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ARTILLERY PROJECTILES FROM THE TWO BATTLES OF ZORNDORF/SARBINOWO (1758) AND KUNERSDORF/KUNOWICE (1759)

The Seven Years' War was one of the most significant conflicts of the 18th century. It is commonly considered to be the first conflict in which battles were fought on several continents apart from Europe – in North America and Asia (India).

Nevertheless, the main theatre of the war was Europe, and its central part in particular. The highest number of war events took place in Silesia and Bohemia, where the Prussian and Austrian armies clashed. The areas located to the north from Silesia were not seriously affected by the war – in the Neumark and Pomerania only a few sieges, including three in Kolberg (Kołobrzeg), took place, as well as several dozen skirmishes and only three major battles – at Zorndorf (Sarbinowo, zachodniopomorskie voivodship), Kay (Kije, lubuskie voivodship) and Kunersdorf (Kunowice, lubuskie voivodship) (Fig. 1). In all three of them, the Prussian and Russian armies fought each other, while in the battle of Kunersdorf the Russians were additionally aided by the Austrian troops.

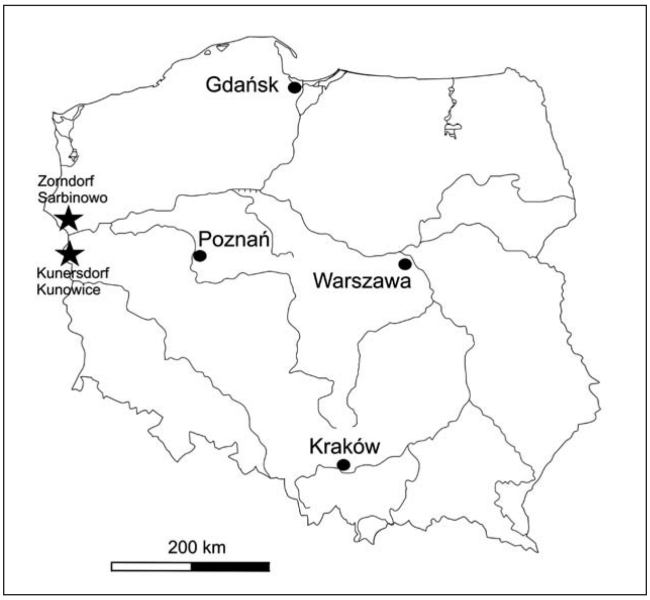

Fig. 1. Location of Kunowice (Kunersdorf), lubuskie voivodship and Sarbinowo (Zorndorf), zachodniopomorskie voivodship .

The battles of that period were mainly fought by infantry. Other weapons, including cavalry and artillery were definitely of less importance. However, the role of artillery increased continuously, which was enabled by constant organisational and technological progress. New and improved cannons were introduced in the army arsenals and skills for their more effective use were developed. The examples of such technological advances were the Russian artillery inventions – unicorns and secret howitzers constructed by an artillery commander, general Peter Shuvalov. On the other hand, an example of the organisational progress was the establishment of the first horse artillery unit in the Prussian army in 1759, thanks to which artillery became a more mobile weapon[1].

In the times of the Seven Years' War the artillery equipment of an army included two basic types of weapons: long-barrel cannons, with a flat trajectory, and shorter howitzers, with a high arcing trajectory.

The third type of cannons – mortars – were basically used in sieges, while they very rarely appeared on the battlefields. The cannons fired roundshots and canister shots. The howitzers fired both canister shots and common shells.

During the Seven Years' War, the Prussian army used three-pounders (cannon calibre – 73,2 mm, ball diameter – 71,9 mm), six-pounders (cannon calibre – 94,2 mm, ball diameter – 90,6 mm), twelve-pounders (cannon calibre – 119 mm, ball diameter – 114 mm) and twenty-four-pounders (cannon calibre – 149,9 mm, ball diameter – 143,9 mm), as well as 7-pound howitzers (cannon calibre – 150 mm, ball diameter – 143,9 mm) and 10-pound howitzers (cannon calibre 172,6 mm, ball diameter 166,3 mm)[2].

The Russian artillery used three-, six- and eight-pound cannons (ball diameter – 105 mm) as well as twelve-, eighteen- and twenty-four-pound cannons and half- and one-pud howitzers[3]. In addition, the Russians had special cannons at their disposal: so called Shuvalov secret howitzers and unicorns. The first type was a howitzer marked

[1] Ch. Duffy, *Friedrich der Grosse und seine Armee*, Stuttgart 1978, p. 165.

[2] W. Gohlke, *Geschichte der gesamten Feuerwaffen bis 1850*, Leipzig 1911, pp. 92-93.

[3] Ch. Duffy, *Russia's Military Way to the West: Origins and Nature of Russian Military Power 1700-1800*, London 1981, p. 68.

by an unusual, oval shape of the barrel with a funnel-like muzzle. The shape of the barrel was designed to increase the effectiveness of canister shots, which, when fired, were to take the shape of a flattened cloud in order to hit the enemy's infantry more efficiently.

The secret howitzer was invented just before the war by count Peter Shuvalov and the battle of Zorndorf was its first real battlefield test. The first battle revealed the construction defects – the unusual shape of the barrel made it incredibly difficult and slow to reload. Moreover, due to their elongated and flattened form, adjusted to the shape of the barrel, the howitzer shells were very inaccurate and their shot range was limited[4].

