FEHMARN BELT FIXED LINK
MARINE ARCHAEOLOGICAL REPORT

The Excavations on the Wreck of Lindormen

Ostsee Gebiet 1433, LA 3

AA2012-279

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Archäologisches
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Fehmarn Belt Fixed Link

The Excavations on the Wreck of Lindormen

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Contents

Abstract

On behalf of Femern A/S, an extensive marine archaeological investigation was carried out in 2012 on a wreck site in the Fehmarn Belt close to Puttgarden. The wooden shipwreck was identified as the Danish warship *Lindormen*, lost in 1644. During the investigation, the remains of the wreck were documented and two trenches were excavated in the ship's interior, leading to numerous finds of ship's equipment, arms, ordnance and personal belongings of the crew. The state of the wreck was thoroughly assessed and the wreck covered for long-term protection.

1. Background

In advance of the construction of a fixed link across Fehmarn Belt in the westernmost Baltic Sea, a number of underwater surveys have been conducted to illuminate the submerged cultural landscape of the affected area, in order to identify vulnerable heritage sites. All investigations were carried out on behalf of Femern A/S by Viking Ship Museum Roskilde and Archäologisches Landesamt Schleswig-Holstein jointly, on the basis of and regulated by appropriate contracts.

Figure 1: Denmark, Sweden and Germany, with Fehmarn Belt hatched.

The surveys ultimately revealed a single wreck site of particular cultural interest in German national waters. The wreck is expected to be the Danish man-of-war *Lindormen*, which was lost in the area on October 13th 1644. During the battle against an overwhelming combined Swedish-Dutch fleet, the ship was hit by an enemy fire ship and eventually exploded with the loss of some 50 lives.

Through the recovery of exposed artefacts and samples, as well as limited excavation and hull documentation, the present investigation had its main objectives to:

- Establish a dating and identification of the wreck.
- Assess the condition and extent of the hull remains.
- Define an appropriate protection plan

2. Administrative data

The investigation took place between June 15th and July 8th 2012 at UTM (EUREF89) coordinate 646082 E 6044520 N, zone 32U, as a cooperative venture between primarily the State Archaeological Department of Schleswig Holstein (Archäologisches Landesamt Schleswig-Holstein, ALSH) for Germany and the Viking Ship Museum (Vikingeskibsmuseet I Roskilde, VIR) for Denmark.

The site is designated as ID 104 and MAJ 2704 by the two institutions respectively and filed as Ostsee Gebiet 1433 LA 3 in the archaeological site records of Schleswig-Holstein. Additional diving personnel from Bohusläns museum (Sweden) as well as Dansk Dykkerservice ApS and JD-Contractor A/S participated.

3. Site description

The wreck is located about 3 km north-north-eastern of Puttgarden on the German island Fehmarn in the western-most Baltic, at a depth of 23 m. The site is already known to the sports diving community, and has been used as a dumping site as well as for recreational fishing.

The site is characterised by a 30 x 20 m rounded mound rising to a plateau 2-2.5 m above the surrounding flat bottom. On the NE-SW axis, the plateau perimeter is defined by the parallel sides of the hull c. 9.5 m apart—the eastern hull side largely blends into the slope and remains covered in places, whereas the western side may rise vertically more than 1 m above the slope, creating a much more abrupt transition. The outline becomes less distinct towards the ends of the mound, with no timbers exposed either end, and gradually blends in with the seabed.

Several individual timbers extend more than 1 m above the plateau, along the sides as well as further inwards. The surface of the plateau is flat but rather heterogeneous, and concentrations of larger rounded stones occur in several places, with sizes range from 15 to 50 cm in diameter.

Currents along the bottom are generally eastern, and the lack of ripples on the smooth sandy bottom seems to indicate limited sediment transport. However, the sediments outside the mound do show broad layering in the upper 30-40 cm (Hoppe 2012).

There is also a clear stratigraphy to the deeper sediments inside the wreck, but here the pattern is finer and more repetitive, suggesting a more cumulative sedimentation process.

- Layer 1 is sludgy with wood fragments, shells and pebbles.
- Layers 2-4 are comprised of homogeneous silty clay containing remains of eelgrass and some shells.
- Layers 5-7 are similar, but more heterogeneous, and the latter with traces of powered shells.
- Layer 8 is fine clay with smaller shells.
- Layer 9 also contains pebbles and organic remains, and
- Layer 10 seems largely comprised of charcoal.

Below layer 1, the stratigraphy generally darkens with each layer. In the transition between the numbered layers, with the exception of 1-2 and 9-10, are very fine layers of sand and eelgrass.

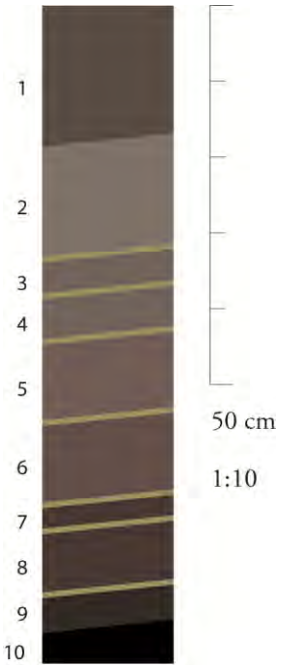


Figure 2: Stratigraphy of Trench 1's north wall, c. 70 cm east of hull side.

4. Methodology

4.1 Geophysical surveys

In preparation of the planning of the fixed link and the subsequent archaeological surveys, the entire planning corridor across the Fehmarn Belt was surveyed with an array of geophysical prospection methods in 2008 and 2009, including a survey of the geological underground using seismics and subbottom profilers and a survey of the seabed implementing side scan sonar- and geomagnetic measurements (Rambøll 2009 for the deep water areas; Al-Hamdani et al. 2009 for the shallow waters). The results of these surveys were assessed by the VIR, the ALSH and the Leibniz-Institut für Ostseeforschung (Tauber 2010) for possible anthropogenic objects of archaeological significance and for submerged Stone Age landscapes. The resulting targets of archaeological interests were examined in several surveys which included the wreck of the Lindormen. As a preparation for a full-scale archaeological examination of the wreck, a detailed geophysic survey was

conducted of the wreck site in 2012 with a multibeam echosounder, producing a high-resolution bathymetric model of the wreck and its surroundings. Furthermore, the wreck mount was analysed with the help of a subbottom profiler and a precise geomagnetic survey of the area was done (Brenk 2012).

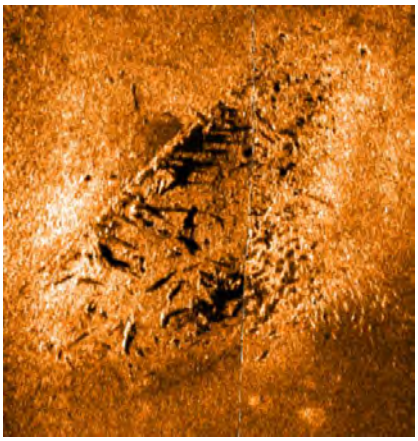


Figure 3: Result of side-scan sonar survey. 1:500

4.2. Archaeological surveys

The wreck site was previously known to the German Federal Hydrographic and Maritime Agency (Bundesamt für Seeschifffahrt und Hydrographie, BSH) as wreck WK 762, mapped in the sea charts as foul ground. In the archaeological survey of the Fehmarn Belt in 2009, the wreck was given the target number ID 104 and again inspected in the course of a survey of the deep water areas with the use of an ROV, mainly to get a basic impression of the wreck for the planning of a detailed examination through offshore divers (Dencker et al. 2015).

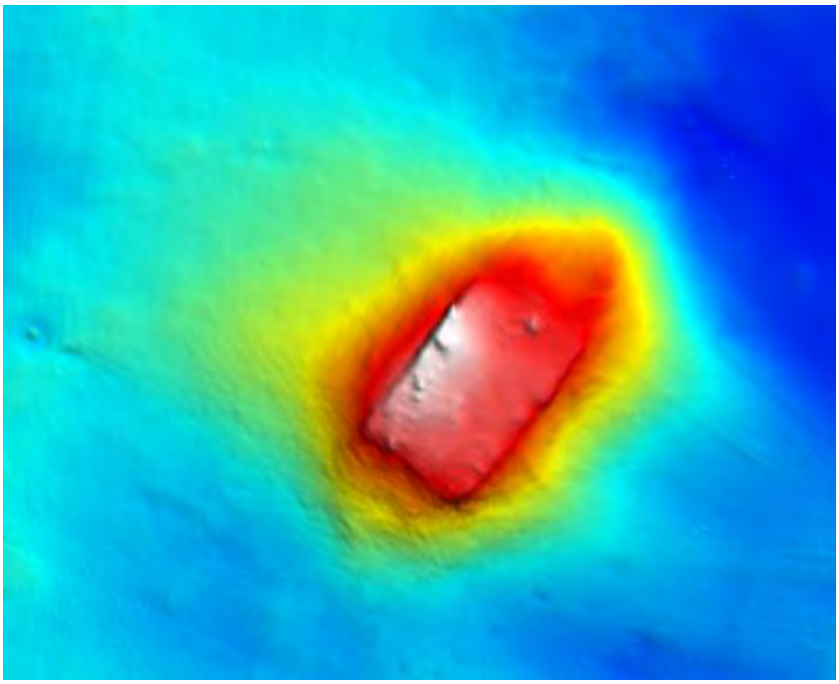


Figure 4: Result of multibeam survey.

Four dives were conducted in September 2009, based on the ROV reconnaissance. The divers gained an overall impression of the wreck site with a special focus on the visible ship timbers, obtaining a more detailed description of the wreck. The

exposed hull structures were measured and several samples taken for dendrochronological dating. A piece of a burst bronze cannon as well as an iron cannon ball were salvaged and a small excavation trench was opened to assess the possibility of a large scale excavation. The ship timbers were dated into the first half of the 17th century with a building date around 1635, which identified the ship with some probability as the Lindormen, sunk in the Battle of Fehmarn in 1644 (Dencker et al. 2015).

4.3. Logistics

The investigation was carried out from the large multipurpose vessel *M/S Vina* operated by JD-Contractor. A six-point mooring system with large anchors allowed the vessel to be fixed above the wreck site, and *Vina* remained in position for the duration of the campaign. Support tasks including anchor handling, transport of personnel and supplies to and from Rødby harbour, as well as enforcement of the safety zone, were carried out by the smaller vessel *JHC Guard* and tugboat *Naja*.

This well-equipped base provided accommodation for up to 24 people at any one time, and the largely empty cargo decks provided ample workspace. For the immediate protection of larger finds, tanks with seawater were also installed on the middle deck, so that only the largest and most cumbersome – limited to the rudder and the largest bronze gun fragments – were stored on the open deck.

Diving was conducted with surface-supplied equipment from a containerised unit with built-in gas blending system, supplying oxygen-enriched (nitrox 40%) breathing air. Divers were dressed in hot water suits with Kirby Morgan helmets, and remained in continuous contact with the surface personnel through two-way voice communication and a colour video feed. Records of both have been saved and archived.

In most cases two divers were deployed simultaneously, but the number was occasionally reduced to a single diver as a result of technical issues, or during the execution of particularly dangerous operations. The ship was fitted with two separate diving baskets, and the dynamic mooring system allowed the entire vessel – Including the baskets – to be repositioned and deliver the divers at the exact location desired for each dive. JD-Contractor supplied six divers including supervisors, but dive teams generally included at least one archaeologist. Bottom time per dive generally approached 2 hours, followed by 30 minutes of in-water decompression, allowing up to four dives per day.

A Saab Seaeye Falcon ROV was launched regularly to oversee lifting operations, survey larger areas or obtain otherwise relevant video footage.

Figure 5: Base of the investigations, M/S Vina, moored in position on site.

4.4. Reference systems

Three different levels of positional reference systems were employed. On the most general level, positions were described geographically with reference to the UTM system (zone 32U) using the WGS84 ellipsoid. During the investigation, positional data was gathered via the RTK-DGPS system aboard *Vina*, and visualised with the NaviPac software from EIVA.

The positional feeds were also patched into 3H Consulting's SiteRecorder 4, allowing for a direct integration with a finer, local reference system. This software is a means of calculating, optimising and expanding a network of fixed control points, enabling the local positioning of finds or features by trilateration. In total, 23 control points were created on the site: 12 of them were located around the wreck at approximately 5 m intervals, between 2 and 8 m away from recognisable hull remains. These points were physically represented by 1 inch iron pipes driven into the sediments. The remaining 11 control points were distributed along and inside the hull remains. Some of these were also represented by pipes, but the majority were attached to the hull structure and simply took the form of a large nail. All points were identified by a single capital letter indicated on a white plastic tag, thus employing the entire English alphabet with the exception of T, W and Z.

After the erection of the physical network, the distances between each of the points and its nearest neighbours were measured and checked by divers with calibrated 30 or 50 m nylon tape-measures, ensuring the highest possible accuracy. Depths for each point were recorded to the nearest 10 cm using a wrist-mounted bottom timer. However, since the waters in Fehmarn Belt are subject to a—for this purpose at least—not inconsiderable tidal range, a reliable and simple method of calibrating depth observations across different dives was instated:

control point A was selected as depth datum, with a reference depth of 23.5 m. Prior to and as soon as possible after any subsequent depth readings of subordinate points, the depth of A would be read. An average was calculated if the two reference readings differed, and the recorded point depths adjusted to reflect the difference between the actual and datum depth of point A.

All of the processed 98 measurements between control points conformed to a calculated error of less than 5 cm, and established a significant redundancy with an average of more than six measurements to each point. The final control network calculations yielded a root-mean-square residual of just 1.3 cm, and depth residual of 1.9 cm, indicating a very close representation of the physical network.

As a third level of positioning, providing a quick and easy rather than particularly accurate reference, a single 22 m long baseline was created running approximately S-N inside the wreck. A tape-measure was attached to a nylon line held taut between concrete bases at either end, and the position of the bases themselves calculated with reference to the surrounding control network. Additional temporary baselines were also employed during particular documentation tasks.

All the established reference systems were removed at the end of the investigation.

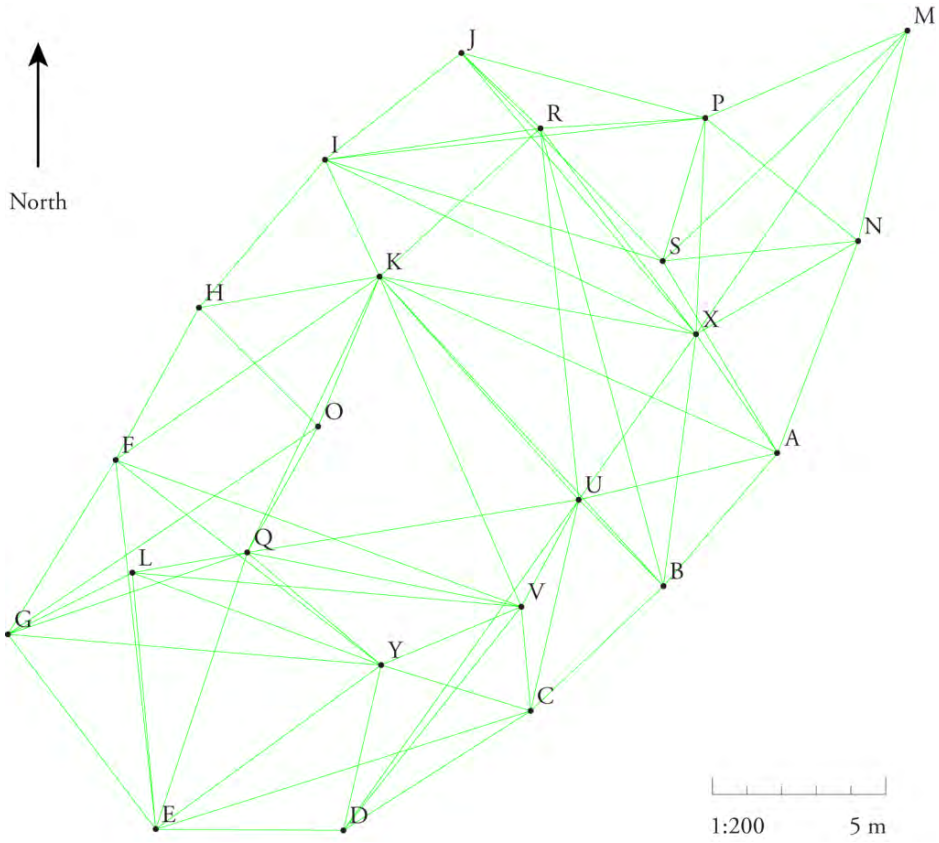


Figure 6: Calculated layout of control network, with point names and indication of measured distances.

4.5. Sampling

Different types of samples were collected for immediate or subsequent scientific analysis.

A limited number of smaller timbers, exposed and buried, were gathered around the site for microscopic and biological analysis. Three samples for dendrochronological analysis were taken from the exposed frame ends, two from the east side and one from the west side. The full samples were removed by divers using regular handsaws, and smaller core samples were extracted using Haglöf's increment borers. Additionally, penetration tests were conducted on various exposed hull elements using the spring-loaded *Pilodyn* device. Penetration depths were recorded as an average of three readings, and repeated every 10-15 cm along the height of each element.

Samples of the upper sediments were collected both inside and outside the wreck area. Transparent plastic pipes with a removable rubber bung and a diameter of 9 cm were used to extract as well as store the samples.

4.6. Excavation

The conditions of the investigation allowed only limited excavation work, and the majority of the effort was focused on a single main trench, designated as Trench 1. This rectangular trench was placed slightly north (aft) of the assumed centre of the wreck, extending from the west (starboard) hull side towards the centre of the wreck. The location was chosen to yield a maximum of information about the hull structure, with significant parts already exposed, while remaining relatively accessible and avoiding major obstacles on the sediment surface. Ultimately, the trench had a width of approximately 2 m along the hull side, and extended up to 3.8 m into the wreck. The depth varied somewhat with the bottom generally sloping towards the hull side where it approached 2.5 m, but with most of the trench around 1 m deep. An isolated local baseline was created along the upper edge of the trench's north profile, represented by a long aluminium straightedge fitted with a tape-measure, with zero at the hull side.

In the north end of the site—beyond any exposed hull remains but within the assumed after section of the wreck—an additional smaller trench designated Trench North was excavated. The layout of this trench was not as rigidly rectangular as Trench 1, and no more than 3-4 m^2 were excavated. The depth, too, was limited to a maximum of about 50 cm. It was hoped that the lower location—at the bottom of the mound—might reveal more intact transverse structures than the relatively higher Trench 1, and that the area might also be rich on diagnostic personal artefacts.

Centrally in the wreck, brickwork identified as the ship's galley was partly excavated, using mainly the recognisable structure itself to delimit the excavation work. The resulting trench thus measured approximately 2.6 x 1.4 m, with a depth of up to 50 cm.

Additionally, sediments were removed in other places for more particular purposes, and to a more limited extent. This included the exposing of bronze gun X120, attempts to identify decks and masts, and a further uncovering of the continuous south-eastern hull remains.

The excavation work was carried out with three levels of increasingly powerful suction tools. A small hand-operated water dredge was used for more delicate work in the surface sediments, particularly around the galley and for uncovering further hull remains. A larger, but still hand-operated airlift was employed for deeper and more extensive work, particularly in Trench 1. The two independent suction systems furthermore allowed both divers to excavate simultaneously, without reducing the performance of either system. For the expeditious investigation of singular anomalies peripheral to the site, a large industrial water dredge was deployed.

On the weather deck of *Vina*, a slightly raised platform extending over the side of the vessel was created to facilitate sifting and inspection of the removed material. Led through a sieve with a mask size of about 1 cm^2, larger objects were caught while sediments were washed overboard immediately. The exhaust from the airlift was channelled through a chamber allowing the air to escape and the water pressure to drop, before being directed to the sieve. The exhaust from the smaller water dredge was collected in mesh bags attached to the dredge itself, and manually distributed on the sieve when brought to the surface.

