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CANNONS OF THE LATE 18TH – EARLY 19TH CENTURIES FROM THE FORTRESS OF KURESSAARE AND THEIR CONSERVATION

JÜRI PEETS
Tallinna Ülikool, Ajaloo Instituut (Tallinn University, Institute of History), Rüütli 6, 10130 Tallinn, Estonia; jyri.peets@ai.ee

INTRODUCTION

While clearing the moat of the Kuressaare fortress at the end of the Soviet time, six cannons cast in the late 18th – early 19th centuries were discovered. These were mechanically cleaned from surface corrosion and placed in front of the castle. After some time extensive corrosion damage was noted, and immediate conservation was required.

Conservation was undertaken in autumn 2011. Salts were removed by hot sublimation. High temperature was provided for 8–10 hours by burning timber in a large stack. After heating the cannon barrels were cleaned with sand sprays and covered with tannin solution. A coat of protective layer suitable for outdoor conditions is yet to be applied to the cannons. The experiment, a success on the whole, proved that basic conditions for the conservation of large iron objects can be achieved also in field conditions.

HISTORICAL BACKGROUND

According to the Brömsebro peace treaty of 1645 Saaremaa was given under the rule of Sweden. In 1684 the Swedes decided to modernize the fortress of Kuressaare once again. Inspired by the ideas of French fortification engineers the military architects Erik Dahlberg and Paul von Essen drew a project, and the new bastions, preserved to the present day, together with the ravelins were built (Pesti & Rikas 1983). Somewhat earlier, after the bishop of Saaremaa and West-Estonia Johannes V Münchhausen had sold his domains in Saaremaa and Curonia to the Danes at the outbreak of the Livonian War (1559), the fortification system of Kuressaare had been also modernized. The new buildings were surrounded with a moat, about 30 m wide, filled with sea water. In the course of clearing the moat at the end of the Soviet period six cast-iron cannons from the late 18th – early 19th centuries were found there.

While most of the *ca.* 50 medieval stone castles on Estonian territory were demolished during the wars of the 16th and 17th centuries, Kuressaare castle was not influenced by military actions until the Great Northern War. The war reached the castle on 15 September 1710, when the Swedish garrison, devastated by the plague, surrendered the castle to the Russian troops without resistance. The following spring the

Russian troops withdrew from the island, practicing the tactics of 'burnt land' (Pesti & Rikas 1983). Although the ruined convent building was deleted from the list of fortifications of Russia in 1783, the bastions and the curtains were still modernized once more at the end of the 18th century. The thickness of the supporting walls was increased and the slopes of the embankments and moats were lined with hewn dolomite blocks. But such busy military construction activities and a seeming rebirth lasted for a very short period – in 1834 Kuressaare was completely deleted from the list of fortifications of the Empire and two years later the whole castle-fortress was sold to the Knighthood of Saaremaa for 3000 roubles (Pesti & Rikas 1983). The following decades were catastrophic: the fortress was used as a quarry. Due to recent renovation the building material was still strong and it was easy to sell the stones at profitable prices to townsmen and others during a construction boom (Basihhina *et al.* 1999, 17–20). Changes for the better, however, took place already in the second half of the 19th century, and they were particularly effective at the beginning of the 20th century. In 1904–1912 the convent building was repaired and adjusted for the office and representation quarters. In the last decades of the Soviet time the convent building was thoroughly renovated to the projects of architect Kalvi Aluve. The archaeological investigations in progress, directed by archaeologists Garel Püüa and Tõnu Sepp, have provided new information about the architecture of the fortifications (for an overview on research history and recent investigations see Püüa *et al.* 2012 and Püüa *et al.*, this volume), and, thanks to the commitment of Endel Püüa, director of the Saaremaa Museum, and his success in securing the necessary funding, the historic appearance of the fortress is being restored.

THE CANNONS OF THE KURESSAARE FORTRESS

How and why the cannon barrels appeared in the moat? At the time of closing the Kuressaare fortress could have had a couple of hundred cannons of various calibre, age and state of condition. Apparently the cannons of the fortress, their ammunition, spare parts, workshops, etc. were taken apart and transported to a place from where they were taken to other fortresses or armouries of the Empire.

The evacuation of cannons from Kuressaare started already in 1831, when some of the cannons, ammunition and technical equipment were taken to the island of Åland. Their new location was to be the fortress of Bomarsund (Aluve 1980, 51).

