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Medieval ship finds from Kadriorg, Tallinn

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INTRODUCTION

In the morning of 22 May 2015, Agu Zilensk – project manager of construction company AS Nordecon, contacted the National Heritage Board and informed them about remains of a wooden ship that had been found at Pikksilma 2/1 in Kadriorg, Tallinn. The construction work had been stopped.

The workers of AS Nordecon had come across an obstacle while installing the steel profile of a sheet pile wall. They started to identify the obstacle by an excavator (Fig. 1). A total of approximately 20 frames and planks were lifted from the watery soil and transported to the Estonian Maritime Museum on 25 May. In the same evening,

Fig. 1. *View of the site of wreck Peeter on the day of discovery.*
Jn 1. *Vaade Peetri vraki leiukohale leidmise päeval.*
Photo / Foto: Maili Roio

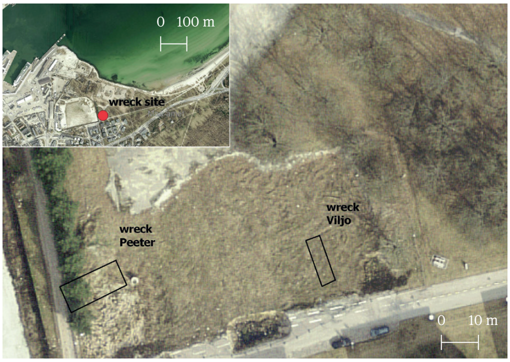

Fig. 2. *Location plan of the wrecks in Kadriorg.*
Jn 2. *Kadrioru vrakkide asendiplaan.*
Map / Kaart: Estonian Land Board / Maa-amet, Maili Roio

Fig. 3. *The excavation pit of wreck Viljo after the wellpoint dewatering system had been installed.*
Jn 3. *Viljo vraki kaevand peale nõelfiltersüsteemi paigaldamist.*
Photo / Foto: Maili Roio

another shipwreck was found from the same construction site at Tuukri 23. This shipwreck was located about 50 metres east from the first wreck (Fig. 2).

The National Heritage Board was on the position that archaeological excavations must be conducted at the findspot of the historical wrecks, the wrecks must be supported by wooden constructions, and relocated to a preservation area in the sea, due to lack of proper space for storing the wreck. Archaeological excavations were conducted at the site by the National Heritage Board between 11 June and 9 August 2015.

For the moment, only a fraction of the collected items (pottery, stone, to a lesser extent also metal, fish and animal bones, etc.) from the wreck is available to study as most of the artefacts are presently undergoing the conservation processes – textile and leather at the University of Tartu, wood and metal at the conservation laboratory of Archaeological Research Collection of Tallinn University. Thus the exact amount of the objects as well as the detailed characteristics of the collection will be presented hopefully more thoroughly within the next few years. Therefore, at the present stage of the research, we can introduce only some preliminary estimations on the wreck sites and the find complex.

FINDSPOT

100 years ago, there was still water at the site of the wrecks (Fig. 2). In the 1930s there were plans to establish a showground by the seaside in Kadriorg, and according to the agreement between the Tallinn City Administration and the Põhja Paberi- ja Puupapivabrik (Eng. North Factory of Paper and Wooden Cardboard), the latter began to carry coal ash from the factory to the site, in order to fill the area. Today, the ash, construction waste and household waste form a four-metre thick filling layer under which the historical wrecks were revealed.

METHODS

Before the archaeological surveys, the ground was peeled to the level of the wrecks and after that research with ground-penetrating radar was carried out to determine the measurements of the wrecks. Since the first details of the wrecks were revealed a little less than a metre below the sea level, a wellpoint dewatering system was placed around the excavation area (Fig. 3). The sheet piling wall surrounding the whole construction area also helped to keep the pits dry. First the inside of the wrecks was cleaned and after that, a trench was dug around the wrecks with an excavator. A steel support frame was placed inside the trench. After that, the soil was removed from around and under the wrecks with shovels, and at the same time a wooden support structure was built around the wrecks.

WRECK VILJO

Archaeological excavations were started on the wreck that was found later. This wreck was named 'Viljo' after the AS Nordecon site manager Viljo Niit. The ship had run aground facing Kadriorg and most of the port side and the bottom of the ship had preserved. The measurements of the well-preserved part are *ca*. 14 × 3.5 metres. The keel has also preserved, but it has come loose from the bottom and was located at the starboard side next to bottom planks (Fig. 4).

The remains of the wreck represent typical Nordic shipbuilding traditions, in which clinker planking has been deployed. Animal hair has been used to ensure the ship's waterproofness. The find material of the wreck was very poor. Most of the finds were discovered from a mixed layer and are clearly connected to later activities on the site. Everything valuable was most probably removed from the ship shortly after it wrecked. The following items can most likely be linked with the wreck of the sailing ship: a wooden block stuck between the frames (Fig. 5), ropes made of hemp (*Cannabis sativa*), a metal tripod pot found under the bottom at the aft, and most probably also a wooden barrel lid found under the keel.

After finishing the excavations and taking dendrochronological samples, the wreck along with the details of the stempost and sternpost were sunk in a deeper sea area between Naissaar and Littegrund in Tallinn Bay (Fig. 6).

Dendrochronological samples for dating the wreck were taken from the wreck planks and floor-timbers, trying to find wood with maximal number of tree rings and with minimal number of lost rings from the outer end of the tree trunk. The ship was made of

Fig. 4. *The view of wreck Viljo from the stern, after the supporting structures had been installed.*
Jn 4. *Vaade Viljo vrakile ahtri poolt pärast toestustöid.*
Photo / Foto: Maili Roio

Fig. 5. *A wooden block between the frames from wreck Viljo.*
Jn 5. *Viljo vraki puidust plokk kaarte vahel.*
Photo / Foto: Maili Roio

Fig. 6. *Sinking wreck Viljo into Tallinn Bay.*
Jn 6. *Viljo vraki uputamine Tallinna lahte.*
Photo / Foto: Maili Roio

softwood. Altogether 20 wood samples were taken from ship planks and frames. 16 cross sections of wood were determined microscopically as pine wood. Eight tree-ring series of the pine samples were averaged to a 215 years long mean series *2epvil04*. The oak samples were not datable due to their small number of rings. The mean series was synchronized with dated pine chronologies of Estonia and the rest of Europe.

