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Recent Research into Medieval and Post Medieval Firearms and Artillery

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JERZY MAIK

PREFACE

Medieval and early post medieval firearms and artillery were the subject matter of the 9th fascicle of 'Fasciculi Archaeologiae Historicae', published in 1996, which contained the materials of the 1st International Colloquium on Arms and Armour, held in Malbork in 1994. The present publication is devoted to the outcomes of most recent scientific investigations conducted by specialists in arms and armour, both archaeologists and historians. The first two papers deal with Greek fire, which cannot be classed as a type of artillery, but to some extent, seems to be its forerunner. It appears that Greek fire was also used outside Byzantium, at least by the Bulgarians and the Cumans, who, however, did not produce this type of weapon themselves.

The following papers discuss the use of artillery and firearms at the close of the Middle Ages and the beginning of post medieval times in the Polish, Bohemian and Teutonic armies. All these papers as well as the papers dealing with Greek fire are based on written records and the remaining three contributions rely on archaeological sources.

The three papers in question are based on archaeological weapon finds coming from excavations carried out on 18th- and early 19th-century battlefields. These excavations permit archaeologists to draw conclusions not only about the artillery and firearms which were in use at that time, but also the contemporary battle array.

The issue of arms and armour in past centuries, firearms and artillery included, is going to be further discussed in 'Fasciculi Archaeologiae Historicae' and looked upon from the perspective of production technology in the near future.

Łódź, October 2012

(*translated by Zuzanna Poklewska-Parra*)

FASCICULI ARCHAEOLOGIAE HISTORICAE
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ADRIAN MANDZY

USING MUNITIONS AND UNIT FRONTAGE: NEW EVIDENCE ABOUT THE RUSSIAN MAIN BATTLE LINE AT POLTAVA (1709)

The Battle of Poltava reached its crescendo with an all out assault of the Swedish army on the Russian camp (Fig. 1). Swedish troops, among the best disciplined in the world, had known many victories over the Slavs and one good march could break the Russian line. Once this line was broken, panic would set in as the remaining Russian troops would begin to flee across the Vorskva River. With a limited line of retreat, the outnumbered Swedish forces would once again inflict a major defeat on the backwards enemy, much like they did at Narva nine years earlier.

Shortly after 9:00 in the morning, Tsar Peter the 1st (Pyotr Alexeyevich Romanov) ordered his troops to form up in two lines in the open ground in front of the fortified camp to face the oncoming northerners. The first line

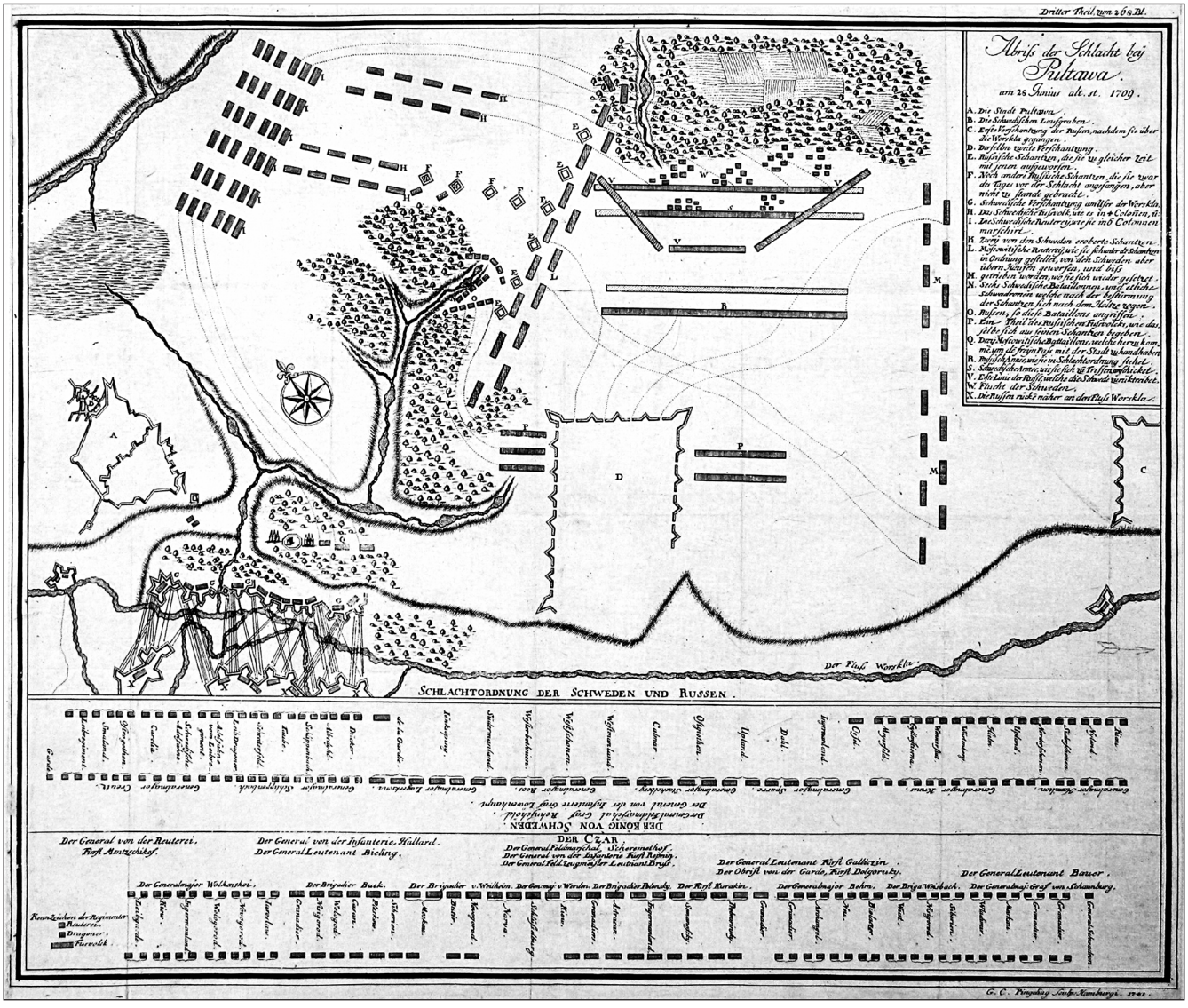

Fig. 1. G. C. Pingeling's Plan 1741, Courtesy of Aleksandr Ianovych, the former Director of the National Historical Cultural Preserve „Fields of the Battle of Poltava".