The unicorns, also designed and introduced by count Shuvalov (the name unicorn originated from his coat of arms – the unicorn), proved to be a much better weapon, which could fire both roundshots and shells or canister shots. The unicorns came in different sizes: 8-pound, 1/4-pud (cannon calibre – 122.9 mm, ball diameter – 120.9[5]), 1/2-pud (cannon calibre – 154.9 mm, ball diameter – 152.4 mm[6]), 1- and 2-pud ones. They were shorter than usual cannons and, in consequence, lighter and easier to operate on the battlefield. In addition, thanks to the possibility to fire roundshots, they could be used for the same purposes as heavier cannons. They were, however, less accurate[7].

Both armies divided their cannons into those which accompanied the infantry on the battlefield and battery cannons. In the Russian army, 3-pound cannons served as regiment cannons, while the Prussian army used 3- and 6-pound battalion cannons. These cannons were moved along with the infantry formation, and they could be usually found beside each battalion (regiment), firing canister shots at the enemy's line. Heavy cannons were used in an entirely different way. They were usually arranged in serried batteries, which fired on the enemy from a distance using roundshots or shells. The aim of the fire was either to defeat the enemy artillery or to hit the enemy infantry, trying to fire on it from a flank in order to increase the killing field[8].

The firing technique was an important factor. When firing using canister shots, the shell, consisting of many smaller balls, dispersed after leaving the barrel, which resulted in a cloud of balls flying in the air, becoming less and less dense along with the increasing distance from the cannon. Roundshots were fired using so called direct fire (the ball moved at a low height parallel to the ground) or by ricochet fire (the bullet bounced against the ground and "somersaulted"). In both cases, the balls landed on the ground after losing speed.

The shell fire was used at longer distances. The howitzers were less accurate but they compensated for it with a wider shot range – an exploding shell hit many targets with its fragments.

In the battle of Zorndorf, the Prussians deployed over 30 thousand soldiers, 114 heavy cannons including 85 twelve-pounders, 2 twenty-four-pounders, 1 ten-pound howitzer and 29 seven-pound howitzers, as well as 76 regiment/battalion cannons. In the same battle, the Russians had at their disposal a 50-thousand-men army, 18 two-pud unicorns and 220 reserve cannons.

In the battle of Kunersdorf, the Prussian army deployed 43 thousand soldiers, 126 regiment/battalion cannons and 114 heavy cannons (94 twelve-pounders and 20 ten-pound howitzers). The Russians, together with the Austrian troops, formed an army counting about 60 thousand soldiers, which had 114 regiment/battalion cannons and 186 heavy cannons[9].

Although the artillery played a significant role in both battles, its impact was greater in the battle of Kunersdorf. At first, the intensive firing by three Prussian batteries allowed for an easy defeat of the Russian soldiers on the eastern edge of the battlefield. In the later stage of the battle, the Russian artillery first drove the Prussian cavalry from the area of Spitzberg, and then largely contributed to repelling the attack of the Prussian infantry in the centre of the battlefield.

123 artefacts of different types related to artillery ammunition were analysed. 21 of them belong to museum collections (the Jan Dekert Museum in Gorzów Wielkopolski and the Regional Centre for Tradition in Witnica), while 102 were found during the archaeological research conducted in the area of both battlefields in the years 2008 – 2012. The items found during the research have their specific localization determined using the GPS system, while the museum items were incidentally found on the Zorndorf battlefield, and their exact finding place is not known. In connection with the above, the authors decided that this article will not contain the analysis of the distribution of projectiles and their fragments, but it will attempt to identify and determine which projectiles were used by which party in the conflict.

The findings can be divided into the following categories: roundshots (7 pieces), common shells and their fragments (4 common shells and 14 fragments) and canister balls (100 pieces).

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[4] J.G. Tielke, *An Account of some of the most remarkable events of the war between the Prussians, Austrians and Russians*, Vol. II, London 1788, pp. 39-43.

[5] R. Bochenek, *Twierdza Jasna Góra*, Warszawa 1997, p. 176.

[6] *Ibidem*, p. 225.

[7] R. Bochenek, *op. cit.*, p. 175; J.G. Tielke, *op. cit.*, p.38.

[8] Ch. Duffy, *Friedrich der Grosse...*, p. 178.

[9] C. von Decker, *Die Schlachten und Hauptgefechte des siebejähriegen Krieges*, Berlin 1839, pp. 213-214.