The mean tree ring series of wreck Viljo appeared to be notably similar with Estonian pine chronology *3epestcr* (AD 1111–2006, Läänelaid & Eckstein 2003; Läänelaid 2012) at the position, where the last ring of the wreck series corresponds to AD 1487 (overlap 215 years, t = 5.63, *Gleichläufigkeit* 61.7 at 99.9 significance level). The mean wreck series was even more similar with a pine series from a Cistercian convent building in Tallinn, *3epgag01* (overlap 152 years, t = 6.07, *Gleichläufigkeit* 66.9 at 99.9 significance level). From that date also the 8 single tree-ring series were dated (Fig. 7). Unfortunately, all of the dated boards have outermost rings planed off. Although, judging from the narrow rings near the edge of the boards, the waney edge (wood surface under the bark) was not far from the board edge. Nevertheless, as we do not possess the waney edge, the dendrochronological date AD 1487 has to be treated as *terminus post quem* – the date after which the trees were felled. The pines were felled probably soon after 1487.

We may assume that the pines for that ship were grown in the region of Estonia. Even if the ship timber was Estonian-grown, it does not tell us about the location of the shipyard. Extensive oak wood trade took place from the Baltic region to Western Europe (see Wazny 2002; Daly 2007). Also the Baltic pine wood could be shipped to any port and shipyard.

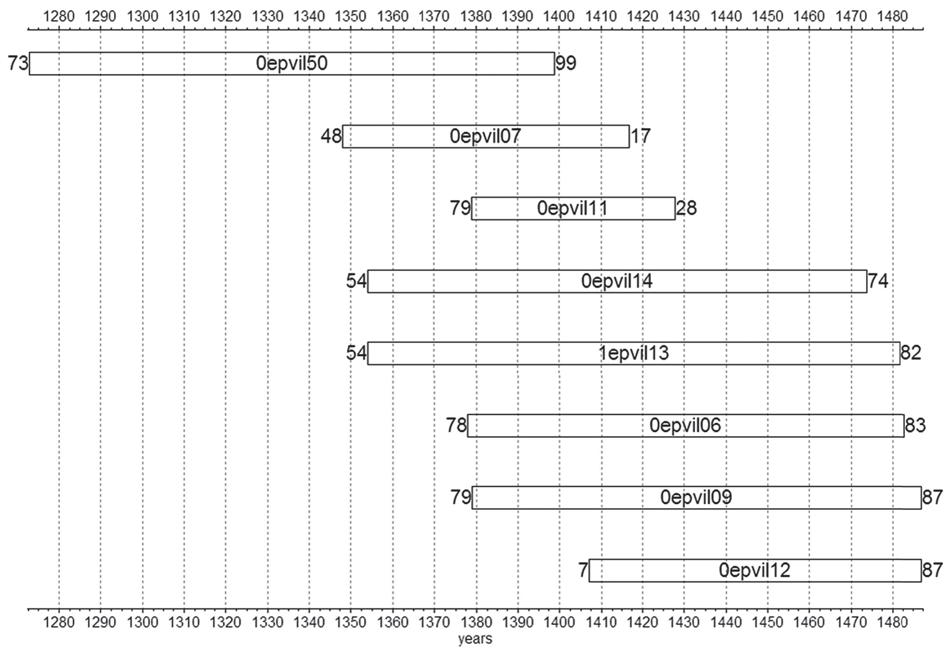

Fig. 7. *Span of dated wood samples of wreck Viljo. Horizontal axis – calendar years, vertical axis – samples with their codes, ending with sample number. Numbers at the ends of the bars indicate the initial and last calendar year of the samples.*

Jn 7. *Viljo vraki dateeritud puiduproovide aastarõngaridade ajaline ulatus. Proovidel nende koodid, vasakul iga proovi varaseima ja paremal hiliseima aastarõnga aasta. Rõhtteljel kalendriaastad, püstteljel proovid.*

Figure / Joonis: Alar Läänelaid

WRECK PEETER

The wreck that was found first and excavated second was located at the west part of the property. The so-called 'Wreck Peeter' was named after the excavator operator Peeter Hallikas. The maximum dimensions of the wreck were 18.08 metres in length, 6.64 metres in width, the maximum height at port side 3.05 metres and 2.11 metres at the starboard. The aft of the wreck was pointing towards the Old Town.

This was a medieval merchant ship, the wreck of a cog. The plank keel had preserved in its entire length, also the ship's bottom part built in carvel planking, sides built in clinker planking, keelson, inner planking, large knee and crossbeams, had preserved of the ship with a straight stem post and stern post (Fig. 8). In addition, the overlapped side planks were clenched with double-bent nails and the frames were treenailed. The bottom and side seams were caulked with moss retained by oak laths, in turn secured by sintels (see characteristics of cog-like vessels in Ellmers 1994; Adams 2013).

The assemblages of mosses used for caulking were rather homogenous, consisting of mainly two very similar Hook-moss species (*Drepanocladus aduncus* and *Warnstorfia fluitans*). Homogenous bundles of moss formed of sickle were used as caulking material for wreck Peeter. Hook-mosses are a relatively cosmopolitan pleurocarpous species with long rambling shoots. They are aquatic mosses which grow in wetlands, including fens, pools of stagnant water, lakeshores and riverbanks, forming green cushions in shallow water. The floating Hook-moss (*W. fluitans*) grows in more oligotrophic wetland habitats.

Fig. 8. *View of wreck Peeter.*
Jn 8. *Vaade Peetri vrakile.*
Photo / Foto: Maili Roio

Knieff's Hook-moss (*D. aduncus*) was one of the species found from a study of nearly hundred Dutch historical ship wrecks, used for caulking in more than five ships; in about half of the studied wrecks Sphagnum mosses of Cuspidata group were used (Cappers *et al.* 2000). The research concluded that until the 13th century mosses for caulking were mainly collected from the forest, whereas from the 14th century onwards they were gathered from wetlands and bogs. One of the reasons might have been environmental change. The famous 15th century Copper Wreck found from Polish waters was also caulked with aquatic Hook-mosses (*D. sendtneri, W. exannulata* and *Calliergonella cuspidate*). Ship caulking with Hook-mosses was widely practiced in medieval Poland (Badura 2014). In the historical ships of North Belgium Hook-mosses have been used to fill cracks, not as the primary caulking material (Deforce *et al.* 2014).

Mosses have been used in Europe to caulk ship planks since the Bronze Age, and in the Medieval Period moss was the main caulking material used in both North-East Europe and Central Europe. Mosses were widely used also in Slavic shipbuilding (see Deforce *et al.* 2014; Crumlin-Pedersen 2000). Since the Early Middle Ages the use of animal hair (processed with tar or wax) spread in Britannia and Scandinavia due to the specificities of construction techniques. In some cases the mosses and hair were mixed, and it is possible that ships from more southern regions were also caulked with animal hair in the Medieval Period, but the origin of those ships is not clear (Deforce *et al.* 2014).