With the excavated material disposed of, actual backfilling was obviously not possible. Rather, industrial bags of sand were slowly emptied directly into the cavities, guided by divers. Around 16 tons of sand was filled into Trench 1, with a further 6 tons in the galley area, and 4 tons in Trench North. Other areas were filled to lesser extents. The filled areas were subsequently covered with gravel in the same manner.

4.7. Recovery of finds

Objects encountered on the sediment surface and during the excavation work were generally recovered as soon as possible. To maintain continuity between discovery, documentation and recovery across multiple dives, finds and features were often initially marked with numbered white concrete tiles. Actual find numbers were only assigned to finds or assemblages subsequently, either before

or after recovery. These numbers are numerically sequential, but prefixed with the letter X (ranging from X1 to X205). Several timbers were recovered, examined and redeposited without having finds numbers assigned, and small parts of the accessioned material were later discarded owing to recent datings or absence of peculiar features.

Different means of recovery were employed depending on the size and condition of the find. Smaller sturdy objects were packed in boxes with sand and seawater, and more delicate materials stabilised with gauze on plastic boards. They were then brought to the surface using the secondary diving basket. Larger objects were recovered either directly in the basket (conglomerates, timbers and smaller gun fragments), or with the ship's crane using either regular lifting strops or a large stretcher sling. The recovery work was accompanied by a conservator on board, also responsible for the packing and appropriate storing on board as well as later treatment in the Laboratory of the Archäologisches Landesmuseum Schloss Gottorf in Schleswig.

4.8. Documentation

4.8.1. Wreck

In order to gain an impression of the buried remains in the bow and stern areas, and to establish an outline of the wreck beyond the already exposed sides, the areas immediately north and south of the mound were probed with a steel spike. Starting at a position well inside the observable limits of the wreck, the diver—moving away from the centre—probed the sediments at regular intervals until the resistance offered by preserved timber ceased. This point was then marked, and the process repeated at 1-2 m intervals. A total of 31 points, thus believed to indicate the extent of preserved remains were marked, 17 in the north and 14 in the south, forming a continuation of the exposed timbers. Subsequently, each recognisable framing element along the sides was fitted with a sequentially numbered tag, starting in the north-western corner and proceeding counter-clockwise. All of the probing markers, and frames at intervals of 1-1.5 m were then positioned against the control network, and the data calculated by SiteRecorder. The resulting outline serves as basis for the general site plan.

4.8.1.1. Scale drawing

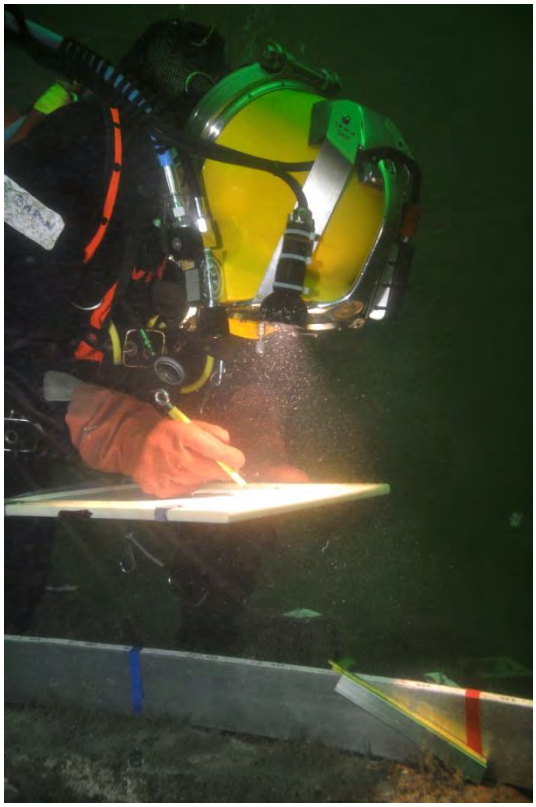


Figure 7: Diver documenting the western hull side using the straightedge as a baseline.

Detailed scale drawings were completed for a limited number of features, the most extensive being a section and a profile of the hull remains which was uncovered in Trench 1. A large plan was drawn of parts of the exposed western hull side, as well as a plan of the galley area. All drawings were made in 1:10 on clear A3 drafting film, which was superimposed on a gridded sheet during the process.

The documentation of the hull was carried out by measuring offsets from temporary baselines. For the plan of the exposed side, a 6 m long aluminium straightedge was simply fitted to the heavy shelf clamp. In Trench 1, the vertical dimension offered somewhat more of a challenge. For this purpose, an articulated rig was manufactured of two shorter 2 m straightedges connected by a bolt near the ends, similar to an oversized pair of dividers. With one leg resting perfectly vertical on the bottom of the trench near the hull side, the other was securely fixed to the top of the hull, creating a stable vertical baseline along the first leg for documenting a section of the exposed inside of the hull. Lengths of regular nylon measuring tape were securely attached to horizontal as well as vertical straightedges. The limited extents of the galley meant that this area did not require any local reference system to be employed. However, recognisable fix-points in the galley were positioned against the control network—along with the position of the baseline along the hull side—allowing the drawn documentation to be directly and accurately integrated in the site plan.

While positions were calculated using SiteRecorder, the data and scanned drawings were edited and compiled using a combination of software, including McNeel's Rhinoceros 4.0 and Adobe's Illustrator.

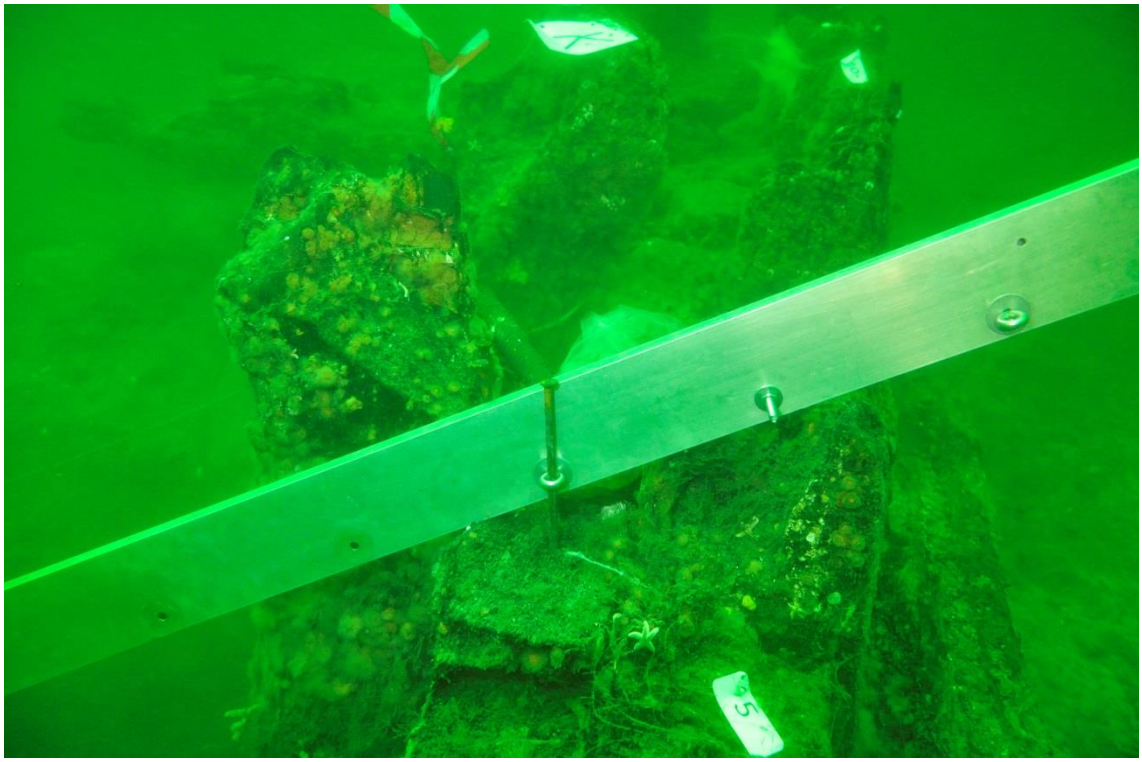


Figure 8: Looking south along the western hull side, with the support leg of the articulated straightedge rig ascending from Trench 1. Small tag denoting frame number 5 in the foreground, and larger tag of control point K further back.

4.8.1.4. Photo and Video

Parts of the wreck were documented by still photography, using a digital SLR camera with a single external strobe. An effort was also made to capture photos of the archaeological work in progress.

High-definition video footage of the wreck site was recorded with the divers' helmet cameras and captured by personnel from JD-contractor. Additionally, hand held HD video footage was produced by Dennis Norman at the end of the campaign.

4.8.2. Finds

Positions of finds outside Trench 1 were generally recorded by trilateration against the control network, while measurements in the trench were offset from the local baseline.

After recovery, finds were transported below decks and documented preliminarily, with registration of dimensions and a short description in a custom-designed Access database. They were then lightly cleaned, wrapped or re-wrapped as necessary, and stored in containers divided by material.

4.8.2.1. Drawing 1:1

After the termination of the fieldwork, all finds were documented more thoroughly, and a selection were drawn at 1:1 on A4 drafting film or traced on rolls of clear acrylic film. The former category is comprised of smaller artefacts drawn in their entirety, while the latter includes barrel heads and details of the bronze guns. The drawings were done in ink, scanned and edited digitally using GIMP 2.

4.8.2.2. Scale drawing

The largest of the finds were drawn at a reduced scale. While still on the weather-deck of *Vina*, the rudder was drawn at 1:20 and some smaller timbers at 1:10. These drawings were subsequently digitised.

The more regular shapes of the gun fragments meant that these were not drawn by hand, but rather reconstructed directly in Rhinoceros based on measurements of lengths and circumferences along their centrelines. A contour gauge was used to accurately capture the barrel profiles, and these shapes were scanned, digitised and incorporated in the reconstructed outline. Finally, the hand-traced details were added.

All of these more structural drawings were finalised in Illustrator.

4.8.2.3. Total station

In order to verify the initial manual drawing of the rudder, as well as to document cross sections and establish a rough record of the individual pieces after its subdivision, the five pieces were subsequently documented digitally using a Leica TCR407 total station. The data was captured directly in Rhinoceros and combined with the digitised drawing to create the final result.

4.8.2.4. Photo

Where possible and deemed relevant, finds were photographed in situ prior to recovery. In all cases, photographs were taken in connection with registration in the database. A semi-permanent studio was created for the finds stored below decks, providing fixed lighting as well as scales and numbered tiles for including find numbers in the photos. Selected finds were later photographed again under professional studio conditions. With the progress of the conservation work, more photos are added to the archive on occasion.

5. Results

5.1. Ship construction

The surviving contract for *Lindormen* was drawn up during the last days of the year 1624. The ship was to be built by the Dutchman Peter Michelsen at his shipyard in Itzehoe, in the southerly Danish duchy of Holstein. King Christian IV had established the shipyard there in 1609 with Scotsman David Balfour in charge, but when Balfour was imprisoned in 1612 following the unfortunate capsizing of one of his newly finished vessel, Michelsen appears to have emerged as head of the shipyard. During the following decade Michelsen builds a number of smaller ships for the Danish king, and all seem to be considered well-sailing (Probst 1996).

Not surprisingly, no drawings of *Lindormen* or any of Michelsen's ships exist—the ability to produce construction drawings was a rare skill to come by in Denmark at that time, particularly in a Dutch shipwright. Fortunately, a number of contracts and drafts relating to Michelsen's work in Itzehoe are preserved, from the incredibly detailed specifications for the first ship, *Fides*, in 1613, to the more general agreements for *Lindormen*. Among other specifications, she was to have a keel of 51 and a half ell, a 16 ell beam and 34 gun ports. The ell referred to is presumably a unit somewhat shorter than the regular Danish ell of two feet (Probst 1992: 291), and probably describes a ship about 38.2 m long between the posts with an 8.8 m wide beam. With a single closed gun-deck, she might later be called a frigate, but in the first half of the 17th century, such medium-sized men-of-war were very much at the heart—or even the head—of the navy. While these dimensions are naturally not necessarily representative of the vessel finished in 1626, contemporary documentation of *Lindormen's* sister-ship, and Michelsen's final delivery, *Tre Kroner* (which was fortunate enough to survive the former) indicates that they are probably rather close (Bruun 1817: 425). Likewise, the King's visit during the construction does not seem to have given rise to any disputes, so everything appears to have been as agreed (Bellamy 1997: 380).

While the documentary material thus gives a decent indication of *what* was being built in Itzehoe, there are only few indications of *how* Michelsen built his ships. In the 17th century, a number of more or less separate traditions of shipbuilding existed alongside one another in northern Europe, with the perhaps most obvious divide existing between British and Dutch approaches, in terms of both process and outcome. Since Peter Michelsen is known to be a shipwright of Dutch origin, and unlikely to have learned his trade under Balfour in Itzehoe, expectations of a certain Dutch heritage seem reasonable. However, shipbuilding in the Netherlands was by no means informed by a single unifying school, but rather by a number of regional and philosophically rather different approaches.

Two such approaches are described by Nicolaes Witsen (1671) and Cornelis van Yk (1697) in the second half of the century, reporting on the methods employed around Amsterdam and further south in Rotterdam respectively. The former, northern approach was evidently quite widely employed in Scandinavia (Probst 1993: 25-6), and perhaps most prominently displayed in the Swedish *Vasa* of 1628. Not surprisingly perhaps, Peter Michelsen's work has also been connected to Witsen's Amsterdam recipe (Probst 1998), but a number of hints in his correspondences suggest that he was in fact much more influenced by the southern school: on one occasion, Michelsen indirectly reveals that his ships are fitted with their internal structure, the frames, in advance of any planking being applied (Lemée 2006: 28-9). This may appear an obvious sequence, but it is in fact one of the fundamental divisions in shipbuilding philosophy—both on a larger scale and within the Netherlands. Secondly, Michelsen seems to adopt a particular nomenclature which reflects the writings of van Yk rather than Witsen. For example, although writing in German, Michelsen's contracts refer to the garboard strake—the planks flanking the keel—as *sandtstrockenn* or *sandtbordt* like van Yk, rather than by Witsen's term *kielgang* (Hoving 2012: 9).

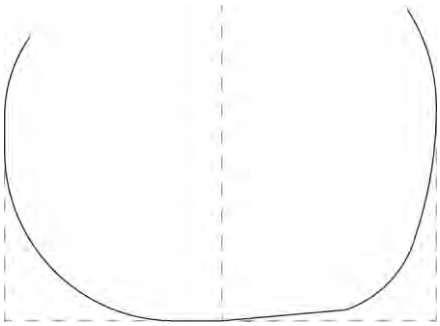


Figure 9: Two Dutch textbook sections – van Yk's on the left and Witsen's on the right. After Probst 1993.

It also is clear, however, that Michelsen's methods were not a pure reflection of van Yk's later treatise, when contracts for example specify an amount of deadrise in the hulls, rather than van Yk's flat bottom. Whether this practice was a traditional style that Michelsen had brought with him, or whether it evolved as an adaptation to the desires of Christian IV and the workforce in Itzehoe remains unknown. Curiously, the ships designed—and drawn—by David Balfour attest to the existence of a style incorporating these elements. When Balfour is first tasked with the construction of large ships for the Danish king around the turn of the century, the shipbuilder's British schooling is quite evident in the shape of his hulls. After crossing paths with Michelsen in Itzehoe, and with the Dutchman's well-reputed ships growing in numbers, Balfour's 1624 *Hummeren* seems to diverge entirely from his previous template (Bellamy 1997: 424-5): rather than a traditional English shape, the ship incorporates van Yk's fully rounded bilge as well as a significant deadrise.

It is of course unwarranted to conclude that Balfour simply adopted Michelsen's particular style of ship shape—although his spell in prison might have encouraged a change of direction—but Balfour's drawings certainly do render the existence of this hybrid-style feasible. Both Michelsen's and Balfour's later ships were largely based on the templates of *Fides* 1615 and *Hummeren* 1624 respectively, and given the combined output of these two shipbuilders, their style may well have dominated the Danish navy before 1644.

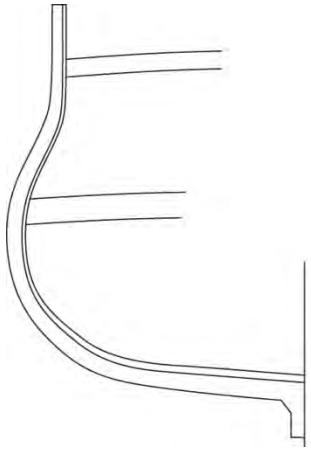


Figure 10: Designed section of Balfour's Hummeren 1624.

Although the limited excavation afforded only a glimpse at the constructional details of the hull itself, a number of observations can be made regarding the exposed parts. The estimated length of 36 m resulting from the probing for timbers around the ends of the wreck corresponds quite well with the contractual length of 38.2 m between the posts, considering the how the present dimensions are likely more representative of the length at the waterline. The wreck should be preserved to about its maximal width around the waterline, and here the distance between the exposed frames either side vary between 8.8 and 9.0 m, again in agreement with *Lindormen's* contract.

5.1.1. Framing

About 90 frames are visible, distributed evenly on either side. Most are heavily eroded, but regarding the samples documented amidships on the starboard side as representative, the frames vary between 23 and 26 cm moulded (ignoring the most heavily damaged) and a more diverse 14 to 30 cm sided, with an average around 20 cm. The gaps in between timbers measure between 1 and 5 cm. The 26 cm thick futtocks, presumably meaning moulded, which were asked for in the contract thus seem to have been realised. The composition of the framing system remains largely obscure, although a gap in the ceiling of the excavated hull side in Trench 1 did

Figure 11: Frame timber with peculiar feature.

reveal the sided face of four framing elements – a single butt joint flanked by two continuous timbers. There is no direct evidence that the elements are connected to one another, but the density of the pattern and the uniform timbers certainly render the possibility feasible. A curious anomaly is a deformed frame on the after port side. It appears that a wedge has been inserted between the frame and the planking, but the wedge and frame are in fact part of the same timber. It seems unlikely that the timber should have received such peculiar damage after the ship's sinking, and might be attributed to a mistake, or perhaps a conscious use of sub-par timber, during the construction process.

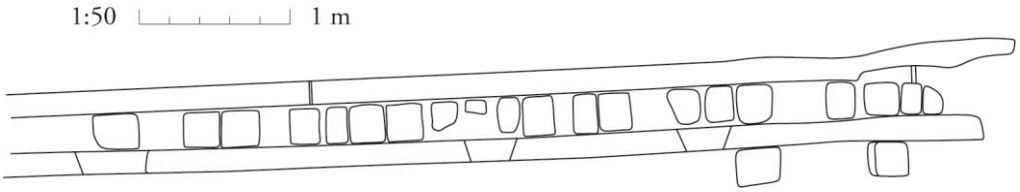


Figure 12: Plan of western hull side with the inside at the bottom, and forward to the left.

5.1.2. Planking

The planking is visible in only a few places, mostly along the east side, but generally has a width which conforms to the contract specifications of c. 10 cm. The contract further specifies the construction of three wales of different dimensions around the level of the deck, one exactly at deck level and on either side. The outer west side of the wreck is largely defined by a large wale measuring some 15-18 cm wide and 30-35 cm high. These dimensions most closely match those given for wales below or above the deck (20 x 37 cm), and the internal structure of the hull renders a position above the deck unlikely. The wale consists of no less than two timbers, as a 1.2 m long flat scarf with the after segment on top is visible approximately 16 m from the estimated stem.