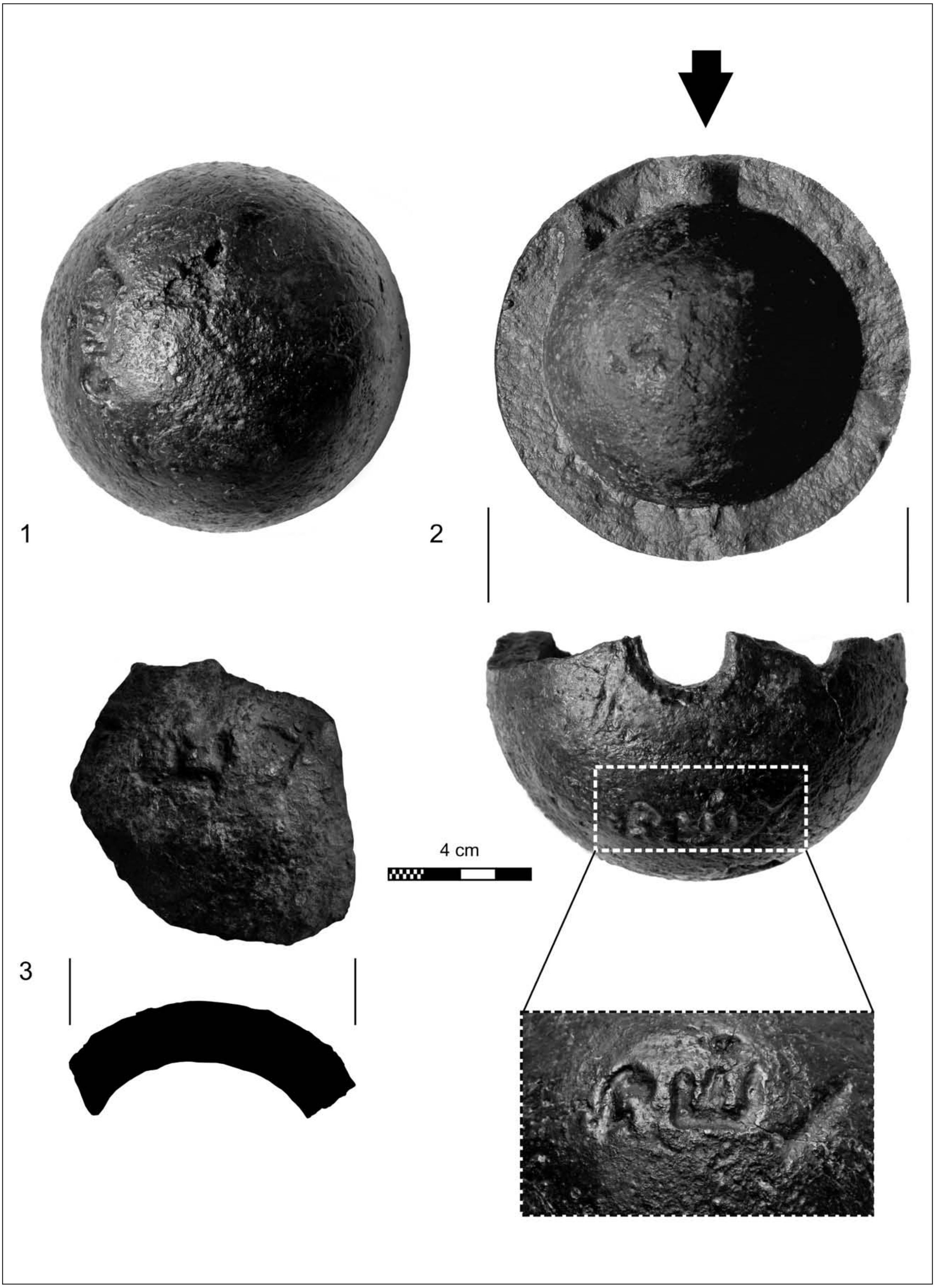

Fig. 2. A cannonball and fragments of common shells. 1 – ball fired by the 12-pound cannon (Zorndorf); 2 – shell fragment from the ¼-pud unicorn (Zorndorf); 3 – shell fragment from the ½-pud unicorn (Kunersdorf). Directional arrow shows a fuse hole. (Photo by P. Kobek).

Fig. 3. Shell with a wooden fuse and a hempen lining fired by the ¼-pud unicorn (Kunersdorf). (Photo by P. Kobek).

The size and weight of the balls should be taken with certain approximation, especially in the case of iron balls as both these parameters are affected by decay due to corrosion.

Roundshots

7 shots were included in this category. The three smallest ones are 79 mm diameter balls (68, 69 and 72 mm) which should be assigned to the three-pound cannon (Fig. 4:6). This cannon, the lightest of all field cannons, was used as a battalion (regiment) cannon. Another cannon ball has the diameter of 81 mm, which does not fit any of the cannons used by the armies fighting at Zorndorf and Kunersdorf. However, it ideally fits the French 4-pound Gribeauval cannon[10]. The ball comes from the collection of the museum in Gorzów Wielkopolski, where it has been on display as one of the items connected with the battle of Zorndorf. However, its connection with this battle should be excluded. It is highly probable that it was rather connected with the battles fought in the area of Neumark during the Napoleonic wars – in the campaign of 1806 or 1813.

Another item belonging to this category is a 88 mm diameter ball. It should be assigned to the 6-pound cannon. The largest balls are two 110 mm and 118 mm diameter roundshots. Both of them should be linked to the 12-pound cannons, however, they do not probably come from the same period. The smaller ball, found on the battlefield of Zorndorf, is definitely related to this 18th century battle (Fig. 2:1). The larger one, on the other hand, probably comes from the 19th century as its diameter is similar to the size of balls used in the French 12-pound Gribeauval cannon (117 mm)[11].

