FASCICULI ARCHAEOLOGIAE HISTORICAE
FASC. XXXII, PL ISSN 0860-0007
DOI 10.23858/FAH32.2019.008

PIOTR STRZYŻ*

RECYCLING AND MODIFICATIONS OF FIREARMS IN CENTRAL EUROPE DURING THE MEDIEVAL AND POST-MEDIEVAL PERIOD

Abstract: Ancient firearms from both Medieval and Post-Medieval times were fairly often damaged in various ways. Depending on the degree of barrel damage, remains could be reused as material for making new weapons or, if the damage was minor, the weapon could be restored to full combat efficiency. Also in the case of obsolete specimens, attempts were made at modernising them e.g. by placing them on a new stock or mounting a newer type of lock. Lastly, we also see cases of barrel modifications which change the character of the weapon, e.g. from hand-held to light artillery. It seems that all these modifications were aimed at the immediate improvement of castle or town arsenals without investing significant amounts of money. Numerous examples to confirm such recycling are provided by finds of ancient firearms in museum collections in Central Europe.

Keywords: Central Europe, Medieval Period, Post-medieval Period, firearms, recycling

Received: 30.08.2019 **Revised:** 5.10.2019 **Accepted:** 11.10.2019

Citation: Strzyż P. 2019. *Recycling and Modifications of Firearms in Central Europe during the Medieval and Post-Medieval Period*. "Fasciculi Archaeologiae Historicae" 32, 117-128, DOI 10.23858/FAH32.2019.008

In the Middle Ages and later the value of a weapon was determined on the basis of not only the costs of manufacturing it but also the costs of raw materials used for its production. The labour of qualified armament craftsmen was highly valued and therefore any purchase of weaponry was very expensive, burdening the budget of any country, town or individual obliged to perform military service. It is also obvious that in turbulent times, with high threat of war, or during ongoing military operations the dilemmas related to purchasing military supplies were unreasonable – it was necessary to be as well-equipped as possible and costs were of secondary importance here. However, it was different during longer periods of peace – the modernisation of arsenals was not such an urgent matter. Therefore, people often settled for modifying older or slightly damaged weapons, as an alternative to purchasing new ones. This made it possible to maintain a satisfactory level of stock, with little loss of the equipment's combat value.

Literature on the subject frequently describes cases of recycling weapons. Remains of such activities are known from as early as the last phase of the Przeworsk Culture.[1] Numerous examples also come from the Middle Ages. Sometimes, as was the case with a kettle hat from the British Museum in London which was converted into a cauldron,[2] or a sword from Świebodzin, which was used to make a drawknife for removing bark from wood,[3] the transformation gave the weapon a new practical use.[4] In other cases, damaged weapons were used to produce new arms, which, for example, we see in sword blades reforged into spear heads or daggers.[5]

We observe transformations and repairs aimed at restoring a weapon to its full technical efficiency also in the case of medieval and post medieval firearms. Their intensive use brought about many dangers, since the main deficiency of both the earliest firearms and artillery was their low durability. This was caused by

* Institute of Archaeology, University of Łódź; http://orcid.org/0000-0001-6846-159X; piotr.strzyz@uni.lodz.pl

[1] For example, converting sword blades to spear heads, cf. Kontny 2019, 31, Fig. 12, further literature there.

[2] Edge and Paddock 1988, 134.

[3] Michalak and Wawrzyniak 2009, 201, 203, Figs. 4-5 and 7.

[4] See Žákovský and Schenk 2017, 23, Fig. 18.

[5] Michalak and Wawrzyniak 2009, Fig. 3:3.

many factors. Probably the most important included manufacturing defects in the form of air bubbles in cast bronze barrels or the low quality of forged iron barrels. Equally frequent as casting defects were design errors in the form of excessively thin barrel walls, which could not withstand the force of expanding powder gases. Another problem was incompetent operation, mainly the application of excessively powerful powder charges or the use of inappropriate (too strong) powder type with a barrel that was not designed for it.[6] Even one of the earliest mentions of using firearms in the Kingdom of Bohemia from 1383, found in the chronicle of Bishop John of Jenštejn, informs us that a marksman who wanted to shoot "de instrumento, quod pusska dicitur" was fatally wounded by fragments of torn barrel.[7] Incidents of this type occurred quite frequently, and were reflected in the pages of chronicles of those times, especially if fatalities were involved.[8] A number of examples which confirm the related dangers are also provided by iconography (Fig. 1).

Fig. 1. Explosion of a cannon. *Kriegstechnik*, ca. 1420-1440, Zentralbibliothek Zürich, Ms. Rh. Hist. 33b, fol. 163.

The degree of damage done to a given barrel could vary, from complete shattering into many fragments to damage of a small fragment of the bore or bottom. Thus, the degree of damage determined the possibility of repairing or recycling the material. With complete destruction, the only possible thing to do was to recast the remains as a new weapon. In the latter case, if the damage was not too serious, an attempt at restoring the weapon to its full efficiency could be made. With little effort and a slight deterioration of combat parameters, a fully operational weapon could be obtained. Another circumstance which must be mentioned is the phenomenon of converting older specimens of firearms, handheld ones in particular, to adapt them to new requirements on the battlefield.

Owing to the high price of raw materials used for manufacturing bronze barrels, i.e. copper, tin and lead, specimens which were no longer in use were recast into new, more modern ones (Fig. 2). The same was done to cannons destroyed by barrel bursting. In Bratislava in 1440 a large mortar was bought for 38.5 pounds of Viennese denars, and its weight could be about 73 centners (over 4 tonnes). The mortar was then, not without problems, broken into small pieces – as many as seven workers were employed on this task for two days. Their work had to be additionally supervised by a gunsmith, as it was necessary to use a large hammer and die and to heat the old barrel appropriately in order to facilitate its breaking.[9] Part of the raw materials prepared in this way was then used as furnace feed for casting a new cannon. When casting a cannon in the foundry in Cheb in 1452, the materials used for the new barrel included an old cannon, which had to be broken up by smiths. Here it was also necessary to heat the barrel.[10]

A large cannon, called "Chmelík", weighing about 3¼-3¾ tonnes, cast during the reign of Wenceslaus IV in Bohemia, also suffered a terrible fate. The cannon survived the turmoil of the Hussite Revolution, and later probably became part of the arsenal of the town of Tábor, which was mentioned by the commissars, Adam

[6] For more on this subject see Strzyż 2014b, 350-358, Figs. 2-6.