consisted of twenty-four infantry battalions and the second had eighteen battalions. Between each of these battalions were the three-pound regimental guns, which were small light field pieces that traveled with the foot battalions. Larger artillery pieces remained in the camp, but were placed on elevated positions, so that they could fire over the heads of the Russian troops and provide covering fire. To the right of the infantry, Peter deployed eleven regiments of dragoons, and six regiments of dragoons secured the left Russian flank. A small reserve remained uncommitted and was available to fill in any gaps that appeared.

Mounted on a his horse Finette, the Tsar moved out in front of his troops as Orthodox priests sprinkled Holy Water on the troops going into combat. By 9:45, the Swedish troops had evoked Jesus and began their move forward. According to the popular myths that arose after the Muscovite victory, the two armies were approximately 800 meters apart as the two massive war machines began to close in on each other. From the start of the Swedish march, the Russian artillery gave fire on the advancing Swedes. When the Swedes moved closer, the regimental guns began to fire round shot and as the Balts moved closer to the Slavic lines, the guns fired canister. According to Von Weihe, a Swedish officer who had taken part in the attack, the artillery "mown down the troops."[1]

At around forty meters, the Russian infantry fired on their oncoming blue-coated adversaries. Yet the Swedish line continued to advance. As trained, the Swedes halted, fired a volley and then charged the Russian line. The first Russian line on the Swedish right began to be pushed back and Russian troops began to flee. On the Swedish left, the Russian Guard regiments exploited a gap in the Swedish line and began to push back the Swedish advance. With not enough troops to cover the open ground, a gap appeared in the Swedish line. As the Swedish attack began to break up, it stalled and the initiative passed to the Russians. The Muscovites began to send in more troops and the Swedish lines began to sway. As the Swedes began to withdraw, their departure from the field of glory quickly turned into a route. Before noon, the new model army created by Peter had changed the balance of power in Europe forever.[2]

This story, more or less, has been told for almost three hundred years. The greatness of Peter, the superiority of Russian firepower over Swedish bayonets, and the overall folly of the Swedish invasion has been analyzed, studied and taught to generations of military officers throughout the world. Napoleon, before advancing on to Moscow in 1812, wrestled with these issues, as did Imperial German and Nazi officers during the two world wars. Yet how much of this story is true and how much it was fabricated to further a political agenda? Accounts from the battle are mostly one sided. With the destruction of the Swedish army at Poltava and the loss of the Royal Chancellery, the Swedish documentary record is rather sparse. The relatively high level of literacy in early modern Sweden allowed for the survivors from the campaign who eventually returned to Sweden after years or even decades of captivity to compiled memories, but how accurate and selective was their memory remains unclear. Worse is the fact that generals and officers often try to shift blame for failure on others and often over or under estimate, consciously or unconsciously, particular events. The documentary records from the Cossack faired even worse, as these were intentionally destroyed in 1775 by Peter's greatest emulator, the Empress Catherine. Therefore, the best primary historical documentary information comes from Russian sources.

These sources, however, are also rather selective. Like the painter who composes a portrait for a particular audience, any records concerning the *de facto* founder of the Russian Empire are inevitably positive. Given that Peter was not above modifying history to fit into his particular perspective, politically sensitive materials would undoubtedly been changed to fit the official version of events. Criticism of the regime or of the Tsar was not tolerated during Peter's reign, so it is unlikely any record of discord would have survived into the twenty-first century.

Yet some variations do show up in the documentary record. Most pictures of the battle, either as specific drawing of the battlefield or as background setting for heroic portraits, illustrate the Russian camp. Most often the camp is shown to be almost square in shape and fortified on three sides with massive earthen walls, ditches and flat firing platforms. The official plan of the battle, often referred to as Peter's Plan, shows a very formal, but much longer, rectangular shape. Other illustrations, however, show an irregular trapezoid shaped structure. More recent twentieth century reconstructions, such as that of Bennedich's plan from 1911, try to place an irregular square shaped trapezoid on top of the current topography.[3] Unfortunately, these more recent reconstructions were influenced by the series of military fortifications that were built on the battlefield in the mid nineteenth century.

Indeed, shortly after the Crimean War, the Poltava military school, which was initially established by Peter to commemorate his victory, decided to re-create a series of fortifications on the battlefield in time for the 150-year anniversary. While popular assumptions suggest that these recreations were built on the ruins of the previous earthworks, we know that in the early years of the nineteenth century the entire battlefield area was evened out so that Tsar Alexander I could have an unobstructed view

[1] P. England, *The Battle That Shook Europe: Poltava and the Birth of the Russian Empire*, London 1992.

[2] Ch. Duffy, *Russia's Military Way to the West*, London 1981.

[3] K. Bennedich, *Karl XII:s krigföring 1707-1709 och krigsskådeplatsens natur och kultur*,1911.

of the Grand Review of the Russian Army during the 1809 Centennial Celebrations. Generally, such leveling of the ground – filling in holes by scrapping off the top soil from high points – is limited in its scope, especially before the advent of steam and gas powered earth moving machines. Yet in the Russian Empire, serfs were plentiful, cheap and were employed in various mundane tasks. While we have no documentary evidence about how much of the terrain was moved, the presence of His Imperial Majesty would undoubtedly have resulted in a concerted effort to make the battlefield as royalty friendly as possible.