Common shells and their fragments

During the archeological research in the area of Kunersdorf, one shell with a well-preserved wooden fuse was found. The shell is slightly damaged and cracked. Inside, there was a fuse with a hempen lining and a small amount of powder (Fig. 3). The shell diameter was about 120 mm and a 3-letter mark in the Russian alphabet – ГШУ – is visible on its surface. This shell was fired by the Russian ¼-pud unicorn. Another three shells come from the museum collection in Gorzów Wielkopolski. One of them, with 92 mm diameter, most probably comes from the 6-pound hand mortar (coehorn), which was a piece of equipment used by the Russian troops of dragoons and horse grenadiers[12]. Another two shells with the diameters of about 100 mm are also of Russian origin, which would comply with the calibre of the smallest Russian unicorn – the eight-pounder.

[10] A. L. Dawson, P. L. Dawson, S. Summerfield, *Napoleonic Artillery*, Ramsbury 2007, p. 62, tabl. 3.1.

[11] W. Gohlke, *op. cit.*, p. 101.; A. L. Dawson, P. L. Dawson, S. Summerfield, *op. cit.,* p. 62, tabl. 3.1.

[12] J. G. Tielke, *op. cit.*, pp. 37-38.

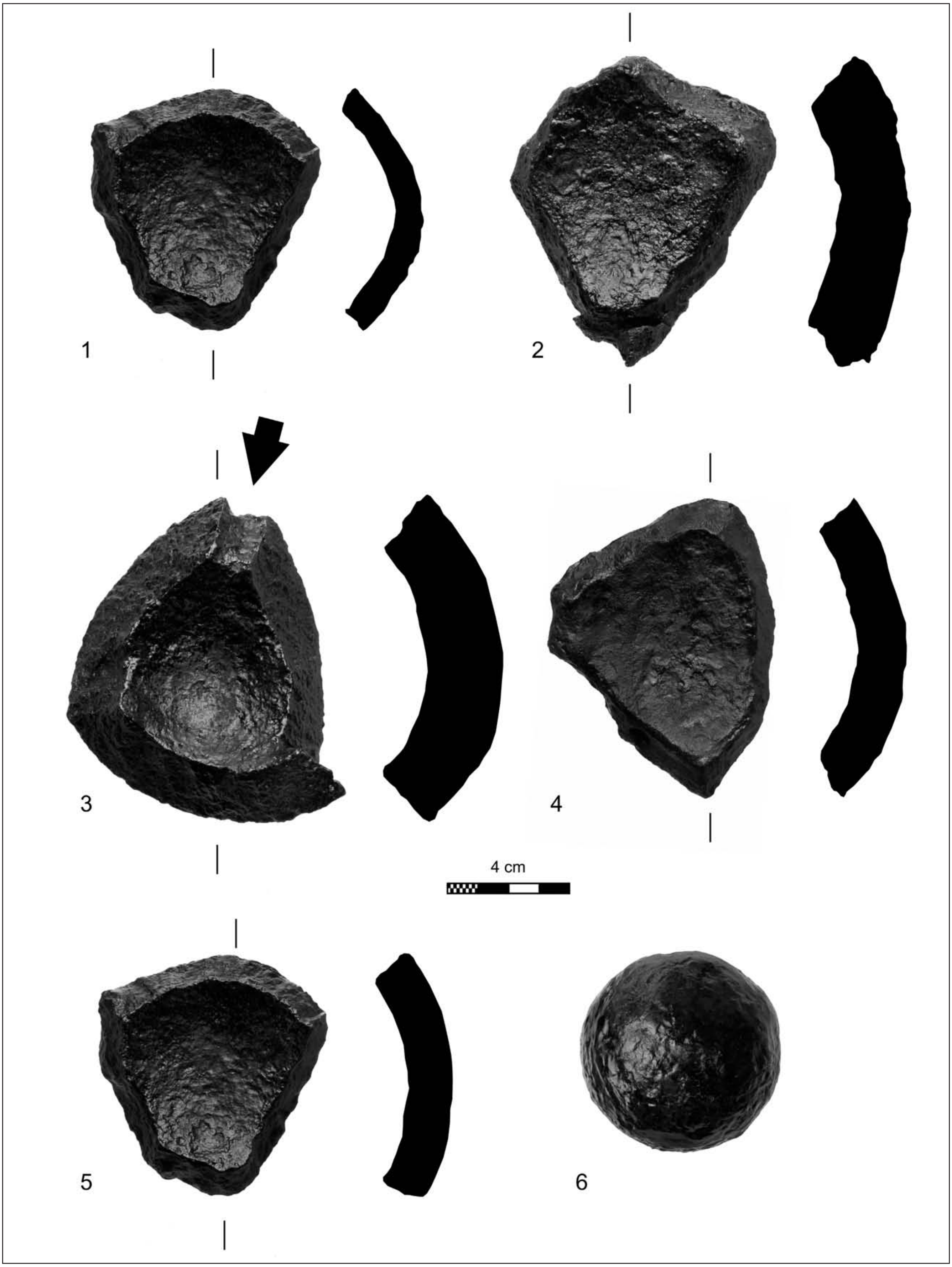

Fig. 4. A cannonball and fragments of common shells found on the battlefield of Kunersdorf. 1 – shell fragment from the Prussian 12-pound cannon; 2 – shell fragment from the Prussian 10-pound howitzer; 3 – shell fragment from the Prussian 7-pound howitzer; 4 – shell fragment from the Prussian 10-pound howitzer; 5 – shell fragment from the Prussian 7-pound howitzer; 6 – roundshot from the Prussian 3-pound cannon. Directional arrow shows a fuse hole. (Photo by P. Kobek).