Fig. 9. *The cross section from the sample of wreck Peeter.*
Jn 9. *Peetri vraki proovi ristlõige.*
Photo / Foto: Alar Läänelaid

The ship was made of oak wood. To preserve the wreck, wood samples (12) from this wreck were taken mainly with increment borer (e.g. Pressler borer in forestry). Besides, four cross sections were sawn from the wreck timbers (Fig. 9). All the samples are of oak wood, except one pine sample. Sapwood was not established in these samples. The ring widths in the wood samples were measured and nine ring-width series of planks and floor-timbers were averaged into a 263 years long chronology *2eqpee05*. This mean tree-ring width series was synchronized with available oak chronologies from Europe. The mean series of wreck Peeter appeared to be very similar with East Pomeranian oak chronology (Wazny 2015) at a position where the last tree ring of the wreck series corresponds to AD 1296 (overlap 263 years, t = 8.79, *Gleichläufigkeit* 66.4 at 99.9 significance level). As there was no sapwood in the wood samples and the outer surface had got lost, the dendrochronological date AD 1296 means *terminus post quem* – the oak trees were felled after that year (Fig. 10). Similarity of the wreck series with the East Pomeranian oak chronology gives a basis to assume that the oaks used to build this ship had grown somewhere in east Poland or even in the region eastward of it.

Selected artefacts found from the wreck

Here, only two find categories will be handled with the focus on dating of the shipwreck and origin of the items, leaving a closer spatial and statistical analysis of the artefacts aside.

The previous section of the present paper showed that the possible building time of the ship was somewhere after AD 1296, however the point in time when the ship wrecked near the hanseatic town of Tallinn (situated *ca.* 2 kms to the west) is much more difficult to determine.

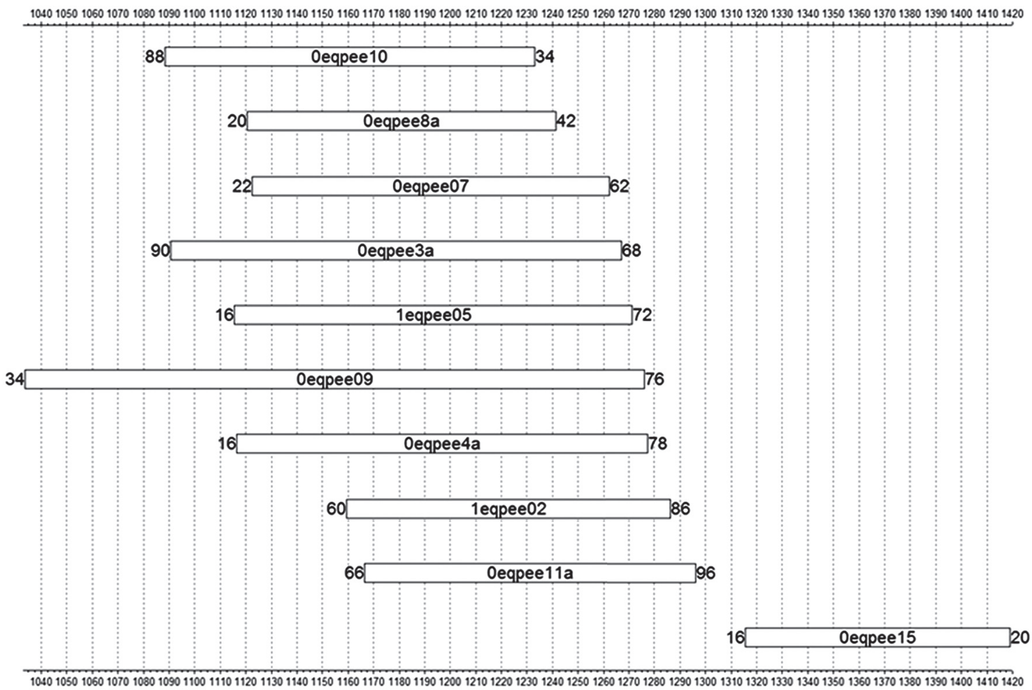

Fig. 10. *Span of dated dendrochronological samples from wreck Peeter. Horizontal axis – calendar years, vertical axis – samples with their codes, ending with sample number. Numbers at the ends of the bars indicate the initial and last calendar year of the samples. Sample 15 (the lowest bar) originates from a later period.*
Jn 10. *Peetri vraki dateeritud tammeproovide aastarõngaridade ajaline ulatus. Proovidel nende koodid, vasakul iga proovi varaseima ja paremal hiliseima aastarõnga aasta. Rõhtteljel kalendriaastad, püstteljel proovid.*
Figure / Joonis: Alar Läänelaid

For the possible terminus for the shipwreck, the most useful approach is to take a closer look at the pottery finds.

Altogether around 30 pottery finds (i.e. number of individual vessels, not sherds) were found from the wreck, all most likely used on the ship and not being part of the cargo. Except for 2–3 greyware pots and one glazed redware jug (Fig. 11), all other items are near stoneware and stoneware jugs (Fig. 12), mostly from Siegburg but also two larger jugs from Langerwehe, both major potting industries of medieval Rhineland. Judging by the typological and technological features of the items it seems that the focal point of the collection should be within the 1320s or 1330s, but since one of the finds belongs to the group of fully developed Siegburg stoneware with traces

Fig. 11. *Glazed redware jug from the wreck Peeter.*
Jn 11. *Punane glasuurkeraamiline kann Peetri vrakilt.*
Photo / Foto: Andrus Anderson

Fig. 12. *Siegburg near stoneware and stoneware found on wreck Peeter.*
Jn 12. *Peetri vrakilt leitud Siegburgi varakivi- ja kivikeraamika.*
Photo / Foto: Andrus Anderson

Fig. 13. *A mortar, possibly a product of medieval stone industry in Normandy.*
Jn 13. *Arvatavasti Normandia kivitööstuses valminud uhmer.*
Photo / Foto: Andrus Anderson

of orange ash glaze, a slightly later dating is also plausible. Thus, at the current stage of the research it seems that the possible time of wreckage should be around the second quarter of the 14th century.

Another group of finds which deserve highlighting here are artefacts made of stone, all found from the kitchen area of the ship. These include a larger mortar, a quern and a few fragments of a baking slate, all having a very different geographical background. The mortar with anthropomorphic decoration (Fig. 13) can be attributed to the 13th – 14th-century stone industries of Normandy, perhaps even to the vicinity of Caen. Similar mortars are rather frequent finds around the North Sea, both from coastal settlements and ships (see Bencard 1971; Dunning 1977), but tend to be less common in the Baltic Sea region, which might be reasoned with the modest attention to the stone artefacts from medieval terrestrial and maritime sites.