Thus, when we began to look at the battle, what evidence could be used to challenge or even verify the official tale told by the state? How did the main attack on the Russian camp develop? How close did the Swedish troops come to victory? Prior to the archaeological survey of what is thought to be the main battlefront area, we conducted a re-creation of the battle lines from the existing Russian Orders of Battle. A record of where each regiment stood in relationship to each other was compiled on the direct orders of Peter. This information is commonly available and was published along the edge of the map shortly after the battle as a record of Peter's accomplishment. Often referred to as Tsar Peter's Plan, this map lists the Russian and Swedish Order of Battle along the bottom of the page.

From this list we can determine that the first line contained twenty-four infantry battalions. A battalion, according to the Regulations of 1704, consisted of four companies of musketeers.[4] The reforms of 1708 stripped the single company of grenadiers from the regiment and placed them in converged Grenadier regiments, with only a few select regiments keeping their grenadiers with the parental unit. To augment the firepower of the Russian infantry, two three-pound guns were deployed with each regiment. The two Guard regiments were significantly larger. Preobrazhanski Guard Regiment had four battalions and a special unit of bombadiers equipped with hand mortars. The Semenovski Guard Regiment was also enlarged and had three battalions. To augment the firepower of these two privileged units, the guard kept their grenadiers and had enlarged batteries of regimental artillery.

The battalion guns had an interesting history. These guns were designed to keep pace with an infantry regiment and were light enough to be man-handled by the infantry. The older regimental guns in the Russian arsenal weighted over 48 *poods* (a bit under 800 kilograms), but in 1706 a new regimental gun was created by Korchmin. Not only were the new guns half the weight of the older design, but they also had two six-pound mortars attached to the front of the carriage. These mortars were designed to launch grenades and were to augment the piece when it was firing grape shot. As a rule, these two battalion guns were formed into a two-gun battery.

According to the Peter's manual, *Rules of Combat*, a battalion was to deploy in the Anglo-Dutch model, that is in four ranks.[5] Troops were trained to fire by volley or by platoons in the Prussian fashion. Like in the Swedish army, one out of every five soldiers was equipped with a pike. Unlike earlier formations in which the pike formed the center of the unit and the musket armed troops were placed on the flanks, both the Russian and Swedish armies intermixed their pikemen with their muskets. In such a way, the battalion was protected from cavalry and could maintain a significant volley of fire. This fire was also augmented with the fire provided by the battalion guns which were deployed with each regiment.

On paper, the regulation strength of a company was one hundred and fifty men.[6] In 1704, the company was commanded by a captain and included one lieutenant, one ensign, three non-commissioned officers, one armorer, one doctor barber, one adjutant, one clerk, six corporals, two drummers, and one hundred thirty-three soldiers.[7] On campaign this number would have been reduced by sickness, battle casualties, and desertions. Estimates of the actual strength of each company vary, but using an average of one hundred to one hundred twenty five men suggests that each battalion could field approximately between four and five hundred men.

Since each battalion was deployed in four lines, the front line or frontage consisted on the average of one hundred to one hundred and twenty five men per battalion. Using the smaller number of a hundred men frontage per battalion, the twenty-four battalions in the first line would represent a minimum of 2400 men. As an individual is widest at his shoulders, each individual would take up between thirty and forty centimeters. Given that the individual would be required to undertake a manual of arms, this frontage increases to fifty-six centimeters per person.[8] Multiplying the space required for individual (56cm) by the minimal number of troops (2400), then we arrive at a figure of 1344 meters for all the troopers standing shoulder to shoulder in one continuous line in front of the Russian camp. If we use the larger number of 125 troops in the first line of a battalion, then we arrive at a distance of 1680 meters.

Of course, no battalion would have been stood directly next to another unit. For the first part, the battalion guns would require space to deploy. Each two three-pound

[4] O. Leonov, I. Ul'ianov, *Rehuliarnaia pekhota 1698-1801*, Moskva 1995.

[5] O. Sokyrko, *Ukrains'kyj Rubikon: Poltavs'ka bytva 27 chervnia 1709 g.,* Part 2, Kiev 2009, p. 15.

[6] A. Konstam, *Poltava 1709, Russia Comes of Age*, London, 1994, p. 21.

[7] A. Konstam, *Peter the Great's Army 1: Infantry*, London, 1993, p. 17.

[8] B. P. Hughes, *Firepower: Weapons Effectiveness on the Battlefield, 1630-1850*, Staplehurst, Kent 1997, p. 80.

gun battalion battery had a crew of twelve men servicing the guns. While the number of infantrymen would rarely maintain its theoretical paper strength, gun crews were always brought up to full strength before the start of an engagement. Guns were too important to leave undermanned and replacement gunners would have been taken out of the line to service the guns. If we follow the order of deployed battalions, then we can also calculate a frontage of the twelve three-pound regimental batteries that served on the front lines.

The exact dimensions of each three-pound battalion gun varied between designs, but on the average, the gun measured two meters from wheel hub to wheel hub. To service the guns, its crew needed to move freely between the front and the back of the piece. This required at least one meter of space on each side of the gun. If we take the minimum required space of four meters per gun, a minimum of eight meters in width is taken up by a single gun battery. Thus, the twelve battalion gun batteries had to take up a frontage of at least ninety-six meters.

Taken together, the twenty-four battalions and twelve batteries of three-pound guns took up a frontage of approximately 1440 to 1776 meters. From Peter's plan, however, we also know that the cavalry was also deployed on the flanks of the infantry. At the time of the Poltava campaign, Peter had expanded his cavalry to thirty-four regiments of dragoons – eleven of these regiments were deployed to the right of the infantry and six on the left. Dragoon regiments were made up of ten or twelve companies, each of which had a paper strength of about one hundred men. Illness, fatigue and injured mounts would reduce this number to about seventy saddles per company. Two companies of dragoons formed a squadron. Cavalry regiments would also deploy in three ranks and maintained a frontage of four or at times five companies. If we take the minimum of a two squadrons frontage per dragoon regiment, we can calculate the space needed for deployment.