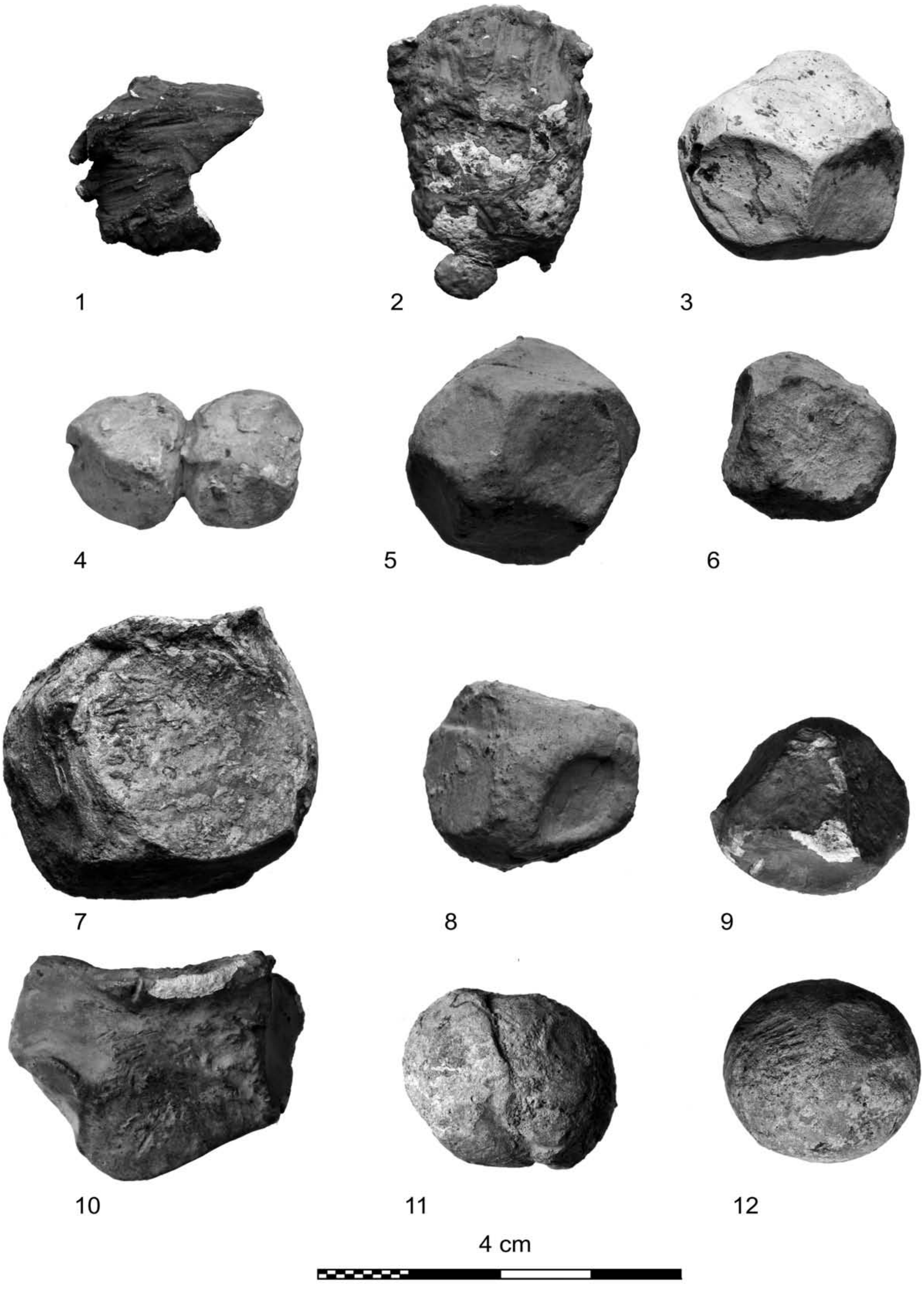

Fig. 5. Led canister balls and their fragments found on the battlefield of Kunersdorf. 1, 2 – fragments of balls that burst apart; 3 – 12 – canister balls. (Photo by P. Kobek).

Another finding included 14 shell fragments. Following their measurements, the authors were able to determine the approximate diameter of the shells and made an attempt to identify them. The first fragment comes from the 113mm shell, which would comply with the diameter of the Prussian 12-pound cannon (Fig. 4:1). Although these cannons did not fire shells, hollow shots were used in order to facilitate transportation by reducing their weight – that is the reason why they were not filled with powder[13].

Another four fragments of the 140-145 mm diameter shells must be assigned to the shell fragments fired by the Prussian 7-pound howitzer (Fig. 4:3,5). The next two shell fragments, with 163 mm diameter, are also the fragments of shells fired by a Prussian howitzer, in this case the 10-pound one (Fig. 4:2,4).

Five fragments should be linked to the Russian artillery. The first two, coming from the 120 mm diameter shells, are the fragments of a shell fired by the ¼-pud unicorn. One of them is an almost perfect half of the shell with a visible fuse hole and the mark ГШУ (Fig. 2:2). Another three shell fragments have a larger diameter, about 155 mm, and should therefore be linked to the ½-pud unicorn (Fig. 2:3).