[7] Jan z Jenšteina, *Život*, 467-468: *Sed quidam, dum se praepararet ad iaciendum de instrumento, quod pusska dicitur, mox illa fracta et scissa iacere volentis unam aurem amputauit, et sequenti die a praesentibus per mortis sublationem vulneri, et spollis finem imposuit*; see also Kocurek 1974, 314.

[8] See, for example, Szymczak 2004, 91; Strzyż 2014a, 238-239; Strzyż 2014b, 351, 358-359; Žákovský and Schenk 2017, 52.

[9] Durdík 1957, 304, 315.

[10] Durdík 1965, 523: *Item geben dem Holbecken 13 gr 1 meissner fur pir den smiden, als man die pussgen zuslag* and *Item geben 11 gr fur 13 segk koln, als man die gross pugssen prach*. We have also certified this process for Dubrovnik. In 1452, a cannon was smashed there, using the raw material for a new barrel, adapted to shoot with a 250-pound shot, see Wilinbachow 1963, 222.

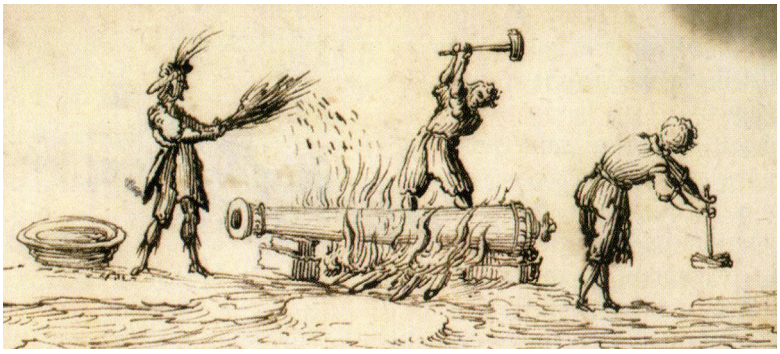

Fig. 2. Breaking up a cannon barrel in fire, drawing from early 18th century. After Volkay 2015, Fig. 7.2.

Řepický and Petr Bechyně, as "velikého moždiře, kterýž jméno má «chmelík» a jakž cejkmaistr V.K.M. praví, že mu zdá, že váží 70 centnéřů". However, in the 1560s the cannon was transported to Prague, and then to Kutna Hora. It was planned first to recover the silver added to the alloy used for its manufacture. It is difficult to determine whether that was done, but soon afterwards Archduke Ferdinand Habsburg decided to recast it into a new – singing – fountain for the royal gardens in Prague. This operation was to be performed by the imperial gunsmith Christopher of Schnepberg.[11] Another case was described in the Old Czech chronicles in 1513 "Toho dne novoměstský měšťan Bartoš, zvonař s puškařem Petrem ulili pro Staroměstské nový moždiř z toho, který praskl při zkušební střelbě".[12] For this reason barrels cast from bronze, so popular in the Middle Ages, have survived so rarely until the present day.[13] However, it was recommended in the casting process for the material acquired from older products (e.g. barrels, bells, etc.) not to exceed 10-20 pounds of scrap per 100 pounds of pure copper.[14]

Such a form of recycling is also most probably confirmed by source information which describes castle or town arsenals storing the remains of exploded barrels. In the description of property found in Brumově in Moravia, in addition to 48 *piszczel* guns "osm zlomkuov od piščel" were also mentioned.[15] At the end of the 15th century in the castle in Kamionka Strumiłowa (formerly Kingdom of Poland, currently Ukraine, Lviv Oblast), apart from several operational hackbuts, there was also one "roztargniona na kiju", and in 1532 in the castle in Olsztyn, besides 12 new hackbuts, the storage also included "antique bombarde alias *kye* 11, sed alique destructe".[16] The inventory made several years later for the castle in Lviv, includes among operational weapons also "hakownic starganych 2, spiże z zgorzałych dział sztuk 8".[17] These possibly completely destroyed specimens were collected as raw material, which could be used for casting or forging new barrels or weapons of a different type. Some other records reveal that non-operational cannons which might still be repaired were kept in storage. Such a collection is listed in the inventory of the castle in Tykocin in 1579, where next to a huge stock of artillery, hand-held firearms, ammunition, and various equipment, a separate paragraph lists "dział […] zepsowanych 5, z których się strzelać niegodzi, t.j. szarfmeca 1, falkon okrągły 1, kwaterszlanga 1, falkonet okrągły wielki 1, średni 1".[18]

A significantly greater ingenuity can be seen in the case of modifying only slightly damaged specimens. Damage types which qualified for repairing could include the following: explosion-torn muzzle part of the barrel or its powder chamber as well as a defect which occurred only in hackbuts, in the form of the hook breaking off.

