship, cf. Strzyż 2011, 55, 95-96, 100, Pls. XLII: 5-7.

[6] Cf. Czubla and Strzyż 2013; Czubla and Strzyż, forthcoming.

Calibre	Granitoids	Syenitoids	Granite--gneisses	Gneisses	Pegma-tites*	Porphyries	Diabases	Sedimen-tary rocks	Fired clay	Total
9,0-9,3 cm	5	-	-	-	1	-	-	-	-	6
10,5-11,6 cm	4	-	2	-	-	-	-	-	5	11
12,9-14,0 cm	64	1	2	2	5	-	1	-	19	94
15,5-16,2 cm	1	-	1	-	-	-	-	-	-	2
Total	74	1	5	2	6	0	1	0	24	113

*This category includes cannonballs made from granitoids with pegmatite veins. It was nearly impossible to make a cannonball solely from pegmatite, as pegmatite veins very hardly form erratic boulders. Their technological properties (resulting from coarse-grained and often miarolitic texture) render intentional processing very difficult.

Tab. 1. Raw materials used for the manufacture of the cannonballs found at Olsztyn. By P. Czubla.

In the assemblage from Olsztyn there is a preponderance of granitoids as a raw material for the manufacture of cannonballs. Out of the total number of 89 stone projectiles, 74 cannonballs were made from such rocks (Tab. 1). They represent all four calibres which were identified. Within this group, it was possible to identify a number of typical granitoids of Scandinavian provenance, e.g., Aland rapakivi granites, Sala, Uppsala, or Siljan granites (Fig. 1:f; 2:a, e). On the other hand, these rocks were probably gathered in Olsztyn or in its closest neighbourhood as erratics brought from Scandinavia by the latest glaciation. It is not entirely clear why in the manufacture of cannonballs preserved at Olsztyn coarse-grained rocks were used relatively often. Such rocks – both granitoids (Fig. 1:e; 2:b-d, f) and pegmatites (Fig. 1: e; 2:c, g) were not very useful raw materials. Their share is as much as 17% in the group of stone projectiles with calibres of 12.9-14.0 cm. Coarse-grained raw material was used even for the manufacture of the smallest projectiles in the assemblage (9.0-9.3 cm), but a very low number of cannonballs of this calibre does not allow for drawing credible conclusions. Coarse-grained texture, and in the case of pegmatites also miarolitic (porous) texture, renders precise processing very difficult. In the course of work it often occurred that bits of raw material flaked off along cleavage planes of minerals, most frequently micas or feldspars. Falling away of part of a crystal with the total size of a few millimetres (in medium-grained texture the average size of grains does not exceed 5 mm[7]) had virtually no influence on the shape of the final product. However, in the case of crystals with the size of one centimetre or more, it could come to considerable and undesirable subsidence on the surface of the processed cannonball. Processing of rocks with miarolitic texture is even more difficult. It is because in the course of work cavities in the rock lead to cracking and falling of material into pieces. There was also a risk that even if a properly shaped product was formed from such raw material, it would fall into pieces after firing the gunpowder charge. Until present day pegmatites with miarolitic texture which occur in granitoid massifs are treated as waste during extraction of ashlar stone. An exceptional case is a cannonball cut from pegmatite containing spangles of biotite which are a few centimetres long (Fig. 2:c). It was possible to manufacture a reasonably processed cannonball from such rock only due to the fact that large crystals of biotite were distributed in a chaotic manner and there were no cavities in the compact (massive) structure.

In the analysed assemblage cannonballs which were made from raw materials with evident directional structure (granite-gneisses and gneisses) were also identified (Fig. 1:b, c). They occur rarely, which seems to be obvious, as such rocks easily decompose into pieces along foliation planes. It is easy to manufacture flat, plate-like artefacts from them. On the other hand, it is possible to make a ball only if the directional structure is feebly pronounced and the rock contains few micas (these are usually biotite and muscovite). A granite-gneiss boulder was used to cut a partially preserved cannonball with the diameter of 13.5 cm (Fig. 1:b). In spite of the low content of biotite, one can anyway see cracks in it, along which it will come to further decomposition of the artefact.