The marks in the form of letters have been preserved on 5 different shells or their fragments. Only one of them uses the Latin alphabet letter. The letter W or M is visible on the 118 mm diameter cannon ball (the Prussian 12-pound cannon) found on the battlefield of Zorndorf. The other marks consist of the Russian alphabet letters and they could be found only on the shells or their fragments. The three-letter mark ГШУ is the most common one, and it can be seen on three shells, as well as the letter Д preserved on one shell.

The analogous marks could be found on common shells associated with the Seven Years' War in the collection of the Polish Weapon Museum in Kołobrzeg. The mark ГШУ was preserved on the 2-pud bomb and 2 shells – 1- and ¼-pud ones (Catalogue Nos. MOPK B 1755, MOPK B B626, MOPK B811), while the letter Д can be seen on the ½- pud shell (Catalogue No. MOPK B 1250/1-3).

These marks were most probably made by the producers – casters who marked their products in this way.

Canister balls

100 balls used in canister shots were analysed. 94 of them were cast in lead and 6 were made of iron.

Lead canister balls

During the Seven Years' War, lead canister balls were used by the Russian army[14]. This material had much worse properties than iron. Due to their relatively low hardness, the balls were deformed on firing, they bounced against the barrel walls and one another, burst and joined together. This all had a negative influence on the effectiveness of the shot, and especially on its range[15].

From among 94 balls, two were the fragments of balls that burst due to the shot intensity (Fig. 5:1,2) and another two were joined together (Fig. 5:4). The other ones are deformed in a characteristic way – flattened in many places – due to which their original round shape disappeared in some cases in favour of different types of polyhedrons (Fig. 5:3,5-10). The diameter was, therefore, very difficult to measure and for this reason the Sivilich formula[16] was additionally applied to determine it. Only the shape of two shells is almost perfect, and their diameters amount to 21mm and 22mm.

The appearance typical for the canister balls, as well as their agglutination and bursting was confirmed in the experiment conducted in Great Britain in 2006. The experiment also confirmed the average weight loss by lead bullets which followed the firing – from 1.71g to 5.16g[17].

Three basic groups in the analysed set were distinguished according to the ball weight and, consequently, the diameter (Fig. 6). The first group (I) included the lightest fragments, weighing from 25 to 43g, with 16 – 19 cm diameter (9 pieces). Group II included 76 balls weighing from 47 to 66 g, with 20 – 22 cm diameter. The last group (III) included 5 pieces weighing from 124 to 175g, with 28 – 31 mm diameter. The average arithmetic values of the weight and diameters in particular groups are as follows:

group I – 32 g / 18 mm
group II – 58 g / 22 mm
group III – 157 g / 30 mm

The ball size was connected with the type of cannon and the canister shot itself. In order to hit closer targets, smaller balls were used, while larger ones were applied when firing at more distant targets. In their canister shots, the Russian army used 4 ball sizes weighing 3, 5, 10 and 20 lots, that is 38.1 g.; 63.5 g.; 127 g. and 254 g. respectively[18].

It is highly probable that group I includes both 3-lot balls and standard gun bullets or slugs which filled the shots used in 8-pound and ¼-pud unicorns[19].

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13 W. Gohlke, *op. cit.*, p. 91; R. von Bonin, L. von Malinowsky, *Geschichte der brandenburgisch-preussischen Artillerie*, Th. 2, Berlin 1841, pp. 427-428.

14 *Praktika edinorogov*, Sankt Peterburg 1760, p. 4.

15 J. Jakubowski, *Nauka Artyleryi*, Warszawa 1781, pp. 257-258.

16 D. M. Sivilich, *What the Musset Ball Can Tell: Monmouth Battlefield State Park, New Jersey* [in:] D. Scott, L. Babits, Ch. Haecker (eds.), *Fields of Conflict. Battlefield Archaeology from the Roman Empire to Korean War,* Vol. 1, *Searching for War in the Ancient and Early Modern World*, Westport, London 2007, pp. 84-101.

17 D. Allsop, G. Foard, *Case shot: an interim report on experimental firing and analysis to interpret early modern battlefields assemblages,* „Journal of Conflict Archaeology", Vol. 3, 2007, no 1, pp. 128-137, table 3.

18 *Praktika…*, pp. 4, 6, 12, 18.

19 *Ibidem*, pp. 4, 6.