One of the more interesting cases which illustrate these defects is an iron hackbut barrel found in the Museum in Sopron, Hungary (inv. no. 58.42.1), which could be dated roughly to the second half of the 15th century[19] (Fig. 3). The first defect which they tried to repair is the hook that was broken in half. It was shortened and filed, preserving its functionality. However, a careful examination of the find indicates that the Sopron hackbut was damaged to a much greater degree. This is shown by the disproportionally long muzzle part of the barrel in comparison with the fairly short chamber (powder) part. Thus, it seems that the chamber exploded when shooting, perhaps also tearing apart the entire bottom part. However, despite such serious damage, the weapon was not crossed out of the stock, but it was decided to repair it. The broken powder part of the barrel was removed (cut off) and the bottom was re-plugged with a tenon. An inventive smith also added a special spike (made as a separate element and hammered to the barrel) in the bottom part, which was designed for a more reliable fastening of the wooden shaft. In this essentially quite simple way, the hackbut could still remain in the stock of the town garrison's equipment.

[11] Tecl 2009, 344.

[12] *Ze starých letopisů*, 355; see also Žákovský and Schenk 2017, 52.

[13] Ustohal et al. 1991-1992, 159.

[14] Piaskowski 1982, 35.

[15] *Libri citationum*, 707, no. 1412.

[16] Górski 1902, 222, 242.

[17] Górski 1902, 223-224.

[18] Górski 1902, 246.

[19] Strzyż 2014a, no. cat. 165, Table LXI: 1-6.

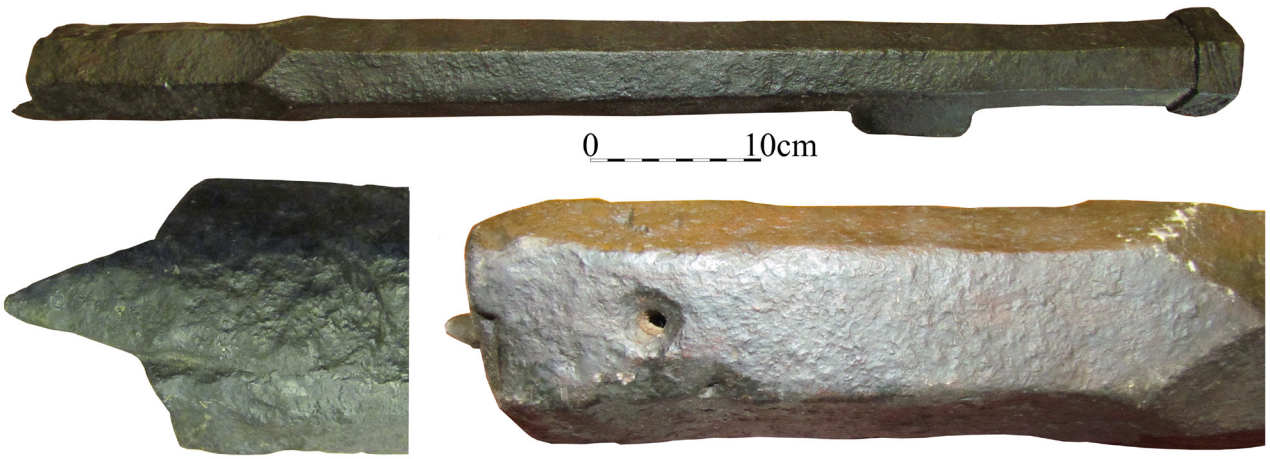

Fig. 3. Hackbut in the Museum in Sopron (HU) and signs of its repairs. After Strzyż 2014a, Table LXI.

Fig. 4. Example of progressing destruction of the barrel muzzle, hackbut from the Museum in Plzeň (CZ). After Strzyż 2014a, Table XXI:1-2.

Another frequent kind of damage, which was relatively easy to repair, was bursting of the muzzle part of the barrel (Fig. 4). It occurred very often, and was caused by insufficient reinforcement of this part of the barrel, which was exposed to the force of powder gases in no lesser degree than the powder chamber. Attempts at preventing this were made by using reinforcing rings in medieval specimens, and funnel-like widening in barrels from the Renaissance period.

However, once the damage was done, the procedure was very simple. All that had to be done was to cut off the damaged section, file the edges and the weapon was qualified for further use. Of course, depending on the length of the removed fragment, the combat parameters of the barrel deteriorated (among other things the initial velocity of the projectile decreased and, consequently, also the range of the cannon was reduced). However, the deficiencies were not significant.

A collection of weapons, which illustrates this method of repair well, is found in the Hungarian Xántus János Museum in Győr (Fig. 5). It includes barrels with circular as well as hexagonal cross-sections (inv. nos.: H. 60.359.1, H. 60.360.1, H. 60.361.1). What strikes us in this case is the fairly careless manufacturing, visible among other things in the unevenness of the internal bore. The touch hole is located at the top or moved to the right side, with a clear, round pan. All three specimens have cut-off muzzles, without a reinforcing ring. After this treatment, they were mounted on massive log-shaped stocks with the use of iron bands. On the basis of the location of the touch hole, their original manufacture time could be estimated as the second half of the 15th century and the first half of the 16th century,[20] but they could still have been in use after the 17th century.

The same method was used to repair the second preserved hackbut from the collection of the museum in Sopron (inv. no. 58.41.1), dated to the end of the 15th century. Now, this specimen has its muzzle cut off right at the hook.[21] The medieval fortifications of Sopron

[20] Strzyż 2014a, 66-67, nos. cat. 148, 149, 152, Tables LXIV: 5, LXV:1-3, LXVI:1-4, LXVII:1-5.

[21] Strzyż 2014a, 61, no. cat. 166, Table LVI: 1-3.

Fig. 5. Firearms with log-shaped stocks with shortened barrels, Xántus János Muzeum, Győr (HU). After Strzyż 2014a, Table LXIV:5.

Fig. 6. Hackbut with a replaced hook, Nový Hrad near Kopřivné (CZ). After Goš 2016, Fig. 3:1.

were very extensive, and a considerable part of them has been preserved until today. It consisted of a number of towers equipped with numerous arrow slits for hand-held firearms and larger roundel bastions designed as artillery posts.[22] With such a high demand for firearms, needed for equipping the fortifications, it should be no wonder that they attempted to restore all their less seriously damaged weapons to operational use.