Problems arose with weapons in a poor state – e.g. cannons with carriages missing or dilapidated that complicated their transport. Since the order from the headquarters evidently commanded the evacuation of all the artillery, it was decided to solve the problem by drowning the troublesome items in the moat. This way the 'veteran cannons' fell into the 'missing' category until they were found 150 years later (Fig. 1).

As mentioned above, six more or less identical cast-iron cannons, about 2.10 m long and weighing half a ton each, were found. The inner diameter at the muzzle of all the cannons is 9 cm, which roughly corresponds with the diameter of 6-pound cast-iron cannonballs. Almost all cannon barrels bear traces of bullets, canister shots or cannonballs, scratches by shell splinters, a broken carriage tenon, etc. (e.g. Fig. 2). They may include also trophy weapons. One cannon originates most likely from France, deciding by the letters 'N' of Napoleon's monogram on the ends of the carriage tenons.[1] It may

[1] Carriage tenons are protruding pegs, about 10 cm long, in the middle of a cannon barrel, meant mainly for attaching the barrel to the carriage (support function). The tenons also allow to move the barrel vertically, e.g. for aiming (axis function).

Fig. 1. 'Moat cannons' of Kuressaare in front of the convent building on 15 Nov. 2011.
Jn 1. Kuressaare "kraavisuurtükid" lähtepositsioonil konvendihoone ees 15.11.2011.
Photo / Foto: Kristjan Sisa

Fig. 2. Several cannons had 'battle scars'. In the foreground the cannon with the imperial monogram or manufacturing mark on the carriage tenon of the cannon.
Jn 2. Paljudel suurtükkidel olid "lahinguarmid". Esiplaanil keiserliku monogrammi või vabrikumärgiga suurtükk.
Photo / Foto: Jüri Peets

also be a manufacturing mark. Another cannon, which is in a better state of preservation than others, has the initials of the Russian empress Catherine II – EA (Ekaterina Aleksejevna) (1762–1796) hewn a little above the touchhole.

Since the cannons are very similar to each other by their calibre, shape and proportions, they all follow the design dictated by the production technology, optimal utility possibilities and endurance demands of the period, we may assume that their production date was also about the same – the second half of the 18th – beginning of the 19th century.

CONSERVATION OF THE CANNONS

Testing the method: the cannons of the Bishop's castle of Haapsalu

After the discovery the cannon barrels were mechanically cleaned of mud and most of the surface corrosion (rust) (with water, steel brush, hammer, chisel, etc.) and coated with linseed oil. Nevertheless, it was clear from the beginning, after the discovery of the cannons, their preliminary cleaning and placing them on carriages in front of the main gate of the castle, that the corrosion of the metal was not only superficial, but had spread also deeper. The crystallization of salts in the micro-cracks of the material would sooner or later cause them to break.

Since I worked as a conservator of archaeological objects at the Institute of History of the Academy of Sciences in 1980–1985, and at times practiced it also later, I had repeatedly discussed the matter with the conservator of the Estonian Art Museum Eerik Põld (1908–1995) since summer 1982.[2] After the discovery of a large set of weapons including cannons, *Hakenbüchse*, ammunition, etc. in the ruins of a tower of the Bishop's castle of Haapsalu in 1989 I informed him about the find. We discussed also about the cast-iron cannon and anchor of the Swedish battleship 'Riksens Ständen' (which ran aground near the island of Aegna during the seafight at Reval/Tallinn (13 May 1790)) standing in the public garden beside the Central Library of Tallinn since autumn 1897. E. Põld recalled that after lifting up from the sea the cannon and the anchor had been placed on a pile of old railway sleepers, burnt to red glow and kept so for hours. After cooling down they had been cleaned from rust and coated with fish-liver oil (Fig. 3).

Fig. 3. Cannon and anchor of the Swedish warship 'Riksens Ständen' displayed by the Central Library of Tallinn.
Jn 3. Rootsi liinilaeva "Riksens Ständeni" suurtükk ja ankur Tallinna Keskraamatukogu kõrval haljasalal.
Photo / Foto: Liina Maldre

Since the work on the Haapsalu find complex was discontinued and the state of the finds deteriorated, the unconserved objects and those with conservation defects, as well as technologically interesting weapons, were taken to the laboratory of the Institute of History, Tallinn University in autumn 2008, for conservation and further scientific studies.

[2] Eerik Põld, who studied ethnography and arts, had attended the workshop of conservation of archaeological objects supervised by the head conservator of the National Museum of Sweden E. Sörling in spring 1925 (Lõugas 1988, 13) and worked as a conservator at the Estonian National Museum since 1937 (see also Mäesalu & Peets 2010, 218; Peets 1989, 29–30).

