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New research results from the smithy site of Käku in 2013–2014

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INTRODUCTION

This article introduces the fieldwork results at the smithy site of Käku conducted in 2013–2014; discussing the smithy constructions and installations, along with analysing the artefacts and waste from the site. Located in the historical parish of Kaarma on the island of Saaremaa, the smithy site of Käku is one of the best preserved smithy sites in Estonia. Archaeological excavations led by Jüri Peets have continued at the site since 2006 and during that time numerous finds of iron processing, bronze and bone working have been found (Peets *et al.* 2013). The site is dated to the 14th to 17th century and consists of four consecutive smithies built above each other (Fig. 1). The smithies are named in the order of their discovery (starting from the latest) *Smithy 1*, *2*, *3* and *4*.

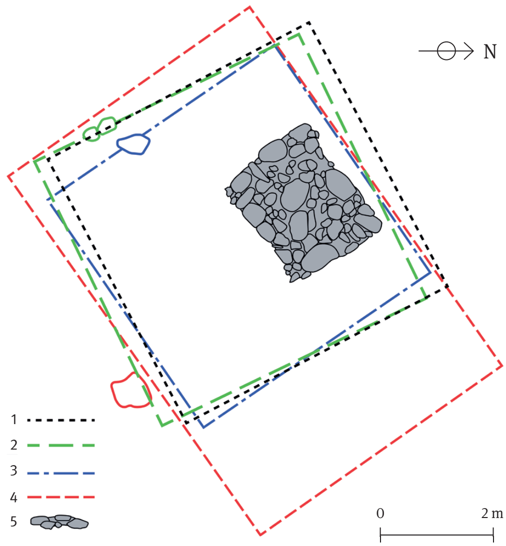

Fig. 1. *Location of Smithy 1–4 and the forge base (5). Presumable door locations are marked with the door sill stone of corresponding colour (Smithy 2–4).*
Jn 1. *Sepikodade 1–4 asukoht ja ääsi alusmüüritis (nr 5). Eeldatavad uste asukohad on tähistatud vastava sepikoja värvi lävepaku kiviga (Sepikojad 2–4).*
Figure / Joonis: Ragnar Saage

The main goal of the 2013 excavations was to investigate the paved area east of the

NE wall of *Smithy 3* and the eastern corner of *Smithy 3*. During two weeks of fieldwork the excavation area was expanded eastward by 8 m². In the last days of fieldwork two burnt log remains were discovered south of the SE wall of the smithy. This referred to an important feature below *Smithy 3*, but this investigation was postponed to the next fieldwork season.

In 2014 an expansion of 5 m² was made in the SE corner of the excavation plot. Also, a trench of 10 × 1 m was dug across the site oriented from NE to SW in order to investigate the forge, the well, and soil beneath the pavement. During the first days of the excavation *Smithy 4* was discovered, as it became evident that the burnt wall remains of *Smithy 3* and the limestone pavement belonged to two separate smithies. After two weeks of fieldwork the site was still not completely excavated, leaving an area of 30 m² containing metalworking waste and installations to be studied in the coming seasons.

During 2013 and 2014, the excavations were directed by J. Peets and R. Saage. In 2014 E. Tiidu conducted the practice of directing excavations as a part of her studies for Master's degree. L. Maldre performed the analysis of worked bone and archaeozoological material. R. Saage analysed the metallographic samples and modelled the 3D documentation.

METHODS

During the years of 2013–2014, the excavations proceeded using 5 cm thick technical layers and the same system of nomination for the squares was used as in the previous years. In 2014 the soil was sieved using a 5 × 5 mm mesh. Total station was used to record the position of all artefacts, plano-convex forge slags and samples. The smithy constructions were recorded with 3D modelling using photogrammetry, which had already proven to be very useful during the excavation season of 2012. 3D models and ortophotos were processed using Agisoft Photoscan (Fig. 2) and the digital terrain model was made with QGis (Fig. 3). The consistency in using photogrammetry as a documentation method has proven a valuable tool in putting together the 3D models made in different years.