The same considerations seem to apply to other collected stone items. The quern was visually identified and later also confirmed by petrological analysis (by Toivo Kallaste and Siim Pajusaar from Tallinn University of Technology) as an artefact made of volcanic rock phonotephrite, possibly coming from the Eifel stone industries of Rhineland. These products were widely exported during the Roman time (Gluhak & Hofmeister 2008), the distribution pattern of late medieval mill stones and querns has not been mapped so far (for early and high Middle Ages see for example Carelli & Kresten 1997). However, it is known that building stone from this region was frequently shipped to southern Scandinavia up to the early 13th century and were mostly used in Danish churches of Ribe and Schleswig bishoprics (Pohl 2012, 153–173). But what is more important in our context, the local documents indicate that Eifel region querns were used on ships during the 18th century (unregistered material from 1757 at Niedermending archive, pers. comm. Meinrad Pohl), thus possibly showing the continuation of stone export to the North and Baltic Sea areas until the Early Modern Age.

Less well preserved (only in fragments) but equally intriguing is also the last stone artefact (Fig. 14). This appears to be a bakestone, a common medieval find on archaeological sites of Norwegian cultural sphere, but such stones were to a certain degree also used in Danish and Swedish centres which had close trading contacts with Norway, with possible mediator being the town of Bergen (Baug 2015, 36–39). Outside Scandinavia, the only archaeological evidence in the Baltic Sea region known to us comes from the hanseatic town of Stralsund (Ansorge 2009, 47 and fig. 18, 11–12), showing once again the interconnectedness of medieval northern Europe.

Fig. 14. *Norwegian bakestone (in the bottom left corner), found from the kitchen area of wreck Peeter.*
Jn 14. *Peetri vraki kööginurgast leitud Norra päritolu küpsetuskivi (pildil all vasakus nurgas).*
Photo / Foto: Maili Roio

Mammal and bird bones from and around wreck Peeter

From and around the wreck 154 mammal bones and fragments were gathered, of which 144 were taxonomically and anatomically analysed (Table 1).[1] In addition to mammal bones, only four fragments of bird bones were found. The osseous material was well preserved and fragmentation was minimal. Some difference was noticed in the preservation quality of bones which probably depended on the time when the bones were buried under the sediments and also other environmental factors. Some fragments have rounded edges which were caused most probably by the wave activity, i.e. waves together with sand particles can roll larger pieces of stones and also bones and thus polish their protruding parts easily. This means that those rounded bones were clucked with sediments for a while before being totally covered by protective sediments.

Most of the identified osseous finds of mammals came from domestic animals: cattle (*Bos taurus*) predominated, followed by pig (*Sus domesticus*), while sheep and/or goat (*Ovis aries / Capra hircus*) were represented by a few bones only. However, no bones definitely associated with goat have been found from the wreck's material. Dominance of cattle and pig was noticed also in other studied shipwrecks of the 15th – 18th century (Migaud 2011, 287–288, table 1). As most of the bones originated from the body regions rich in meat, the provision was taken on board probably for cooking purposes.

[1] Bones were determined by a comparative method where reference skeletons of the Archaeological Research Collection, Tallinn University, were used. Bones of the sheep and goat were distinguished according to the bone atlas of Boessneck *et al.* (1964), for the exclusion or identification of bison bones Olsen's (1960) and Stampfli's (1963) identification criteria were used. Age of death/slaughter was estimated according to the teeth growth and replacement of deciduous dentition (Schmid 1972) and epiphyseal fusion (Silver 1969).

Bones of domestic cattle originated from a minimum of four individuals: one was of 2.5 years of age, one somewhat less than 4 years and two individuals were over 4–5 years old. Fragments of vertebrae and costae formed more than a half of the identified cattle bones, the rest originated from other body parts. According to the fragmentation of bones, a pattern of butchering can be reconstructed: vertebral column has been chopped longitudinally in half and then crosswise into shorter parts; ribs are chopped off at a distance of about 5–10 cm from the vertebral column and then into 11.5–16.5 cm rib pieces. There were no ventral parts of ribs among the bone finds as well as no sternum pieces. Pelvis was chopped from the part of ilium and long limb bones have chopping marks in both the proximal and distal ends. Dominance of the fragments of vertebrae and costae has been noticed also among osteological finds of the 15th century shipwreck Aber Wrac'h in France. There the vertebral column was chopped in half along the median plane, but transverse cuts were not noticed (L'Hour & Migaud 1990, 8–9). As there were also bone fragments of cattle's skull and lower limb bones in wreck Peeter, we cannot exclude live animals as cargo on board, who were only killed at the time when food was required by sailors.

In the bone assemblage of the wreck, two extra large bones of bovids (more precisely *Bovinae*) have been identified – a distal end of humerus and a tibia. They seem to be too large for medieval domestic cattle, especially the large tibia was exceptional. Morphologically it does not fit with the tibia of European bison either. Considering the spatiotemporal origin of wreck Peeter, we can take into account also an aurochs (*Bos primigenius*). Aurochs has disappeared from Estonia much earlier than the Medieval Period, but there are some 14th-century finds in Lithuania (Paaver 1965, 320). According to historical documents, the species survived in Europe until the last recorded aurochs died in the Jaktorów Forest, eastern Poland in 1627 (see e.g. Paaver 1965, 321 and references therein). Bartosiewicz *et al*. (2010) when studying the archaeozoological evidence in reconstructing mundane diets in Hungary (the study concerns zoological identification of wild mammals in a cookbook published in Hungarian at the end of the 17th century in Transylvania), discuss about a possibility that some 'wild ox' could be aurochs, even though this species had disappeared from Hungary in about 10th – 11th century. Meat of the wild oxen was very valued at the Medieval Period. Meat of game animals was valued also in other provisions of ships: there are finds of rabbit, red deer, roe deer, wild boar and bison found from these ships (e.g. Migaud 2011, table 2; L'Hour & Migaud 1990, 7; Heinrich 2002, 262; Bruseth & Turner 2005, 125–126). Thus, the aurochs as cargo in wreck Peeter is not excluded.

There were only eight bones of sheep or goat in wreck Peeter: two vertebrae, one fragment of costa, fragment of metacarpal bone, pelvis, tibia, tarsal and metatarsal bone. These bones originated from at least two individuals: one was less than 10 months and the other over 3.5 years of age. While bones of cattle have mainly butchery marks visible, some of the bones of sheep/goat (a fragment of costa and metatarsal) had cutting marks caused most probably during the meat removal process.

Pig was somewhat more numerous in the bone assemblage and was represented there at least by two individuals: one was less than a year old and the other *ca*. 3.5 years old. Anatomical representation of pigs refers that no heads and legs were used much for food: there was only one skull fragment, a tarsal bone from lower limbs and metapodial bones were absent altogether in the material. Chopping marks were observed at the mentioned skull fragment, also at two lumbar vertebrae and one femur.