A fragment of a cannonball made from syenitoid is a single find. On the one hand, it is not as hard as granitoids (this results from a much lower content of quartz in syenitoids). On the other hand, it is certainly much more mechanically resistant than sandstones and limestones. This means that it was not technological properties which prevented this rock from being used for the manufacture of artillery projectiles. The reason is much simpler – syenitoids occupy only small areas in Fennoscandia and mainly in western Sweden and Norway[8]. Due to this, they are rather rarely found as erratics in the territory of the Central European Plain, with special reference to its eastern part, where raw materials for the manufacture of the cannonballs from the discussed assemblage were gathered. It must be also remembered that syenitoids weather at a faster pace than granitoids. Therefore, in a majority of cases they may have been rejected by stone-cutters already at the stage of

[7] Czubla et al. 2009, 67.

[8] Smed 2002, 152-155.

Fig. 1. Olsztyn, the High Turret, stone cannonballs: a. diabase; b. gneiss with layers of biotite, evident directional texture and cracks appearing along laminas with biotite; c. fine-grained (phaneritic) granite-gneiss, rich in biotite; d. coarse-grained Uthammar granite with large potassium feldspars; e. leucocratic granitoid with feldspar pegmatite, strongly weathered; f. strongly weathered Sala granite. A-f Photo P. Czubla and P. Strzyż.

Fig. 2. Olsztyn, the High Turret, stone cannonballs: a. Aland rapakivi granite b. red Scandinavian granitoid; c. weathered granitoid with pegmatite (almost only feldspars and biotite); d. fine-grained (phaneritic) granitoid; e. Siljan rapakivi granite; f. fine-grained (phaneritic) granitoid; g. pegmatite with large sheet-shaped crystals of biotite. A-f Photo P. Czubla and P. Strzyż.

preliminary selection of material as completely useless for further processing.

Diabase, which is heavy and very hard rock, seems to be an ideal raw material for making of projectiles. In spite of potentially very good technological properties, diabases were rarely used for the manufacture of ammunition. The most probable reason behind it is their sporadic occurrence in Pleistocene sediments[9] and generally small sizes of erratics composed of this rock. It must be also remembered that it was certainly worth spending a couple of working days in order to make a high-quality diabase axe which would be used for many years. However, using the same raw material for labour-consuming manufacture of a projectile which would in all probability be used only once was hardly rational. In the assemblage from Olsztyn there was only one projectile made from the discussed rock (Fig. 1:a). It is worth stressing that its diameter is 13.5 cm and it weights as much as 3.81 kg. In comparison with the same artefacts made from granitoid (which weight up to 3.25 kg), the difference is nearly 20%.

In contrast to many assemblages of stone projectiles from Northern Poland[10], in the course of examinations of the High Turret in Olsztyn no cannonballs made from sedimentary rocks were found. It is especially astonishing in the context of confirmed manufacture of clay ammunition, which had much worse combat properties than artefacts made from limestones or sandstones. Even if not the town itself, its closest neighbourhood was certainly abundant in various kinds of erratic rocks – not only granitoids, syenitoids, granite-gneisses and gneisses, but also sandstones, dolomites and limestones. This means that sedimentary rocks must have been intentionally rejected by stone-cutters in Olsztyn. A question should therefore be asked whether stone projectiles and fired clay projectiles were manufactured at the same time. The manufacture of projectiles from sedimentary rocks was much less time- and labour-consuming than from igneous rocks, and ballistic properties of such projectiles were much better than those made from clay. It seems that if clay projectiles had been a cheaper substitute of stone projectiles, sedimentary rocks would have been used first, and then one would have made use of clay. However, it was not done so, which is evidenced by a complete absence of sedimentary rock projectiles in the discussed assemblage.