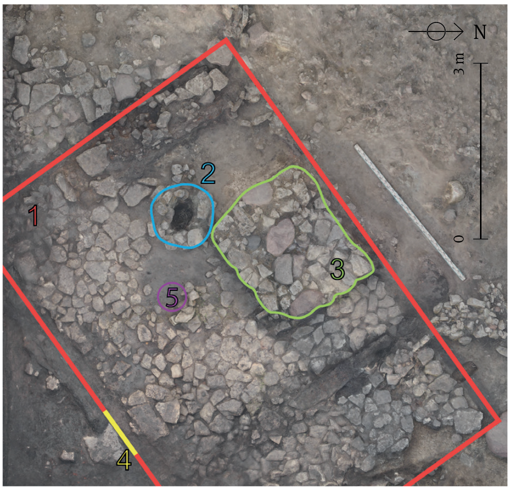

Fig. 2. *The presumed layout of Smithy 4. 1 – walls, 2 – well, 3 – forge, 4 – door, 5 – anvil stump.*
Jn 2. *Sepikoja 4 arvatav plaan. 1 – seinad, 2 – kaev, 3 – ääs, 4 – uks, 5 – alasipakk.*
Figure / Joonis: Ragnar Saage

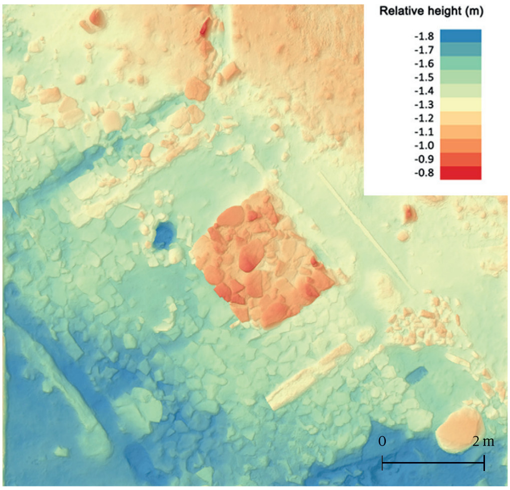

Fig. 3. *Digital elevation model of Smithy 4.*
Jn 3. *Sepikoja 4 digitaalne kõrgusmudel.*
Figure / Joonis: Ragnar Saage

CONSTRUCTION REMAINS

Fieldwork during the years of 2013 and 2014 gave new information about *Smithy 3* and *4*. A small part of the eastern corner and the SE wall of *Smithy 2* were also excavated. While the preserved constructions of *Smithy 1* had already been excavated in the previous years, artefacts connected with the latest smithy were found from the extensions.

As mentioned above, the excavation of the NE wall of *Smithy 3* revealed that beneath the log there was another layer of charcoal which was not oriented in the same direction as the log remains. Thus it was concluded that *Smithy 3* was built on the burnt remains of *Smithy 4*. The orientation of *Smithy 3* matched very well with *Smithy 4*, while the orientation of *Smithy 2* overlapped better with *Smithy 1*.

Smithy 4 was the largest smithy in Käku, with the dimensions of 8 × 5.4 m (Fig. 2). The walls of *Smithy 4* were observable by burnt remains of horizontal logs, although the SW directional log seemed to be disturbed by a drainage ditch that could have been built during *Smithy 3*. The burnt wood remains that were found inside the drainage ditch were probably not part of the SW wall of *Smithy 4* (Table 1). In case of all the other walls, the log remains bordered with the floor pavement, so the SW wall of the smithy was presumably located also at the end of the pavement.

The door of the smithy was in the SE wall located by a stone used as a door sill. In case of *Smithy 2* and *3* a very straightforward way of slag disposal was noticed, as the biggest slag concentration was located just to the right of the door of both smithies (Peets *et al*. 2013, 98). Provided the stone of the door sill marked the place of the door, then a similar pattern is visible in the case of *Smithy 4* as a slag heap was found just to the left of the presumed door location.

INSTALLATIONS

The site has yielded new information about the layout of installations in the smithies. The quadrangular forge that was used during *Smithy 2*, *3* and *4* was 2.3 × 1.8 m (Fig. 2: 3). The forge has been built of large granite and limestone slabs; the space between the stones was filled with smaller stones and clay. Only the foundation of the forge was preserved, so the initial height could not be determined.

Fragments of at least five different grindstones have been identified from the site (Fig. 4). All the grindstones have been made of Jotnian sandstone[1], also found on Saaremaa, so the grindstones may have been made somewhere on the island. In the case of *Smithy 4* the possible location for the grindstone might be at the SE wall where all of the fragments were found (Fig. 4: 5), but

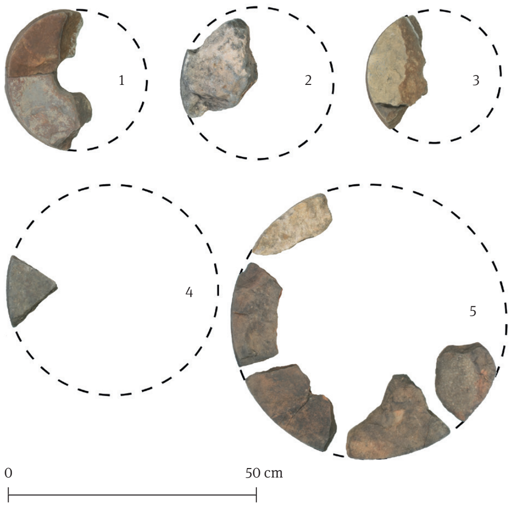

Fig. 4. *Grindstones from the smithy site.*
Jn 4. *Käiakivid sepikojaasemelt.*
(AI 6845: 241, 240, 246, 668, 661–664.)
Photo / Foto: Ragnar Saage