In several specimens of iron hackbut we can see traces of attempted repairs of the hook, which absorbed the recoil of the weapon. Prolonged usage resulted in the possibility of its breaking off.[23] Repair methods were simple. The damaged element had to be removed and then a new hook was made of iron sheet and slid onto the barrel near its muzzle. Such a variant of repair was applied in one of the specimens from the collection of the Museum in Plzeň.[24] Unfortunately, during later maintenance this provisional repair was removed, restoring the original look of the hackbut.[25] It seems that the specimen found in Nový Hrad Castle near Kopřivné, Czech Republic may have been repaired in a similar manner.[26] Regardless of the method selected, a weapon repaired in this way regained its full combat parameters.

[22] See Holl 1967; Holl 1968.

[23] The broken-off hook is known from studies of the castle in Muszyna, see Strzyż 2014a, no. cat. 118, Table LXXI: 5.

[24] Sixl 1902, 265, Fig. 66:7, Table 1.

[25] Frýda 1988, 9, no. cat. 11, Fig. 11; Frýda 2007, 386, no. cat. 11; Strzyż 2014a, no. cat. 31, Table XX: 4-9.

[26] Goš 2002, 185-186; Goš 2016, 283, Fig. 3:1.

Fig. 7. Hackbut from the collection of the museum in Sibiu (RO). After Strzyż 2014a, Tables XXXVIII:5-8 and LIII:6-8.

However, the largest group of firearm barrels subjected to modifications are the finds without basically any damage, which were adapted to new functions. This consisted in modernising the weaponry as well as changing the method of use from hand-held to artillery.

Some remarkable specimens from this group include the hackbut in the Brukenthal National Museum in Sibiu, Romania (inv. nos.: M3680, M3778, M3779). Originally, their bottom parts were fitted with a socket to accommodate a wooden shaft (Fig. 7). Because of this, such hackbut were fired as the marksman held the wooden shaft under his arm.[27] In three of the above hackbut, while they were stored and fully operational, the mounting was later modernised. The sockets for the wooden shafts were cut off and the bottoms are currently flat, without any redundant elements. However, a visible mark remains after this treatment – the partially preserved fold of the socket. The modification allowed the barrel to be mounted on a newer stock with a well-formed butt. However, in order for such a connection to be possible, an opening was made in the hook to fit a wooden pin, designed for stabilising the connection between the barrel and the stock. What is equally important, later, thanks to the modernised stock, it was possible to equip the weapon with a simple matchlock, which released the marksman from the necessity to touch the igniter pad with a smouldering match. Here this was done automatically and the shooter was able to focus on aiming, which was also facilitated by the presence of simple aiming devices.[28] The form of the lock leads us to believe that the described modifications were introduced in the early 16th century, and thanks to them the hackbut constituted valuable weapons until the end of the century.

The same method was used to convert a hackbut from the collection of Kopidlno Castle, currently stored in the Vojenský Historický Ústav in Prague. It is dated to the first half of the 15th century[29] but the applied improvements probably prolonged its usefulness until the late 15th century or even longer. The possibility that some hackbut from the Museum in Pilzň were later

[27] Strzyż 2014a, 51-53, no. cat. 137, Table LIII:1-5.

[28] Strzyż 2014a, 61, nos. cat. 136, 138, 139, Tables XXXVIII:1-8 and LIII: 6-8.

[29] Durdík et al. 1986, 74, no. cat. 63; Čepička and Dolínek 1991, 18, Fig. 15; Dolínek and Durdík 1993, 179, Fig. 209; Strzyż 2014a, no. cat. 13, Table LV:4.

Fig. 8. Hackbuts converted into light field cannons, Český Šternberk Castle (CZ). Photo P. Strzyż.

mounted on newer stocks and equipped with simple matchlocks also cannot be ruled out.[30] However, in their current state they have none of these improvements.

The above treatments applied in order to restore obsolete hand-held firearms to full functionality are backed up by the sources of the times. The stock list of the castle in Stará Ľubovňa in Slovakia drawn up in 1553 confirms this. The castle in Stará Ľubovňa was then a part of Spiš County, which was pledged by Sigismund of Luxemburg to the king of Poland in 1412 and remained under Polish administration almost until the 18th century Partitions of the Polish-Lithuanian Commonwealth. This castle had "w izbie nad sklepem nowym […] hakownic starych przedziałanych 24", whereas "w izbie u bramy […] hakownic nowych 31, półhakownic nie nowych 10, hakownic przedziałanych 16".[31]

Another interesting group of modified barrels are the weapons from the collection of arms in the Český Šternberk Castle in the Czech Republic (inv. nos.: 336/394 CS 987, 337/395 CS 998, 342/b CS 988, 342/341 CS 997).[32] The firearms were initially hackbuts, forged from iron (Fig. 8). Their muzzles have slight funnel-like widening, which was supposed to provide effective protection from bursting of this part of the barrel. In each of these specimens, the touch hole is located on the right side and was initially accompanied by a rectangular pan plate with a hollow for the igniter. The bottoms of these hackbuts are plugged with a characteristic prism-shaped tenon, screwed into the barrel. The preserved specimens are fitted with aiming tools: a cylindrical front sight and

[30] Sixl 1902, 265, Fig. 66: 10-11.

[31] Górski 1902, 243: *In the chamber above the new soreroom there are 24 dismantled old hackbuts*. […] *In the chamber by the gate there are 31 new hackbuts, 10 semi- hackbuts that are not new and 16 dismantled hackbuts*.

[32] The author would like to thank the Management of Český Šternberk Castle for the possibility to document the abovementioned finds.