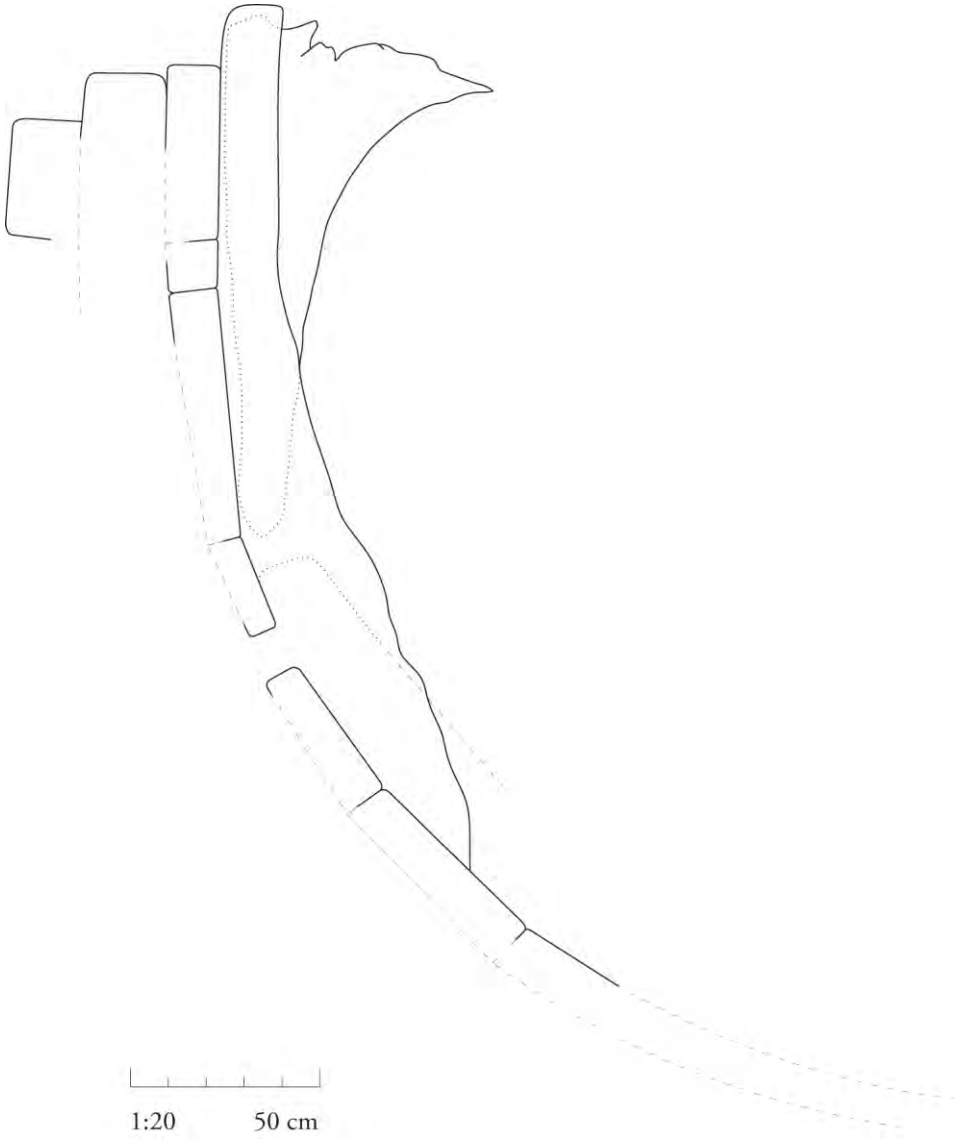


Figure 13: Section of the western hull side at Trench 1, with knee inserted. Rotated 3° counter-clockwise to compensate for the assumed list of the wreck.
Dots = hidden, dashes = reconstructed.

5.1.3. Ceiling

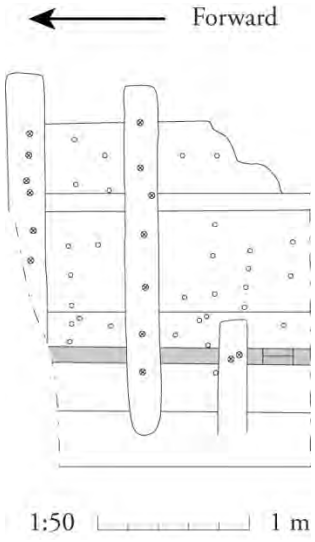


Figure 14: Western hull side as seen from Trench 1.

While the inside of the hull has suffered significant fire damage, in some places as far down as the turn of the bilge, seven longitudinal elements could be identified. The thickness of the elements is difficult to gauge due to the charring, but seems to be preserved to between 8 and 12 cm for the ceiling, a reasonable reflection of the 13 cm stipulated in the contract. The uppermost timber is a shelf clamp, identifiable by both the thickness of about 14 cm and the 37 cm wide trapezoidal recesses cut in its upper face to accommodate deck beams. The second element, although much narrower, also measures about 14 cm in thickness and must also be regarded as a clamp. As mentioned earlier, a very regular gap which continues throughout the excavated section occurs in the ceiling about 1.5 m below the top of the shelf clamp. The phenomenon is not mentioned in the contract of *Lindormen*, but is however included in that of *Fides*, where it is noted that an opening of a plank's width should be left in the ceiling below the clamps in the hold (Holck 1932: 84). The gap in hardly the same width as the surrounding ceiling planks, but otherwise does seem to match the description. The contract offers no explanation for the feature, and the conscious omission of a strengthening element, particularly at the position of a butt joint between two (presumed) futtocks, seems odd indeed. The ceiling and clamps are fastened with Ø 3 cm treenails with no apparent features. They form an irregular pattern where the discernible vertical lines are spaced between 20 and 28 cm apart.

5.1.4. Internal Structure

The hull is fitted with a fairly dense system of riders fastened with Ø 4 cm iron bolts. Two of these are visible in Trench 1, 22-25 cm sided and up to 30 cm moulded, and separated by only 50 cm. The top of what must be a bilge rider, 20 cm sided and moulded, is visible just 40 cm further along. Two differently shaped hanging knees were documented in detail, one discovered *ex situ* on the seabed by Trench 1 (a), and one recovered from its original position in the NW corner of Trench 1 (b). Both are heavily eroded and show very few original edges, and the latter is charred all the way to the bottom. Both have Ø 3 cm holes for fastening, but only (a) displays transverse holes for supporting a beam. Additionally, what appears to be a lodging knee, approximately 170 x 150 cm was observed in position along the end of an exposed deck beam. The deck beam itself is 38 cm

wide and 23 cm thick, and matches the recesses in the shelf clamp, but not the dimensions given in the contract, 34 x 42 cm. It is however possible that the beam belonged to the upper rather than the gun deck, and this may account for the smaller dimensions. The beams are however largely identical to those of the somewhat larger *St. Sophia* (Bergstrand and Arbin 2003: 20), and may simply indicate a reconsideration of the contracted dimensions. Only three recesses in the shelf clamp were observed, the northern-most pair 1.4 m apart and the last a further 2.6 m removed, presumably originally with an additional recess between the latter two, giving a uniform beam spacing of c. 1.3 m. The contract stipulates that the beam spacing cannot exceed 1.1 m, and taken as the size of the gap between the beams, this holds true. There are clear signs of charring inside the northern-most recess, indicating that at least parts of the gun deck structure collapsed while the ship was still afloat.

The documented part-section in Trench 1 shows a hull preserved to a level just above the waterline. The shelf clamp must therefore have supported the widest beams of the vessel, belonging to the—presumably only—gun deck. While the shape of the hull section is probably quite representative of the midships section, it should be borne in mind that it is in fact a section recorded someway abaft of midships. This means for one thing that the contractual depth of the hull does not immediately apply, since the run of the gun deck will have risen slightly relative to the keel. An estimate of the depth is of course difficult since the shape of the hull past the bilge remains unknown, but given the contractual depth of 3.1 m, the deck would have to have risen about 30 cm at the documented station. Assuming that the widest and deepest points more or less coincide, this does not seem altogether unreasonable. Similarly, nothing definite can be said for the shape or the width of the bottom, but it can hardly have been much more than half the beam at this station, and perhaps a maximum of two thirds amidships. The near-perfect arc of the bilge again points to a hull built along the lines of van Yk's description (1697: 69-70).

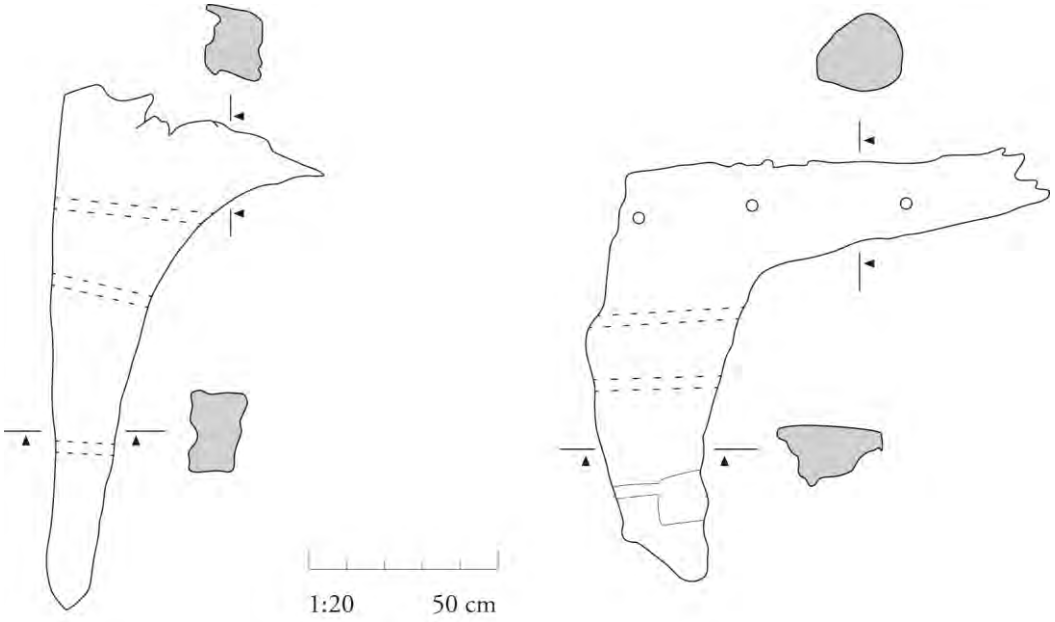


Figure 15: Two hanging knees, one discovered in its place in the north-west corner of Trench 1 (left), and the other a surface find near the same trench (right).

Across the central wreck, 18 stanchions or bitts are visible, two of which are probably associated with the galley. The stanchions seem to fall into three parallel lines, one along the keel and one either side. The two peripheral lines quite consistently run about 1.8 m from the ceiling measured at deck level, and would—depending on their angle through the sediment—intersect the ship's hull around the bilge. All of the stanchions are severely eroded, but it seems that the keel row may have been somewhat sturdier that the bilge rows. The largest in the former category measures 25 x 18 cm and the row averages around 20 x 15 cm, while the latter sports a maximum of just 15 x 16 cm and an average around just 10 x 12 cm. While the requirement for these three rows of supports is mentioned in the contract, their orientation is not. Contemporary drawings often illustrate these bilge supports as leaning towards the keel, sometimes close to diagonally, rendering them more struts than stanchions (Howard 1979: 53, 92). As far as could be observed, the case here is hardly that extreme. The supports are preserved in a more or less vertical position, and with no obvious pattern to their deviation from this position, although a slight lean may exist or have existed originally.

5.1.5. Rudder

Some 12 m SW of the presumed bow of the wreck, a large rudder was discovered on the basis of its magnetic signature. The rudder was recovered and documented on deck. Upon arrival at the conservation facilities, it was divided into five pieces, each of which was finally re-documented using a total station.

The rudder consists of two structural elements, a main piece and a back piece, and is preserved to a length of 6.15 m, with a maximum thickness of 0.40 m and a width of 0.97 m, of which the main pieces accounts for 0.58 m. The back piece tapers slightly from the base, more abruptly at 3.4 m, and ends 4.0 m from the base. The starboard side is largely flat and seems significantly better preserved than the port side which has a more convex section. While only little iron remains on the surface of the rudder, the rusty traces of five 8-10 cm wide pintles are clearly visible at intervals of c. 1 m, with the lower two extending onto the back piece. Several holes from the square nails with which the pintles were fastened to the rudder are also visible, some places in pairs of smaller and a larger nail. Along the after face, eight holes would have allowed the two structural pieces to be securely connected with treenails, of which some still remain. Only the hole nearest the base passes through the main piece. At the very top of the main piece, some 0.4 m from the end, may be traces of a final treenail. Between 3.1 and 4.6 m from the base, another three holes, the largest up to 20 cm wide, penetrate the main piece perpendicularly.

All edges are quite eroded, but in certain areas a chamfer of c. 45° is recognisable along the forward edge. From the iron preserved around the bottom pintle, and the well-preserved wood around the top pintle, it seems clear that the rudder was fitted in a manner similar to that of more or less contemporary Swedish wrecks *Riksnyckeln* (1617) and *Rikswasa* (1599), where the pintle is sunk into the forward face of the rudder to create a flush edge against the sternpost (Cederlund 1983: 199, 225).

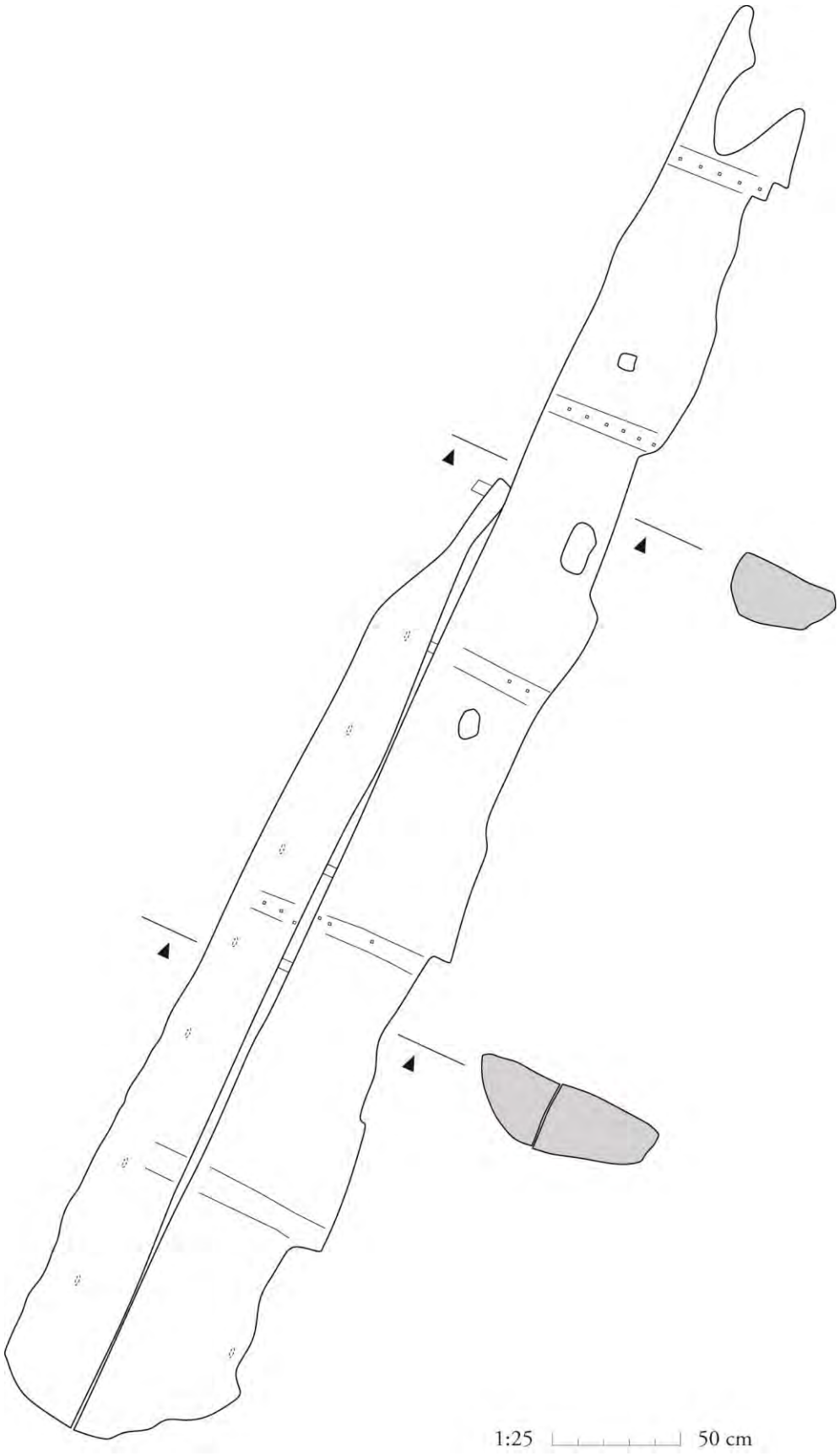


Figure 16: Rudder.

According to Witsen (Hoving 2012: 158), a rudder of the later 17th century should be 4 inches wide for every 12 feet of ship's length, or about 3% thereof. From this assumption, an original width of between 1.1 and 1.2 m could be expected for *Lindormen*. Given the relative ease of identifying the original extent of the forward edge, the discrepancy between the preserved 0.97 m and Witsen's estimate must be found in the erosion or damage of the after edge of the back piece. While it is clear that this edge is not preserved to its original extent, the dimensional relation to the main piece may give an indication of how much is missing. In the case of the *Rikswasa* the back piece has a width up to 80% that of the main piece and for the *Vasa* (Cederlund 2006: 243) the number has dropped to about 65%. In its current state *Lindormen* stands at 67%, so while there is still room for the ratio to be increased and remain comparable, it seems unfeasible to reach Witsen's ideal: even at a speculative original 80%, the width would only just exceed 1 m. However, this calculation does assume that the well-preserved area around the lower pintle was also originally the lowest pintle and the widest point on the rudder, an assumption that needs not necessarily to hold true.

The height is the dimension reduced most noticeably, compared again to *Vasa* and *Rikswasa* sporting over 10 and 8 m high rudders respectively, and the majority of the damage has probably been sustained at the upper part of the rudder. The base may appear to have preserved a shape moulded for the heel of the sternpost, and thus support the assumption of minimal transformation that end, but the reduced thickness of the wood in the area makes this impression less than certain. Similarly, the back piece is likely to have been longer than the present 4 m, and this reduction may have occurred either end. Regardless, allowing the back piece a height of about half the main piece and considering the ships dimensions, an original rudder height of no less than 8 m seems reasonable.

Surprisingly perhaps, considering the appearance of the rudder's cross section, the thickness of the main piece seems largely original on the lower half, with three of the pintle traces and nail holes visible on both sides. The pronounced wedge shape and narrowing towards the forward edge must therefore be original. The back piece would presumably have continued this shape to some degree, perhaps increasing the maximum thickness beyond 0.4 m.

The half-exposed treenail at the top of the back piece may indicate the former presence of a second back piece in a fashion similar to *Rikswasa*, creating a more flush after edge. The final tapering of the preserved back piece would then in fact constitute a scarf joint, with the treenail in a position to secure the overlap of the two back pieces. Although a piece situated mainly above the waterline would certainly have required a less thorough fastening system, the absence of treenail

holes beyond the end of the present piece, with the possible exception of the very top of the main piece, does render the theory dubious.

5.1.6. Pumps

What are most likely two pump shafts, protrude from the seabed about 11.5 m from the presumed stem. They are positioned symmetrically around the ship's centreline 2.9 m apart, and the shafts consist of two similar hollowed-out tree trunks with an outside diameter of 25-27 cm and an inside diameter of about 8 cm. Both shafts were examined to determine their internal depth. The western shaft, which extends 45 cm above the seabed, was found to be obstructed at a depth of 2.5 m below the seabed, and the eastern shaft, which extends a full 80 cm above the seabed, at just 2.2 m. The discrepancy may partly be explained by the slight starboard list of the ship, raising the port side relative to the seabed, and thus resulting in a slightly shallower sounding depth. The shaft may naturally also be obstructed at different depths by objects other than the ship's bottom, resulting in different readings again.

Figure 17: Protruding pump shaft.

5.1.7. Galley

The galley is located near the centre of the ship, 16.5 m from the presumed stem. Part of the after wall and the port side were excavated, and the exposed remains measure 2.6 x 1.4 m, although this most likely does not represent the original extent of the galley. Compact charred matter covers most of the floor of the hearth, and as a result the original depth was only reached in a few areas.