[1] Grindstones were identified by Juho Kirs (Department of Geology, University of Tartu) and Tõnu Pani (Museum of Geology, University of Tartu).

as the grindstone fragments were recovered outside the wall, it is also possible that the stone was dumped there after it was broken. The trench dug in 2014 confirmed that the possible well (Peets *et al*. 2013, 96) was indeed lined with large stones and provided a source of water needed for metalworking (Fig. 2: 2).

The bellows could have been located on either side of the forge. As can be concluded from the numerous ethnographic smithies in Estonia, there is a tendency to place the bellows to the left of the forge. Out of 85 smithies documented in the mid-20th century, 70 had the bellows on the left, 13 on the right and in two cases the bellows were on both sides of the forge (ERM KV 98–99). In *Smithy 4*, the floor was paved on the right side of the forge, while the left side was not. On the left of the forge a heap of sand was found, which could be deposited there during *Smithy 3* or *4*. As the natural soil surrounding the site is clay, this sand was probably brought to the smithy and used as a flux for welding. If the bellows were on the left of the forge, the sand heap would have located under it and therefore be protected from being littered by the feet of smiths working around the forge. Hence, the most probable location for the bellows for *Smithy 3* and *4* was on the left side of the forge. There are no artefacts that can be connected to the bellows with great certainty, although several iron tubes have been found, which could have served as the nozzle.

The most probable location of the anvil stump is the semicircle lined with stones in front of the forge (Peets *et al*. 2013, 96; Fig. 2: 5). One of the few anvil stump descriptions from an ethnographic smithy says it to be 1 m long, out of which 0.5 metres was dug in the ground (ERM KV 98: 210). If the anvil stump in Käku was similar in proportions, the lower half of the stump would have been dug into the virgin soil and may be found once the excavations at the site continue.

SLAG

Slag is the most abundant metalworking evidence from the smithy site and up to the year 2014, 1.5 tonnes of it have been recorded. Wet-sieving experiments from other metalworking sites have shown that only 25–50% of slag is identified, while the fine fraction is discarded with the soil (Peets 2003, 46). Therefore the amount of slag produced in the smithy might be closer to 3–6 tonnes. Taking into account the settlement survey during which slag was also found at the other end of the settlement 150 m away (Saage 2011, table 3), the precise amount of slag originating from the smithy is impossible to determine. The recorded slag and smithing waste was divided into four categories: 1) homogeneous and heavy purification slag; 2) lighter and often layered secondary smithing slag; 3) heavily corroded fragments of furnace bloom; 4) burnt clay lining the forge.

It is widely accepted that the homogeneous plano-convex slag cakes have been formed mostly during the reheating and purification of currency blooms and furnace blooms (Buchwald & Voss 1992, 34–36; Espelund 1992, 93 ff., fig. 2; Buchwald 2005, 96–101; Pleiner 2002, 184–186; Peets 2003, 151–153). The currency blooms, weighing 2–3 kg and with the slag content of roughly 50%, were processed out of furnace blooms that were taken straight from the iron smelting furnace and usually wrought on the iron smelting site in an open air forge. In the purification process that was done in the smithy, currency blooms were wrought into iron bars lowering the slag content from 50% to 2–5% (Buchwald & Voss 1992, 42). Taking into account the slag content in currency blooms and the quantity of purification slag found from the site, the amount of iron that was wrought into bars or artefacts could be comparable to the slag quantity, i.e. several tonnes.

In the eastern corner of *Smithy 2*, *3* and *4* a large number of heavily corroded lumps were found. A metallographic analysis of one of the pieces (found outside the walls of *Smithy 4*) revealed a highly porous and slag rich structure, common in furnace blooms (Fig. 5). Similar pieces of slag rich blooms, with different degrees of completion, have been found and investigated metallographically in previous years (Saage 2013, 41–43), but none of the bloom fragments found before have been so heavily corroded. Therefore, it is not possible to identify all the lumps, but based on the metallographic analysis the heavily corroded pieces are currently considered as furnace blooms. The large number of furnace bloom pieces in the corner of the smithy might be waste from the purification process. Purification experiments with the 14th century blooms from Novgorod have shown that blooms of lower quality might easily break into pieces (Kolchin & Yanin 1982, 46; Terekhova *et al*. 1997, 8ff.).