I had already previously read and heard from the colleagues-conservators from the Nordic countries, particularly from Finland, about the conservation of large marine-archaeological finds (cannons, anchors, ship details, etc.) in industrial gas furnaces, so I decided to try the conservation scheme based on hot sublimation[3] for cleaning the finds and elimination of salts in the micro-cracks of the objects. For cleaning archaeological objects from rust and salts (mainly chlorides) various conservation methods based on hot sublimation were used in the 19th century as well as in later times. Mostly common smithy forges were used, where the objects were heated to red glow and then cooled down in water or linseed oil, usually a number of times (Rathgen 1898, 86–95). Choosing of a suitable resolution was easy since with the emergence of the problem I instantly recalled the conversations with E. Põld, the cannon and anchor of 'Riksens Ständen' and the pile of old railway sleepers. For performing the task we got permission to use the bonfire of the Midsummer Eve 2010 of the Eha farm in the village of Sipa, Läänemaa, which, beside its 'routine task' also had to play the part of a conservation 'device'.

After cooling the object (cannon) for about a day it was cleaned from loose rust with a brush and rotor-brush, followed by surface treatment with 10% tannin solution in water and ethanol (ratio usually 1:2). Other weapons were conserved in a similar process, but they were heated with gas blowpipes. Still sizzling hot objects (*ca.* 200 °C) were coated with paraffin (Fig. 4). The experience gained and the analysis of the whole process I decided to apply also for the conservation of the Kuressaare cannons.

Conservation of the cannons of the Kuressaare fortress

Initially I intended to start the conservation in summer 2010, concurrently with the archaeological excavation of the Salme complex, but due to financial reasons the work was postponed until autumn 2011. The work was performed in several phases. In the middle of October (15.–17.10.2011) we cleared the cannon barrels from stones, empty bottles, and other rubbish. We discovered that one of the cannons still had a cannonball in the barrel. We tried to wrench it out with crowbars and percussion drill, but the cannonball only jammed tighter in the rusted barrel. At the same time we prepared the site for burning and started to collect firewood. In the evening before burning we had all six cannons needing a 'fire cure' brought to the site and placed upon an underlay of raw aspen logs. The logs were set on fire at 3:40 PM on 28 October and the barrels were kept at red glow until next morning, constantly adding wood in the gaps appearing in blazing fire (Fig. 5). In the afternoon the remains of the pyre were still glowing and the cannons were sizzling hot. Further treatment with a sandblaster and coating with tannin solution took place on 12 November in

Fig. 4. The 15th-century 'tower cannon' of Haapsalu after heating and surface cleaning.
Jn 4. Haapsalu 15. sajandi "tornisuurtükk" pärast "kuumutusravi" ja pinnapuhastust.
Photo / Foto: Jüri Peets

[3] Sublimation is the transformation of solid substance into gas without the intermediate deliquescence.

Fig. 5. Blaze an hour after setting fire to the pyre.
Jn 5. Tulemöll üks tund pärast riida süütamist.
Photo / Foto: Jüri Peets

Nasva and once more on 22 November. In the same evening the cannons, violet from the iron tannate and phosphate coating, were taken back to the wall niche in the Kuressaare fortress for winter.

Situation after conservation

The cannons outlasted the winter more or less satisfactorily – although there were patches of surface corrosion caused by superfluous moisture and condensate water under the tarpaulin, deep and active corrosion pockets could not be observed. In the middle of July 2012 we cleaned the cannons again, this time only with a hand brush and a rotor-brush, and coated them with tannin solution. In the hope that new carriages would soon be ready and the weather would remain fine, and being aware that the final waterproof coating would be damaged by recurrent relocations, the cannons were left on the embankment of the fortress without the final coating. That was a mistake, as we learned later. Soon the weather turned to autumn with constant rainfall, the carriages were still not ready and heavy rain washed off the protective tannin coating; hence the surface corrosion activated again. The hope throughout the summer work was to transfer the cannons at one go to their stationary location where they could have had their final treatment and a coating of linseed oil. However, autumn rain made it vital to protect the achieved results, i.e. the preservation of *status quo* by all means. Nevertheless our following activities (another cleaning with a rotor brush, drying and heating the barrels with a gas jet and coating with linseed oil) were vain. Under the tarpaulin water condensed again and the surface corrosion increased. The situation could be improved only by building a supportive framework to keep the tarpaulin off the cannons, which would provide at least slight ventilation and reduce the relative humidity under the cover. Such framework was built in November. When I checked the state of the cannons in December 2012 the situation was not hopeless: there was no more condensed water, but due to humidity the linseed oil coating applied in autumn had not hardened. The patches of surface corrosion had widened, especially on the parts that had been in direct contact with the tarpaulin. Hence another mission awaited us in spring 2013: the cannons had to be finally cleaned, coated with a protective layer, placed on their carriages and transported to their locations (Fig. 6).