The hearth is built up of light yellow bricks measuring 22 x 10.5 x 4.5 cm (X42). A number of bricks from the collapsed wall structures are immediately visible on the seabed, but excavation along the after wall revealed that no less than eight brick courses are still standing to some degree. The uppermost courses are however

limited to a small number of bricks on the starboard side, with proportionally fewer courses represented further towards the port side. Although no direct measurement can be made between the brick floor and the top of the wall, the height of the preserved brickwork totals c. 50 cm. All bricks in the wall are placed flat, but the orientation alternates—although not with absolute regularity—between the courses, starting with single bricks lying perpendicular to the wall (*headers)*, then pairs of bricks perpendicular to the first (*stretchers)*, then another course of single bricks, and so on. The floor is only partly visible along the forward and port limits, and is here made up of bricks lying athwartships on their side, and standing on end along the centreline respectively.

Part of a 2-3 cm thick plank delimits the galley in the forward direction, with traces of copper sheathing between brick floor and wood. A thicker wooden element, 7-8 cm across, is visible along the port side. Whether intentional or otherwise, the sheathing here covers the wood and may thus indicate a threshold rather than a wall. What appears to be three smaller wooden posts stand upright along the inside of the after wall. The presence of wooden elements other than firewood inside the hearth itself is quite puzzling, although their uniform orientation and spacing does seem to indicate that they are still in their original position.

Central to the galley is the 2.1 m long iron structure presumably intended to support cookware. The iron bars are all horizontal—with the exception of the very ends which curve slightly upwards—and the entire structure is raised 20-30 cm off the floor. Although his dimensions are somewhat smaller, this is no doubt what Van Yk refers to as an *ezel* (1697: 136). The divided layout clearly indicates the possibility of having several items over the fire at once, rather than having to rely on a single big pot for all cooking.

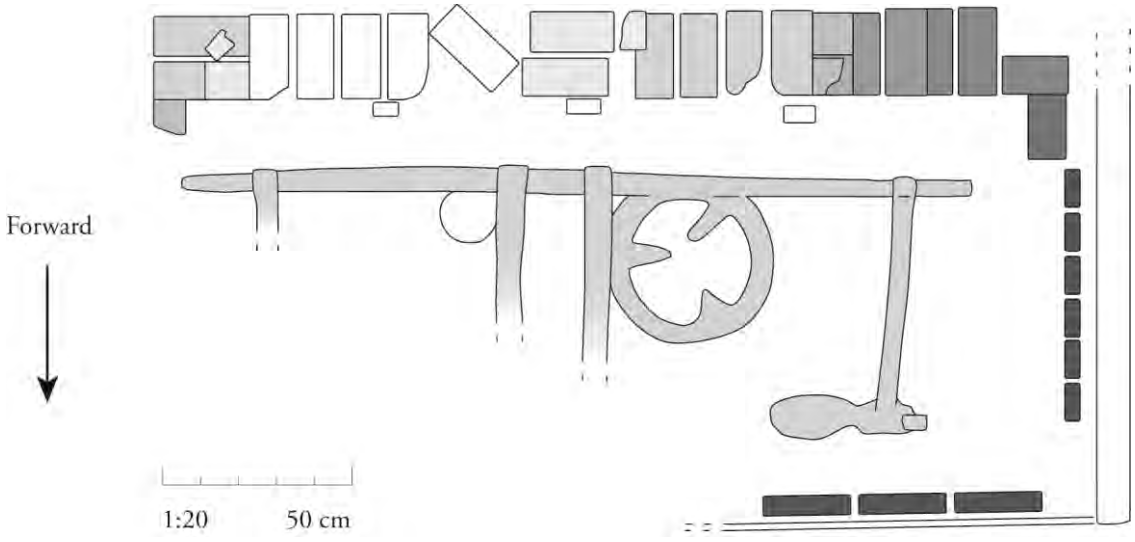


Figure 18: Galley, with darker shades representing deeper tiers.

The protruding bricks either end of the after wall seem to indicate the full length of the wall, and assuming the woodwork on the starboard side is similar to the port side—although presumably in the shape of a full wall rather than merely a threshold—the width of the galley athwartships is nearly identical to the 2.75 m measured on *St. Sophia* (Bergstrand and Arbin 2003: 22, 31), and slightly smaller than the 2.90 m of the *Vasa* (Ray 2009: 42). The dimension along the keel, around 1.3 m, is however strikingly short in comparison to these two ships, both sporting galleys well over 2 m long. Considering also the proportion of the floor space occupied by the *ezel*, the excavated area seems unlikely to have made up the entirety of the galley workspace, leaving simply no room for a cook. Perhaps, then, the forward plank does in fact not delimit the forward edge of the galley, but rather a transition from the hearth to a second compartment.

Figure 19: Looking north in the north brick wall of the galley.

The small yellow bricks used throughout are again very similar to the type used in *St. Sophia* and the later *Lossen* (Molaug and Scheen 1983: 156), and probably with good reason. Danish brick production had declined through the 16th century, and by the turn of the century many bricks were imported from the duchies and the Netherlands. The galley bricks match the type known as *flensborgsten* very well, characterised by its generally yellow colour, slight thickness of no more than 4.5 cm, and 1:2:4 side ratios including mortar joints (Cathrinesminde 2002: 49, 63, 80). However, these flensborgsten predominantly produced in the duchies only gained widespread popularity in Denmark during the 18th century. During the 1620s and 1630s similar bricks were exported from the Netherlands in large

quantities, and Danish developers—not least the King himself—seem to have been regular customers: the construction of Christian IV's perhaps most famous monument, the Round Tower in the middle of Copenhagen, was commenced 1637 using imported Dutch bricks measuring 22 x 10 x 4.5 cm (Lønskov 2010: 55). These bricks no doubt created the foundation for the later popularity and domestic production of similar types like the flensborgsten. It seems likely that the bricks were either produced in the duchies, whether near Flensburg or elsewhere, or imported from the Netherlands. The continuity of style makes it difficult to determine an origin with certainty, but not least given the trend in Copenhagen during the subsequent decade, a Dutch provenience seems a reasonable guess. For a ship itself constructed in the duchies, it may seem the obvious choice to procure locally available building materials. However, it appears that Peter Michelsen may not have had much of a choice since—according to his contract—the bricks would be supplied for him by the king. The brickwork was presumably nonetheless built up while in the shipyard in Itzehoe, and the materials thus not likely to have ever been in Denmark although clearly of a type also known and used in Copenhagen.

Contrarily, the bricklaying technique—or at least the resulting patterns—differ significantly. Given the very different results in the two excavated areas it is not entirely clear how the floor of the galley is composed, although it is clear that neither has much in common with *St. Sophia* where the bricks are placed flat along the ship's centreline. Laying the bricks on their smallest face seems somewhat inefficient, and the area on the port side may simply represent a particular pattern used to fill the edges. Similar to the *Vasa* (Cederlund 2006: 373), a pattern of bricks lying athwartships on their side, as indicated by the forward-most exposed bricks, seems more likely to have filled the floor of the galley.

The position of the galley in terms of relative distance along the keel, while interesting for comparison, cannot be more than a crude estimate: if the ship was indeed built in accordance with the contract, then the preserved remains have been shortened by c. 2.5 m of which—given the longer rake—the majority probably occurred at the bow. Reducing the contractual forward rake by 1.5 m to account for this damage, and assuming a keel 28.3 m long, results in a galley with its centre 65% forward of the after end of the keel. This very tentative ratio is somewhat higher than for both *St. Sophia* and *Vasa*, probably mainly due to the uncertainties of the calculation, but does indicate a position just in front of the mainmast similar to the other two ships.

Determining the vertical position of the galley is fortunately a less speculative exercise. Since the floor of the galley is covered under sediments and the gun deck's beam is not, it is highly unlikely that the galley foundations rest on the deck, as seems to be the case for the *St. Sophia*. Although a collapse of the deck structure

could mean the galley was originally located higher up in the ship, the condition and orientation of the brickwork does not point to any violent changes haven taken place. Rather, as prescribed by Witsen (Hoving 2012: 157) and realised in the *Vasa*, the galley must have been located—or at least seated—in the hold. If the galley was constructed in a fashion similar to the *Vasa* (which could at least be taken as a measure for the heaviest plausible option) with 30 cm of sand under the two brick courses making up the floor, and a supporting wooden framework underneath, the entire structure would reach almost 2 m down into the hold. With a significant proportion of depth of the hold taken up by floor riders and ballast, a similar layout does seem feasible, although the galley may have been raised slightly to allow access from the gun deck.

5.2. Finds

5.2.1. Rigging and cordage

The archaeological discovery of rigging elements is to some extent an occurrence against the odds. While the category accounts for a huge and essential part of the equipment of a ship at sea, it is also a generally fragile and perishable category, prone to scattering beyond the recognisable perimeters of the ship wreck itself. This clearly applies doubly so for a ship burnt to a wreck, with the endless lengths of sailcloth and tarred cordage suspended above the deck almost inevitably falling victim to the flames. Even so, a few hard rigging elements and numerous fragments of cordage were recovered from the site, mainly from Trench 1. As it is hard to separate possible fragments of sailcloth from textile fragments deriving from garments, both are described in the chapter "Personal belongings".

5.2.1.1. Deadeye

One of the elements, a partially eroded three-hole deadeye (X6), was found on the surface in the bow area of the ship. The deadeye measures 21.5 x 17.3 x 7.4 cm although only the thickness is completely representative of the original size. Two of the presumed three holes are evident although only one is intact, and both show signs of wear. Their maximum diameter measures around 3.5 cm. The surface is

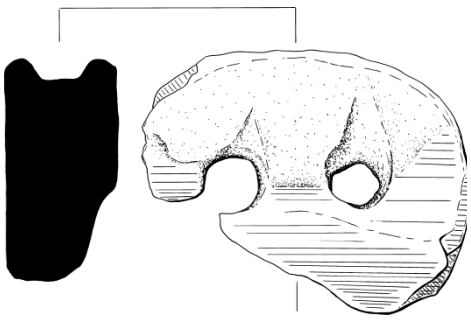


Figure 20: Deadeye X6. Scale 1:5.

completely flat, and the most well-preserved half is partly covered in a greyish encrustation which does not appear original. Around the edge runs a score with a trapeze-shaped cross section 2.5 cm wide at the bottom. Three-hole deadeyes are most often employed in pairs in the standing rigging, attached to the bottom of the numerous shrouds supporting the masts. While the upper partner has the shroud running from the masthead attached at the score around its perimeter, the lower partner is secured with an iron strop to either the hull via a chain-wale on the outside of the ship, or to the shroud below in the case where the pair is attached to the topmast. A lanyard is threaded through the six holes between the pair, the manipulation of which in turn regulates the tension of the shroud. To allow for the two different means of attachment, each deadeye is manufactured with a score of either a semi-circular section to accommodate the shroud, or—as in the case of X6—a more angular section to suit the iron strop. The recovered deadeye was thus more than likely the lower partner of a pair attached to a shroud.

To which shroud, or rather which mast, it was associated is more difficult to determine with any certainty. Working from the most tangible parameter available—the diameter of the lanyard holes—a somewhat vague postulate could be that the thickness of the lanyard should have been half, or slightly less than half, that of the associated shroud (Anderson 1927: 95; Mondfeld 2008: 290-1). Details of the rigging on board *Lindormen* are not available, but two other sources provide suggestions which may lead to reasonable estimates. Most interesting is

the overly detailed draft of Peter Michelsen's contract for *Fides*, where the circumference of the shrouds is proposed as 7 inches (5.9 cm in diameter) for the seven shrouds either side of the mainmast, and 6 inches (5.0 cm in diameter) for the five flanking each side of the foremast (Bricka and Fridericia 1887: 80). These measurements are omitted in the final contract and may as such have been entirely inappropriate, but are in fact supported by Witsen who claims that, as a general rule, a ship the size of *Lindormen* should have shrouds 7 and 6 inches in circumference (but only 5.7 and 4.9 cm in diameter, given the slightly shorter Amsterdam inch) for the main- and foremast respectively (Hoving 2012: 225). He does, however, also provide an example of a similar vessel with shrouds of just 6¼ and 5½ inches in circumference (5.1 and 4.5 cm in diameter) on those same masts (Hoving 2012: 171). While these numbers are thus presumably neither fixed nor exact, Witsen does provide a very believable indication of possible sizes, and certainly lends credibility to the draft contract. Although *Fides* was slightly smaller than *Lindormen*, the fact that the shroud dimensions proposed for the former are already at the upper end of the suggested range, it seems unwarranted to enlarge them further to account for the difference in size. An estimate for the shrouds of *Lindormen* could thus reasonably be around 5.9 and 5.0 cm in diameter. Allowing for a bit of clearance, the 3.5 cm hole in the deadeye could have accepted a lanyard

with a diameter up to c. 3.0 cm, and might as such have been suitable for use with any of the ship's shrouds. A lanyard with a diameter around 2.5 cm seems quite appropriate (Molaug and Scheen 1983: 95), but the attachment of the lower shrouds on the upper outside of the hull clearly puts the deadeyes there in a precarious position from an archaeological perspective. The size and wear of the lanyard holes also seems a poor match for the rigging further aloft—topmast shrouds being as little as half the thickness of their lower counterparts (Hoving 2012: 171; Anderson 1927: 116)—but it is perhaps possible that X6 was associated with the main topmast which was allegedly damaged during the battle. Such conclusions clearly remain somewhat speculative.

Typologically, the deadeye is rather easier to position. While the outline of the deadeye is not preserved in its entirety, the remains indicate that it was not perfectly circular but rather slightly ovoid. This flat ovoid shape is in clear accordance with Continental fashion around the middle of the 17th century, representing a step in a more general British-led development over the course of the century from a flat, elongated and triangular shape towards a circular one with a more bulging cross section (Howard 1979: 144; Anderson 1927: 93). The deadeye is thus very similar to many of those recovered with *Vasa* from 1628 (SMM 2008), and still fits Witsen's 1671 description as a 'flat, and egg-shaped' element (Hoving 2012: 181). During the second half of the century, however, both Norway and Sweden (Molaug and Scheen 1983:94-5; Rålamb 1943: table M; Johansson 1985: 258-9) appear to have turned to favour the circular bulging type, and it seems more than likely that block-makers on the continental side of the kingdom would have followed suit around the same time.

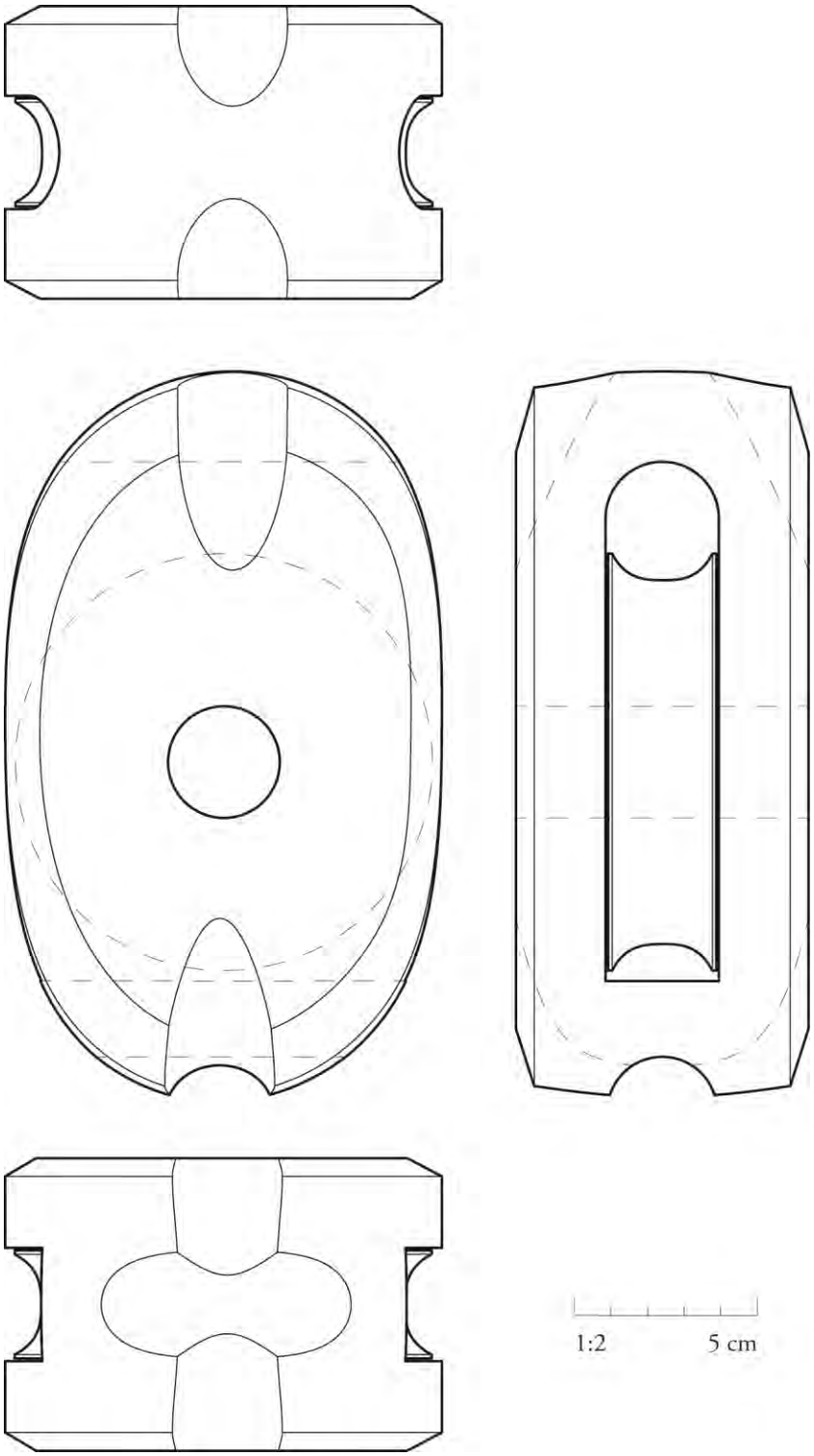


Figure 21: Idealised drawing of block X46.

5.2.1.2. Blocks and sheaves

Two single-sheave blocks (X45 and X46) were recovered together from Trench 1. They are both completely unscathed, and are preserved with fragmentary remains of both external strops around the shell and lines running through the sheave. All lines have a diameter of c. 2.5 cm, and whereas the working line is laid as a regular three-stranded hawser, the strop of X46 appears to be plaited of four strands. The blocks are very similar, no doubt intended for the same purpose, but are not identical with X45 being just slightly larger. The shell of the smaller X46 measures 20 x 12 x 8 cm, and the single sheave-hole is 14.2 cm long and 3.1 cm wide, whereas X45 is approximately 22 cm long and other dimensions correspondingly larger. Aside from the variation in size, the two blocks exhibit identical features. The shell is rounded but not quite elliptic with chamfered rather than rounded edges, and both ends have 2.3 cm wide scores cut to accommodate a strop. That is, however, the extent of the symmetry. The sheave-hole still holds a 3 cm wide wooden sheave, and the extremes of the hole clearly indicate a working end, or *swallow* (with remains of the running line), terminating in a soft arch, and a *breech* not intended to take a line and thus with no need to reduce chafing. Curiously, the tail end of the shell—near the breech—has an additional and deeper score cut perpendicular to the first, along the same plane as the sheave. Any further stropping through this score would obvious block the sheave, so it was more than likely intended to accommodate an external line, giving the block a point of attachment either end. Since the blocks were not only stropped, but also fitted with a running line, they would no doubt have been in use during the wrecking, rather than kept as spares. As such, their discovery in the hold of the wreck is unlikely to be indicative of their original position and function. Rather, two other possibilities exist: the blocks may have been employed as parts of the general rigging. This is naturally a very broad category and any exact function is not postulated, although the moderate size of the blocks could suggest a function around or beyond the topmast. Alternatively, they may in fact have been put to use below decks, albeit not as far down as the hold. Their size, the position near the side of the ship, the thickness of the line and the possibility of two attachments are all features which render the blocks appropriate for use as gun-tackle on the deck above. Here, the pair could have been part of a pulley system connected to a gun carriage, gaining the sailors a mechanical advantage when rolling the heavy bronze pieces into firing position, or indeed withdrawing them. However, considering the state of the gun fragments which also ended up in the hold, it seems peculiar that the two blocks should have suffered no obvious damage from the fire whatsoever.