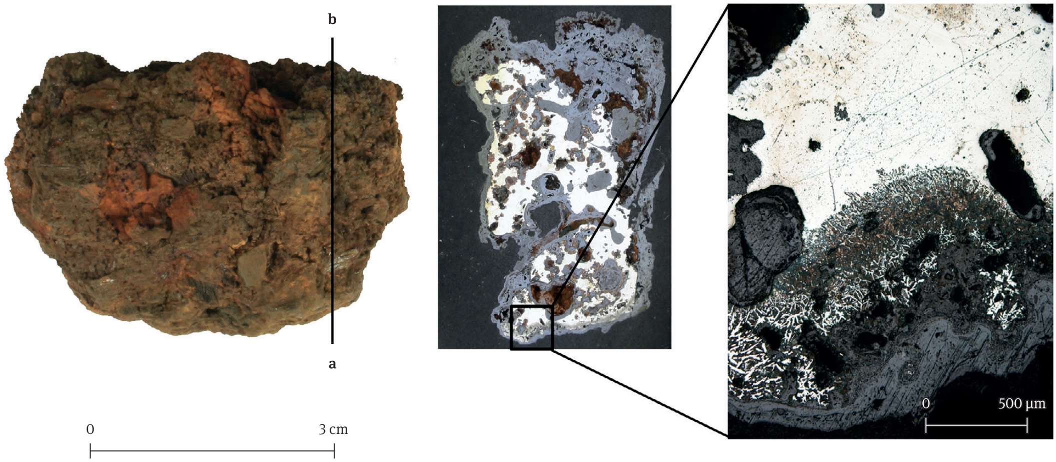

Fig. 5. *Metallographically investigated fragment of a furnace bloom: location of the cut (left, a–b); polished and etched cross-section (middle); hypereutectoid steel with martensite needles (right).*

Jn 5. *Metallograafiliselt uuritud toorraua katke: lõike asukoht (vasakul, a–b); poleeritud ja söövitatud ristlõige (keskel); martensiidinõeltega hüpereutektiline teras (paremal).*

(AI 6845: P56.)

Photos and analysis / Fotod ja analüüs: Ragnar Saage, Jüri Peets

The largest group of iron processing waste was secondary smithing slag, which was light, had a glazed enamel-like multi-colored surface, and often had vitrified forge lining attached to it. Secondary smithing slag was formed from ash and flux containing quartz; into which iron scale, slag and clay forge lining had melted. The plano-convex smithing slag cakes from Käku are usually lighter and more layered compared to purification slags. In addition to the slags named above, there was a lot of non-diagnostic slag of irregular shape and size which could not be connected to any specific process.

While secondary smithing slag and the forge lining are present everywhere, the concentration of the primary smithing slag is the highest in the larger slag heaps. Curiously, the primary smithing slag and the bloom iron pieces were not found in the same areas in large quantities. However, as different slag types were found all over the excavation area and in all depths, it is reasonable to believe that the slag heaps might have been moved several times. This would have happened during reconstructions of the smithy, but also as the result of intense land reclamation in the Soviet time.

ARTEFACTS

Iron

Similarly to the excavations in the previous years, iron artefacts constituted the majority of the finds during the fieldwork of 2013–2014 as well. Most commonly the iron pieces were surplus material that had been cut off while an iron object was being finished. The sizes of these pieces vary from small nail-like rods to large iron bar fragments weighing several hundred grams. In addition to that, horseshoe nails form the largest find category that reaches into thousands. Identifiable artefacts include knives, scythes, hooks, metal components of furniture and other iron objects that were common in a rural household. Of the more unique finds a Tatar arrowhead from the Livonian War period and a small chisel were recovered (AI 6845: 615, 619).

A remarkable number of fine mechanisms like padlocks and wheel lock fragments for firearms have been found from the site. In addition to the artefacts recovered in the previous years (Peets *et al.* 2013, 98–99), a push key lock (Fig. 6: 3), three padlock fragments (Fig. 6: 1, 2, 4), three key fragments (Fig. 6: 5, 7, 8) and one gun lock mechanism (Fig. 6: 6) were unearthed in 2013–2014. The push key lock was unusual, as it did not possess visible holes (even when X-ray was used) for the key or the spring shackle. Therefore it could be a semi-finished product indicating local production of such mechanisms.