DISCUSSION

Conservation methods based on hot sublimation are today used quite widely for the conservation of large iron objects – cannons, anchors-, etc. Usually industrial annealing[4] furnaces (working on gas) or reducing hydrogen furnaces are used for this purpose. The first attempts to conserve cannons found from the sea by hot sublimation of salts were made in Denmark in 1947, when a part of the cannons and cannonballs from a Russian battleship that sank in 1758 near Tornby Strand were conserved by this

[4] Annealing is a heating process whereby a metal is heated to a specific temperature/colour (steel, depending on its carbon content, to 750–850 °C) and then allowed to cool slowly, usually together with the furnace. The process is necessary for stress relief; it softens the metal, which means it can be cut and shaped more easily.

Fig. 6. Cannons on their carriages in front of the Kuressaare castle, spring 2013.
Jn 6. Alusele paigutatud suurtükid taas lähtepositsioonil Kuressaare lossi ees 2013. a kevadel.
Photo / Foto: Jüri Peets

method (Eriksen & Thegel 1966, 29ff). The objects under conservation were kept in an industrial gas furnace at a temperature of 850 °C for 8 hours. The results were good – the analyses' results revealed considerable reduction of the amount of chlorides. After the first successful experiments the Danish Military Museum (Tøjhusmuseet) started a more extensive series of experiments with other cannons – of different periods and varying state – from museum collections. After several years of work, supplemented by exhaustive laboratorial investigations they could asset that hot sublimation gave totally satisfactory results in most cases and can be regarded as an acceptable conservation method to safeguard the preservation of large iron objects (Eriksen & Thiegel 1966, 93–97). Naturally it cannot be applied on all objects (e.g. on heavily damaged objects) and the conservator must choose the optimal method in each case. Unfortunately in our circumstances the cost of the work is quite decisive in the planning and performing the conservation. In summer 2010 I visited the Tøjhusmuseet in Copenhagen and ascertained that the weapons mentioned in the conservation reports and now placed in the exposition are still in excellent condition.

The following description will present a brief analysis of the process as performed in fire and in an industrial gas furnace.

Preconditions: 1. A device that can provide the temperature required for the sublimation of chlorides, i.e. *ca.* 700–900 °C, for at least 8–10 hours;
2. Preferably the heating environment of the device (furnace) must be neutral or reducing;
3. Slow cooling of the object is essential;
4. The process must facilitate the removal of surface corrosion products (rust).

Heating in a gas furnace

1. The required temperature is achieved by the burning of gas; temperature can be adjusted according to the set task. Temperature is measured with bimetal thermometer;
2. Due to the complete burning of gas the heating environment is neutral (with carbon dioxide (CO_2) and steam (H_2O) emerging);
3. Cooling takes place together with the furnace;
4. At high temperatures the iron hydrates, disintegrating the main components of surface rust, changed into iron-3-oxide, which can be easily removed mechanically.

Heating in fire

1. The temperature required for the sublimation of chlorides is achieved by burning wood in an open furnace/fire; temperature can be adjusted/controlled, according to the set task, by increasing or reducing the amount of wood; the temperature of the object is visually determined by the hue of the glowing metal (at 700–800 °C iron glows dark red), or measured pyrometrically; the use of thermometer is complicated;
2. Due to CO_2 emerging from the burning wood and glowing charcoal around the objects the heating environment is slightly reducing;
3. Slow cooling of the ground, heated during the hours of burning grants the smooth glide/fall of the temperature of the object after the end of the process;
4. Heating disintegrates the iron hydrates, which are the main components of surface rust, into iron-3-oxide, which can be easily removed mechanically.

This brief analysis allows us to assert that basic conditions required for the conservation of large metal objects can be achieved also outdoors.