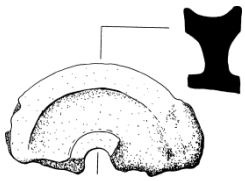


Figure 23: Bronze sheave fragment X18. Scale 1:5.

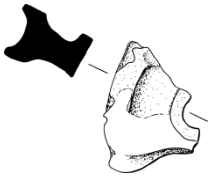


Figure 22: Bronze sheave fragment X79. Scale 1:5.

In addition to the complete blocks, two fragments of one or two separate bronze sheaves (X18 and X79) were also recovered from Trench 1. The fragments are very similar but somewhat deformed by heat, and since neither accounts for more than half the original circumference, they may have been part of the same sheave. They are slightly larger than the sheaves in the blocks, with a thickness of up to 3.7 cm and an estimated original circumference of approximately 14 cm. The shallow score has a width of 2.7 cm, and the central hole a diameter of c. 2 cm. The sheaves are otherwise completely plain with no spokes or other holes, although the material thickness is reduced between the rim and the hub. Bronze sheaves were not uncommon around the middle of the century (Bergstrand and Arbin 2003: 63, 66; Hoving 2012: 181), but curiously the King expressedly demands in *Fides'* draft contract from 1613 that no block on the ship is to be fitted with bronze sheaves (Bricka and Fridericia 1887: 81). This suggestion, too, did not make it through to the final contract, and may simply have been an overzealous expression of the King's endeavour to procure copper for his gun production (Blom 1877: 178-9). Nevertheless, even if *Fides* was fitted exclusively with wooden sheaves, the rationale appears to have changed by the 1640s at the latest.

A final artefact which may or may not warrant mentioning with the blocks and sheaves is X136. This small lead cuboid measures 3.3 x 3.1 x 2.7 cm and has a central hole with a diameter of 1.5 cm. It may have been used as a coak—a bush in the centre of a sheave, serving to reduce the wear from friction between the sheave and the pin in larger, heavily loaded blocks. While modern coaks are more subtle, the block style is known particularly from 16th century ship wrecks (Keith 1989: 90-1; Springmann 1998: 118), but also historically attested in the first half to of the 17th century (Mainwaring 1922: 128). Similar contemporary Danish examples may in fact be known (Bergstrand and Arbin 2003: 58, 62). Both archaeological examples and documentary references do, however, invariably seem to agree that the coak should be fashioned out of a copper alloy, casting some doubt on the possible identification of X136.

5.2.1.3. Cordage

Fragments of cordage in various states of preservation were recovered from the galley as well as from both trenches, which, given the expected damage to the rigging, presents no surprise. The disaster did however not penetrate the hold

entirely, and a large coil of approximately 2.5 cm thick rope (X38) was encountered in the SW wall of Trench 1—presumably more or less where it was placed before the wrecking. The cordage falls into three groups based on diameter: small stuff between 0.4 and 0.9 cm, light rope between 1.1 and 1.6 cm, and heavier rope around 2.5-2.6 cm, although these groups are unlikely to represent functional or actual categories. All samples are hawser-laid of three strands in a Z-twist, with the exceptions from Trench 1 (X77) where a 21 cm length of small stuff is done in a tight three-strand plait, and the block strops in a somewhat looser four-strand plait.

In the port side of the wreck near the bow, an area of several square meters was found covered with one or more coils of a significantly heavier type. Samples were recovered (X1 and X195) and indicate a cable with a diameter of approximately 11 cm, closed with an S-twist of three hawsers, each of three strands. The position and size of the cable clearly suggest that the coil may well represent the remains of an anchor cable, and historical sources are in unison agreement on the suitability of the observed diameter in fulfilling this function. Witsen instructs that a bower anchor should be fitted with a cable measuring 1 inch in circumference for every 10 feet of ship's length (Hoving 2012: 169), resulting in a diameter of 11.0 cm for a ship the size of *Lindormen*. Likewise—although not quite in agreement with Witsen's formula—the size of bower anchor cable initially suggested for *Fides* was a circumference of 13 inches, or a diameter of 10.9 cm (Bricka and Fridericia 1887: 80). There seems little doubt, therefore, that the coil did indeed belong to one of the ship's main anchors.

A number of fragments display knotting in different manifestations, but two stand out in particular. The first (X47) was recovered with the two blocks in Trench 1, and is of the same 2.5 cm material as that which is preserved with the blocks. The length of rope is formed into a simple overhand knot, with no rope extending outside the knot itself. An opening in the asymmetrical knot suggests that it was most probably tied as a half-hitch around a rounded object with a diameter similar to that of the rope itself. The working end would likely have been seized to the standing part forming a secure eye, and the arrangement may well have been used with the gun-tackle. The second (X77) is another hitch recovered from Trench 1, but of a quite different nature. This smaller 0.6 cm line is not tangled or knotted itself, but is preserved in a coiling shape which suggests it was wound around an object with a diameter around 0.6 cm. At the ends of the coil are what appear to be half-

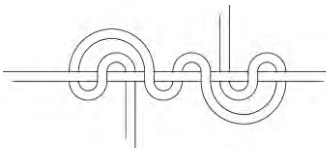


Figure 25: Apparent preserved twist of line, X77.

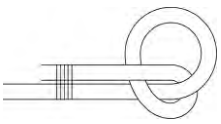


Figure 24: Potential use of X47 – half-hitch with the working end seized.

hitches, essentially making the entire coil a clove-hitch with a full extra turn in the middle. This extra turn would make little sense if the hitch was intended to hold any significant load, and may as such indicate a hitch simply intended to hold the winding in place. The reading of more or less unravelled hitches is obviously a rather uncertain exercise, but the fragment may conceivably–to linger in the ordnance department—be a piece of match still showing the traces of it being wound around a linstock.

5.2.2. Ordnance

5.2.2.1. Guns

Five more or less identifiable bronze gun fragments of different calibres where recovered from both Trench 1 and the aftermost area of the wreck. A further three smaller pieces barely recognisable as barrel fragments where recovered directly from the surface. All pieces show clear signs of having been exposed to very high temperatures, from surface damage to outright deformation and structural damage.

Some confusion may arise from the terminology applied to ordnance during the reign of Christian IV. While the use of specific names for particular types of guns—or indeed particular guns—was widely used, a designation by poundage was also used, alone or as a supplement to the former. However, this designation did not relate to the weight of the gun's shot, as has otherwise been the norm, but rather to the height of its bore (Blom 1877: 102). Depending on its windage, a piece may thus appear as both a 16-pounder and a 14-pounder, depending on the location and period of the source. To avoid this confusion, the notion of poundage in the following section will refer exclusively to the weight of the shot.

Figure 26: Left: The bronze gun X120 being lifted on board. Right: Detail of the gun's cascable, showing a women holding a sea-animal by the tail.

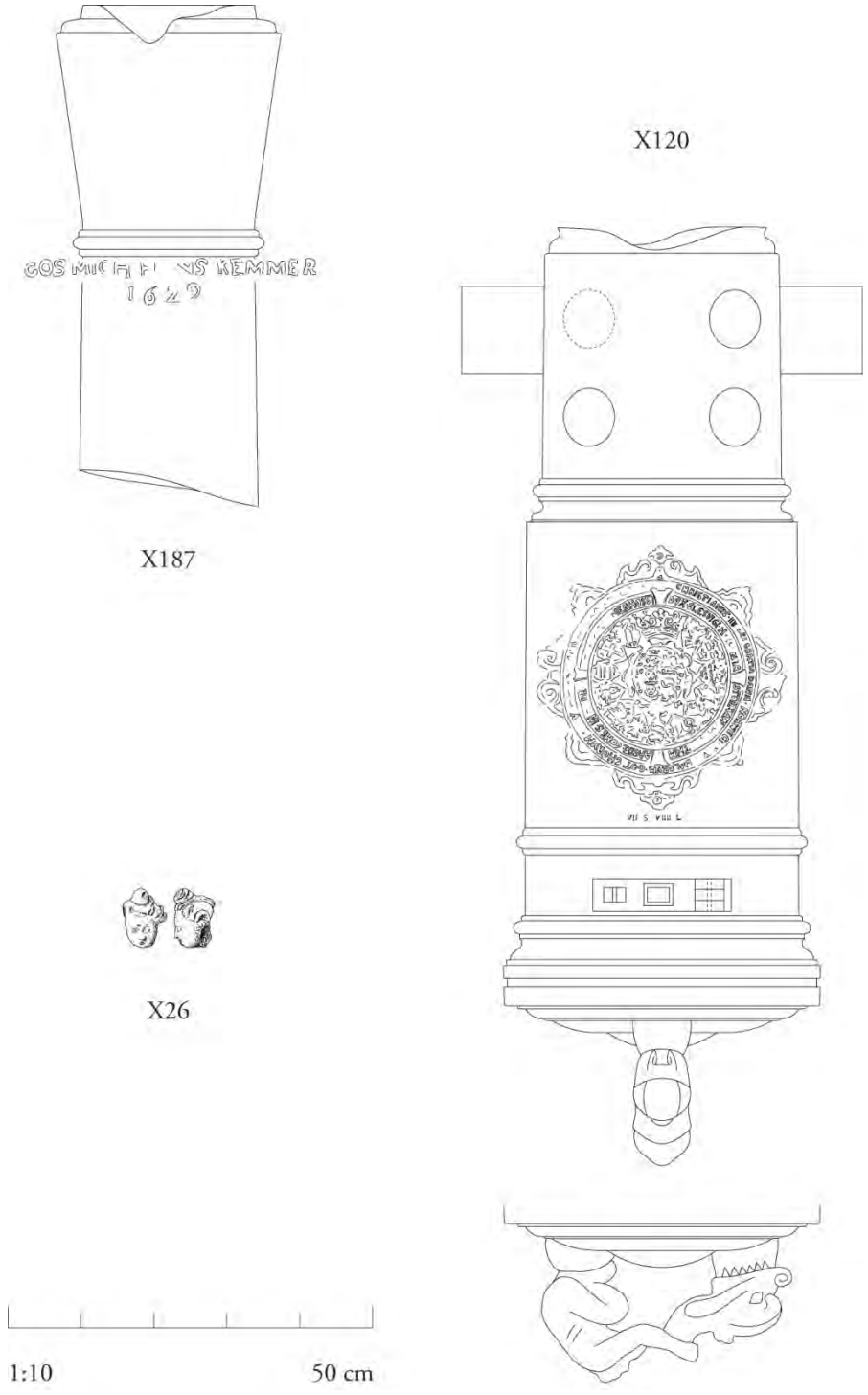


Figure 27: Fragments of bronze guns.

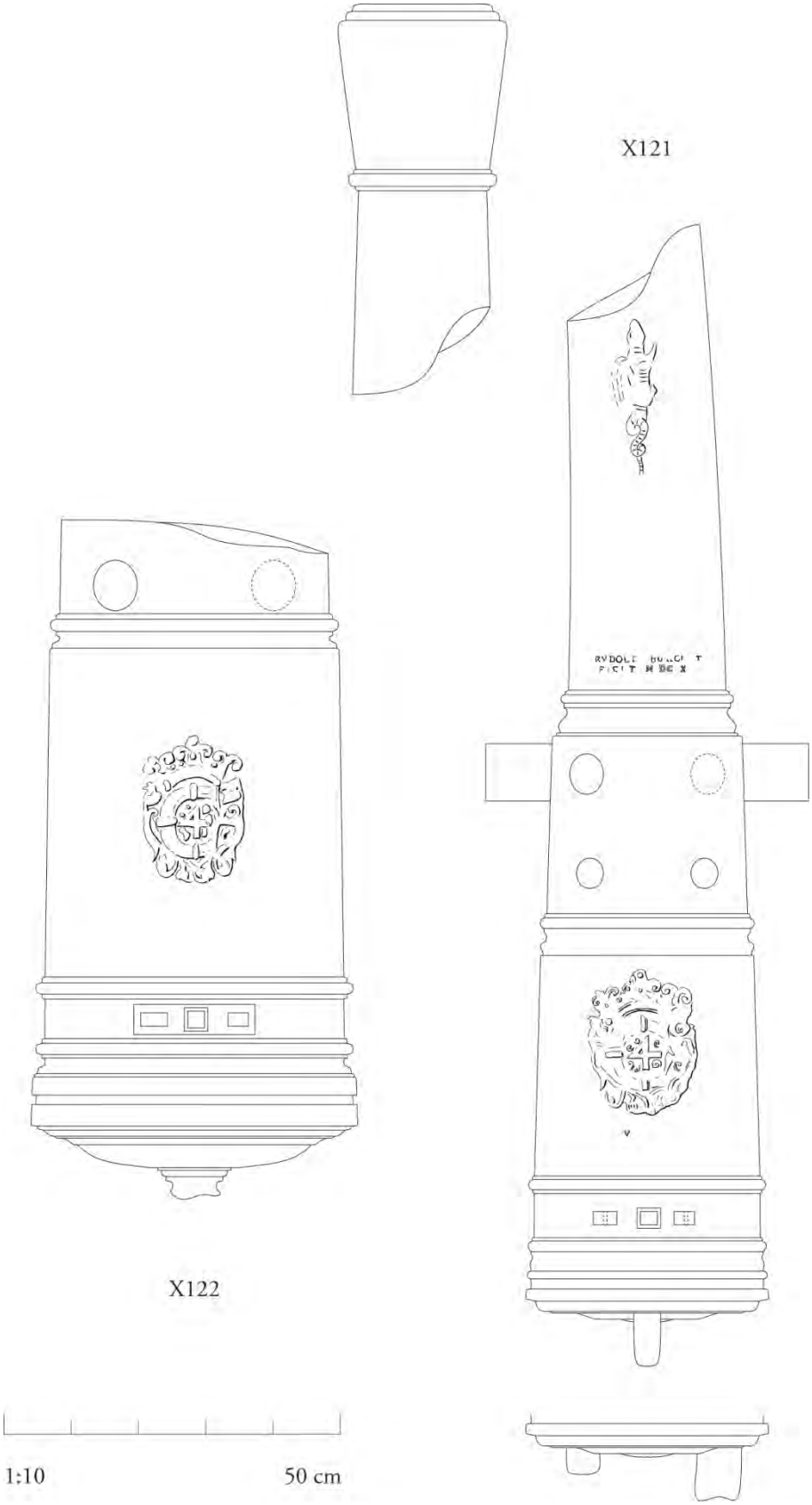


Figure 28: Fragments of bronze guns.

The two pieces combined under X121 were discovered separately in Trench 1, but their similarity and the shape of the fractures strongly indicate that they belong together. In this regard, the length of the gun from the base ring to the muzzle becomes 204 cm, with a diameter at the vent of 33.6 cm and a bore of 11.0 cm. The trunnions are cylindrical and only stumps of the dolphins and handle-style cascable remain, all evidently melted or broken. The attachment for a vent cover is preserved, but the cover itself is missing. Two motifs stand in relief; Christian IV's royal cypher on the first reinforce, and a dragon-like creature on the chase. The Roman numeral 'V' is incised underneath the cypher, and partly readable at the beginning of the chase

RVDOLF BO CH T F CIT M DC X

It is likely that more digits originally followed, but are now rendered unintelligible, leaving the date open between 1610 and 1650. The incision almost certainly refers to founder Rudolf Borcharts operating in Copenhagen between 1619 and 1626 (Blom 1877: 175), and the animal figure firmly places the piece in the group known, quite appropriately, as *dragons*. Three other examples of Borcharts' dragons are known, two of which were recovered from the wreck of *Dannebroge* in the later 19th century (on display at the Royal Danish Arsenal Museum and the Ivar Huitfeldt Memorial, both in Copenhagen), and the third an isolated find from the early 20th century on display at the Royal Danish Naval Museum. In terms of both appearance, dimensions and calibre, X121 is very similar to these examples of the nominally 8-pound piece. The incised 'V' indicates an actual weight of 5 *skippund* or 1600 pounds, and is a very good match for the 21 pieces of 1616 pounds which Borcharts is believed to have completed in 1623 (Blom 1891: 59). Additionally, the piece found in the 20th century has a very clear dating which shows, although historically undocumented, that he was producing such pieces as early as 1621, and it is more than likely around this year that X121 was cast. The two pieces from *Dannebroge* carry the numbers '44' and '45' respectively in relief under the animal on the chase, suggesting a close chronological relation, with the latter clearly dated 1623. Curiously, they also both carry the slightly different incision

RVDOLF BURKARTS GOS MICH ANNO M DC XX III

Aside from the variation in spelling, the Latin term 'fecit' is replaced by the German 'gos[s]'. This needs not necessarily to indicate a definite transition from one style to the other, but may simply be a result of different artisans at work in the foundry. Regardless, X121 is marked in the same style as the 1621 piece, which furthermore carries the number '30' in relief, cementing its earlier date, and it thus seems reasonable to consider the two pieces more or less contemporary.

The large piece X120 was found in the after part of the wreck in very good condition, and was the first to be recovered. The fragment is broken off at the second reinforce, just after the cylindrical trunnions, and measures a maximum of 110 cm from the base ring to the fracture. The diameter at the vent is 37.5 cm and the bore measures 13.0 cm. Unlike X121, the vent cover attachment is asymmetrical with one knuckle on the left and two on the right. On the right side a fragment of the cover is still held by an iron pin. The hinge arrangement would probably have been permanently fixed on the left side, meaning that the piece may well have been primed with the cover closed at the time when it was abandoned. The dolphins are melted or broken, but the handle-style cascable is nearly intact. It consists of a squatting woman, probably intended to exhibit oriental features, grasping a teethed sea-animal, perhaps a porpoise but probably largely imaginary, by the tail. The tip of the tail is missing, and the woman's head was lost but recovered as X26. A single relief dominates the first reinforce: the national coat of arms along with the arms of the 13 provinces, surrounded by Christian IV's full title in Latin. A clearly incised weight of 'VII S VIIII L' translating to 2384 pounds appears underneath the emblem.

Unfortunately no obvious identifiers, names or dates are visible on the piece. The bore diameter of 13.0 cm matches a 16-pounder most closely, but by the mid-17th century a certain adherence to a few main calibres had been established, and the 16-pounder was not among them. The few examples which are known furthermore bear no resemblance to X120 (Grunth 1860: VII A) and are much too heavy (Blom 1891: 53). The next larger main calibre is 24 pounds—a rather unreasonable leap—and the next smaller one 14 pounds, an altogether more plausible alternative with a nominal bore of c. 12.6 cm (Blom 1877: 192-3). Of the known 14-pounders, the majority is significantly lighter than 2000 pounds, and only one series matches the attested weight of 2384 pounds: the series known as *the old kings.*

The series was arguably one of the first real attempts to modernise and standardise the nation's ordnance, and was to encompass 100 near-identical, sequentially numbered pieces each carrying a depiction and a verse related to a different mythical king on the chase. The large order was spilt in two so that founders Hans Wolf in Elsinore and Borchart Jensen in Copenhagen would each

supply 50 pieces, numbers one to 50 and 51 to 100 respectively. The entire series appears to have been completed between 1602 and 1606, with a small number of possible replacement pieces delivered 1625 by Hans Kemmer (Dedenroth-Schou 1974: 61, 90; Blom 1877: 207). Pieces from the original series—by both founders—are known, again from the *Dannebroge*, and on display at the Arsenal Museum and Huitfeldt Memorial. Although the two founders were evidently working from the same basic idea, two somewhat different templates nonetheless emerged, and based on the profile of the base and reinforce rings, shape of the trunnions and the design of the relief, there is little doubt that X120 was cast by Hans Wolf. Unfortunately the part of the emblem where Wolf's other known pieces carry the year of production is completely obscured on X120. Assuming a strong continuity of design in the foundry, the piece could therefore also possibly—but rather unlikely—be one of the few later replacement pieces cast in Elsinore 1625.

All of Wolf's preserved pieces are dated 1603, but an older drawing of piece number 40 dated 1604 (Grunth 1860: XV B) suggests that there may have been a slight change in the composition of the royal relief by then. This change is not evident on X120 so assuming a certain reliability of the drawing, the piece was probably cast no later than 1604 (which also appears to be the last year of casting of the series in Elsinore), and more interestingly perhaps, with a number lower than 40. Just over half of Wolf's pieces are plausibly accounted for and can be disregarded as candidates, and documentary evidence for the actual weight of every one of the 50 pieces has been compiled (Dedenroth-Shou 1974: 90-1). The 2384 pounds of X120 do however have no perfect match in the list, and an exact identification of the piece has therefore not been possible.