Fig. 6. *Artefacts from fine mechanisms.*
Jn 6. *Mehhanismidest pärit peensepis.*
(AI 6845: 670, 673, 602, 624, 674, 669, 675, 678, 676, 626, 672.)
Photo / Foto: Ragnar Saage

Copper alloys

In the previous years, a lot of waste from forging and casting copper alloys has been found from the site (Peets *et al.* 2013, 98–99). Unfortunately, not a single casting mould has been recovered, which makes it difficult to separate the smithy produce from scrap metal. However, in 2014 direct evidence for scrap metal usage was collected (Fig. 7). A leg from a tripod pot has been deliberately chiselled in half, presumably with the aim to fit it into a smaller crucible. The recovered crucible fragments confirm casting smaller items, as only crucibles with a rather small volume have been found so far. One of the most valuable sources for studying metal re-use in Käku is a partly melted copper alloy lump (Fig. 7: 3). It seems that different artefacts were being melted into one until something disrupted the process. Hence, an elemental analysis from the cross section of the lump would provide information whether the partly melted artefacts were of similar chemical composition.

Fig. 7. *Copper alloy casting evidence.*
Jn 7. *Tõendid vasesulamite valamisest.*
(AI 6845: 671, 680, 613, 681, 611.)
Photo / Foto: Ragnar Saage

DATING

Dating of smithies has proven a difficult task as the occupation layers are indistinguishable from the destruction layers. The deposition depth of the artefacts is certainly one of the indicators for the age of the finds, but several cases of earlier finds in later deposits and *vice versa* show that the stratigraphy has been disturbed. Unfortunately, the two coins found from the site cannot be linked with the wall remains. Thus, radiocarbon dates from the burnt wall remains serve as the best option to date the smithies. As the radiocarbon dates form a stratigraphic sequence, OxCal Bayesian statistics function was used on four of the contexts (Table 1): the charcoal layer preceding the forge; burnt NW wall of *Smithy 4*; burnt SW and NE walls of *Smithy 3*; and burnt SW wall of *Smithy 2*. A sequential model with four phases was used for the modelling (Bronk Ramsey 2009, 348), with *Smithy 3* being represented by two overlapping dates. One log remain from what was thought to be the SW wall of *Smithy 4* proved to be the latest of the samples and did not fit into the model. It must be stressed that the modelled dates indicate a probability of a probability. However, as there is also no

Table 1. *^{14}C dates from the Käku smithy site. Calibrated and modelled using OxCal 4.2 (Bronk Ramsey 2013; Reimer* et al. *2009).*
Tabel 1. *^{14}C dateeringud Käku sepikojaasemelt. Kalibreeritud ja modelleeritud OxCal 4.2 abil.*
Compiled by / Koostanud: Ragnar Saage & Jüri Peets

No. / Nr	Lab. No. / Lab nr	Archaeological context / Arheoloogiline kontekst	^{14}C BP	95.4% (2 sigma), cal. AD	95.4% (2 sigma), Modelled AD
P55	Tln 3599	Sub-forge layer / äasialune põlengukiht	556±50	1298–1372 (50.4%) 1378–1439 (45.0%)	1333–1366 (5.1%) 1376–1441 (90.3%)
P52	Tln 3597	*Smithy 4* NW wall / Sepikoda 4, kirdesein	478±45	1320–1350 (5.0%) 1391–1491 (89.6) 1603–1610 (0.8%)	1401–1444
P53	Tln 3598	*Smithy 4* SW wall (?) / Sepikoda 4, kirdesein (?)	412±40	1426–1524 (73.3%) 1559–1631 (22.1%)	Poor agreement / Halb kattuvus
P36	Tln 3482	*Smithy 3* NE wall / Sepikoda 3, kirdesein	515±55	1299–1370 (29.8%) 1380–1466 (65.6%)	1413–1452
P40	Tln 3485	*Smithy 3* SW wall / Sepikoda 3, edelasein	470±55	1315–1355 (6.9%) 1388–1522 (82.4%) 1575–1625 (6.1%)	1413–1452
P23	Tln 3483	*Smithy 2* SW wall / Sepikoda 2, edelasein	429±50	1410–1526 (74.5) 1556–1633 (20.9%)/	1417–1488

contradiction with other evidence dating the site, the modelled dates are currently the best estimation for the building time of *Smithies 2*, *3* and *4*.

There is no reliable sample from *Smithy 1* as there were no burnt wall remains (Peets *et al.* 2013, 96). The latest coin that was found outside the walls of *Smithy 1* has been dated to *tpq* 1621.[2] Taking into account the Tatar arrowhead, wheel-lock mechanisms for firearms, and padlocks, *Smithy 1* was operating roughly between AD 1550–1625.