Table 1. *Taxonomic and anatomical distribution of mammal bones according to the number of identified specimen and minimum number of individuals (NISP/MNI and relative values are represented).*
Tabel 1. *Imetajaluude taksonoomiline ja anatoomiline koostis (näidatud on määratud luufragmentide arv / minimaalne isendite arv ning suhteline osakaal).*
Compiled by / Koostanud: Liina Maldre

	cornus / processus cornualis / sarv ja sarvjätke	*cranium / kolju*	*mandibula / alalõualuu*	*dens / hammas*	*vertebra / selgroolüli*	*costa / roie*	*scapula / abaluu*	*humerus / õlavarreluu*	*radius / kodarluu*	*ulna / küünarluu*	*radius + ulna / kodarluu + küünarluu*	*os carpi / randmeluu*	*os metacarpale / kämblaluu*	*pelvis / vaagen*	*femur / reieluu*	*tibia / sääreluu*	*os tarsi / kannaluu*	*os metatarsale / pöialuu*	*phalanx / varbalüli*	Total / Kokku	%
Bos taurus Cattle / Veis	2/2	2/1	1/1	2/2	27/3	37/3	4/1	7/3	3/1	2/2	2/2	1/1	2/2	3/2	8/3	5/2			2/1	110/4	76.4
Bovinae Pärisveislased								1/1								1/1				2/1	1.4
Ovis aries Sheep / Lammas													1/1			1/1	1/1	1/1		4	2.8
Ovis aries/ *Capra hircus* Sheep / goat / Kits / lammas					2/1	1/1								1/1						4	2.8
Sus domesticus Pig / Siga		1/1			2/1	5/2		1/1		2/1				3/2	4/2	1/1	1/1			20/2	13.9
Equus caballus Horse / Hobune		1/1																		1/1	0.7
Cervus elaphus Red deer / Hirv	1/1																			1/1	0.7
Phocidae Seals / Hülged					1/1															1/1	0.7
Odontoceti Toothed whales / Hammasvaalalised				1/1																1/1	0.7
Total / Kokku	3	4	1	3	32	43	4	9	3	4	2	1	3	7	12	8	2	1	2	144	100
%	2.1	2.8	0.7	2.1	22.2	29.9	2.8	6.3	2.1	2.8	1.4	0.7	2.1	4.9	8.3	5.6	1.4	0.7	1.4	100	

Horse was represented by one bone find – an occipital, which originated from a young individual. Whether this bone was connected with the shipwreck at all, is not very clear. Horse bones in shipwrecks are not common (Migaud 2011, table 2, 289); only one phalange was known before.

Bones of the red deer were not present in the shipwreck, only a fragment of antler (i.e. an antler section cut off together with one tine), which had working and probably also exploitation marks visible. This item looks like a handle of something (Fig. 15).

Fig. 15. *A fragment of red deer antler.*
Jn 15. *Hirvesarve katke.*
Photo / Foto: Reet Maldre

Fig. 16. *Tooth of the toothed cetacean (Odontoceti).*
Jn 16. *Hammasvaalalise (Odontoceti) hambakatke.*
Photo / Foto: Reet Maldre

A most outstanding find in Estonian context is probably a tooth of the toothed cetacean (Odontoceti). This identification has to be checked since it needs more precise conformity with some certain species (Fig. 16). According to the tooth size and shape it may most probably come from orca (*Orcinus orca*), known also as killer whale (L. Lõugas' opinion). However, larger sperm whale (*Physeter macrocephalus*), which has also larger and more oval teeth should not be excluded since its teeth can be somewhat different depending on their position in the jaw and age of the animal. We do not have enough comparative material to distinguish that.

Avian fauna[2] was represented by a humerus of *ca*. two-month-old domestic hen (*Gallus gallus*); one fragment of radius and one tibiotarsus could originate also from the hen (age of individuals respectively *ca*. two months, and six weeks). In addition, there was a pelvic fragment of a middle-sized Anseriformes in the material.

Evidence of fish and fish trade

The current study also focused on the fish remains found *in situ* from the bottom of the wreck and to some extent also outside of the board. Fish remains had some clear distinguishable accumulation places within the ship: kitchen waste in the ship's stern, two separately located bunches of fish whose tails were originally tied together, a barrel in the ship's fore and a box made of birch bark.

Altogether 2675 fish bones and approximately 5000 scales were taxonomically and anatomically analysed (Table 2). Only 241 fish bone fragments were left as unidentified. Such a low number of unidentified fish bones is not very usual in archaeological contexts since fish skeleton can provide a lot of fragments of costae, rays, spines and radials, which in most cases remain unidentified. In our case, when many individuals were found *in situ*, such bones were associated with the rest of the fish skeleton and could be identified accordingly.[3]

The largest fish-bone assemblage came from the stern of the ship and could be associated with kitchen waste. Part of it was most likely washed out from the board since similar accumulation of fish bones was found just from the other side (outside) of the board. The kitchen waste included bones of minimum 47 individuals and *ca*. 3700 scales of pike (*Esox lucius*). A minimum number of individuals was counted based on the right dental bone (*Dentale dexter*). Among 1445 bones of pike there were only 135 vertebrae, which all came from the very end of the cranial or caudal part of the vertebral column. The rest of the bones were from fish heads. Thus, this accumulation seems as typical waste which is a result of fish processing (decapitation) and from where trunks of fish have been taken away (sold?) somewhere else. Probably such kitchen waste formed during quite a short time just before the shipwreck, since keeping

[2] Bird bones were identified by Teresa Tomek (Polish Academy of Sciences, Institute of Systematics and Evolution of Animals).
[3] Fish bones were determined by a comparative method where reference skeletons of the Archaeological Research Collection, Tallinn University, were used.

smelling fish remains in the boat for a longer time seems doubtful. Beside the remains of pike, 89 bones of cod (*Gadus morhua*), mainly vertebrae, and only one dentale of turbot (*Scophthalmus maximus*) were found from this waste accumulation (Table 2).

Fig. 17. *Bones of cods tied into a bundle.*
Jn 17. *Kimpu seotud turskade luud.*
Photo / Foto: Jaana Ratas

Two separately located bunches of fish whose tails were probably originally tied together, included only cod and were found also from the ship's stern, but more towards the middle part of the ship from the kitchen waste. One was found in starboard (Fig. 17) and the other in port side. There were vertebrae of cods, 16 individuals in one bunch and 10 in another. Individual fish were counted mainly based on fifth vertebra as the most frequently occurring bone element in these bone accumulations, but also the size and location of bones were counted. From the pectoral girdle (Table 2), the most commonly represented bone was cleithrale. In most cases they were cut in half when decapitated, thus posterior parts of the cleithral bones (sometimes scapula was also connected) stayed with the trunk. In addition to the individuals of two bunches there were also four other individuals counted in the ship's stern (mentioned above) and three individuals in the ship's fore, but they were represented by a few bones only, including some bones from the skull.