Horses are notoriously hard to control, even at the best of situations. A perusal of any historical period were cavalry played an important role shows that horses often panicked and were almost impossible to stop after they began a charge. For this reason, cavalry manuals always seem to stress the need to slowly advance toward the enemy and work up to a charge in the last moments before contact. As the cavalry forces in Peter's army were relatively new and poorly trained, especially when compared with their Swedish counterpart, the Russian cavalry was trained to advance at the trot and discharge their firearms approximately thirty meters from their enemy. Once the initial volley had somewhat dispersed the enemy, the Russian cavalry manual stated that the troopers were to draw swords and advance at the trot. The school book emphasis of keeping such slow speeds was put into place so that the dragoons could maintain their unit cohesion. As the dragoons advanced, they strove not to leave any gaps between the men in the front lines and charged the enemy in the classic cavalry formation of riding "boot to boot".

Riding "boot to boot" theoretically is not to leave any spaces between the riders. However, even when riding in this formation, gaps of ten to twenty centimeters quickly emerge between riders. Given that a rider and his horse occupy approximately a meter wide frontage, in the field a single dragoon company would occupy approximately eighty-four meters. A single regiment would therefore occupy four times that space, or 336 meters. Thus, the right cavalry wing would require just under 3700 meters to deploy, while the left wings would take up a frontage of just over 2000 meters.

Based on this analysis, the Russian army, according to the official records provided by Peter, would require a significant amount of space to deploy. On the whole, the Russian army occupied a frontage of almost eight kilometers in length. If the cavalry were not deployed in line, but were placed one regiment behind another, this would reduce the initial deployment area significantly.

According to Peter's Plan, the Russian army held the position of between the Takhtaulov Stream to the north and eroded streambed of the Iakivtsi Stream to the south. While the topography has been changed with the construction of a railroad cut in the eroded streambed of the Iakivtsi Stream, the distance between these two points of reference is under 1,800 meters. Given that the minimal deployment area for the infantry and supporting battalion guns is between 1,440 and 1,776 meters, the cavalry had little to no space to maneuver, much less deploy properly into line. Indeed, the infantry would be hard pressed and had no space to wheel in line. Perhaps the Russian deployment in front of the camp was a measure undertaken to give the Imperial Muscovite army room to deploy before being attacked by a professional and aggressive foe.

Given the compacted nature of the Russian line and the descriptions of concentrated Russian fire, there was a strong indication that an archaeological battlefield survey would uncover large quantities of materials.[9] Two senior scholars in the project had worked in areas heavily impacted by modern development and both had found traces of the former fields of conflict. Being aware of the ferocious nature of the battle, the amount of troops deployed, and the amount of ordinance expended, the team had envisioned finding huge deposits of spent ordinance.

[9] An invitation from V. Vadimov, the general city architect of Poltava, to Prof. M. Bevz, the Chair of the Department of Restoration and Reconstruction of Architectural Complexes at the National University "L'viv Polytechnic" resulted in the author visiting the battlefield. After a series of discussions and meetings, an international Ukrainian, American and Swedish team came together under my direction for two seasons and examined the numerous military conflicts that took place at Poltava.

Unfortunately, this never occurred.[10] Although we were able to recover a significant sample of spent ordinance, most of the military artifacts found on the area of the main battlefield came from the Second World War. Quantities of spent shell casings littered the battle areas, with spent 8mm Mauser cartridges being the most common artifact. Soviet Mosin-Nagant ammunition also was recovered in large quantities, as were spent 9mm pistol cartridges. Given the amount of ordinance expended on the Eastern Front, it was not surprising that we recovered an unexploded 76mm German anti-tank round.

The recovery of WWII ordinance indicates that the local topography was not significantly modified in recent years. Earth moving projects, be it grading for a parking lot or the removal of topsoil, have become more prevalent with the advent of gasoline and stream powered machinery. Such grand projects were also very popular in the Soviet Union and used in two areas of the Poltava battlefield. In the area just to the south of the historical museum, the ground was moved and scrapped to construct protective earthen walled barriers for the aviation fuel storage facilities of the air force base. Yet for most of the battlefield, the recovery of distinct concentrations of fired ordinance not only lets us reconstruct German MG firing positions, but provides us with a clear indication that the earth was not subject to significant impact following 1945.

While the two seasons of metal detecting failed to recover hundreds of pieces of ammunition from the 1709 engagement, those found provide a good sample to help us understand the battle. The overwhelming majority of rounds recovered were Russian.[11] This is not surprising, as the Russian doctrine emphasized firepower and the Swedish practice of *ga pa* focused on maintaining momentum during the advance. While some scholars have focused on the question of the quality and the available Swedish gunpowder, military theorists of the eighteenth century were loathed to have troops engage in a protracted firefight. Not only did this allow the attacker to suffer greater casualties, but there was a great possibility that the initiative would pass and the charge would fail to materialize.

An analysis of the ammunition showed two different types of projectiles, lead small arms ammunition, that which would have been fired from muskets, pistols and carbines, and lead anti-personnel artillery ordinance which would have been fired from artillery. This anti-personnel artillery ordinance consisted of lead or at time iron balls held together in a cloth bag (grape shot), or a tin canister (canister shot). At close ranges, this ammunition made the cannon into a very large shotgun, as it disbursed hundreds of pieces of metal into the oncoming enemy.

To date, eleven pieces of anti-personnel ammunition have been found on the main battle lines. This includes a pewter fragment from a canister round, nine lead pieces and one iron piece. The nine lead pieces can be divided into four categories, poured small rounds balls with a diameter between 10.0mm and 13.4mm, folded cube shaped lead with a diameter of 13.3mm, poured cubes shaped pieces with a diameter between 15.3mm and 16.1mm and poured cubes between 19mm and 20mm. A fifth type of ordinance is represented by the recovery of a single cubed iron piece. While the sample size is too small for any useful statistical comparisons, the existence of five distinct groupings suggests variations in the manufacturing and supply of artillery based anti-personnel ammunition.