OSTEOLOGICAL ANALYSIS

There were not many bone artefacts and worked bone recovered during 2013–2014: in 2013 a handle fragment made of elk antler was found, while in 2014 a possible gaming piece of antler and a fragment of a gunpowder flask made of deer antler were the only worked bone finds (Fig. 8). The possible gaming piece has been sawn off from one end and the other side has been turned. The powder flask fragment originates from the same flask as the pieces recovered in 2012 (Peets *et al.* 2013, 99, fig. 11). In addition to the mentioned finds, there are a few bone fragments with vague cutting marks that need further examination.

Fig. 8. *Fragment of an antler artefact (left), and a gunpowder flask (right, 1) with fragments found in 2012 (2–3).*
Jn 8. *Sarvest eseme katke (vasakul) ja püssirohusarve katke (paremal, nr 1) koos 2012. a leitud fragmentidega (nr 2–3). (AI 6845: 610, 607, 73, 132.)*
Photo / Foto: Reet Maldre

The archaeozoological finds that were recovered in 2013 and 2014 numbered about 260 specimens out of which 92 were identified (Fig. 9). The age of butchered animals was determined by the replacement of deciduous teeth and the eruption of permanent teeth (Schmid 1972), and the fusion of epiphysis (Silver 1969). Sheep and goat bones were separated using the handbook by Boessneck *et al.* (1964); teeth were distinguished by morphological attributes introduced by Halstead *et al.* (2002).

The majority of the archaeozoological material comes from domestic animals. Sheep/goat (*Ovis aries*/*Capra hircus*) and cattle (*Bos taurus*) specimens are represented in almost equal quantities, i.e. 36 and 35 finds, respectively. There are 12 pig specimens (*Sus domestica*) and at least two horse bones (*Equus caballus*). Dog (*Canis familiaris*), cat (*Felis domestica*) and hare (*Lepus* sp.) are all represented with two bones. Finds from 2014 included at least one deer antler fragment from a powder flask and one uncertain flake, that might originate from a deer antler.

The anatomical composition is, similarly to the previous years (Peets *et al.* 2013, 103–104), a mixture of kitchen and butchery waste. The overrepresented teeth indicate a highly

[2] Dated by Mauri Kiudsoo (AI).

fragmented material. Based on the eruption and wear of teeth, the cattle bones belonged to a calf of 6 months or less, one juvenile less than 2 years, one subadult of 2–3 years old, and one adult individual. One phalanx and a carpal bone seem to originate from a newborn calf. Out of sheep/goat specimens at least six were identified as sheep, none as goat, and 30 specimens remained unspecified to precise species. Based on teeth the remains originate from one adult and three juveniles. Pig bones are represented by one adult boar and 1–2 juvenile pigs.

Among the aforementioned bones, a number of finds were recovered from a pre-smithy layer under the pavement of *Smithy 4*: nine sheep/goat, five cattle, three pig, one dog specimen, and a small antler flake.

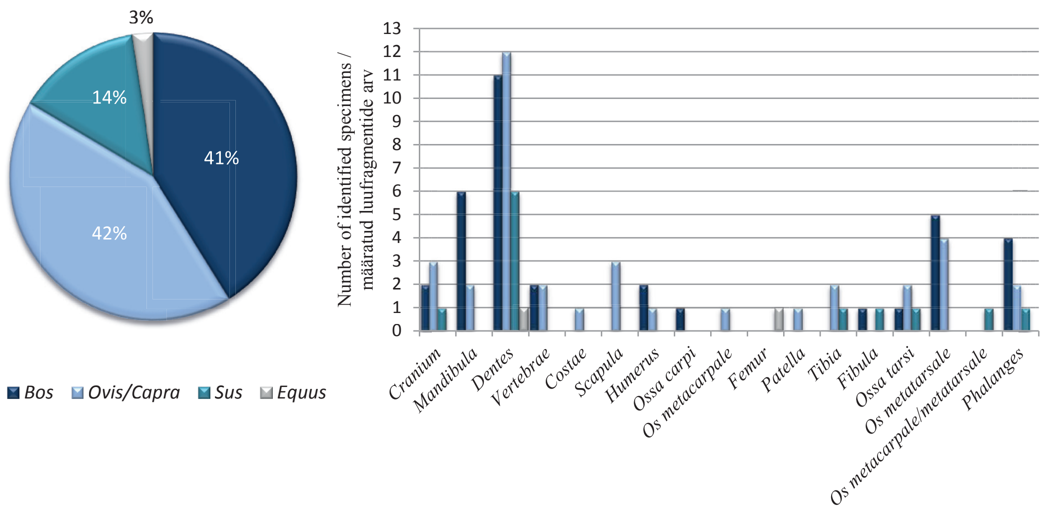

Fig. 9. *Number and anatomical composition of dominant domestic animal species (cattle, sheep/goat, pig, horse).*
Jn 9. *Põhiliste koduloomaliikide (veis, lammas/kits, siga, hobune) luude suhteline arvukus ja anatoomiline koostis.*
Composed by / Koostaja: Liina Maldre