Table 2. *Taxonomic and anatomical representation of fish bones.*
Tabel 2. *Kalaluude liigiline ja anatoomiline koostis.*
Compiled by / Koostanud: Lembi Lõugas

Anatomical section / Kehaosa	**Pike / Haug (*Esox lucius*)**	**Cod / Tursk (*Gadus morhua*)**	**Baltic herring / Räim (*Clupea harengus membras*)**	**Perch / Ahven (*Perca fluviatilis*)**	**Turbot / Kammeljas (*Scophthalmus maximus*)**
Head (including mandible) / Pea (sh lõualuud)	824	96	48	2	1
Opercularia / Lõpusekaaneluud	81	1	28		
Pectoral girdle / Esivööde	83	60			
Vertebral column / Selgroog	135	510	27		
Other bones (costae, spines, rays, etc.) / Muud luud (roided, lülijätked, uimekiired jne)	322	443	14		
Total (NISP/MNI) / Kokku:	1445/50	1110/33	117/5	2/2	1/1

The analyses of sediments from a wood barrel and a box made of birch bark gave quite a small amount of herring bones (NISP=87, MNI=2 from barrel and NISP=26, MNI=2 from box) and a lot of scales, especially from the barrel. There were also two bones (articulare and dentale) of perch (*Perca fluviatilis*) in this barrel, which came from different individuals, both less than 15 cm in total length. The body size of herrings refers rather to the Baltic herring, remaining at *ca*. 18–25 cm in total length. The size estimation here was done in comparison with the skeletons in reference collection of the Archaeological Research Collection, Tallinn University.

Morphometrics of discovered fish

The aim of morphometric analyses was to get more precise information on the sizes of pikes and especially cods found from the shipwreck. For pikes a right dental bone (NISP=47) and for cod a fifth vertebra (NISP=21) were measured (measurements are according to Morales & Rosenlund 1979). These bones were chosen since they serve as a basis of calculating a minimum number of individuals and thus the duplication of individuals in a data set was excluded. The size estimation was done in comparison with the skeletons of our reference collection. Pikes of this reference collection were captured from the coastal waters in west Estonia, but cods from the northern fjords in Norway (cods from the Baltic Sea were clearly too small for the reference). Measurements were entered into the charts which give a general impression of the body sizes (TL). There are not enough reference skeletons of pike available in our collection, but still we can say that most of pikes from the shipwreck remained at a length of 40 to 60 cm (Fig. 18: A). No much larger individuals occurred. Reference cods were more numerous (NISP=13), but appeared to be smaller than those in the shipwreck (Fig. 18: B). A probable explanation is that coastal cods in northern Norway are usually smaller (i.e. growth rate is slower) than those of the open ocean (see e.g. Berg & Albert 2003) and that the reference skeletons are coming from the fish captured randomly by amateur fishermen in northern fjords. Cods from the shipwreck were quite large, at the total length of *ca*. 100 cm, but seemingly even larger specimen occurred. This means that those cods were most probably captured in the

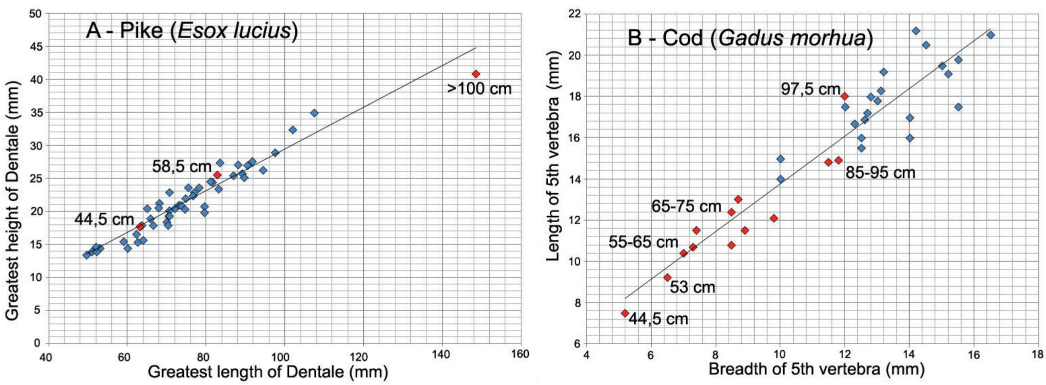

Fig. 18. *Simplified charts for the estimation of the body length (TL) of pike, Esox lucius (A) and cod, Gadus morhua (B) found from wreck Peeter. The line indicates a mean linear value of growth. Red rhombs mark fish with the known body length (lengths written near the rhombs) from reference collection; blue rhombs mark fish bones from the shipwreck.*

Jn 18. *Lihtsustatud graafikud haugi, Esox lucius (A) ja tursa, Gadus morhua (B) kerepikkuste (TL) hindamiseks. Graafikut läbiv joon näitab lineaarset kasvu. Punased rombid markeerivad võrdluskollektsioonist pärit kalu, mille kerepikkused on teada (pikkused on näidatud rombi juures), sinised rombid markeerivad kalu, mis leiti Peetri vrakist.*

Figure / Joonis: Lembi Lõugas

open ocean, but the body size of cods does not indicate from which part of the Atlantic Ocean. Previous studies (Orton *et al*. 2011) allow estimating the origin of imported cod in medieval Tallinn and other towns in Estonia from the north-eastern Atlantic or North Sea.

Long vs short-ranged fish trade

Archaeological evidence, in the form of fish remains, from medieval towns explains mostly local fisheries within Estonia and it is not possible to detect the distances involved in the trade of fish. The latter is based on our knowledge of fish distribution in local and/or distant water bodies (Lõugas 2001; 2016). This means that only taxonomical analyses are not very helpful in determining the trade distances. Tartu is an exception here since there bones of large cod were found and definitely marine fish are not natural inhabitants in freshwaters, but reflect the imports from the sea coast.