Clay cannonballs

The assemblage of clay ammunition is 24 cannonballs altogether. They survived either in whole or in smaller or larger fragments (Fig. 3:a-j). What is important here is that also in this case there are small differences with regard to their size. Finds with diameters between 13.1 and 13.5 cm dominate within the assemblage (Fig. 3:a-g). There are 13 intact projectiles of this kind and a few which partially survived. Their weight oscillates between 2.15 and 2.42 kg. This means that the difference in weight between clay and granite projectiles of similar calibre is about 0.8-1.0 kg in favour of the latter (clay cannonballs are approximately 30% lighter than those made from igneous rocks). Regrettably, among clay cannonballs of smaller calibre only one survived intact, while the remaining ones are preserved in fragments. In a majority of cases their diameters are 10.5-10.7 cm (Fig. 3:h-j). The weight of these remains oscillates between 0.53 and 0.63 kg. Therefore, the weight of complete artefacts may have been about 1.2-1.3 kg. Comparing the weight of stone and clay cannonballs within this calibre group, we find a difference of about 0.57-0.71 kg.

While analysing the technology of manufacture of these clay projectiles, their high quality and careful manufacture must be underlined. The cannonballs are ideally regular and their surfaces are smooth. It is probable that before firing their surfaces were smoothened or covered with clay mass mixed with water. Based on surviving fractures it can be said that the clay was leaned in the same way as for pottery manufacture. In this case, admixture of sand with 1-2 mm fraction was used. Projectiles made in this way were fired in oxidising atmosphere, which is evidenced by fractures which have intensive brick colour (Fig. 3:b, e). The final result were artefacts of excellent quality and high hardness. It must be stressed that clay cannonballs are the best indicator of calibres of municipal artillery, as they were probably best adjusted to bore diameters and it was hardly possible to use them more than once.

A purposefulness of manufacturing of cannonballs from such raw material as clay should also be discussed. There is no doubt that financial savings were a significant advantage, as such projectiles were cheaper than their stone equivalents. As such cannonballs were lighter than those made from stone, it is probable that smaller (weaker) gunpowder charge was needed to launch them, which caused further savings. The fact that clay ammunition caused less damage to the bore of the barrel than stone projectiles did may have also been taken into consideration. On the other hand, the range of applications of clay ammunition was limited. Apart from fighting the adversary's manpower, clay projectiles could be only used to practice shooting. Due to their fragility they were certainly useless against fortifications or residential buildings.

It should also be noted that both calibre groups of clay cannonballs match the size of stone projectiles. A conclusion can therefore be drawn that both kinds of stored cannonballs were meant to be used for the same cannons. Based on the diameters of surviving projectiles only four calibre groups can be isolated. The first one would encompass barrels designed for ammunition with the calibre of about 16 cm. There are only two finds of that kind.

[9] Cf. Schulz 2003, 176-186; Rudolph 2008, 120-123; Chachlikowski 2013, 25-27; Czubla 2015, 147, 154, 206, 207.

[10] Cf. Czubla and Strzyż 2013, 103-105; Woźniak 2014, 387-389.

Fig. 3. Olsztyn, the High Turret, a-j: clay cannonballs and their fractures/cross-sections. Photo P. Strzyż.

With regard to its numerical strength, the best represented group is the ammunition with calibres between 12.9 and 14 cm. It can be assumed that it was designed to be used for several different cannons. This group includes as much as 85% of the entire assemblage. The next group, represented by both types of raw materials, was designed for barrels with calibres of 11.5-12 cm. Finally, the last group encompasses projectiles for the lightest cannons with calibres of 9.5-10 cm. However, discovered projectiles for such cannons were made from stone only. Both the circumstances of the discovery and the calibre assortment itself demonstrate that it was a municipal arsenal and it was probably prepared in advance in the times of peace. The closest vicinity of the Old Town in Olsztyn and the town itself were erected mainly on glacial tills of the Pomeranian Phase of the Vistulian Glaciation and only in a small part on outwash sands