It is generally assumed that the artillery in Peter's army played a significant role in the main battle.[12] Given the special limitations for deployment faced by the Russian forces, the heavy artillery remained in the rear. Although the records indicate that they were raised on platforms and fired over the heads of the Muscovite troops, any such bombardments would have made these direct fire weapons into mortars. While some of the guns in Peter's arsenal were indeed specifically designed mortars, the majority were made to fire over open sights directly into the enemy in front. Such limitations in fields of fire were not unusual, and in the seventeenth century, heavy field guns were modified to achieve a much arc of fire by digging a hole to lower the back of the gun carriage into the ground.[13] However, anti-personnel ammunition could not be used in such a manner. Given the irregular flight patterns of anti-personnel ammunition, neither canister nor grape shot could be fired into the enemy without causing significant casualties to the troops directly in front of the guns. Thus, the fragments of canister recovered were fired from the Russian three-pound battalion guns that were stationed directly in front with the infantry.

The most commonly recovered battlefield related items found during this survey were musket balls. Made of lead, these projectiles were notoriously inaccurate and required groups to fire a volley at a mass target with the hope of producing casualties. While some sources suggest that musket fire could be effective beyond 100 meters, a series of test run by the Prussian army during the Napoleonic wars found that the British musket, relatively the same model as used at Poltava in 1709, was able hit a man sized target at eighty yards only forty-seven percent of the time.[14] Given

[10] A. Mandzy, *Doslidzhennia poliv Poltavs'kukh bytv na zemliakh derzhavnoho-kul'turnoho zapovidnyka „pole poltavs'koi butvy"*, „Arkhitektura, Visnyk natsional'noho universytetu L'vivs'ka politekhnika", L'viv, No. 632, 2008, pp. 146-149.

[11] A. Mandzy, M. Bevz, *Kompleksne doslidzhennia istorychnoho polia bytvy: metodyka i dosvid mizhnarodnoi arkhekturho-arkheolohichnoi ekspedytsii*, „Fortress", vol. 1, L'viv 2009, pp. 550-558.

[12] J. V. Shokarev, *Istoriia opuzhuia artilleriia*, Moskva 2001, p. 76.

[13] E. Wagner, *Ars Bella Gerendi*, Praha 1980, p. 163.

[14] G. Nafziger, *Imperial Bayonets,* London 1996, p. 32.

that these were paper targets and the troops were not actually in combat, this number would have been significantly lower under real battlefield conditions. This theoretical exercise is supported by Griffith's analysis of British firing patterns during the Peninsula Campaign (1809-1814).[15] Using contemporary source descriptions of the battles, Griffith argues that while musket firing could begin at ranges greater than 100 yards, British troop usually began to shoot at 75 yards.

The inaccuracies of firearms were well known in the eighteenth century. Troops were taught to give fire and aiming at individual targets was discouraged. Some legendary commands like Frederick the Great of Prussia and Gustaph Adolphus of Sweden preferred to charge the enemy directly, rather than allowing their troops to fire and get drawn into a long firefight. Along with the ever-larger armies, European armies maintained the longstanding tradition of employing small groups of marksmanship. Unlike the masses who were taught to fire blindly, marksmen trained and developed their skills from an early age. Marksmen, usually hunters of game or members of urban shooting clubs, learned to increase the accuracy of the weapons by decreasing windage, i.e. the difference between the diameter of the ball and the diameter of the barrel. As all weapons were loaded from the barrel, the only practical way of reducing windage was to wrap the ball in greased cloth patch. As the loading of a patched ball often required the use of a hammer to push the round down the barrel, such loading was done previous to the start of an engagement. Traces of such a patch were noted on a ball recovered from the 1677 Landskrona Battlefield.[16] A similar patch ball was recovered during the author's excavation of the 1782 Battle of Blue Licks.[17]

To date, two Swedish musket balls were recovered at Poltava. While these balls are similar to some of the balls used by the Russians, the weight of the Swedish balls is significantly greater. The Swedish balls, which have a diameter of 18.8mm to 19.7mm, weight 35.3g and 37.5g respectively. Russian balls of the same diameter are on the average ten grams lighter. Even largest Russian musket balls, one of which is almost 21mm in diameter, weighs 3 grams less than a Swedish ball which is 19.7mm in diameter.

The Russian ordinance recovered from our excavations is best described as mixed. From the small sample of fifty-six balls, four or possible five distinct ammunition types were noted in the area of the Russian camp. Of these, round Russian balls were the most commonly encountered ammunition. The other types of munitions recovered include: extended sprue ordinance, two types of cold-hammered improvised munitions and slugs (Fig. 2).

Although it would be nice to always link a particular weapon based upon the diameter of an individual ball, both the nature of black powder firearms and contemporary manufacturing techniques resulted in bullets being made to rather loose tolerances. The British Brown Bess musket, which had a .75 bore, was to use a ball of 0.693-inch diameter, but in practice, balls in the range of 0.67 to 0.73 are generally attributed to this weapon.[18] In addition, not only were variations in the size of rounds balls common, but in the seventeenth and eighteenth centuries, different size calibers were often used contemporaneously. For example, excavations of the wreck of the Swedish warship *Solen*, which sank during the Battle of Oliwa on 28 November 1627, produced 466 pieces of small arms ammunition, of which four specific sizes were identified: 17mm (the most common), 14mm, 11mm and 21mm.[19]

Thirty-one round balls were recovered from the main area. Some of these balls exhibit traces of casting sprues, but in all of these examples, the sprue has been cut very closely to the ball itself. The most common type of ball measured between 9.3mm and 11.8mm, with the majority in the 10mm range. These may relate to buckshot, that is multiple small balls fired out a larger caliber musket, or relate to smaller caliber weapons.[20] A second possible concentration of round balls appears to be in the 14mm range, with bullets varying in size from 13.2mm to 15.8mm. A third possible grouping may exist between the 17.3mm to 19.0mm range. Though only four balls of this size were recovered, these balls are all significantly larger than the previous grouping and are thought to represent different weapons. Finally, the recovery of 12.1mm round ball and 20.8mm ball may represent the use of different weapon systems, but the single recovery of each size does not allow us to state much more than record their presence.