Morphometrics sometimes helps to determine the origin of fish, especially when we distinguish for example the (sub)species of the Baltic and the Atlantic like e.g. cods (*Gadus morhua*) and herrings (*Clupea harengus*). In ocean environment the growth rate in all age-classes is faster than in more brackish inland sea, thus the specimen at the same age range in the Atlantic ocean are larger than those in the Baltic sea, especially in the eastern part of the Baltic sea (see e.g. Cardinale & Arrhenius 2000). Analysis of stable isotopes (e.g. ^{13}C, ^{15}N) is a quite effective tool in detecting the origin of fish (see e.g. Barrett *et al*. 2008; Orton *et al*. 2011). Thus many large cod bones found from medieval town sediments and the discovered wreck originate from the Atlantic side, most probably the North Sea. Fish bones in combination with other archaeological finds shed light to the trade more efficiently, for example, oyster shells prove long-ranged trade more clearly as they do not live in the Baltic sea. Oyster shells were found e.g. in Tallinn (Tartu Street 1, Vabaduse Square) and Pärnu (Lõugas 2001; 2016), but not from the shipwrecks in Kadriorg. Here, it seems that some fish (*stockfish*) were imported from much farther distances than the origin of the ship indicates, while herrings seem to represent the local Baltic stock.

SOME THOUGHTS ON THE SITE FORMATION

A time capsule is a commonly used comparison to a shipwreck (see Adams 2013), since differently from the objects studied on land, shipwrecks usually constitute immovable monuments that have formed during a certain, and usually a very short time period. Therefore, the items found on board of a ship and in its immediate proximity form a time capsule – the everyday items have been in use at the same time, which gives us an opportunity to have a glimpse into a ‘frozen’ workday. It is seldom possible to encounter a similar situation on land. Usually the archaeological finds have stratified in the ground in the course of a long time and often after some catastrophe (fire, landslide, collapse, etc.) occurred, the valuables and practical items were picked out from the destruction layers. It is also important to emphasise that due to better preservation conditions, the finds are much more complete, than for example the pottery sherds and other fragmentary material found in the course of urban excavations. When talking about the location of the Kadriorg wrecks, their closeness to the city has to be taken into account, which is essential in the site’s formation process.

The formation of each wreck-site is unique, since the complex and interacting variables that constitute the environmental setting, the nature of the ship, and the circumstances of its loss will combine to create a set of attributes unique to each site (Martin 2011, 47).

When interpreting excavation material of these medieval shipwrecks, one must keep in mind that the ships were lost near the shore, where there were brisk life activities, and still 100 years ago the place was used actively as a beach and at the same time also waste was dumped to the site. The marine processes that have taken place throughout several hundred years in relatively shallow waters are also a reason for distinguishing the site from a traditional notion of a time capsule. Therefore, the whole find material must be critically analysed and when connecting each find with the wreck, one must consider the possibility that it has reached the site by chance. For example, when comparing the find context of fish bones and animal bones in wreck Peeter, the fish bones were found in expected places like the galley or inside the barrels, and they have not been found outside the wreck or from the filling layer. There is a complete opposite situation with most of the animal bones that were found, for example a horse bone was collected from outside the wreck next to the starboard.

CONCLUSION

The archaeological excavations of two wrecks organised by the Estonian National Heritage Board took place in a relatively limited time frame and with even more limited preparation time, in the course of salvage excavations. It was decided that both wrecks were to be preserved: wreck Viljo was placed under water in Tallinn Bay and wreck Peeter is waiting to be conserved and exhibited at the Estonian Maritime Museum.

The construction time of wreck Viljo was soon after AD 1487, according to the dendrochronological studies. As the tree-ring series of the wreck appeared most similar with Estonian pine chronology, we may assume that the pines for that ship were grown in the region of Estonia. The artefactual material from that wreck was too scarce to establish a possible time of wreckage. Wreck Peeter preserved with more find material was built after AD 1296. Similarity of the tree-ring series with the East Pomeranian oak chronology gives a basis to assume that the oaks used to build this ship were grown anywhere in east Poland or even in the region eastward of it. It is difficult to establish when the ship went aground but the preliminary study of pottery suggests that it happened around the second quarter of 14th century. Both examined ceramics as well stone artefacts show a very broad geographical background of the finds but more thorough studies of wrecks and their find material still waits ahead. The animal and fish bones, and plant residues have been determined, but a more in-depth analysis will be conducted in the near future.

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KESKAEGSED LAEVALEIUD TALLINNAST KADRIORUST

Maili Roio, Lembi Lõugas, Alar Läänelaid, Liina Maldre, Erki Russow ja Ülle Sillasoo

22. mai hommikul 2015 võttis Muinsuskaitseametiga ühendust AS Nordecon projektijuht Agu Zilensk ja andis teada Tallinnas Kadriorus Pikksilma tn 2/1 leitud puidust laeva osadest ja ehitustööde peatamisest: ehitajad olid sattunud sulundseina terasprofiili paigaldamisel takistusele, mille päritolu asuti kindlaks tegema kopaga. Kokku tõsteti kopaga vesisest pinnasest välja ligi paarkümmend kaart ja planku, mis toimetati 25. mail Eesti Meremuuseumi. 25. mai õhtutundidel satuti samal ehitusplatsil aadressil Tuukri 23 veel ühele laevavrakile, mis paikneb esimesest ligi 50 meetrit idas (jn 1, 2).

Muinsuskaitseameti seisukoht oli, et ajalooliste vrakkide leiukohal tuleb korraldada arheoloogilised väljakaevamised, kaevamiste käigus vrakid toestada ja teisaldada säilitusalale meres, kuna maapinnal puuduvad vastavad hoiustamisruumid. Arheoloogilised uuringud vrakkide leiukohal toimusid 11.06.–9.08.2015 Muinsuskaitseameti eestvõttel.

Enne arheoloogilisi uuringuid kooriti ehitusplatsil maapinda kuni vrakkide tasapinnani ja seejärel uuriti ala georadariga, et välja selgitada vrakkide ulatus. Kuna esimesed vrakkide detailid paljandusid veidi vähem kui meeter allpool merepinda, paigaldati väljakaevamiste ala ümber nõelfilterkuivendussüsteem (jn 3). Lisaks aitas kaevandite kuivana hoidmisele kaasa kogu ehitusala ümbritsev sulundsein. Vrakid puhastati esmalt seest ja seejärel kaevati kopaga vrakkide ümber kraav, mille sisse paigaldati terasest tugiraam. Seejärel eemaldati järk-järgult vraki alt ja ümbert labidatega pinnas ja samaaegselt ehitati puidust tugistruktuur.

Vrakkide leiukohal laius veel 100 aastat tagasi meri. 1930. aastatel planeeriti Kadrioru mereranda näituse väljakut ning Põhja Paberi- ja Puupapivabrik hakkas kokkuleppel linnavalitsusega vedama sinna täiteks vabriku põlevkivituhka. Praegu moodustabki tuhk, ehituspraht ja olmeprügi kuni nelja meetri paksuse täitekihi, mille alt paljandusid ajaloolised vrakid.