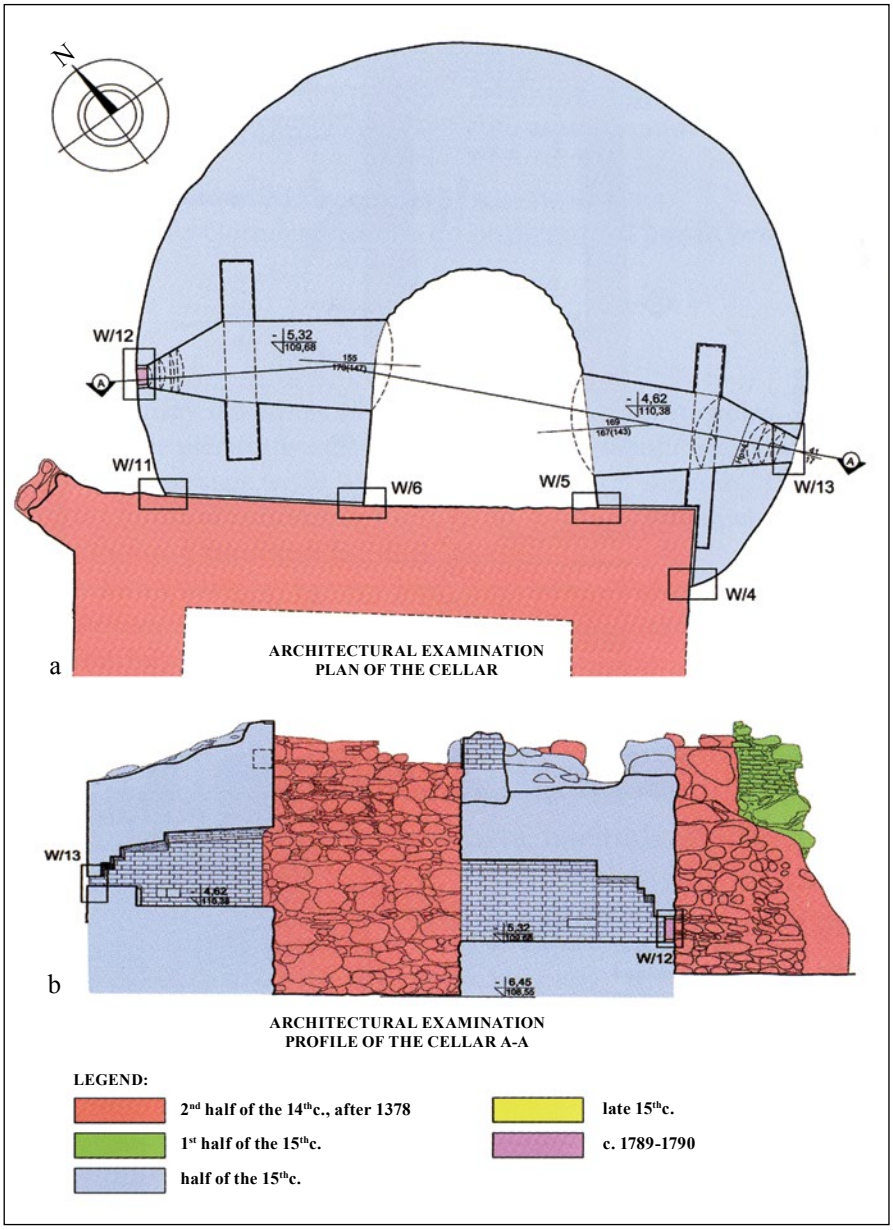

Fig. 4. Olsztyn, the High Turret: a. projection of the remains of the turret with marked embrasures, b. cross-section through the remains of the turret and the embrasures. After Wojciechowska-Grygo 2014, Fig. 11, 14.

and gravels[11]. This means that there should be no problems here with access to granitoid erratic boulders for cannonball manufacture. As a matter of fact, it cannot be excluded that all boulders had been picked and used for construction of fortifications, foundations and masonry walls before artillery went into use. On the other hand, this hypothesis does not seem to be very probable.