In addition to round balls, seventeen balls were recovered at Poltava with extended sprues. These are round balls with the casting sprue intentionally left on the ball. The recovery of impacted balls with visible sprues indicates that these rounds were fired with the sprues still attached. Unlike eighteenth century cartridges, where both the ball

[15] R. Muir, *Tactics and the Experience of Battle in the Age of Napoleon*, New Haven 1998, p. 81.

[16] B. Knarrström, S. Larsson, *Hans Majestäts Friskyttar av Danmark*, Stockholm 2008, p. 109.

[17] A. Mandzy, E. Hale J. Marin, *A Phase I Survey of the Blue Licks Battlefield*, Frankfort 2008, p. 24.

[18] D. M. Sivilich, *What the Musket Ball Can Tell: Monmouth Battlefield State Park*, [in:] *Fields of Conflict*, ed. D. Scott, New Jersey 2007, p. 86.

[19] A. Koperkiewicz, *Solen*, Gdańsk 1986.

[20] Since most oriental „Turkish" weapons in the museums of Poland and Ukraine have a much smaller caliber bore than muskets, the initial study suggested that these bullets correspond with Ottoman weapons. Further analysis of Ottoman weapons captured by the Christian forces following the 1683 Siege of Vienna by the author at the Heeresgeschichtliches Museum, however, suggests that many seventeenth century Ottoman weapons had a larger diameter than the Ottoman firearms commonly found in the museums of Poland and Ukraine.

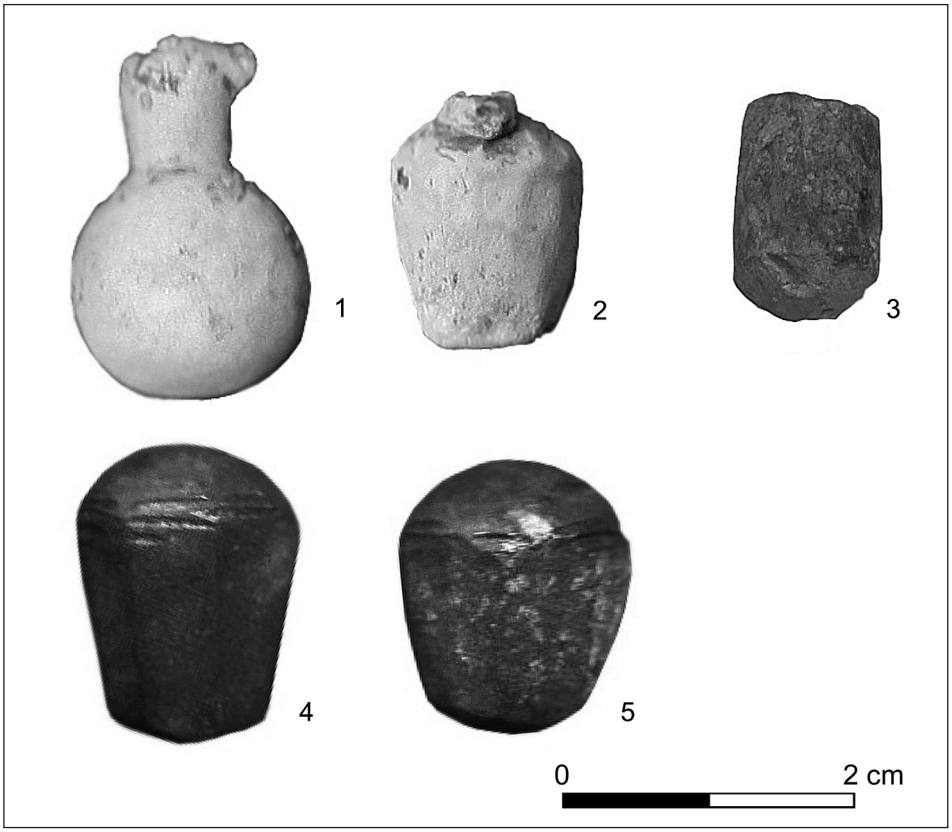

Fig. 2. Lead projectiles recovered at Poltava battlefield and recreated ammunition. 1 – Extended Sprue Ordinance; 2 – jug-shaped ammunition; 3 – slug; 4-5 – examples of re-created jug shaped rounds made by cold hammering round lead balls.

and powder were inside a paper tube, makers of seventeenth century cartridges used the sprue to attach the ball to the paper tube. While such cartridges may have been in use by the mid-sixteenth century, in 1697, Saint Remy, a French scholar, "illustrated a cartridge with a ball attached by its sprue as the latest type.[21]

The presence of the extended sprue shifts the center of gravity of the bullet forward. This is the opposite of round balls, which have their center of gravity at the mid point. Like a modern air-gun pellet or skirted shotgun slug, the presence of the extended sprue adds additional weight to the bullet. Upon impact, the low velocity round will either split, creating two separate wound cavities, or tumble and make a much larger hole than would a round ball of the same caliber.

The most common sprue ordinance recovered from the main battle area of Poltava has a diameter between 14.6mm and 16.3mm. Ten of such size ordinance was recovered, with six balls displaying a diameter of 15mm. A second possible grouping of balls measures between 17.3mm and 18.6mm, but with only four balls recovered, it is difficult to say anything with certainty. The recovery of a single extended sprue ordinance ball with a diameter of 21.6mm is interesting, but again the lack of additional balls of this size does not allow for further speculation.

Excavations of other battlefields in Ukraine and Sweden have recovered similar extended sprue ordinance. Excavation of the 1649 Zboriv battlefield by the author found extended sprue ammunition in two sizes.[22] The most common rounds have a diameter between 12.6mm and 13.3mm. These are the most common type of seventeenth century small arms ordinance recovered at Zboriv and make up almost fifty percent of the assemblage. Less common are the slightly larger rounds that have a diameter of 14.1mm to 14.7mm. Larger caliber weapons do not appear to have used sprue ammunition and utilized the more traditional round ball pattern.