The largest fragment, not in terms of completeness but rather in terms of mass, is X122 found in Trench 1. The piece is broken in the second reinforce, just after the rear dolphin attachment points, and measures a maximum of 90 cm from the base ring. Dolphin stumps are melted and broken like the cascable button, but the symmetrical vent cover attachment is well preserved. The surface is light blue and appears to have been heated extremely, the barrel is deformed and the bore almost entirely collapsed, as if the barrel was bent under its own weight and finally broke in two. This obviously renders it impossible to measure the height of the bore directly. Assuming that the piece is reasonably similar to other large pieces of ordnance and thus sports a wall thickness of about one calibre, the vent field diameter of 44.5 cm yields a bore height of 14.8 cm, precisely the nominal height of a 24-pounder, which was by far the most prevalent calibre in the demi-cannon range (Blom 1891: 47). The piece seems to be modelled on what one might call the Elsinore template, and thus appears quite similar to X120 with the exception of the cascable. The piece shows no obvious indications of founder or dating, but carries a royal cypher very similar to X121 in relief on the first reinforce. Although the

surface is rather badly damaged by high temperatures, it seems that a band of text stands in relief at the very beginning of the first reinforce, just after the vent field, but is largely melted past intelligibility. At the right side of the barrel, what is more than likely the end of the text probably reads

DER GOS MICH

This position and wording seems to have been favoured particularly by Hans Wolf who signed his pieces with the additional name Entfelder, which agrees nicely with the melted relief (Grunth 1860: VIII C+F, XII B). The practice was however continued—at least for some time—by Hans Kemmer when he took over the Elsinore foundry in 1616 (Blom 1877: 176; Grunth 1860: IX C), and given the state of the relief and the risk of misinterpretation, he cannot be ruled out as the possible founder of the piece. Both Wolf and Kemmer produced a large number of demi-cannons during their time in Elsinore in the first half of the 17th century (Blom 1891: 47), and the absence of weight stamps and identifying marks means that X122 cannot be placed chronologically with any certainty.

Conversely, the provenience and dating of the fragment X187 from Trench North is very straight forward. The 69 cm long conical muzzle fragment is reinforced by an astragal with two fillets, and at the top of the chase a very informative relief reads

GOS MICH H NS KEMMER 1629

The fragment is quite well preserved, but has been subjected to force which has rendered the bore rather elliptic. The two axes measure 16.1 and 12.8 cm, and the circumference is equal to a circle with a diameter of just over 14.5 cm, a slight detour which also places this fragment in the 24-pound demi-cannon range. As mentioned above, Hans Kemmer did cast a significant number of such pieces, and was very productive during the late 1620s and early 1630s. From the documentary evidence it even appears that he was particularly busy during the years 1628-9, delivering at least three different lots of no less than 58 pieces in total, none of which are known archaeologically (Blom 1891: 47).

Lastly, three separate barrel fragments—presumably from the chase—were recovered as surface finds. All are rather eroded, and neither represents more than a quarter of the barrel circumference, making a determination of calibres difficult.

An attempt was made to estimate the height of the bores by calculation from the preserved curvature. Width and depth was recorded at three stations along the fragments, but results should be regarded as highly tentative. Fragment X48 yielded the results 12.6, 13.2 and 10.9 cm with a mean of 12.2 cm. Along with the wall thickness of about 6.5 cm, the measurements point to a 14-pounder, and thus not unlikely another of the old kings. The values recorded for X204 also provide quite a range: 17.1, 15.3 and 13.0 cm, with a mean around 15.1 cm. The wall thickness of about 8 cm verifies that it is indeed a larger piece, probably a 24 pound demi-cannon. The final fragment X49 yielded the most consistent results, 16.5, 16.9 and 17.0 cm with a mean of 16.8 cm, seemingly the largest bore of the three. Surprisingly, the observed wall thickness is the smallest among the fragments at just 6 cm. If both measurements are indicative of the dimensions of the original pieces, it may thus have been a very light cannon of 30 pounds or more.

All the recovered pieces were clearly cast during the reign of Christian IV, and the muzzle fragment X187 dated 1629 solidly defines the earliest possible occurrence of the wrecking incident. Defining the other possible extreme is not quite as straight forward, since similar pieces are known to have remained in service for more than a century, surviving not only Christian IV but several subsequent monarchs. Conveniently, the mere presence of dolphin stumps and a cascable handle may help to narrow the range significantly, since these were ordered removed in 1667 (Blom 1891: 54). Compared to the examples recovered from *Dannebroge* wrecked in 1710, it is clear that this order was indeed carried out, at least to some extent. A few of these pieces still have their cascable intact, and some sport obvious remains of dolphins, but the majority have had cascables removed and dolphins chiselled flush with the reinforce. Dolphins and cascables, particularly of the handle type, constitute the weakest and most exposed parts of any piece, and can reasonably be expected to sustain a disproportionate amount of damage in a violent event. This fact, along with the presence of a cascable handle on the also otherwise well-preserved X120 and the absence of evidence of chiselling on any of the pieces, indicates that no intentional modification has been attempted. The wrecking thus most probably occurred before c. 1667.

Around 1600, Christian IV seems to have encountered problems sourcing raw materials for his increasing production of bronze ordnance. In order to remedy this obstacle, he – like others before him – ordered the collection and reuse of church bells from all over the country. The initiative seems to have been rather successful, with tonnes of copper collected and the majority ending up in the gun foundries. It is therefore quite likely that the guns from *Lindormen*, particularly X120 from the early years of the century, were cast from recycled bell material. Ironically, a bell cast by Hans Wolf himself at the Elsinore foundry in 1614, shortly

before his death, is still in operation in Valby church outside of Copenhagen (Bill-Jessen 2007).

There is no exact record of how many—or which—pieces *Lindormen* carried in 1644. Her contract specifies that she was to have 20 ports along the gun deck and 14 higher up in the ship, perhaps with an additional number in the cabins, totalling between 34 and 40 ports. The 1653 description of her sister ship *Tre Kroner* lists 50 ports, 24 on the gun deck, 20 along the full length of the upper deck and six in the cabins. Only 42 of the ports were in use, but the associated ordnance conforms neatly—at least in theory—to four calibres: 12 demi-cannons (presumably 24-pounders) and 10 old kings (listed as 16-pounders, but nominally 14-pounders) on the gun deck, 16 10-pounders (8-pounders) on the upper deck and four 4-pounders in the cabins (Holck 1943: 557). It is not unlikely that *Tre Kroner* had been refitted to carry more pieces than she had originally been designed for by 1653, and the ports on the weather deck in particular may partly be a later addition (Glete 2000: 30-1). Whether or not *Lindormen* was refitted, or perhaps already deviated from the contract before she was finished, it seems likely that she would have carried around 38 pieces (excluding smaller calibres) in 1644. The three pieces recovered perfectly match the calibres listed for *Tre Kroner*, and although the armament of *Lindormen* need not have been quite as systematic and the distribution between calibres identical, there is every reason to assume a rather close reflection.

5.2.2.2. Ammunition

In addition to the guns, a considerable amount of ammunition was recovered from Trench 1 as well as directly from the surface. A range of types and sizes are represented in various states of preservation, including round, chain, spike and scissor shot.

A total of six iron round shot were found. The smallest are 6.6 – 6.8 cm in diameter, corresponding to 3 pound shot, two belong to the 8-pounders with 9.6 cm and a slightly smaller shot of 9.1 cm matches 6 pounds most closely. The last and largest shot has a diameter of c. 13 cm and thus inhabits the rather barren space between 14 and 24 pounds, indicating perhaps the presence of an 18-pounder on board.

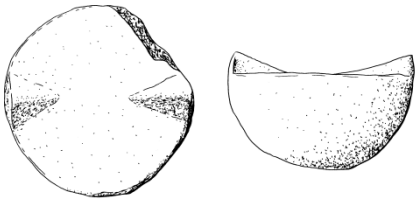


Figure 29: Shot X4 Scale 1:5.

What is assumed to be chain shot, or remains thereof, was encountered in at least three and up to five cases, all concerning larger calibres. The most well-preserved take the shape of solid iron hemispheres with a 1 cm wide groove along the outside, and two triangular features on the flat face—in the shape of either recesses or protrusions—allowing a degree of interlocking between two hemispheres of matching orientations. A 1.4-2.0 cm wide square hole is present on the outside just below the edge, and the channel continues parallel to the flat fact up to c. 5 cm into the hemisphere. Remains of cast barbs inside the channel are visible in one of the finds, showing that the eyelets attaching the chain clearly were not cast with the shot, but rather produced separately and inserted subsequently. The shot diameters more or less evenly cover the range from 12.3 to 14 cm, thus covering calibres from 14 to 24 pounds inclusive. On a different note, many of these finds—as one of very few groups of finds—seem to have been attacked by larger boring animals, leaving slightly curved holes with a fine ripple texture and a diameter of 1.5-2.5 cm into and through the degraded iron.

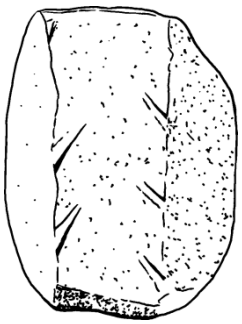


Figure 30: One of four fragments making up cross-bar shot X151. Note the barbs in the channel. Scale 1:2.

A group of four pieces, some only fragments, are identified as spike or cross-bar shot in spite of the fact that no remains of spikes or bars were encountered. They appear as solid round shot, but with a channel of square cross section through the core, able to accommodate an iron bar 1.9-3.0 cm thick. Like with the chain shot, remains of barbs are visible inside some of the channels. The recovered examples are limited to the smaller calibres, ranging from a reconstructed diameter of c. 8 to 11.5 cm, and probably cover one 4 pound, two 8 pound and a single 14 pound shot.

The smallest group is made up of just two finds, one half and one whole scissor shot. The shot consists of two solid iron hemispheres connected by a Ø 2 cm bolt allowing the two halves to rotate around their centre. Although the blades of the scissors themselves have mostly corroded away, both finds show traces of a 4 wide and 2 cm deep recess running across the flat face, which is in both cases also more or less occupied by remains of the blade. As with the previous composite types of ammunition, it seems evident that the blades were cast separately. The diameters measure 13.0 and 12.4 cm, both probably intended for use with calibres above 14 pounds.

The final category is a number of smaller round shots, falling into two groups according to size: one with diameters between 4.8 and 5.0 cm, and one with diameters between 5.4 and 5.8 cm, with the latter group accounting for the majority of the finds. They were initially interpreted as balls from grapeshot, but constituting roughly 1 and 1.5 or 2 pound round shots respectively in their own right, may also have been used as ammunition for smaller-calibre deck armaments. Shots of both iron and lead are present, although iron is far more prevalent. This hints at an intended use as individual shots, but is by no means decisive since grapeshot seem to have been executed in both materials, and although steeply declining during the period, the occurrence of lead shots for the smaller calibres is not altogether unlikely either. Grapeshot were comprised of both 1, 1.5 and 2 pound balls, but may in fact not have been particularly popular, and the role of the grapeshot seems often to have been fulfilled by more crudely manufactured bags of scrap iron (Blom 1877: 263-83). Nevertheless, *St. Sophia* apparently carried significant numbers of both balls and scrap, with a separate lot of iron round shot for her 1-pounders, and archaeological finds strongly suggest that 5.5 cm iron balls were indeed used in clusters (Bergstrand and Arbin 2003: 42-3, 63). It seems reasonable to assume that *Lindormen* also carried a small number of falconets or similar pieces requiring ammunition, but the amount of small shots found (11) relative to the total amount of round shot found across all other calibres—most of which were undoubtedly better represented in the ship's armament—renders the grapeshot alternative much more likely.

The recovered sample of ammunition seems highly representative of a normal assortment aboard a Scandinavian man-of-war with a reasonable distribution between the types (Blom 1877: 266). It compares very well to the inventories and finds of both *St. Sopia* (Bergstrand and Arbin 2003: 46) and *Vasa* (Höglund 2002: 23)—in fact, the execution of the composite types is so similar to those recovered from the *Vasa* (Hocker 2011: 61), that a Dano-Norwegian origin cannot be guaranteed for any single shot. It does, however, remain unlikely that Swedish or Dutch ammunition should have significantly contaminated the sample.

Although it appears that some types were limited to a particular range of calibres—chain and scissor shot to the larger calibres and spike shot to the smaller ones—this is need not be the case since a variety of composite shot seems to have been used across almost all calibres (Blom 1877: 267). Nonetheless, the diversity of sizes does raise a possible objection to the assumed uniformity of the armament, introducing the possible use of both 6- and 18-pounders. The occurrence of several different shot sizes across a range, but with only little clustering in distinct groups, does however suggest that the diversity may not relate directly to a diversity of calibres, but rather attest to a high tolerance in terms of windage. Although *Lindormen* may not, as previously mentioned, have had the uniform armament

attributed to *Tre Kroner*, the variation found in the ammunition can at least to some degree be explained by manufacturing and windage tolerances, and need not suggest any significant increase in the range of calibres carried on board.

Insofar as the ship was indeed completely deprived of soldiers, one can only agree that this fact is perfectly reflected in the nature of the naturally very limited sample of recovered ammunition, where not a single musket shot is represented. A single ball with a diameter of just 10 mm (X186)—and thus probably too small to constitute a part of a larger piece of anti-personnel ammunition—was likely intended for a pistol, and is the only evidence of personal weaponry encountered.

5.2.3. Containers

5.2.3.1. Barrels

There can be little dispute over the primacy of staved vessels for storage aboard ships during the previous millennium, and not surprisingly fragments of no less than three large barrels were encountered during the investigation. Two lots of fragments, one from each of the trenches, were recovered.

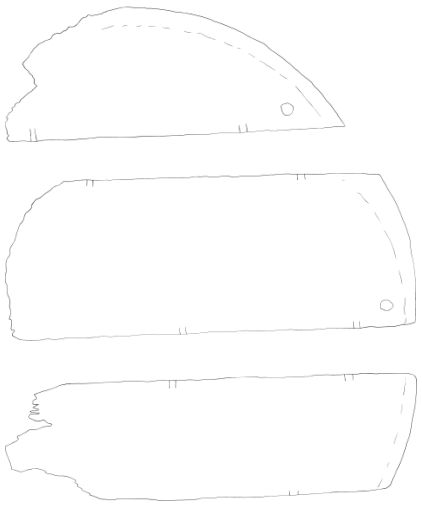


Figure 31: Head pieces X180.9 - X180.11. Scale 1:10.

The fragments from Trench North, most of them grouped under X180, are generally the best preserved, and include seven staves, three head pieces and a separate square plug. The staves are mostly complete, and all measure around 126 cm in length with a thickness between 1.5 and 2 cm. There is somewhat more variation in maximum widths, ranging between 6.5 and 11.3 cm with most falling around the middle of the range. All staves are bevelled to make the inside face c. 1 cm short than the outside, with the croze groove set a rather consistent 3.5 – 3.7 cm before the end. The croze is 3-4 mm wide with a trapeze-shaped cross section, and is on most of the staves embedded in a circular or ellipsoidal (depending on stave width) shallow chiv hollow. None of the head pieces survive intact, or even at their full length, but the two middle pieces and single cant piece share widths between 16 and 20 cm and a common thickness of 2 cm. Both faces are bevelled, but one much more noticeably that the other, presumably indicating the inside face. Where the edge is most well-preserved, the edge terminates in a finely carved lip. Two of the pieces feature a Ø 1.5 cm hole with a plug clearly inserted from the less-bevelled side, removing any doubt as to the orientation of

the faces. All joining faces have a number of holes for round dowels, apparently in a system with three dowels between a pair of middle pieces, and only two dowels between a middle and a cant piece.

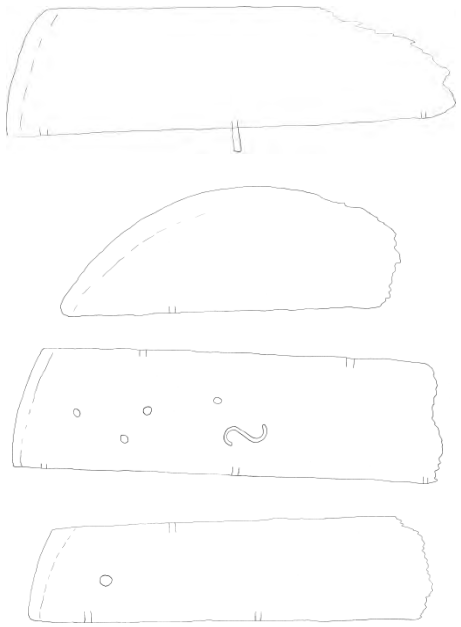


Figure 32: Head pieces X128.1 - X128.4. Scale 1:10.

Although the fragments from Trench 1 (X128) were recovered in a somewhat worse condition, they appear very similar to their counterparts in Trench North. The lot includes five staves, four head pieces (one cant and three middle pieces) and two square plugs. One of the middle head pieces is only 13.5 cm wide, but otherwise both head pieces and staves reflect the dimensions and features of X180. Notwithstanding their state of preservation, the pieces do however exhibit a number of features not observed elsewhere: one of the middle head pieces (X128.3) has no less than four smaller plugged holes with diameters of 1-1.3 cm, and the same piece—along with two of the staves—carry inscribed marks. Stave X128.5 has the two letters BF carved at the bilge, set at a slight angle. The degraded state of the surface, as well as the slightly off-centre position of the letters, means that they may well have been preceded by a three letter. The aforementioned head piece and stave X128.9 both carry a reversed letter S. Unlike the inscribed piece of furniture, these marks are all done in a rectangular rather than V-shaped cross section, and with much more care than a simple incised marking. The letters BF are most likely the initials of a person or group involved somewhere along the supply chain from wood sourcing to shipboard use, but seem unlikely to refer to either of the extremes. The articles of the coopers' guild in Copenhagen issued 1678 requires all coopers to sign their products with name and (or) mark (Clemmensen 1928: 14). Although other parties may have had an interest in marking barrels in their possession according to content or supplier, the cooper's mark—insofar as it was viewed with similar importance before 1678—seems a plausible explanation for such a singular inscription. There was nominally allocated one dedicated cooper to the ship (Holck 1943: 489), and while he probably did not engage in manufacturing on this scale at sea, he may well have repaired the large barrels—whether he would also have had time and privilege to mark them is doubtful. After the introduction of new standards of measurement in the later 17th century, it was

suggested in 1704 that coppers should brand their barrels by the bung and on both heads (Nielsen 1886: 719). Whether or not this somewhat overly cautious suggestion won any adherence, it does suggest that two identical marks on one barrel might not have been entirely implausible. The notion of branding, however, raises some interesting question about the nature of the marks, since both the slight misalignment of BF, the rectangular cross section of the marks and their degree of sophistication might be explained as a result of branding. That one or both marks should be made by the cooper remains likely, but if branding was indeed as commonplace a method as it seems to have been half a century later (Molaug and Scheen 1983: 81-4) then one might also expect shallower brands to have eroded away with the top layers of the wood, leaving the interpretation of preserved marks quite open. While the source may be the same for the reversed S symbol, this mark may perhaps carry a significance relating more directly to the barrel or its content: it appears unlikely that the cooper or merchant would take the time to mark both the head and a stave if the mark was not of some importance—the elements might of course belong to separate barrels, but it appears no less puzzling that the mark should then have different positions. While the symbol may merely be a symbol, it may also represent the actual letter S, or indeed (and not at all unusual at the time) the number 2 (Kroman 1975: 55-64).

A number of staves still have traces of hoops, but none more clearly than X128.5. While not preserved in its entirety, this stave bears indications of as many as eight 6 cm wide bands, more or less evenly distributed along the length of the stave. The hoop fragments found in Trench 1 (none were encountered in Trench North) are mostly grouped under X123, and all have a width between 2.5 and 3 cm. The near-semicircular cross section is almost constant throughout the samples, and no decisive evidence of joinery encountered.