Artillery in the High Turret

After the removal of rubble, two embrasures were discovered in the remains of the High Turret. Their loopholes were bricked up in a later period (Fig. 4). A niche situated on the S-E side is 1.6 m wide and 1.8 m high. On the N-W side the embrasure was 1.6 m wide and 1.7 m high. Loopholes of both posts have the same dimensions: their width is 0.3 m and their height is 0.5 m. What is worth stressing is the presence of anti-ricochet walls and openings used to fix beams which supported barrels of cannons or hand-held siege defense firearms (Fig. 5). Obviously, we cannot be certain for what cannons the embrasures discovered in the basement were intended. It seems that in this case, due to their narrow openings, one can take into consideration either heavy siege defense hackbuts (with the calibre of 2-3 cm) or lighter cannons, such as terrace-guns or veuglaires[12]. In this particular case, due to the fact that the basement of the turret was situated below the foreground, these embrasures could be used only to conduct fire on the level of moats[13]. It is anyway obvious that the discovered assemblage of ammunition was a stock for firearms deployed in the entire turret. On the basis of archaeological-architectural research the original structure of the High

[11] Rumiński 1996.

[12] Cf. Szymczak 2004; Strzyż 2014.

[13] Lewicka 2014, 51; Wojciechowska-Grygo 2014, 33..

Fig. 5. Olsztyn, the High Turret. Shooting niche, arrows mark openings for beams supporting firearms. After Kaczyński and Mackiewicz 2014, Fig. 20.

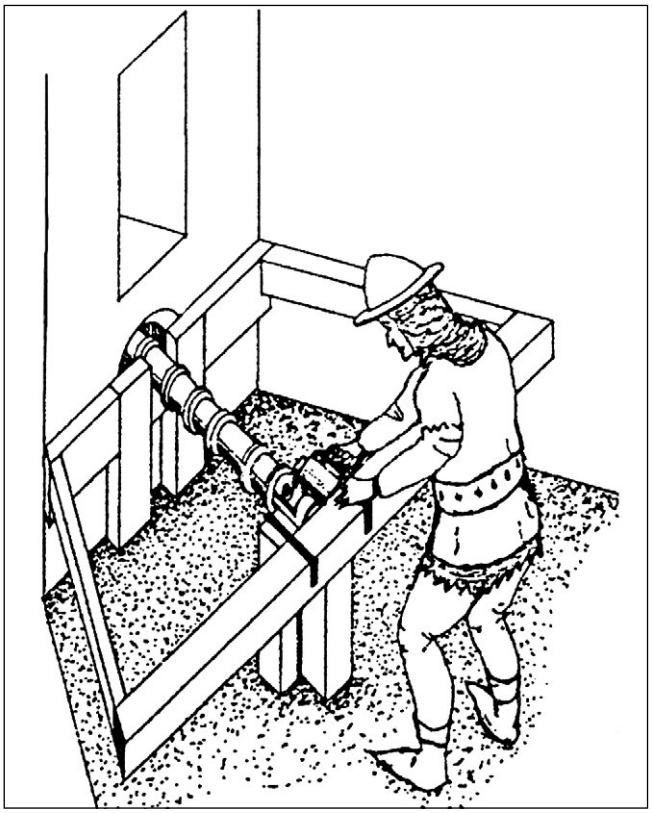

Fig. 6. Veuglaire post at the castle, re-construction. After Varhaník 2002, Fig. 9.

Turret is re-constructed as composed of a basement with a cellar, a ground floor and four utility storeys[14].

On each such level there may have been other embrasures, where cannons protecting the area of the High Gate were deployed. In all probability, projectiles were originally stored on subsequent usage levels, or, what is more doubtful, they were all kept in the basement. Clear traces of smoke-blackening, which are especially notable on smaller clay projectiles (Fig. 3:h-j), but also on some finds of stone cannonballs (Fig. 2:f), allow to suppose that their joint deposition may have been a result of fire, which caused loaded ceilings to collapse into the cellar. However, we are not able to offer a more precise chronology of these events. On account of the fact of long storing of stone ammunition[15], it cannot be excluded that these may have even been events from 1622 or 1657[16]. Dismantlement of the turret in the late 18th c. may have been another circumstance of their deposition into the ceiling[17].