CONCLUSIONS

Fieldwork during 2013 and 2014 has greatly improved our understanding of the well-preserved smithy site of Käku. 3D-modelling techniques implemented in the documentation of the structural remains of the site enabled an easy way to combine the results of different fieldwork seasons. Following the general layout of *Smithy 4*, subsequent smithy phases have made use of the forge base of earlier smithies even if the location of the walls do not match. Installations that are needed for running a smithy – a forge, a well, an anvil on a stump and bellows – could be placed in the smithy layout with varying certainty as some of the installations leave traces while others do not. Metallographic analyses from slag revealed more evidence of iron purification; which by the amount of documented slag, has been an important source of income for the local smiths. Iron artefacts found from the site show the smithy had a wide range of produce, from the most basic iron working to more complex mechanisms such as padlocks. In addition to iron working, the smiths at Käku melted and cast bronze alloys and worked with bone and antler, which further widens the range of different products that were made on the site. Investigation of the site and further analysis of the artefacts will take place in the near future.

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ERM KV 98 = Eesti Rahva Muuseum, korrespondentide vastused 98. *(Replies of correspondents to the museum, manuscript in ERM.)*

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UUED UURIMISTULEMUSED 2013.–2014. AASTA VÄLITÖÖDELT KÄKU SEPIKOJAASEMEL

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2013. ja 2014. aastal jätkusid välitööd Käku sepikojaasemel Saaremaal Kaarma vallas, mille käigus uuriti sepikoja varasemate järkude ehitusjäänuseid, sepikoja sisseseadet ning tootmisjääke. Praeguste teadmiste järgi on tegemist 14.–17. sajandisse kuuluva muistisega, kus on leitud nelja üksteisele järgneva sepikoja konstruktsioonid, mille all on metallitööga mitte seotud ja loomaluid sisaldav kasutusjärk. Sepikojad nummerdati nende leidmise järjekorras alates kõige hilisemast, s.t *Sepikoda 1*, *2*, *3* ja *4* (jn 1).

2013. aastal laiendati kaevandit ida suunas 8 m². 2014. aastal tehti 5 m² suurune laiendus kaevandi kagunurka ning kirde–edela-suunaline tranšee mõõtmetega 10 × 1 m, mis kaevati läbi sepikoja põrandasillutise, ääsi, seinapalkide ja kaevu. Välitööde kõige olulisem tulemus oli kõige vanema sepikoja järgu (*Sepikoda 4*) eristamine eelviimasest (*Sepikoda 3*) järgust. Välitööde käigus ei kaevatud kogu kaevandi ala loodusliku aluspinnani ning suur osa paekivisillutise alusest kultuurkihist on läbi uurimata, mistõttu jääb lõplik hinnang sepikoja kohta ootama tulevasi välitöid.

Ehitusjäänuste dokumenteerimisel kasutati fotogramm-meetrial põhinevat 3D modelleerimist: 3D mudelid ja ortofotod on tehtud Agisoft PhotoScan'i abil (jn 2) ning digitaalne kõrgusmudel töödeldi QGis'is (jn 3). Metoodiliseks uuenduseks võib lugeda 2013.–2014. aasta 3D mudelite ühendamist, mis võimaldab väljastada ortofoto ja digitaalse kõrgusmudeli, kus on koos kuvatud mõlema aasta kaevamiste situatsioon.

Käku sepikojaaseme leiuaines andis palju uut teavet sepikoja sisseseade ja planeeringu kohta (jn 2). Ääsi mõõtmed *Sepikoja 3* ja *4* puhul olid 2,3 × 1,8 m ning see oli nelinurkne. Ääsi ehitusel on kasutatud suuremaid pae- ja maakive, mille vahele on tihenduseks pandud väiksemaid kive ja savi. Käku sepikojast on leitud vähemalt viie käiakivi fragmendid (jn 4) ning kuna käiakivid on tehtud Jotnia liivakivist, võivad need olla valmistatud Saaremaal. 2014. aastal kaevatud tranšee lõikas kaevu ning näitas, et tegemist oli tõepoolest kividega vooderdatud süvendiga, mis tõenäoliselt täitis sepistamisel vaja mineva vee võtmise koha.