A similar situation was noted during the author's excavation of the 1649 Zbarazh battlefield.[23] Fought just days previous to the Battle of Zboriv by many of the same Cossack and Tatar troops, it was logical to assume that we would discover similarities between the two assemblages. Indeed, not only did we find that two sizes of extended sprue ordinance and the three diameters of round ball ammunition noted at Zboriv were all recovered at Zbarazh, but as in Zboriv, the percentages between the different types and sizes of ammunition were very similar. The only difference between the ammunition from the two sites was the recovery of large round lead balls from the Zbarazh battlefield.

[21] P. Surirey de Saint Remy, *Memoires d'Artillerie*, second edition, Vol. 2, Paris 1707, as quoted in Harold L. Peterson, *Arms and Armor in Colonial America 1526-1783*, Harrisburg, Pennsylvania 1956, p. 64.

[22] A. Mandzy, *Tatars, Cossacks, and the Polish Army the Battle of Zboriv*, [in:] *Fields of Conflict*..., pp. 193-207.

[23] A. Mandzy, *Doslidzhennia oblohy Zbarazha 1649 r.*, „Dezhava ta Armiia, Visnyk natsional'noho universytetu L'vivs'ka politekhnika", L'viv, No. 571, 2006, pp. 124-130.

These large balls measure in diameter between 20.4mm and 20.6mm.

The presence of sprue ammunition indicates that the Russian troops at Poltava were using cartridges. The use of cartridges simplified the loading process and resulted in a faster rate of fire. Previously, musketeers relied upon bandoleers of pre-measured powder charges. Bandoleers were cheap to produce and continued to be found in European arsenals until the end of the seventeenth century. Infantry cartridge boxes, however, were new and were in use in Ukraine as early as 1649.[24] Russian troops first began to use leather cartridge boxes in the last years of the seventeenth century under the direct reforms implemented by Peter.

The two types cold-hammered ammunition are rare and may have only been used in this engagement. Both of these types appear to have been modified to fit smaller size diameter barrels. The first type of modification begins by taking a standard extended sprue ordinance ball and cold hammering it on its sides to reduce the balls diameter. Although lead is a rather soft substance, it is difficult to directly hammer the ball. Rather than directly hammering the ball straight on, the ball was hammer on an angle. This procedure shifted the lead away from the sprue and produced a jug shaped bullet, with the sprue creating the "mouth" of the jug-shape. The three recovered jugs had their diameters reduced to 15.8mm, 16.3mm and 16.6mm respectively.

The second modified type of ordinance appears to have been hammered on all sides. This technique seems to be cruder than the jug style balls and was made by cold hammering a round ball to produce a multi-sided bullet. The lack of a sprue by which to hold the ball when hammering would have made it more difficult to modify the shape of this ammunition and the three recovered pieces all are slightly wider one on side. The three recovered pieces measure 14.8mm, 15.9mm and 17.4mm.

The modified cold hammered balls suggest a temporary solution to supply the Russian troops in the field. While it is possible that these modifications were done to increase the lethal power of the more rounded bullets, it is more likely that these modifications were done so that the issued balls could fit down the barrel of a soldier's weapon. The lack of standard weapons and correspondingly, standard barrel diameters, was a well known feature in Peter's army. Since it would have been nearly impossible to deliver the correct size ball for each individual firearm, each individual trooper would have needed to make allowances for such discrepancies. If the delivered balls were too small, they still could be shoved down the barrel and while not as accurate as a correct sized round, they still would be lethal at a point blank range. This philosophy of military logistics remained prevalent in Imperial and later Soviet military planning, and arms production was set up so that capture ordinance could be used with Russian arms (i.e. the Soviet 82mm mortar was designed to fire the 81mm NATO mortar rounds).

If the issued balls were too larger however, then steps would be needed to ensure the ammunition would work. Cold hammering of rounds would ensure that the issue balls would fit down the barrel of each firearm – and it did not matter if the gun was a modern French import, an older weapon from Holland or recently produced arm from one of the Tzar's new arsenals. Since the tools and skills required to produce these modifications could be easily applied in the field, it is most probable that these modifications were undertaken to address the logistical issues that plagues Peter's newly created Western-styled military force.

The final type of ammunition recovered from the 1709 battlefield is cylindrical shot, also known as a slug. Whether these poly-sided balls were cold hammered from a piece of cut lead rod or from a slightly larger ball is impossible to tell, but unlike the hammer round balls described above, no part of the bullet is wider than the other. Such bullets are periodically encountered at seventeenth and eighteenth century assemblages and the two slugs recovered at Poltava had a diameter of 13.7mm and 15.8mm respectively. At the 1651 Berestechko battlefield, for example, a number of cylindrical pieces of lead, along with scrap pieces of lead, were recovered from an ammunition pouch attributed to fallen rebel peasant.[25] The recovery of ten cylindrical bullets and fifteen round balls from a cartridge box at the 1690 *Anse aux Bouleaux* shipwreck is a good indication that these munitions were used by New England militia troop on their way to attack Canada.[26] Five slugs were also found in a leather pouch on the pirate ship *Whydah* which sank in 1717.[27]

At Poltava, it appears that the Russian army used all types of bullets in its various weapons. If we were to combine all the ammunition together and sort it by diameter, we are not much closer to discerning any distinct patterns. While we can see some clustering of diameters, one with a range between 14.1mm and 16.6, and a second range between 9.3mm and 11.8mm, these bullets represent still only make up sixty-five percent of the total assemblage. The diversity of recovered bullet diameters is truly remarkable and illustrates an army using every possible firearm that it could get its hands on.

When Peter began to reform his army, the troops used a variety of weapons and no regulation patterns existed.

[24] The recovery of extended sprue ordinance at both Zboriv and Zbarazh document the use of paper cartridges in 1649, while the recovery of actual leather and wood cartridge boxes from the 1651 Berestechko battlefield illustrates their common usage. I. K. Sveshnikov, *Bytva pid Berestechkom*, L'viv 1993.

[25] I. K. Sveshnikov, *Bytva pid Berestechkom*..., p. 254.