It can be also discussed to what kind of artillery the projectiles found in the ruins of the turret were designed. There is no data on stores of hand-held firearms and no find of ammunition could be classified in this way. The calibres of the cannonballs fitting into the range between 9.5-10 and 15.5-16 cm allow to say that this was generally light artillery. Terrace-guns and veuglaires are especially relevant here. The former are defined in the literature as slender, rather long (up to c. 1 m) barrels with calibres from 4 to 10 cm. They were usually deployed in terraces, where they were fixed on wooden trestles. This did not exclude a possibility to use them inside rooms[18]. Another kind of light artillery which deserves a more detailed discussion here are veuglaires, or cannons with interchangeable powder chambers. With regard to their construction and parameters they were very similar to terrace-guns, but their calibre was often 15 cm or more. The mentioned interchangeable chambers significantly facilitated the use of such cannons, especially bearing in mind the lack of space in embrasures in turrets and towers (Fig. 6). This was chiefly influenced by the fact that after firing it was not necessary to withdraw the entire cannon in order to charge it again. Instead of it, it was only necessary to replace the powder chamber and load the projectile[19].

Conclusions

The projectiles from the High Turret in Olsztyn are one of few assemblages of ammunition in Poland which can be considered as remains of municipal artillery. In the discussed case there were four calibre groups of cannons which protected this part of Olsztyn's fortifications. It is especially worth underlining that the projectiles of such cannons were made both from stone and from clay. In the case of stone cannonballs stone-cutters preferred igneous equal-grained (medium- and fine-grained) rocks, mainly granitoids. Syenitoids and diabases were used sporadically. There are no clear reasons behind the use

[14] Wojciechowska-Grygo 2014, 34, Fig. 7.

[15] Cf. Strzyż 2011, 63-64.

[16] Wojciechowska-Grygo 2014, 26. It came to a deposition of projectiles in the tower of the castle in Reszel in a similar way, when loaded ceilings collapsed into the cellar, cf. Strzyż 2007, 461-462.

[17] Wojciechowska-Grygo 2014, 30.

[18] Szymczak 2004, 53-54; Strzyż 2014, 72.

[19] Szymczak 2004, 55-56; Strzyż 2014, 92-93.

of coarse-grained rocks, including pegmatites with much worse technological properties, for the manufacture of cannonballs in Olsztyn. Furthermore, all sedimentary rocks were completely omitted, in spite of the fact that the manufacture of fired clay projectiles (perhaps in a later period) was undertaken. The latter are remarkable for their very high quality and they are the most homogeneous with regard to their calibres. It is also the first assemblage in Poland which contains such a great number of cannonballs of this kind.

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Bibliography

Chachlikowski P. 2013. *Surowce eratyczne w kamieniarstwie społeczeństw wczesnoagrarnych Niżu Polskiego (IV-III tys. przed Chr.)*. Poznań.

Czubla P. 2015. *Eratyki fennoskandzkie w osadach glacjalnych Polski i ich znaczenie badawcze*. Łódź.

Czubla P., Mizerski W., Świerczewska-Gładysz E. 2009. *Przewodnik do ćwiczeń z geologii*. Warszawa.

Czubla P., Strzyż P. 2013. *Rock materials in the manufacture of cannonballs in Poland – selected examples*. „Fasciculi Archaeologiae Historicae" 26, 99-109.

Czubla P., Strzyż P. in print. *Surowce skalne w produkcji amunicji artyleryjskiej na terenie Zakonu Krzyżackiego w Prusach*. „Prace i Materiały Muzeum Archeologicznego i Etnograficznego w Łodzi, Seria archeologiczna" 46.

Kaczyński B., Mackiewicz A. 2014. *Badania archeologiczne przedbramia Bramy Górnej w Olsztynie*. „Olsztyński Rocznik Konserwatorski" 2014, 5-24.

Lewicka L.L. 2014. *Konserwatorski i utylitarny aspekt odsłoniętych w 2012 r. zewnętrznych budowli Bramy Górnej w Olsztynie*. „Olsztyński Rocznik Konserwatorski" 2014, 43-67.

Rudolph F. 2008. *Noch mehr Strandsteine; Sammeln & Bestimmen von Steinen an der Nord- und Ostseeküste*. Neumünster.

Rumiński J. 1996. *Szczegółowa Mapa Geologiczna Polski, ark. 175 Olsztyn*. Warszawa.