Sarnaselt varasemate aastate välitöödele, oli ka 2013.–2014. aasta kõige arvukam leiuliik šlakk. Kõige arvukamalt leidus sepikojaasemel sepašlakki, mis tekib ääsi põhja raudesemete valmistamisel. Väiksemas mahus, kuid siiski sadadesse kilodesse ulatus rikastusšlaki hulk. Rauarikastus seisneb rauasulatusahjust pärineva toorraua kvaliteedi tõstmises selles sisalduva šlaki väljasepistamise abil. Metallograafiline analüüs *Sepikoja 4* kagupoolsest palgist väljapoole jäänud roostesest kamakast näitas, et tugeva korrosioonikihi all poorne ja suure šlakisisaldusega toorraud (jn 5). Tõenäoliselt pärines seegi toorraua tükk rikastamisprotsessist ning võis sattuda räbu hulka suurema toorraua tüki purunemisel. Kuigi Käku rauatöö kompleksi kõige varasema šlakikihistuse peaks moodustama raua rikastusräbu, ei paikne sepajäätmed kindlas stratigraafilises järjestuses ning kõiki räbutüüpe võib leida kogu kaevandi ulatuses erinevatel sügavustel. Seega näib, et enamik räbukogumeid on sepikoja (ümber)ehituste käigus korduvalt teisaldatud ja ei paikne oma esialgsel kohal. Kahtlemata on sepikojaaset kahjustanud mõned talu majandustegevusega kaasnenud kaevetööd ja ilmselt kõige enam kolhoosiaegne agraarponnistus.

Põhilise osa rauast leidudest moodustasid eri suurusega sepistamisel tekkinud rauajäägid, mis on eseme valmistamise käigus selle küljest ära löödud. Selle kõrval on äratuntavatest esemetest rohkesti hobuse kabjanaelu, aga ka nuge, vikateid, konkse, mööbli metallosasid jne. Erandlikest leidudest tuleks ära märkida Liivi sõja aegne tatarlaste nooleots ja väike meisel (AI 6845: 615, 619). Omaette leiugrupina tuleks käsitleda peensepise alla kuuluvaid esemeid, mille hulka lisandus 2013. ja 2014. aastal üks surulukk, kolme tabaluku katked, kolme võtme katked, üks püssi luku osa ja muid mehhanismide detaile (jn 6). Suruluku puhul hakkas silma asjaolu, et sellel puuduvad augud lukustava vedru ja võtme jaoks. Seetõttu on tõenäoline, et tegemist on sepikojas valmistatud toorikuga, millele ei ole veel vastavaid auke tehtud.

2014. aastal leiti otseseid tõendeid pronksi ümbervalamise ja selleks kasutatava toormaterjali kohta. Kõige ilmekama esemena leiti sepikojast ilmselt meisliga pooleks löödud pronksist kolmjalgnõu jalg (jn 7: 1–2). Purustamise eesmärk oli ilmselt mahutada vanametall väiksemasse tiiglisse (jn 7: 4–5). Kõige väärtuslikumaks leiuks metalli taaskasutamise uurimisel on aga pooleldi kokkusulanud pronksi kängar (jn 7: 3). Mittetäieliku kokkusulamise tõttu on pronksi seest on võimalik eristada erinevate esemete katkeid, mistõttu väärib ese detailset elementanalüüsi kogumi ristlõikest.

Sepikodade täpne dateerimine on osutunud problemaatiliseks kihtide segatuse ning samal ajal pinnasekihtide eristamatult sarnase värvuse tõttu. Samas on kolme järgu põlenud seinapalkidest (*Sepikoda 2, 3, 4*) ning ääsi alusest põlengukihist olemas neli üksteisele järgnevat etappi, mis võimaldab rakendada Bayesi statistikal põhinevat dateeringute modelleerimist (tabel 1). Kuigi tegemist on vaid tõenäosusega, on see siiski hetkel parim viis kitsamalt piiritleda sepikodade ehitamise aegu. Kõige hilisem järk (*Sepikoda 1*) dateeriti leidude abil umbkaudu 1550.–1625. aastasse.

2013.–2014. aasta materjalis oli ainult kolm luueseme katket – põdrasarvest noapideme fragment ja eseme katke (jn 8: 1) ning hirvesarvest püssirohusarve katke (jn 8: 2). Viimane on pärit samast esemest, mis leiti 2012. aastal. Arheozooloogilises materjalis domineerivad koduloomade luud, lammaste/kitsede ja veiste luid on ligikaudu võrdselt, sealuid on veidi vähem (jn 9), hobune, koer ja kass on esindatud üksikute luuleidudega. Ulukiluudest on kaks jäneseluud. Päritolult näib luuaines olevat toidu- ja tapajäätmete segu.