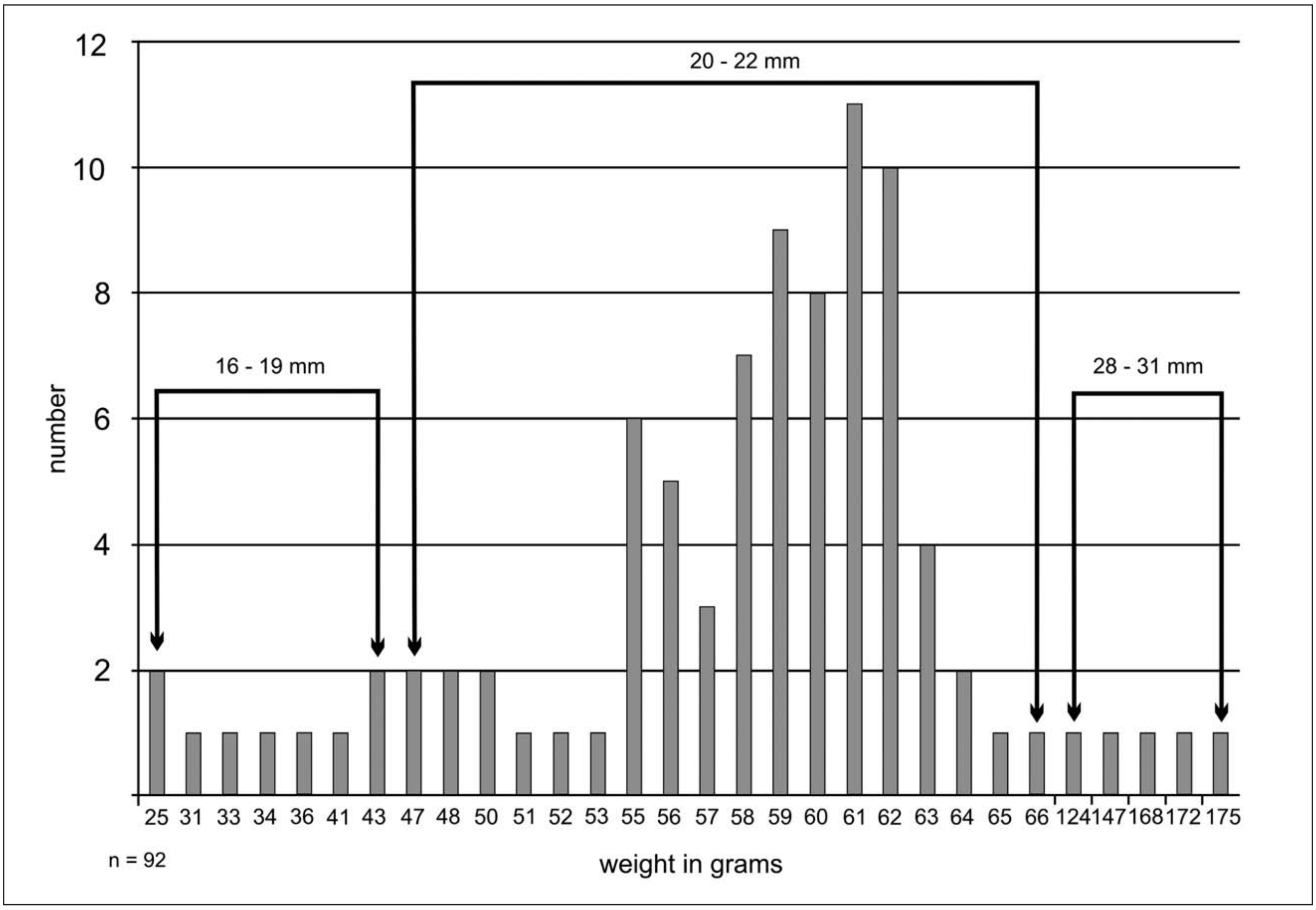

Fig. 6. Specification of lead canister balls in terms of weight and quantity.

The most numerous group II is a collection of balls of different sizes, that is the 5-lot balls. The average weight in this group is lower than 63,5g and amounts to 58 g, which might be caused by the ball shrinkage on firing, and not by the corrosion or the weight norms followed by the producers. It should be underlined that one of the balls found in an almost perfect state weighed 61g. (Fig. 5:12). The 5-lot canister balls were used in ¼-, ½-, 1- and 2-pud unicorns[20].

Group III included the heaviest items, which can be connected with the 10-lot balls. Although the great majority of the balls in this group is heavier than 127g, it is difficult to link them to another size, that is the 20-lot balls. Probably, the difference is the effect of certain margin of tolerance used during the production process. These types of balls were used in ½-pud unicorns[21].

Apart from the deformations caused by firing, other marks were observed on several items belonging only to group II. In 3 cases, the casting sprue was removed by cutting using a sharp tool, probably a knife. In one of the bullets, the sprue was not removed, and the mold seam is off-centre, which is the evidence of quite imprecise casting of the bullet (Fig. 5:11).

[20] *Ibidem*, pp. 6-21.
[21] *Ibidem*, p. 12.

Summing up, the most numerous type of lead canister balls found on both battlefields are 5-lot balls. They are the most common size used in different types of cannons. Depending on the unicorn type, canister shots consisted of balls of the same or different weight. And so, the 5-lot balls were used in the shots of the 12-pound unicorn (60 pieces in a shot), while in the ½-pud unicorns, 120 five-lot balls along with 60 ten-lot ones were used[22].

Iron canister balls

Only 6 canister balls made of iron were found on both battlefields. This type of balls used by the Prussian artillery can be divided into three groups – according to their diameter and weight. The first group consists of four 24 – 25 mm diameter balls weighing between 32 and 47g. The second group includes a 37 mm ball weighing 125,6g, and the third group – a 46 mm diameter ball weighing 342g. At the time, the Prussian artillery used the canister shots weighing 2 (29,2 g), 4 (58,4 g), 6 (87,6 g), 8 (116,8 g), 12 (175,2g) and 16 (233,6 g) lots, as well as 1-pound (468,5g) ones[23]. Previously, the 28-lot (408,9g) canister shots were also used[24].

[22] *Ibidem*, pp. 6, 12.
[23] R. von Bonin, L. von Malinowsky, *op. cit.*, pp. 430-431.
[24] *Ibidem*, p. 413.