Schulz W. 2003. *Geologischer Führer für den norddeutschen Geschiebesammler*. Schwerin.

Smed P. 2002. *Steine aus dem Norden: Geschiebe als Zeugen der Eiszeit in Norddeutschland*. Berlin, Stuttgart.

Strzyż P. 2007. *Zespół kamiennych kul działowych z zamku w Reszlu*. „Komunikaty Mazursko-Warmińskie" 4 (258), 461-471.

Strzyż P. 2011. *Średniowieczna broń palna w Polsce. Studium archeologiczne*. Łódź.

Strzyż P. 2014. *Broń palna w Europie Środkowej w XIV-XV w.* Łódź.

Szymczak J. 2004. *Początki broni palnej w Polsce (1383-1533)*. Łódź.

Wojciechowska-Grygo A. 2014. *Badania architektoniczne reliktów zespołu przedbramia Bramy Górnej w Olsztynie*. „Olsztyński Rocznik Konserwatorski" 2014, 25-41.

Woźniak P.P. 2014. *Stone cannonballs recovered from the Copper Ship – analysis of the materials and surface features*. In: Ossowski W. (ed.), *The Copper Ship – A Medieval Shipwreck and its Cargo*. Gdańsk, 387-392.

Streszczenie

Kule z olsztyńskiej baszty

Podczas badań reliktów Baszty Wysokiej, położonej w północnej części Starego Miasta w Olsztynie (Mazury), w jej piwnicy znaleziono 113 kul kamiennych i glinianych do dział. Amunicję kamienną stanowi łącznie 89 egzemplarzy. Najliczniej reprezentowane są średnice od 12,9 do 14,0 cm. Łącznie jest ich 75 sztuk. Ich waga mieści się w granicach 3,0-3,25 kg. Mniej jest pocisków innej wielkości: dwa mają kaliber 15,5-16,2 cm (waga 4,58-5,1 kg), a w przedziale 10,5-11,6 cm znalazło się sześć egzemplarzy o ciężarze 1,77-2,01 kg; odkryto także sześć kul o średnicy 9,0-9,3 cm, o wadze od 0,94 do 1,09 kg.

Jako surowca do wyrobu kul kamiennych użyto przede wszystkim granitoidów (74 pociski spośród ogółem 89 kamiennych). W tej grupie udało się oznaczyć szereg typowych granitoidów pochodzenia skandynawskiego, np. alandzkie granity rapakiwi, granity Sala, Uppsala czy Siljan. Skały te zostały zapewne zebrane w Olsztynie lub okolicach jako eratyki przywleczone przez ostatnie zlodowacenie ze Skandynawii. Dość często korzystano także ze stosunkowo mało przydatnych skał grubokrystalicznych: granitoidów i pegmatytów. Ich grubokrystaliczna tekstura, a w przypadku pegmatytów często również miarolityczna (porowata), bardzo utrudniała precyzyjną obróbkę. W analizowanym zbiorze rozpoznano również

kule wykonane z surowców o wyraźnej teksturze kierunkowej – granitognejsów i gnejsów. Jednostkowe znaleziska stanowią kule zrobione z diabazu oraz syenitoidu.

Amunicja gliniana to łącznie 24 kule zachowane w całości oraz w mniejszych lub większych fragmentach. Dominują wśród nich egzemplarze o średnicy mieszczącej się w przedziale 13,1-13,5 cm i wadze od 2,15 do 2,42 kg. Mniejsze kalibrowo fragmenty kul glinianych mają średnicę 10,5-10,7 cm, a w całości mogły osiągać ciężar do 1,2-1,3 kg. Należy podkreślić wysoką jakość i staranność ich produkcji: są one idealnie foremne, a ich powierzchnia jest gładka.

Kule z Baszty Wysokiej w Olsztynie są jednym z nielicznych w Polsce zespołów amunicji, które można uznać za pozostałości artylerii miejskiej. Na szczególną uwagę zasługuje odkrycie amunicji wykonanej z wypalanej gliny – jest to pierwszy w Polsce tak liczny zbiór tego rodzaju pocisków do dział.