Fig. 9. Terrace gun from the first half of the 15th century, mounted on a carriage from the 16th century, Český Šternberk Castle (CZ). After Strzyż 2014a, Table LXXVI.

a cuboid rear sight with a notch. The barrels were fitted with hooks in their muzzle parts to absorb the recoil. There were openings in the hooks designed to form a better connection between the barrel and the stock. The total length of these specimens is 99-100 cm and 132.5-138 cm, and the calibre ranges from 2.2 to 2.7 cm.[33] The design features of the weapons, particularly the touch hole, allow for their manufacture time to be estimated at the first half of the 16th century.[34]

At an unknown moment, the castle owners decided to adapt their arquebuses to fulfil a new function. For this, the touch holes were plugged and the pan plates were removed. The new touch holes were made in an artillery manner – vertically at the top. Later, the hooks were removed. The modified barrels were set upon carriages, and fastened using three iron bands. In this way, four light cannons were made, which could be used throughout the 16th and some time into the next century. Although their calibre was only 2.2 to 2.7 cm, the carriages certainly made a more menacing impression than their original form. Thanks to this treatment they became more versatile in use. They could be utilised during field operations, without the need to lean the barrels against the side of a wagon or portable field fortifications.

It seems that in the 16th century, the owners of Český Šternberk Castle realised the need to modernise their arsenal, but they were not able to invest a sufficient amount of money in this objective. Probably, at the same time as the hackbuts we have described were converted, the Castle's owners also decided to modernise the older artillery. The castle also owned two terrace guns, made probably in the first half of the 15th century[35] (Fig. 9). The first of them (inv. no. 340/395 CS 967) has an octagonal barrel, with a prominent ring at the muzzle, and a massive hook hammered to the bottom. The touch hole is located at the top, with a triangular pan mounted around it. With the length of 90 cm, the calibre of this specimen is only 2.8 cm. The other cannon (inv. no. 338/378 CS980) is also octagonal in cross-section, with a slightly widened muzzle. The touch hole is located at the top, but has no pan. The bottom is massive and considerably thickened. This specimen's length is 83.5 cm and it fired projectiles of 4.4 cm in diameter.[36] Originally, the barrels were probably mounted to classical log-shaped stocks, fitted with arched elevating mechanisms.[37] In the 16th century, such a form of carriage was completely outdated, so in order to take advantage of the still functional weapons, they were mounted on wooden carriages. The barrels were fitted onto wooden blocks, hollowed to match the shape of the cannon, using iron bands additionally. In this way, they were converted into two light field cannons, although their actual combat parameters in this case might be considered as dubious to say the least.

A shift in the function of the weapon can be observed in the case of a veuglaire from the Museum in Znojmo, Moravia (Fig. 10). Veuglaires are a peculiar type of medieval and early Renaissance artillery because, unlike other types of cannons from that period, their barrels were breech-loading, using an appropriately adjusted and replaceable powder chamber.[38]

The chamber from Znojmo is forged from iron and its internal bore widens conically so that the muzzle diameter is 6.5 cm. The total length of this specimen is

[33] Pertl 1985, 131, 136, Figs. 3-6.

[34] Cf. Strzyż et al. 2017, 100-101, Figs. 3-5. M. Pertl (1985, 136) dated them to the last third of the 15th century, which, owing to the way the bottom part and the touch hole were shaped does not seem correct.

[35] Strzyż 2014a, 75. M. Pertl estimates the time of their manufacture to the 1420s and 1430s., see Pertl 1983, 312-313; Pertl 1985, 136.

[36] Strzyż 2014a, 74.

[37] Cf. Strzyż 2014a, 82-83, Fig. 9:1-2, further literature there.

[38] Szymczak 2004, 55-56; Strzyż 2014a, 92-93, Fig. 14.