The final barrel was discovered embedded lengthwise in the surface roughly halfway between the two trenches. It was excavated internally, but not recovered. The most well-preserved end consisted of approximately half a head with all staves attached, but remains had eroded to a wedge-shaped profile with the lowest staves cut down to a length of about 1 m. No less than 12 staves of varying width could be identified, but none exhibited any noteworthy features. The joints between elements of the head were orientated perpendicular to the surface, so the four pieces—again of slightly varying widths—were clearly distinguishable, adding up to a diameter around 70 cm. Since there were no sign of croze grooves at the eroded end of the staves, it seems that this barrel may well have been of proportions very similar to the remains recovered from the trenches.

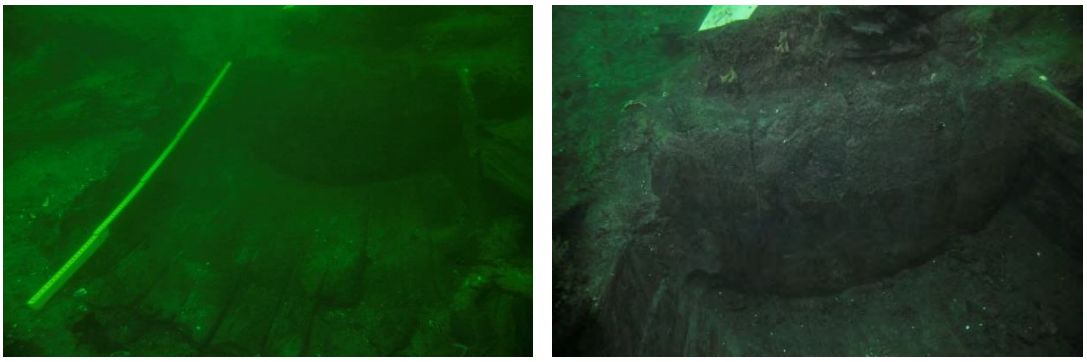


Figure 33: Preserved barrel remains from the surface. Not recovered.

Assessing the size and capacity of the barrels requires a certain amount of speculation. Since none of the recovered head pieces are preserved to their full length, the original diameter of the barrel heads can only be approached as an estimate. Assuming that all heads were composed of four pieces, the average and recurring width of approximately 16 cm suggests a diameter of 64 cm. Similarly, an analysis of the curvature of especially cant pieces from both trenches suggests a diameter between 63 and 66 cm. The height of the barrel at 126 cm is quite well established from the number of intact staves, and it is probably not coincidental that the dimensions 63 x 126 cm correspond almost perfectly to 2 x 4 contemporary Danish feet, perhaps even explaining the reversed S-symbol as denoting a two-foot barrel. However, the amount of bulging at the bilge—contributing significantly to the capacity of the vessel—is more difficult to pin down. Among the staves of X128 there is little agreement on the degree of curvature, with many pieces heavily eroded and some even curving inwards rather than outwards, while the curvature of X180 is much more consistent and therefore interesting. Here, most staves are curved to such a degree as to indicate a bilge diameter approximately 6 cm larger than the diameter at the very end of the staves. Additionally, the longest hoop fragment recovered (X81) maintains a curvature indicating a diameter of approximately 77 cm. Accounting for the position of the croze along the stave as well as the thickness of the head, the internal height of the barrels would have been around 116 cm. With a head diameter between 63 and 66 cm and allowance for the depth of both croze and chiv, the capacity of the barrel adds up to a considerable 435 to 473 litres, and would have featured an external bilge diameter between 75 and 78 cm.

While the properties of the barrel itself are pursuable through such reconstructive efforts, and original—or previous—contents is a different matter. The oaken construction and the presence of tap holes in the head suggest, albeit not indisputably, that the barrel has contained a liquid. Although of little impact in itself, the fact that the barrel excavated near the surface showed no signs of

remaining solid contents (such as animal bones) does support this notion. An initial candidate for the original content, not least given the significant size of the barrels, might be fresh water. With a weight of approximately half a ton each, the barrels would certainly have been cumbersome to load and to handle below decks, but as water barrels they could have remained a more permanent element of the ship, generally being refilled rather than replaced. For a number of reasons, however, it seems the barrels may have contained another, but no doubt equally important liquid. A single stave from each trench (X128.7 and X180.1) feature, or show evidence of, an open square bung hole. The recovered square plugs are assumed to have been used as bungs, even though all are slightly too small to fit either stave. Square bung holes are known from both *St. Sophia* (Bergstrand and Arbin 2003: app. 5) and *Vasa* (Kaijser 1982: 79), and in the latter case at least one of the barrels in question had clearly been taken into—presumably secondary—use as personal storage. While it seems unlikely that the square bung hole should have any relation to this secondary use, everything also does point to the recovered barrels having been used in their intended function: they are significantly larger than the barrels of the *Vasa*, and the fine-edged head and sharp croze do not exhibit signs of wear from, and nor do they appear constructed for, repeated opening and closing, as one might expect for personal storage.

The peculiar square hole may however be a valuable clue to the contents of the barrels, as the feature has been tentatively associated with beer barrels in particular (Ratcliffe 2012: 216-28). While the feature is of course difficult to ascribe as one unique to beer barrels, there is no doubt that there was some connection in the 17th century (Unger 2004: 224). Interestingly, a regular barrel-measure at the time was equal to approximately 139 litres, whereas a barrel of beer was set to only about 116 litres (Aakjær 1936: 263-4). Four such beer measures (464 litres) would thus fall comfortably within the estimated capacity range, whereas multiples of the regular barrel unit would not. Additionally, the volume of two beer barrels is referred to as a *fad*, or cask, effectively making the vessel a two-cask barrel, and thus constituting a different, and perhaps more intuitive, explanation for the S-symbol as referring to volume rather than height. This may quite likely be a coincidence, but certainly does not undermine the beer theory. A final possibility, and probably the best candidate for a mark alongside that of the cooper, is the brewer himself. As a means of maintaining control with the quality of beer from many different suppliers, from the mid-16th century brewers were (also) obliged to mark the barrels that contained their beer (Barfod 2004: 50-1). Whether this practice continued into the 17th century is unclear, but it certainly would provide a strong indication of both the nature of the marks and the original content.

Considering the amount of beer consumed on board a navy ship, it appears quite likely that one should encounter a few beer barrels—or three—among the wreckage. Not only was it the most space-consuming food item on board, it was also the largest single expense in the navy food budget by a wide margin. Every man on the king's ships was allotted a ration of about 3.6 litres per day, and a complement of 200 men would thus require a supply of up to 700 litres every day: to get the entire navy through the 1644 season, more than three million litres of beer were required (Holck 1943: 491). Even a relatively large barrel of 473 litres would have been emptied in less than a day, and so while the ship undoubtedly carried a huge variety of goods in barrels of different shapes and sizes, it is not altogether odd that beer barrels should be particularly well-represented among the remains.

One last find may also belong to the story of the barrels. Trench North revealed a small lead artefact (X194) in the shape of a slightly tapering cylinder, 3 cm long and the ends 1.5 and 1.7 cm in diameter respectively. The cylinder is pierced by a 7 mm wide circular hole perpendicular to the longitudinal axis. A 2 mm wide copper-alloy wire extends 1.3 cm out from the centre of the larger end surface, flanked by two smaller circular indentations, one on either side of the wire. The shape and size of the object suggests that it may have been part of a cask tap, constituting a rotatable key controlling the flow through the tap. It may however also amount to nothing more than recent contamination, and two issues in particular being the archaeological value in question. Whether encountered in Denmark (Berg 1981: 97), in neighbouring regions (Grieg 1933:170-2; Baart et al. 1977: 352-6) or at sea (Kaijser 1982: 90; Sténuit 1974:222-3), similar contemporary tap keys appear to have been manufactured almost exclusively from copper alloys, with a small minority made from wood (no doubt at least partly a consequence of a preservational bias). An example in lead would thus constitute an exceptional archaeological rarity. Secondly, contemporary tap keys feature a more or less ornate handle extending in the direction of the wire on X194—predominantly in the shape of a cockerel profile or a clover made up of three rings—and the entire key cast as one. The lead cylinder is clearly missing any such top, and while the area connecting the cylinder to a top part would certainly be a weak point, there is no sign of any damage in this regard. The features on the larger surface may constitute some sort of coupling arrangement for a separate top part, but such a composite device appears archaeologically unattested.

5.2.3.2. Ceramics

Although no complete vessels were recovered, numerous ceramic remains were encountered, albeit mostly as smaller scattered fragments. At least 11 different vessels, including a small tripod cooking pot or pipkin, are represented by one or more sherds. The execution of the pieces ranges from rather rough and irregular to more finely thrown and decorated, although no paint and only little glaze remains. Likewise, different degrees of firing are evident. Fragments were discovered in several different areas of the wreck, with no obvious relation between types and distribution.

The most complete vessel in terms of related sherds (X134) was discovered more or less intact in Trench 1. This bulbous jug originally had a height of 17.5 cm and a maximum diameter of 16.6 cm, with a wall thickness varying between 4 and 7 mm and a calculated capacity very close to 2 litres. It has a flat base and a small semi-circular handle orientated horizontally either side of the short neck. A pronounced lip surrounds the just 2 cm wide opening. On the inside of the lower half in particular, a softly spiralling pattern is evident. The pattern originates in the centre of the bottom, and may be indicative of a manufacturing process involving both coiling and throwing. Most of the body is decorated with a smooth horizontal ribbing, while three deep and narrow incisions encircle the neck, and a fourth initiates the ribbing just below the handles. Similar vessels have been identified elsewhere as both water canteens (Berg 1981: 66) and wine jugs (Molaug and Scheen 1983:193-4), and the piece in question may well have contained either of the two.

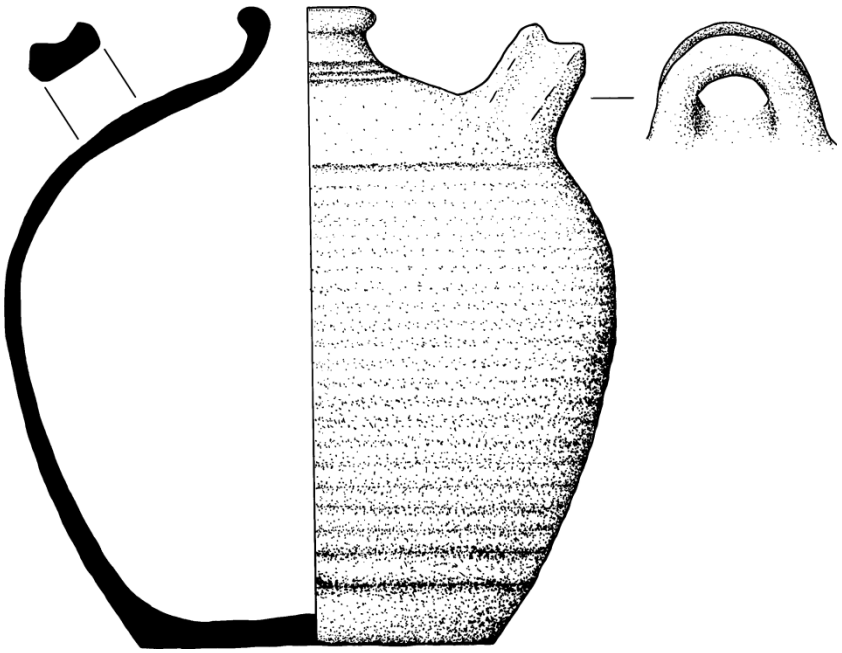


Figure 34: Reconstructed ceramic jug X134. Scale 1:2.

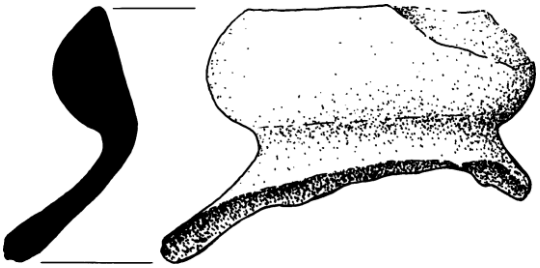


Figure 35: Ceramic fragment X188. Scale 1:2.

A much smaller fragment (X188), comprised only of a complete rim, is worthy of mention more by the circumstances of its discovery than the nature of the piece itself. The fragment has a larger opening than the previous and probably belonged to a vessel of greater capacity, but no related fragments were encountered. Amazingly, the fragment was discovered inside the demi-cannon barrel fragment recovered from Trench North (X187). While there appears to have been no shortage of ammunition aboard the ship, it cannot be ruled out that the ceramic sherds were in fact intentionally loaded into the guns as emergency anti-personnel ammunition. It does however seem prudent that such a desperate effort should have been followed by the immediate firing of the piece. Even more questionably is the feasibility of the fragment subsequently remaining in the barrel—particularly in the disassociated muzzle end—through the evidently violent fate of the gun. Nonetheless, since a deposition of the ceramics in the barrel during the destruction or sinking of the ship requires an equally generous measure of imagination, the possibility of an intentional act should not be disregarded.

5.2.3.4. Other

Two smaller wooden containers, presumably personal possessions, were recovered from Trench 1. One is the oval 11.4 x 7.4 cm lid of a traditional bentwood box (X106). The upper surface is decoratively carved in an angular pattern of triangularly divided squares, and remains of several dowels are visible along the edge. These dowels would have joined the lid to a thin wood sheet or band making up the outside of the box. Boxes of similar type and size are known from both earlier (Kaijser 1982: 83) and later (Molaug and Scheen 1983: 211-3) Scandinavian shipwreck assemblages, although decorated examples seem rare. The construction method has a long history in Scandinavian countries in particular, but the technique has been practised in many regions of continental Europe. Unfortunately, the most indicative features in terms of dating and provenience relate to the sides and the fashioning of the bottom, about which nothing can be said (Nylén 1968: 381). There is however little doubt that the box would have contained the small or fragile possessions of a person of some standing—perhaps a craftsman not fortunate enough to own a chest with a till.

The second small container survives in a much more intact state. It is a rectangular box (X93) with a base measuring 9 x 3.7 cm and a height of 4 cm, carved from a

single block of ash wood. The walls are up to 7 mm thick, albeit somewhat thinner along the sides, and around the inside near the edge is a groove for accommodating a sliding lid. The back end is fitted near the centre with a round 6 mm peg, flush with the outside but extending 1.5 cm from the inside wall into the box. At the opposite end—where the lid would be inserted—the bottom features a shallow, circular depression 1 cm in diameter set right against the end wall. A suitable 8.3 x 2.8 cm lid (X101) discovered separately is assumed to have belonged to the box. The lid has a flat bottom and a slightly convex top, and is bevelled both ends. The top surface also features a shallow semi-circular recess to ease removal of the lid. There is no single obvious explanation for the use of the box, even though the box was quite probably manufactured for a particular purpose. A collection of similar but somewhat larger carved and composite boxes are known from the *Mary Rose*, and although they have been identified as tinderboxes this conclusion is remains expressedly tentative (Hildred 2011: 499-502). These boxes do exhibit similar internal depressions, but this feature is more likely to be a result of the method of manufacture—probably the bottom of a hole drilled as a means of gauging the progress while carving—rather than of any relation to the function of the box. Furthermore, the boxes from *Mary Rose* and others are almost invariably divided into two or more separate compartments. Not only does the smaller dimensions of X93 make such a subdivision highly impractical, the limited capacity itself seems less than ideal for a tinderbox. An alternative interpretation, perhaps applicable to the oval bentwood box as well, is the use of the box to store tobacco for consumption (Johansson 1985: 92). The internal peg, otherwise quite difficult to explain, might then have acted as a pipe tamper for the narrow and fragile clay bowls.

5.2.4. Furniture

A number of furniture remains were recovered, including elements of at least four different storage units, with the highest concentration encountered in Trench North. The assemblage is quite diverse in terms of both furniture type and construction technique, and amounts to a rare glimpse of a fragile category of artefacts rarely preserved. However, exactly because examples of the practical, everyday furniture of more or less common people are relatively few, interpretation of individual pieces

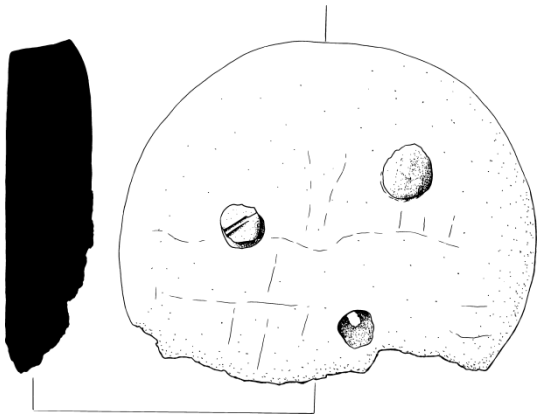


Figure 36: Tripod stool seat X71. Scale 1:5.

and reconstructive attempts are possible only within a framework with a certain allowance for speculation.

5.2.4.1. Dovetailed chest #1

The largest single element, and the only element of what is probably also the largest piece of furniture, was discovered in Trench 1 (X90). The 94.5 x 30.5 cm large pine board is 2 cm thick, and although two edges have sustained some fire damage, these dimensions represent the original extent of the piece. Triangular holes, creating *tails*, for joining the board dovetail-wise to another are present along the most intact short side.

A small groove, 6 mm wide and 6 mm deep, runs across the base of the tails on one side of the board, presumably intended to accommodate a corresponding lip on the joining element in order to strengthen the joint. The otherwise very well-preserved bottom edge shows no obvious signs of joints or fasteners. Several features indicate that the board must have constituted a piece, and most probably the back wall, of a larger chest. On the inside, which must necessarily be the side with the aforementioned groove, there is carved a 6 mm deep and 11 mm wide L-shaped track enveloping the top-right corner, with a slightly deeper 15 mm wide circular depression at the very corner of the board.

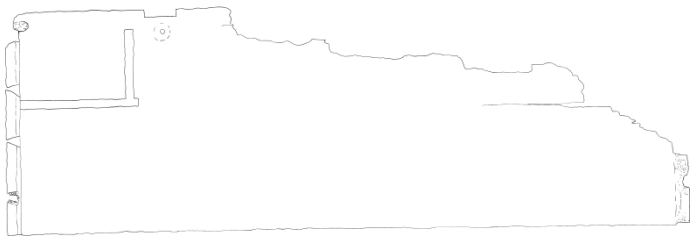


Figure 37: Backboard from chest X90. Scale 1:10.

An identical track was no doubt present on the opposite side of the chest, and served to fix the bottom and side of an internal till, while providing a pivotal point for its small lid. Along the rather damaged long side is a small rectangular notch, 4.3 cm wide and 1.1 cm deep, which on the outside shows clear traces of having accommodated an iron strap. The trace narrows slightly but continues across to the bottom of the board, a feature which is also discernible, albeit very faintly, on the opposite and more damaged end of the board. A number of square nail holes are visible along the centre of the iron trace on the outside, and on the inside, just below the notch, is an imprint of a larger, circular nail or rivet head. This strap no doubt supported—or was itself a part of—one of two hinges for the chest's lid (perhaps recovered as X7), with the notch allowing the rest of the hinge to be fastened on the underside of the lid. Identifying the board as a back wall

furthermore puts the till in the left side of the chest, and thus in agreement with traditional and archaeologically attested practice (Barrot 2011: 60; Richards 1997: 90-92; Molaug and Scheen 1983: 119-120; Kaijser 1982: 66).

5.2.4.2. Dovetailed chest #2

A further two examples of dovetail-joined remains were discovered in Trench North. They are both smaller pieces of oak, and quite probably originate from the same piece of furniture. The first piece (X189.5) is the corner of a board and measures 27 x 21 cm with a thickness up to 2.4 cm. It is burnt to roughly the shape of a quarter-circle, but sports two triangular protrusions, or *pins*, on one side, indicating the remains of an end rather than a side piece. The edge at the base of the pins show remains of a fine supporting lip extending only a few millimetres beyond the end of the board. The second piece (X161) is slightly larger at 34.5 x 20 x 2 cm, but is otherwise damaged in much the same way. It has one intact and at least one partial tail along one side, and a 5 mm wide groove similar to that on X90 along the base of the tails. What is most probably the bottom edge shows evidence of a rebate of about half the thickness of the board on the same side as the groove. Although the two pieces were not found concurrently or directly connected, the compatibility of their features and the similarity of their damage renders it reasonable to consider them as one unit.