SUMMARY

Regardless of some setbacks, mainly caused by exceptionally bad weather conditions, the experiment can be considered a success. Even after staying in permanent rain without protective coating for a long time, no vestige of deep corrosion could be observed, which proves that the hot sublimation process was successful. The emerged thin layer of surface corrosion is easy to remove mechanically. Even the fact that the linseed oil coating exfoliated may be positive. It is possible that linseed oil is not, after all, the best coating for objects to be exposed outdoors and other possibilities should be considered. The experiment proved that satisfactory results can be achieved by simple means. The process is simple, relatively cheap and fast. It is possible that the obtained experience may soon be applied to save other analogous objects.

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KURESSAARE KINDLUSE 18. SAJANDI LÕPU – 19. SAJANDI ALGUSE SUURTÜKID JA NENDE KONSERVEERIMINE

Jüri Peets

1980. aastatel toimunud Kuressaare kindluse vallikraavi puhastustöödel leiti 6 enam-vähem ühesugust, 2,10 m pikkust ja pool tonni kaaluvat malmsuurtükki (jn 1). Kõigi suurtükkide sisemine läbimõõt on suuosas 9 cm, mis vastab enam-vähem 6 naela kaaluvate malmkuulide diameetrile (nn "6-naelased"). Peaaegu kõigil suurtükiraudadel on näha tabamuste märke – püssi-, kartetši- või suurtükikuulide jäljed, mürsukildudest kriimustatud pinnad, murdunud lafetitapp jms (jn 2). Kuna kaliibrilt, väliskujult ja proportsioonidelt on suurtükid väga sarnased, järgides oma aja valmistamistehnoloogia, optimaalsete kasutusvõimaluste ja tugevusnõuete poolt dikteeritud disaini, võis suurtükkide valamine toimuda 18. saj II poolel – 19. saj alguses. Pärast leidmist puhastati relvarauad mudast ja enamikust pindmistest korrosiooniproduktidest mehaaniliselt (vesi, terashari, haamer, meisel jms) ning kaeti linaseemneõliga. Ometi oli kohe pärast puhastamist ja paigutamist lossi peavärava ette selge, et metalli korrosioon ei ole ainult pindmine, vaid on levinud ka selle sisemusse. Materjali mikropragudesse sattunud soolade väljakristalliseerumine põhjustab aga varem või hiljem eseme lagunemise. Kuna paarikümne aastaga oli see protsess silmnähtavalt aktiveerunud, tuli relvaraudade edasise lagunemise peatamiseks need võimalikult kiiresti konserveerida. Tööd algasid 2011. a sügisel. Protsessi läbiviimiseks otsustasin kasutada kuumutus-sublimatsioonimeetodit, milles soolade sublimatsiooniks vajalik püsiv 700–900 °C temperatuur pikema aja (8–10 tundi) jooksul tagataks puude põletamisega suures tuleriidas (jn 5).

Tööd toimusid mitmes järgus. Oktoobri keskel puhastasime suurtükkide rauaõõned kividest, tühjadest pudelitest jms. Selgus, et ühes neist on veel kuul rauas. Samal ajal valmistati ette põletusplats ja hangiti küttematerjal. Suurtükkide põletamisele eelnenud õhtul olime lõkkeplatsile toimetanud ja paigaldanud märgadest haavapalkidest alusele kõik 6 "tuleravi" vajavat suurtükki.

Tuleriit süüdati 28. oktoobril kell 15.40 ja relvarauad hoiti järgnevate tundide jooksul pidevalt kütust juurde tassides ning lõõmavas lõkkes tekkinud tühikutesse heites, punahõõgvel järgmise päeva hommikutundideni (jn 5). Pärastlõunasel ajal tuleriidaase veel hõõgus. Edasine töötlemine liivapritsiga ning katmine tanniinilahusega toimus Nasval. Seejärel toimetati suurtükid tagasi Kuressaare kindluse võlvialusesse "talvekorterisse".

Talve olid suurtükid enamvähem korralikult "üle elanud" – relvaraudade pealispindadel esines küll koormakatte alusest liigniiskusest ja kondensaatveest tekkinud pindmist korrosiooni, kuid sügavaid ja aktiivseid roostekoldeid ei täheldatud. Juuli keskel 2012 puhastasime suurtükid veelkordselt, sedapuhku ainult käsi- ja rootorharjadega ning katsime tanniinilahusega. Kuna suurtükkide alused ei valminud õigeaegselt ja nende paigutamine oma püsivasse asukohta ei olnud võimalik, jäid suurtükid lõpliku viimistluseta. Seetõttu lõpetati konserveerimistööd 2013. a kevadel (jn 6).