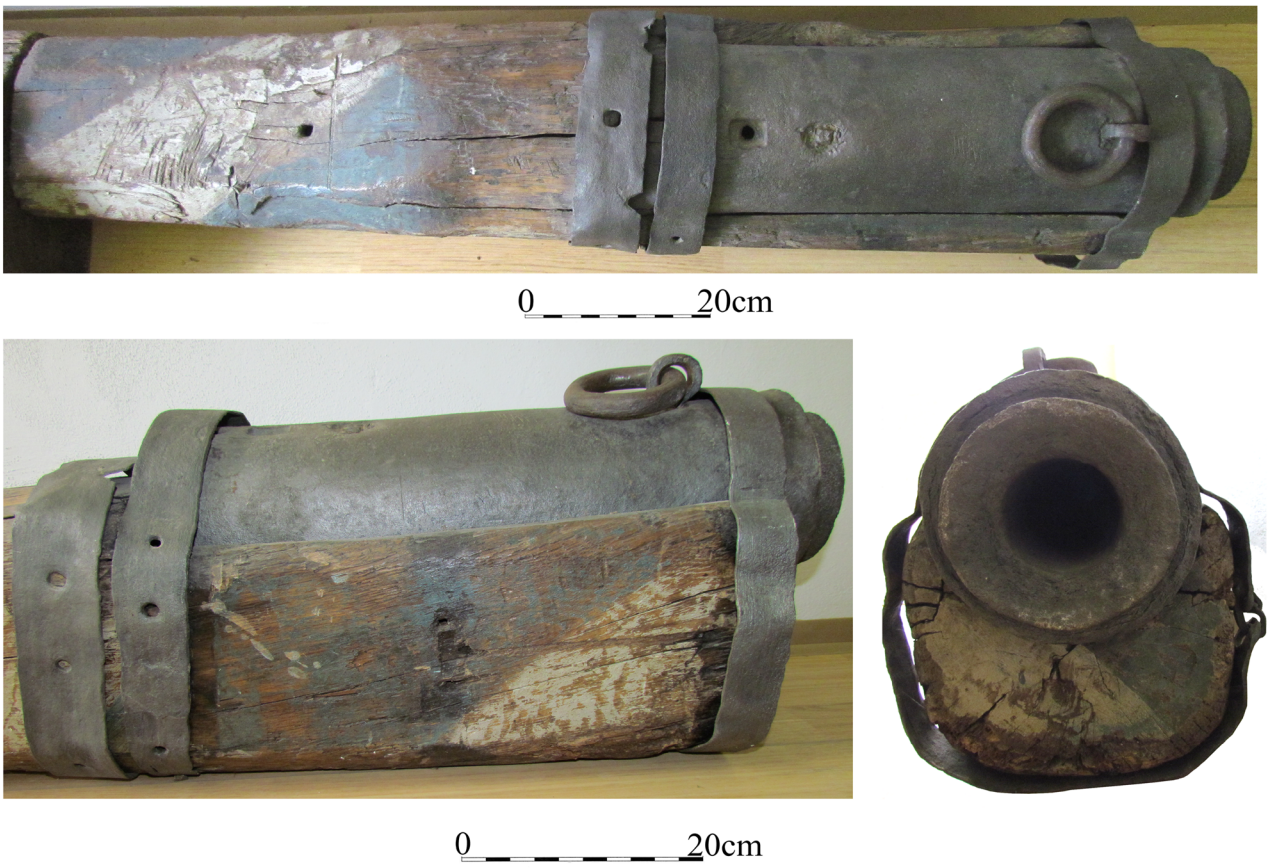

Fig. 10. Chamber of a veuglaire, converted to a cannon, Znojmo (CZ). After Strzyż 2014a, Table LXXXVIII.

48.4 cm, of which the powder bore alone is 42 cm long, and the original diameter of its chamber was about 13 cm. The touch hole is located at the top, and it is fitted additionally with an oval pan for the igniter. In the upper part of the barrel, there was a loop with a wire ring to facilitate lifting this quite heavy chamber using ropes or poles. Also in front of the pan, there is a visible mark left after another loop with a ring, which must have been torn off. The chronology of this specimen was estimated as the first quarter of the 15th century,[39] but it seems more probable that it was the first half of the 15th century.[40]

Important modifications were introduced in a later period, probably already in the 16th century, which is seemingly confirmed by the remains of a Renaissance style of painting in white and blue oblique stripes. It was at that time that the useless or withdrawn from use chamber was mounted to a wooden block with three iron bands. The fact of remounting the chamber on a wooden stock, with a view to using it as a cannon, is particularly interesting. From the practical point of view, it can be assumed that such a weapon could be functional, as the length of the internal bore of around 42 cm is similar to the lengths of bores in light field cannons from the 15th century.[41] The conical shape of the bore certainly resulted in reduced range and insufficient accuracy of the shot. However, this did not deny the combat value of such a cannon in any way, although it is difficult to say whether it was actually ever used in combat.

The modification of the function of a barrel function and repairs to the weapon are represented by an iron barrel stored in the Castle Museum in Malbork (Fig. 11). Originally, the weapon was constructed as a hackbut but it was damaged during use – the muzzle part burst. The damage was repaired but at the same time it was decided to modify the function of the barrel. By adding iron side tenons, stabilised with a ring, it was adapted to the function of a light cannon of the terrace type, or rather even a falconet, as the tenons allowed its mounting on a wall stock and easy adjustment of the barrel elevation. The touch hole located on the right side was plugged and the pan plate was removed. The touch hole was moved to the top of the barrel, in the same way as in the specimens from Český Šternberk Castle. Additionally, in order to

[39] Durdík 1955, 88-91; Chamonikola 1999, 579, cat. 301.

[40] Strzyż 2014a, 95-96, no. cat. 72, Table LXXXVIII: 1-5.

[41] Cf. Szymczak 2004, 60-61; Strzyż 2014a, 84.

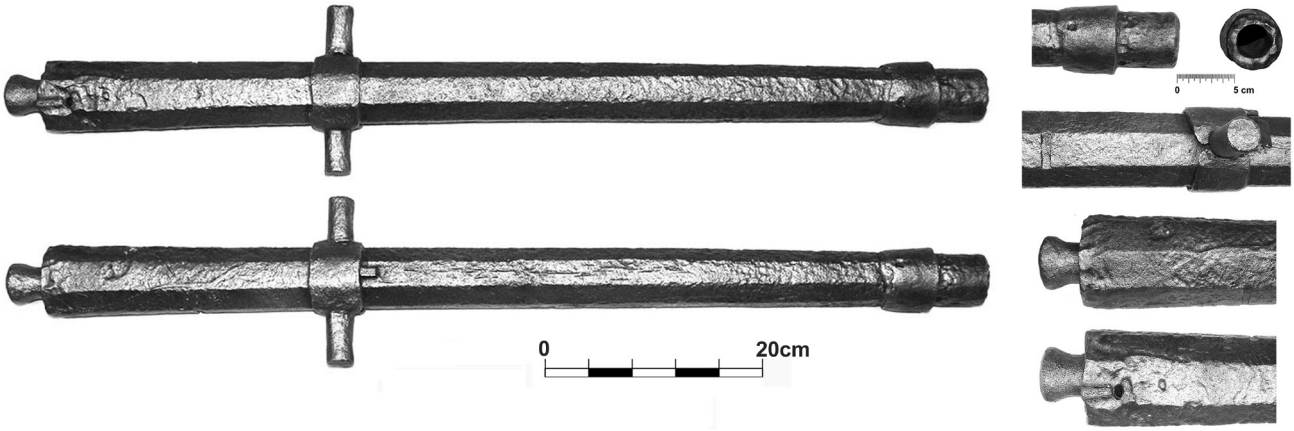

Fig. 11. Hackbut converted into a light field cannon. Castle Museum in Malbork. After Żabiński et al. 2019, Figs. 1 and 2.

prevent similar damage in the future, the muzzle was reinforced by adding an iron ring, which was made as a separate element and slid on the barrel near the muzzle. All the other small elements were also removed, such as the loops used to connect the barrel to the stock or the aiming devices. All that is left of them are some rectangular recesses. Also in this case, the resulting cannon did not have an impressive calibre, which was only 2.8 cm and allowed for projectiles between 91 and 145 grams to be used, depending on the material they were made of – iron or lead.[42]

It seems that the main factor which induced the recycling and repairs described above was the financial one. Firearms, despite their considerable popularisation in the second half of the 15th century, and the related reduction of prices of ready-made products, were still quite expensive. The price of a barrel alone depended on its size (calibre), which resulted from the amount of material that had to be used to make it and the amount of labour of a qualified bellfounder or smith. The expenses were disproportionately high in relation to those required to restore slightly damaged specimens to full combat efficiency. It is also not without significance that such repairs could in most cases be performed by a regular local smith and not a highly-qualified gunsmith from a remote production centre.