[26] http://www.mcccf.gouv.qc.ca/phips/wreck19b.htm

[27] D. M. Sivilich, G. W. Stone, *The Battle of Monmouth: The Archaeology of Molly Pitcher, the Royal Highlanders, and Colonel Cilley's Light Infantry*, Freehold 2003, p. 18.

Local production of weapons was limited to the Kremlin Armory and most weapons were either matchlocks or used the newer Baltic lock snaphaunces. Peter's efforts in establishing local centers of arms production is well documented, with weapons being produced in Tula, Moscow, Olonetz and Petersburg. The monarch's interest in modernizing his military also lead to his purchasing of arms in Western Europe, especially Amsterdam. Within the Russian army, the infantry firearms could be have been made by the Dutch, English, French, Muscovites or any other production center.

This inconsistence in firearms was noticeable at the regimental level. Sizes, weights, and calibers of weapons varied and no standardization existed. According to Peter's notes, infantry muskets were to fire an eight *zolotnik* ball (approximately 34g.), but how often this was achieved is debatable. According to Aleksandr Ianovych, the former director of the National Historical Cultural Preserve "Fields of the Battle of Poltava", among a surviving historical arms in the Tula Arsenal that date to the time of the Poltava campaign is a musket with a 16mm bore. Yet how common was the caliber from this individual firearm remains speculative.

In the Russian army, standardization of weapons continued to be a long-term problem. While the capture of large quantities of Swedish arms would go a long way of replacing the oldest and least effective firearms, the army that Peter created would continue to be plagued by weapon shortages on and off for the next few hundred years. Given the vast numbers of troops in the Russian military, similar disparities would show up during times of crises. During Napoleon's invasion, various weapons were pressed into service, including captured French muskets, purchased British muskets, and even war trophies taken from campaigns against the Turks. But the development of a theoretical standardized round indicates a move toward greater standardization.

Conclusions

So what does the information recovered from the main battle line tell us about the battle? For the first part, we know that the Russian army was confined in a spot that was very narrow, too narrow in fact to properly deploy the cavalry. The lack of any archaeological evidence for large caliber cannon, such as those that would have been part of the artillery train, also supports the fact these cannons were employed in a supporting role at best and were not used to their full potential. Finally, the recovered ammunition tells us that the Russian Army was truly using a wide variety of ammunition. Unlike the Swedes, who maintained a standard ammunition caliber, the Russians were forced to use whatever weapons came their way. Indeed, the lack of standardization of ammunition into distinct sizes is a good indication that the firearms used by the troops were also not standardized. However, the use of extended sprue ordinance also demonstrates that while the firearms and ammunition supply may not have been standardized, the new Russian army was adopting cartridge boxes and on the path to modernization.

Streszczenie

Użycie uzbrojenia i długość linii frontu: nowe dowody w sprawie głównej rosyjskiej linii bojowej pod Połtawą (1709 r.)

Dwa sezony badań pola bitwy pod Połtawą dostarczyły nowych informacji na temat szwedzkiego ataku na główne siły rosyjskie. Prace terenowe wykazały, że armia rosyjska była ograniczona wąską przestrzenią i nie była w stanie w pełni wykorzystać swojej kawalerii i artylerii. Analiza pocisków do broni ręcznej wykazała szeroką różnorodność kalibrów i rodzajów używanej amunicji. Dwa typy pocisków wydzielone podczas badań nie zostały dotychczas znalezione na innych XVII- lub XVIII-wiecznych polach bitew. Badania wykazały, że wojska rosyjskie modyfikowały ołowiane kule poprzez zmniejszenie ich średnicy w celu dopasowania do używanej broni palnej, natomiast stosowanie pocisków z nieusuniętym kanałem wlewowym sugeruje, że rosyjska armia była dopiero w trakcie wprowadzania do użytku ładownic.

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LIST OF AUTHORS:

ALEKSANDER BOŁDYREW
Institute of History of the Jan Kochanowski
University of Humanities and Sciences in Kielce,
Branch in Piotrków Trybunalski
J. Słowackiego 114/118
Pl 97-300 Piotrków Tryb.
Poland
bow0@poczta.onet.pl

TADEUSZ GRABARCZYK
Institute of History of the University of Łódź
A. Kamińskiego 27a
Pl-90-219 Łódź
Poland
tadeuszgrabarczyk@gmail.com

MACIEJ KOKOSZKO
Institute of History of the University of Łódź
A. Kamińskiego 27a
Pl-90-219 Łódź
Poland
mkokoszko@komandor.pl

MIROSŁAW J. LESZKA
Institute of History of the University of Łódź
A. Kamińskiego 27a
Pl-90-219 Łódź
Poland
mirleszka@poczta.onet.pl

ADRIAN MANDZY
Morehead State University
Morehead, KY 40351
USA
a.mandzy@moreheadstate.edu

GRZEGORZ PODRUCZNY
Collegium Polonicum
Adam Mickiewicz University
Kościuszki 1
Pl-69-100 Słubice
Poland
podruczny@amu.edu.pl

PIOTR STRZYŻ
Institute of Archaeology and Ethnology
of Polish Academy of Sciences
Tylna 1
Pl-90-364 Łódź
Poland
piotr_strzyz@wp.pl

JAN SZYMCZAK
Institute of History of the University of Łódź
A. Kamińskiego 27a
Pl-90-219 Łódź
Poland
jkszym@interia.pl

WITOLD ŚWIĘTOSŁAWSKI
Institute of Archaeology and Ethnology
of University of Gdańsk
Bielańska 5
Pl-80-851 Gdańsk
Poland
e-mail: swietoslawski@op.pl

JAKUB WRZOSEK
National Heritage Board of Poland
Archaeology Department
Szeroki Dunaj 5
Pl-00-255 Warszawa
Poland
jwrzosek@nid.pl, j.wrzosek@wp.pl

GRZEGORZ ŻABIŃSKI
Academy of Jan Długosz
Institute of History
Armii Krajowej 36a
Pl-42-200 Częstochowa
Archeo-Logos
ul. Mieszka I 30
Pl-41-106 Siemianowice Śląskie
g.zabinski@gmail.com