The difference between the weight of the findings and the standard weight of canister balls probably results from the decay caused by corrosion. For that reason, the items from group I are identified with the 4-lot balls, those from group II – with the 12-lot balls, and those from group III – with the 1-pound ones.

Summary

Artillery projectiles are important artefacts in the research conducted on the battlefields of Zorndorf and Kunersdorf due to the fact that specific items can be relatively easily assigned to the particular parties in the conflict. The canister balls are most suitable for such analysis because it is enough to identify the material a ball was made of. Also the howitzer shells and their fragments can be easily identified as the diameters of the Prussian shells differed greatly from those used by the Russian. The most difficult task is assigning the roundshots to the particular party in the conflict because they do not differ significantly and the identification is only possible thanks to occasional marks found on the balls.

The factor hampering the identification of balls is corrosion. This concerns to a lesser extent the cannon balls as they can be identified based on their diameter, even in the case of a major weight loss. Corrosion hampers the identification of howitzer shell fragments (it decreases measurement precision) and iron canister balls.

It is also noteworthy that the items whose localization was determined by the GPS system, and which were found as a result of the planned search, are more reliable than those belonging to museum collections.

Streszczenie

Pociski artyleryjskie z bitwy pod Zorndorf/Sarbinowo (1758 r.) i pod Kunersdorf/Kunowice (1759 r.)

Bitwy pod Zorndorf (Sarbinowo) i Kunersdorf (Kunowice) są jednymi z największych, jakie stoczono w czasie wojny siedmioletniej na terenie Nowej Marchii i Pomorza. Starcia tego okresu toczyła przede wszystkim piechota. Inne bronie – tak kawaleria jak i artyleria – miały zdecydowanie mniejsze znaczenie. Jednak rola artylerii ciągle rosła, umożliwiał to stały postęp techniczny i organizacyjny. Do arsenałów wprowadzano coraz to nowe, ulepszone działa, uczono się poza tym lepszego ich wykorzystania. Przykładem postępu technicznego były rosyjskie wynalazki artyleryjskie – jednorogi i tajne haubice konstrukcji generała artylerii Piotra Szuwałowa. Z kolei przykładem postępu organizacyjnego było stworzenie w armii pruskiej w 1759 r. pierwszej baterii konnej, dzięki której artyleria stała się bronią bardziej mobilną.

Na wyposażenie artyleryjskie armii polowej okresu wojny siedmioletniej składały się dwa zasadnicze rodzaje broni: długolufowe armaty, strzelające torem płaskim, oraz krótsze i strzelające stromotorowo haubice. Trzeci typ dział – moździerze zasadniczo stosowano w oblężeniach, na polach bitwy pojawiały się bardzo rzadko. Armaty strzelały kulami pełnymi, oraz kartaczami. Haubice strzelały tak kartaczami jak i granatami.

Analizie poddano 123 różnego rodzaju artefakty związane z amunicją artyleryjską. 21 z nich pochodzi z muzeów (Muzeum Lubuskie im. Jana Dekerta w Gorzowie Wielkopolskim oraz Regionalna Izba Tradycji w Witnicy), zaś 102 z badań archeologicznych prowadzonych na polach obu bitew w latach 2008-2012. Przedmioty z badań posiadają swoją ściśle ustaloną lokalizację namierzoną za pomocą systemu GPS, natomiast zabytki z muzeów pochodzą ze znalezisk przypadkowych, dokonywanych na polu bitwy pod Zorndorf, a ich dokładne miejsce znalezienia nie jest znane. W związku z powyższym autorzy postanowili, iż w zakres niniejszego tekstu nie wejdzie analiza dystrybucji pocisków lub ich fragmentów, lecz próba identyfikacji oraz ustalenia, które z nich zostały użyte przez daną stronę konfliktu.

Znaleziska podzielić można na następujące rodzaje: pociski kuliste pełne (7 sztuk), granaty artyleryjskie i ich odłamki (4 granaty i 14 odłamków) oraz kule kartaczowe (100 sztuk – 94 ołowiane i 6 żelaznych).

Pociski artyleryjskie są ważnymi zabytkami dla badań nad polami bitew pod Sarbinowem i Kunowicami, ponieważ stosunkowo łatwo można przypisać określone obiekty do poszczególnych uczestników starcia. Najlepsze pod tym względem są pociski kartaczowe, bowiem wystarczy do tego zidentyfikowanie surowca, z którego wykonano pocisk (strona rosyjska używała ołowianych kul kartacznych). Również granaty artyleryjskie i ich odłamki są łatwe do identyfikacji, gdyż średnice granatów pruskich były znacząco różne od rosyjskich. Najtrudniej do strony konfliktu przypisać pełne pociski, te bowiem nie różnią się od siebie istotnie. Umożliwiają to jedynie sporadycznie pojawiające się sygnatury.

Czynnikiem, który utrudnia identyfikację pocisków, jest korozja. Dotyczy to w mniejszym zakresie kul armatnich, te – bowiem nawet przy znacznej utracie masy – są identyfikowalne przez ich średnicę. Korozja utrudnia identyfikacje odłamków granatów (zmniejsza precyzję pomiarów) oraz identyfikację kartaczy żeliwnych.

Podkreślić należy również fakt, że obiekty, które zostały znalezione w wyniku planowych badań archeologicznych, są bardziej wiarogodne dla badań bronioznawczych niż pochodzące z kolekcji muzealnych.