Sources

Jan z Jenšteina, *Život – Život Jana z Jenšteina, arcybiskupa Pražského*. Fontes Rerum Bohemicarum 1. ed. J. Emler. Praha 1873.

Kriegstechnik – Kriegstechnik, Zentralbibliothek Zürich, Ms. Rh. Hist. 33b, http://www.e-codices.unifr.ch/de/searchresult/list/one/zbz/Ms-Rh-hist0033b. Available on-line 20.08.2019.

Libri citationum – Libri citationum et sententiarum seu Knihy půhonné a nálezové 3, *Půhony Olomucké 1437-1448*. ed. V. Brandl. Brunae 1880.

Ze starých letopisů – Ze starých letopisů českých, eds. J. Porák, J. Kašpar. Praha 1980.

Bibliography

Čepička L., Dolínek V. 1991. *Výběrový katalog expozice voenského historického muzea*. Praha.

Chamonikola K. (ed.) 1999. *Od gotiky k renesanci. Výtvarná kultura Moravy a Slezska 1400-1550*. Brno.

Dolínek V., Durdík J. 1993. *Encyklopédie des armes*. Paris.

Durdík J. 1955. *Znojemské puškařství v první třetině 15. století*. "Historie a vojenství" 1, 52-99.

[42] Żabiński et al. 2019, Figs. 1-2.

Durdík J. 1957. *Pracovní postupy v bratislavské puškařské huti v 1. polovině 15. století*. "Historie a vojenství" 3, 301-327.
Durdík J. 1965. *Palné zbraně a puškaři v Chebu v letech 1450-1470*. "Historie a vojenství" 4, 513-545.
Durdík J., Dolínek V., Šáda M. 1986. *Vzácné zbraně a zbroj ze sbírek Vojenského muzea v Praze*. Praha.
Edge D., Paddock J.M. 1988. *Arms and Armour of the Medieval Knight. An Illustrated History of Weaponry in the Middle Ages*. New York.
Frýda F. 1988. *Plzeňská městská zbrojnice* 1. Plzeň.
Frýda F. 2007. *Plzeň, středověká městská pevnost a její zbrojnice*. In: M. Drda, Z. Vybíral (eds.), *Jan Žižka z Trocnova a husitské vojenství v evropských dějinách. VI. Mezinárodní husitolologické symposium, Tábor 12.-14. října 2004*. Husitský Tábor – Suplementum 3. Tábor, 379-393.
Goš V. 2002. *Archeologové na Novém Hradu u Kopřivné na Šumpersku*. "Vlastivědný věstník moravský" 54, 183-187.
Goš V. 2016. *Nálezový soubor z Nového Hradu u Hanušovic. Etuda z archeologie všedního dne*. "Pravěk. Nová řada" 24, 265-294.
Górski K. 1902. *Historya artyleryi polskiej*. Warszawa.
Holl I. 1967. *Sopron köépkori városfalai. Jelentés az 1961-64. évi ásatásokról*. "Archaeologiai Értesítö" 94, 155-183.
Holl I. 1968. *Sopron köépkori városfalai* 2. "Archaeologiai Értesítö" 95, 188-205.
Kocurek L. 1974. *Vojenská technika*. In: L. Nový (ed.), *Dějiny techniky v Československu [do konce 18. století]*. Praha, 307-320.
Kontny B. 2019. *Archeologia wojny. Studia nad uzbrojeniem barbarzyńskiej Europy okresów wpływów rzymskich i wędrówek ludów*. Oświęcim.
Michalak A., Wawrzyniak P. 2009. *Między bronią a narzędziem, czyli w co przekuto miecz ze Świebodzina?* "Acta Militaria Mediaevalia" 5, 197-212.
Petrl M. 1983. *Dělostřelecké hlavně z počátku 15. století z hradu Český Šternberk*. "Archeologické rozhledy" 24 (3), 312-314, 351-352.
Petrl M. 1985. *Nejstarší palné zbraně ze sbírek hradu Českého Šternberka*. "Sborník vlastivědných prací z Podblanicka" 25, 129-137.
Piaskowski J. 1982. *Technologia odlewania luf armatnich w XVI-XVIII wieku*. "Przegląd Odlewnictwa" 32, 32-36.
Sixl P. 1902. *Entwickelung und Gebrauch der Handfeuerwaffen*. "Zeitschrift für historische Waffen- und Kostümkunde" 2 (1900-1902), 264-269.
Strzyż P. 2014a. *Broń palna w Europie Środkowej w XIV-XV w*. Łódź.
Strzyż P. 2014b. *Słabości średniowiecznego odlewnictwa broni ogniowej. Wybrane spostrzeżenia z terenu Europy Środkowej*. In: M. Bis, W. Bis (eds.), *Rzeczy i ludzie. Kultura materialna w późnym średniowieczu i w okresie nowożytnym. Studia dedykowane M. Dąbrowskiej*. Warszawa, 349-360.
Strzyż P., Dzieńkowski T., Gołub S. 2017. *Hakownice z ratusza w Chełmie. Przyczynek do znajomości środkowoeuropejskiej ręcznej broni palnej w XVI stuleciu*. "Acta Archaeologica Lodziensia" 62, 99-107.
Szymczak J. 2004. *Początki broni palnej w Polsce (1383-1533)*. Łódź.
Tecl R. 2009. *Palná výzbroj města Tábora v 15. a prvé polovině 16. století*. "Husitský Tábor" 16, 343-347.
Ustohal V., Stránský K., Hanák V. 1991-1992. *Hákovnice ze slovácké půdy*. "Slovácko" 33, 159-170.
Volkay M. 2015. *Artylerya Nasvishskaga zamka*. Minsk.
Wilinbachow W. 1963. *Początkowy okres rozwoju broni palnej w krajach słowiańskich*. "Kwartalnik Historii Nauki i Techniki" 8 (2), 215-235.
Żabiński G., Biborski M., Miśta-Jakubowska E. A. 2019. *A Late Medieval or Early Modern Gun Barrel from the Castle Museum in Malbork – Typology, Technology of Manufacture and Identification of the Smelting Process*. "Archaeological and Anthropological Sciences" 11 (5), 2007-2026.
Žákovský P., Schenk Z. 2017. *Středověké a raně novověké zbraně Přerovska. Zbraně a zbroj od kolapsu Velké Moravy do konce třicetileté války*. Přerov, Brno.