Arheoloogilisi väljakaevamisi alustati teisena leitud vrakil, mis sai Nordeconi objektijuhi Viljo Niidi järgi töönimeks "Viljo". Vrakk oli randa kinni jooksnud ninaga Kadrioru suunas ning sellest on säilinud suurem osa pakpoordist ja põhi (jn 4). Terviklikult säilinud osa mõõtmed on umbes 14 × 3,5 m. Alles on ka laeva põhjast lahti tulnud kiil, mis paiknes väikese nihkega põhjaplankude kõrval tüürpoordis.

Viljo vraki puhul on tegemist tüüpilise Põhjamaade laevaehitustraditsiooni järgiva laeva jäänustega, kus on kasutatud klinkerplangutust. Laeva veetiheduse tagamiseks on tihtimiseks kasutatud loomakarvu. Vraki esemeline leiumaterjal oli äärmiselt kesine. Enamik leidudest pärineb segatud kihist ja on seotud hilisemate tegevustega. Tõenäoliselt on laevalt juba üsna kohe peale hukkumist ära viidud kõik väärtuslik, mida vähegi oli võimalik kätte saada. Purjelaeva vrakiga seonduvateks saab lugeda kaarte vahele jäänud puidust plokki (jn 5), vööri põhjaosas säilinud harilikust kanepist (*Cannabis sativa*) tehtud köiestikku, ahtriosas põhja alt leitud metallist graapenit ja tõenäoliselt ka kiilu all asunud puidust tünnikaant.

Viljo vrakist võtsime 20 puiduproovi peamiselt plankudest ja kaartest; neist 16 ristlõiku (männipuit) ja 4 puurproovi (tammepuit, tääv). Männiproovide aastarõngarida võrreldi olemasolevate männikronoloogiatega Eestist ja mujalt Euroopast, otsides sarnaseid lõike. Tõenäoliselt raiuti plankude männid peatselt pärast 1487. aastat (jn 7). Vraki aastarõngaridade suurim sarnasus Eesti männikronoloogiaga lubab oletada, et Viljo laev oli valmistatud Eestis kasvanud puidust.

Esimesena leiti ja teisena kaevati välja krundi läänepoolses osas asunud vrakk. Sellele, nn Peetri vrakile andis töönime kopajuht Peeter Hallikas. Ahtriga vanalinna poole paiknenud vraki maksimaalne pikkus on 18,08, maksimaalne laius 6,64, maksimaalne kõrgus pakpoordis 3,05 ja maksimaalne kõrgus tüürpoordis 2,11 meetrit (jn 8).

Tegemist on keskaegse kaubalaeva, koge vrakiga. Sirge vöör- ja ahtertääviga laevast on säilinud kogu pikkuses plankkiil, karveelplangutuses ehitatud põhjaosa, klinkerplangutuses pardad, kiilson, siseplangutust, suured kniid ja põikitalad. Lisaks olid plangusaamad kaetud puuliistudega, mis on plankude külge kinnitatud raudklambritega ja planguservad on omavahel kokku liidetud seestpoolt kahekorra keeratud ja uuesti plangu sisse tagasilöödud raudnaeltega. Laeva triivimiseks kasutatud samblaliikidest olid esindatud peamiselt kallas-sirbik (*Drepanocladus aduncus*) ja ujuv vesisirbik (*Warnstorfia fluitans*).

Peetri vrakist võtsime 12 puiduproovi puuriga ja 4 ristlõiku (jn 9). Peale ühe männipuidu on kõik proovid tammepuidust. Peetri vraki tammepuidu aastarõngarida osutus väga sarnaseks Ida-Pommeri tammekronoloogiaga positsioonis, kus Peetri vraki viimane aastarõngas on kohakuti kalendriaastaga 1296 (jn 10), laev saadi ehitada selle aasta järel. Peetri vraki tammepuidu aastarõngaridade sarnasus Ida-Pommeri tammekronoloogiaga annab alust oletada, et laevapuiduks tarvitatud tammed on kasvanud kusagil Ida-Poolas või sellest ida pool.

Kogelt kogutud leiud on väga mitmekesised, sisaldades kõike alates puitesemetest ja tekstiilist kuni keraamika ja kivini. Laevalt leitud kolmekümne savinõu (nt jn 11, 12) põhjal näib, et laev uppus millalgi 14. sajandi teisel veerandil, seevastu kolm koge kööginurgast leitud kivieset osutavad laeva materiaalse kultuuri geograafilisele mitmekülgsusele. Nii kuulub leitud antropomorfse kujundusega uhmer (jn 13) ilmselt Normandia 13.–14. sajandi kivitööstuse toodete sekka, kahepoolne käsikivi valmistati Reinimaal Eifeli piirkonna vulkaanilisest kivimist ning küpsetuskivi (jn 14) esindab tüüpilist Norra köögitarvet, mis väljapool Skandinaavia kultuurisfääri ei levinudki.

Peetri vrakist ja selle vahetust lähedusest koguti 154 imetajaluud ja luufragmenti, neist määratavateks osutus 144 eksemplari (tabel 1); lisaks imetajaluudele oli materjalis ka neli linnuluu katket ning kalaluud ja -soomused. Enamik luumaterjalist on pärit koduloomadelt: ülekaalukalt domineerivad veise (*Bos taurus*) luud, arvukuselt järgmisel kohal on siga (*Sus domesticus*), lambad-kitsed (*Ovis aries*/*Capra hircus*) on esindatud üksikute luuleidudega. Valdav osa luumaterjalist on pärit loomade liharohketest kerepiirkondadest, seega on tegemist jäänustega toidu valmistamiseks varutud lihast.

Analüüsitud kalaliikidest leidus köögijäätmete seas haugi, räime, turska, ahvenat ja kammeljat (tabel 2). Kaks leitud tursa selgroogude kogumit (jn 17) pärinevad keskajal ulatusliku kalakauba-artikli – kuivatatud turskade – seast. Nende turskade pikkused, mis mõõtmistulemuste järgi jäid 1 m kanti, on iseloomulikud Atlandi ookeani populatsiooni(de)le.

Kadrioru vrakkide juures tuleb arvestada, et leiukoht asus tiheasustusega ala lähedal, mis on määrav sealsete ladestuste tekkeprotsessis. Väljakaevamise materjali tõlgendamisel tuleb silmas pidada, et laevad olid hukkunud ranniku lähedal, kus toimus vilgas elutegevus ja mis veel 100 aastat tagasi oli aktiivselt kasutusel supelrannana, aga samas ka prügi ladustamiskohana. Mitmesaja aasta jooksul suhteliselt madalas vees aset leidnud merelised protsessid on samuti põhjuseks, mis eristavad leiukohta traditsioonilisest ettekujutusest ajakapslist. Seetõttu tuleb väga kriitiliselt suhtuda kogu leiumaterjali ja iga leiu seostamisel vrakiga arvestada võimalusega, et see on sattunud leiukohta juhuslikult.