Streszczenie

Recykling i modyfikacje broni palnej w średniowieczu i nowożytności w Europie Środkowej

Dawna broń palna, zarówno średniowieczna, jak i ta renesansowa, dość często ulegała różnego rodzaju uszkodzeniom. Do najbardziej istotnych czynników należały niedoróbki produkcyjne w postaci pęcherzy powietrza w odlewanych lufach brązowych lub słaba jakość kutych luf żelaznych. Równie często występowały błędy konstrukcyjne – zbyt cienkie ściany lufy, które nie były w stanie wytrzymać siły działania gazów prochowych.

W zależności od stopnia zniszczenia lufy, jej pozostałości można było wykorzystać wtórnie przede wszystkim jako komponent w produkcji nowej broni. Było to spowodowane wysoką ceną surowców używanych do produkcji luf brązowych, czyli miedzi, cyny i ołowiu. Wychodzące z użytku okazy przetapiano zatem na nowocześniejsze egzemplarze, jak np. w 1440 r. w ludwisarni w Bratysławie oraz w 1452 r. w Chebie, zaś działo z czasów Wacława IV zwane „Chmelík" w 2. poł. XVI wieku przetopiono na fontannę.

Jeśli uszkodzenia nie były zbyt duże, można było próbować przywrócić broni pełną sprawność bojową. Uszkodzenia, które kwalifikowały się do naprawy mogły być następujące: rozerwanie wybuchem wylotowej części lufy lub jej komory prochowej. Tego rodzaju przeróbki dokumentują okazy z Sopronu – odcięcie rozerwanej komory prochowej oraz zabytki z Győr, w których odcięto części wylotowe. W przypadku hakownic z Pilzna i Nového Hradu koło Kopřivné wymieniono uszkodzone, oderwane haki. Z kolei w przypadku przestarzałych egzemplarzy, często próbowano je unowocześnić. Zwykle było to odpowiednie przerobienie i osadzenie w nowym łożu starszych luf, czasami połączone z zastosowaniem nowszego rodzaju zamka. W tej grupie mieszczą się m. in. trzy XV-wieczne hakownice z siedmiogrodzkiego Sybina, usprawnione tak w początkach XVI wieku. Wreszcie, spotykamy się także z modyfikacjami broni, zmieniającymi charakter oręża. W przypadku foglerza Muzeum w Znojmie, jego komorę wykorzystano do skonstruowania działa w rodzaju hufnicy. Bardziej zaawansowane prace wykonano przy przeróbkach hakownic znajdujących się na zamku Český Šternberk, wykonanych zapewne w 1. poł. XVI wieku. W tym celu ich dotychczasowe otwory zapłonowe zaślepiono, usuwając też przy tym płytki panewek. Nowe zapały wykonano na sposób artyleryjski – pionowo u góry. W dalszej kolejności usunięto haki amortyzujące odrzut. Tak przygotowane lufy zamocowano do łoży kołowych z wykorzystaniem żelaznych taśm. Uzyskano tym samym cztery lekkie działka polowe. Prawdopodobnie w tym samym czasie, w XVI wieku na lawetach kołowych ustawiono też dwie znajdujące się na zamku stare taraśnice z 1. poł. XV wieku.

Interesujący jest też przypadek żelaznej lufy z Muzeum Zamkowego w Malborku. Pierwotnie broń wykonano jako hakownicę, jednak w czasie jej używania nastąpiło rozerwanie jej części wylotowej. Uszkodzenie to naprawiono odcinając zniszczony wylot, ale jednocześnie zdecydowano się lufie nadać inną funkcję. W tym celu dodano żelazne czopy boczne, co dostosowało lufę do roli lekkiego działa, bowiem czopy umożliwiały jej umieszczenie w łożu ściennym i łatwą zmianę kąta podniesienia. Z pracami tymi łączy się też zaczopowanie starego otworu zapłonowego i przeniesienie go na górę lufy.

Jak się wydaje wszystkie te działania miały na celu doraźne poprawienie wyposażenia arsenałów zamkowych lub miejskich bez wydawania na ten cel znaczniejszych sum pieniędzy. Praca wyspecjalizowanych rzemieślników zbrojeniowych była ceniona, stąd też wszelkie zakupy uzbrojenia stanowiły niemały wydatek. Tak oszczędnościowo pomyślana modernizacja arsenałów pozwalała na utrzymanie stanu posiadania na zadowalającym poziomie, przy niewielkiej utracie wartości bojowej sprzętu.