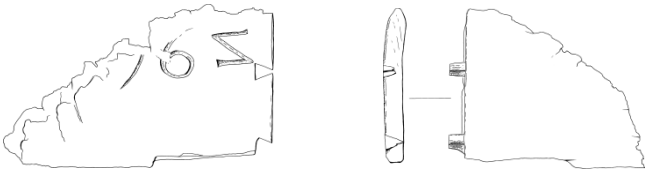


Figure 38: Chest fragments X161 (left) and X189.5 (right). Scale 1:10.

The suggestion that the tails of X161 makes it a side piece is further substantiated by the presence of a carved inscription, a feature likely located on the front face of a piece of furniture. The inscription is only partly preserved, and under the assumption that the rebate does indeed indicate the bottom of the board, it is the latter part. Of the inscription, the last two characters are clearly readable as the Arabic numeral 6 followed by the slightly smaller reversed letter 'Z', almost touching the tail in the edge of the board. On the left side of these, however, are the partial remains of another two characters, both of them single downward sweeps with a slight leftwards curve. It is difficult to establish an accurate baseline for the direction of the inscription, but from the legible characters it appears that the

incomplete characters would both extend below such a baseline. While the meaning of the last symbol remains obscure—perhaps a maker's mark, or a later addition by the owner—it seems plausible that the rest of the characters indicate the year of manufacture. The shape of both characters could match the numerals 1, 5, 7 and 9, and to construct a meaningful date, the first number must then necessarily be a 5 with an assumed preceding 1. At the very top of the preserved part of the second number—where the charring has created its own patterns in the surface—may be a trace of the bottom of a loop, which would indicate the number 9 (Kroman 1975: 42-3). Given the size of the pieces, their joinery and the inscription's proximity to the bottom and side of the board, they probably constitute the corner of a well-built chest similar to X90, or perhaps somewhat narrower. While the state of the wood surface makes the interpretation of the inscription far from final, the tentative result, and thus dating, of 1596 does not seem altogether unreasonable.

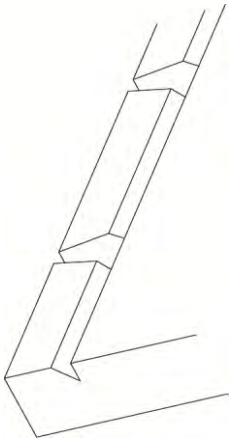


Figure 39: Idealised joint on X90 and X161.

5.2.4.3 Nailed chest

Trench North also revealed a number of smaller pine pieces with nail holes, and although their function and internal relation is less than clear from the damaged remains, they may well belong to some form of chest as well. Most well-preserved and rich on features are X189.1 and X189.3, both more or less wedge-shaped boards with two original edges, but with no indication of their original extents. They measure 63 x 15 x 1.2 cm and 45 x 9.5 x 1.5 cm respectively, and both feature 3 mm wide rectangular nail holes along their short side. The longer edge of X189.1 is bevelled on both sides, and near the short edge is a 3 cm wide and 0.6 cm deep notch. Traces of a strap running to the notch are clearly visible on one side of the board. All edges of X189.3 are flat with no bevel, but the long side does have a similarly sized notch, albeit only cut halfway through the board. There is no trace of a strap, although there is a nail hole centred under the notch indicating the original presence of some kind of fitting. Aside from the similar features, the main evidence that these two pieces are probably more than typologically related lies in the position of these notches, differing no more than 2 mm in their distance to the short side. The difference in features may be explained as functional differences between the front and back sides of the chest, with the half-notch perhaps accommodating the end of a batten (perhaps X189.4 or X193) or iron strap rather than a hinge.

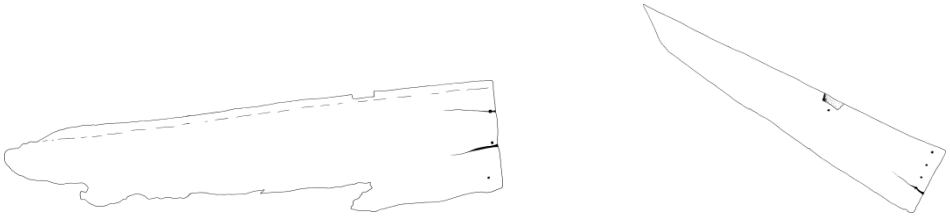


Figure 40: Chest fragments X189.1 (left) and X189.3 (right). Scale 1:10.

Nevertheless, insofar as these remains do indeed belong to a chest, as the traces of a lid arrangement seem to suggest, the workmanship sets it rather far apart from the rest of the furniture recovered. The wood is of rather poor quality, and the carving and nailing seems to have been completed in a rather crude and indifferent fashion, quite unlike the attention given to the dovetailed joinery. While the piece would not strictly have been disposable, it is certainly functional rather than decorative, and may have served as a storage unit for supplies, equipment or tools.

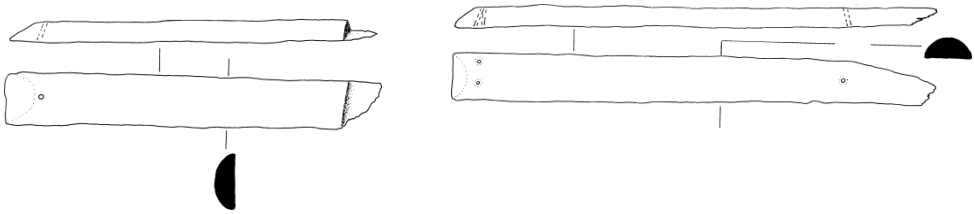


Figure 41: Strips or battens X189.4 (left) and X193 (right). Scale 1:5.

5.2.4.4. Cabinet

Finally, Trench North also revealed a rather complex piece of oaken furniture, to which as many as nine recovered elements may belong (X190.1-9). However, despite the number of preserved elements (the majority in a nearly complete state), it does seem likely that major parts of the piece are missing. Only two elements were recovered in a connected state (X190.5 and X190.9), but it is quite clear that these, along with another three elements, together form a drawer. The front panel (X190.2) measures 59 x 9 x 2 cm and is penetrated by a central keyhole, with the inside and top edge showing imprints and recesses of a locking mechanism. At each end, 2.5 cm from the edge, the inside face features vertical grooves for accommodating sliding, or French, dovetails. The two side panels (X190.3 and X190.9) are c. 26 x 8 x 2.3 cm, and have one of their ends cut to a tail to fit the groove in the front panel. The tips of the tails are, however, quite damaged on both pieces, giving the tails a rather more rectangular cross section. They sides are fitted with two dowels at the rear, and three or four c. 7 mm dowels or dowel holes along the bottom respectively. The back panel (X190.4), although somewhat warped and probably not preserved to its full length, measures 52 x 8.2 x 2.2 cm and has five dowels or dowel holes along the bottom. One short side features a 2 cm wide rebate preserved with a single dowel hole, matching a joint

with the sides. The opposite end has neither rebate nor hole, but considering the length of the back panel against the assumed size of the drawer (and particularly the bottom), it appears that the element is in fact c. 2 cm too short. Previous damage may thus account for the now missing rebated end. A thinner pine sheet (X190.5) makes up the bottom of the drawer. It measures 54.2 x 23.3 cm and is up to 1 cm thick, but is missing the entire original edge at the back. Each short side has a number of dowel holes matching those of the side panels, but because of the aforementioned damage there are no holes to match the back panel.

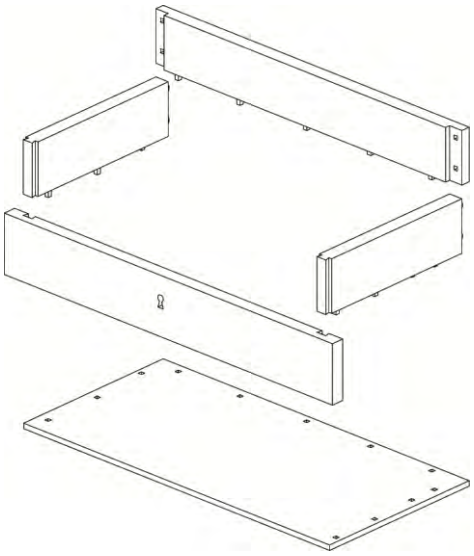
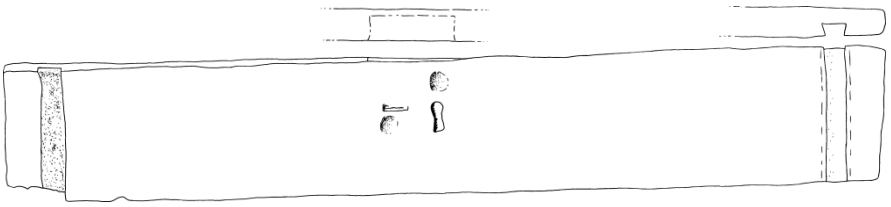
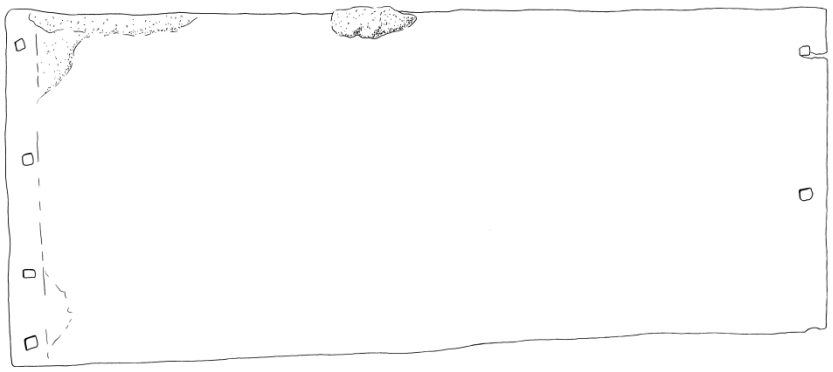


Figure 42: Assembly of the drawer X190.

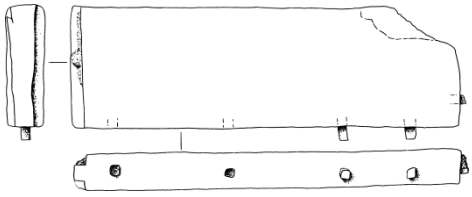
Judging by size, features and proximity of the finds, the remaining four pieces are likely belong to the furniture in which the drawer was seated. However, no obvious structural relation has presented itself between the elements of the group, or indeed between this group and the drawer. The two smaller pieces (X190.6 and X190.7) have both sustained some damage, but are considered functionally identical, albeit mirrored, elements. They both measure 27 x 12 x 2.2 cm with more or less obvious remains of an up to 1.5 cm wide rebate along one long side. The best-preserved short sides have a slight slant, making the boards slightly longer along the rebated side. Both have dowel holes in the narrow face opposite the rebate, and X190.7 has remains of what may be a single nail opposite the slanted face. The size and shape suggests that they were fixed side panels fitted either side of the drawer, presumably with the rebate facing downwards and inwards, and dowels pointing up, but there is no direct evidence of this. The board (X190.8) most suitable as a base for the fixed side panels does have similar dowel holes, but none that match the dowels in the panels—regardless of orientation. With its intact 60 x 27.5 x 2 cm, the board does however seem likely to have had some connection with the drawer. It is chamfered at 45 degrees on three sides, but on one face only, and would thus also be a poor match for the rebated sides. However, the imprint of a nail head on the non-chamfered face does indicate that the board was connected via the chamfered face. The final piece of the assemblage (X190.1) is another partially preserved board of similar size, 56 x 28 x 1.6 cm. It has a wider chamfer on the three preserved sides, but on both faces. Interestingly, there are no apparent evidence of joinery, holes or otherwise, with the exception of a possible partial hole along the damaged long side.



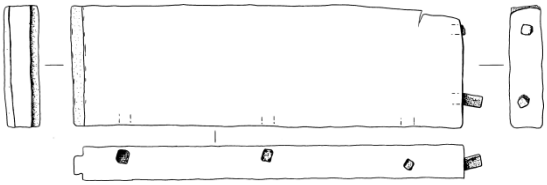
X190.2



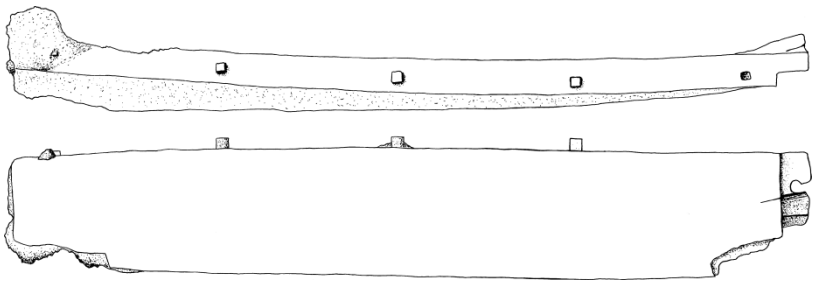
X190.5



X190.9

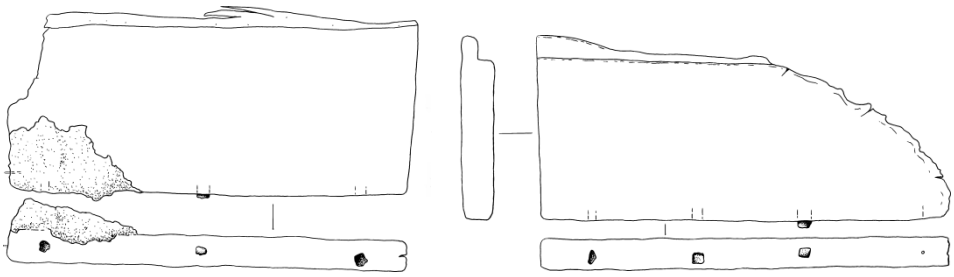


X190.3

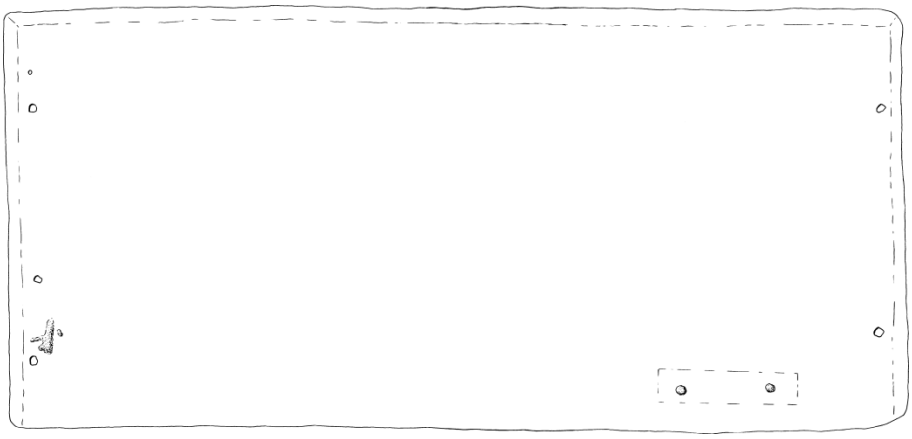


X190.4

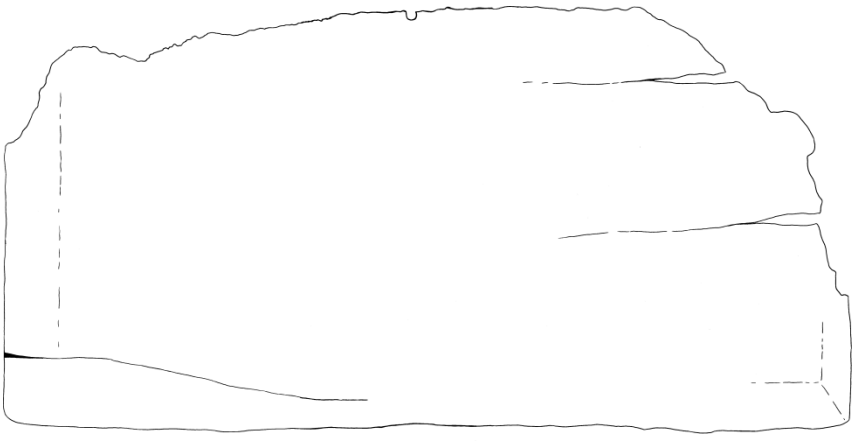
Figure 43: Furniture elements X190. Scale 1:5.



X190.7 X190.6



X190.5



X190.1

Figure 44: Furniture elements X190. Scale 1:5.

This somewhat thinner board with its lack of fasteners does seem a plausible candidate for a top piece or lid, hinged at the now-missing rear, but again no direct evidence is available. Furthermore, while it may well be a hinged lid, it does seem rather unlikely that it should have been placed directly over the drawer and thus invoke a significant degree of functional redundancy. However, neither does it seem likely that the drawer should simply be encased in a fixed unit. Rather, it seems reasonable to conclude that the drawer unit and the other elements belong to a piece of furniture of which some form of superstructure remains largely missing. The possibility of a larger hinged lid may point in the direction of a small writing table or bureau, but the largely rectangular side panels suggests something more akin to a somewhat typical 17th century cabinet, with a wide drawer unit at the base, and a taller—but slightly narrower—body of smaller drawers and compartments on top (Wallin 1931: 24-32). The evidence, however, does not allow for any solid reconstructive conclusion.

Comparative material is—as mentioned initially—rather far in between, and strict typological conclusions are made difficult by a number of factors, not least the high potential for significant local variations, and, not altogether paradoxically, the relative ease of imitation. Insofar as concerns the three possible chests, they all seem to have had straight sides (admittedly based on rather meagre evidence in this respect), similar to the chests recovered from the *Vasa*. With the recovery of the twelve chests from the *Vasa* came the speculation that the quintessential sea chest with its slanted sides, forming a trapeze-shaped cross section wider at the bottom, must have been a product of the 18th century (Kaijser 1982: 63). Indeed, the shape is represented along with straight-sided examples among the pieces salvaged from Dano-Norwegian frigate *Lossen* lost in 1717 (Molaug and Scheen 1983: 117-9), but the same is the case in the assemblage of the English *Mary Rose*, wrecked one hundred years before the action in Fehmarn Belt (Richards 1997: 89-90). The style may have made its way across the North Sea during the latter half of the 17th century, or may previously have been avoided in a preference for working with right angles—or, importantly, simply be archaeologically underrepresented for secondary reasons.

More tangible, but equally dangerous, is the comparison of features and method of joinery in particular. Here, the picture does unfortunately not become significantly clearer in terms of neither geographical nor chronological trends. The collection from the *Vasa* is unusually homogeneous, consisting solely of chests assembled by means of dowels. This supports the notion that this type of joinery may have had a special Nordic connection (Kaijser 1982: 65-6), but again the archaeological evidence demands consideration: like the present assemblage, that of the *Mary*

Rose exhibited a wide mix of methods, including nails, dovetails and dowels with and without rebates. Add to this the fact that dovetailing was itself considered a more or less exclusively Continental practice (Richards 1997: 91)—and certainly widely employed in Denmark (Clemmesen 1963: 22-23)—and the potential problems are rather apparent. Rigid geographical preferences for certain types of joinery is undoubtedly a very real factor, at least through certain periods of time. However, as a means of establishing artefact provenience, and certainly if regarded as indicative of the identity of an assemblage or ship wreck, it remains a source to be treated with care if not suspicion.

It should perhaps not be surprising that assemblages of furniture, and sea chests in particular, should prove so diverse. Regular sailors were prohibited from taking any furniture aboard Danish navy ships in 1609 (Barfod 2004: 90), probably as a sacrifice in order to accommodate more guns. Regardless of whether or not this order was strictly followed, it seems likely that well-made chests, and certainly more delicate pieces of furniture, would have belonged exclusively to the professional or higher-ranking members of the ship's complement. Consequently, such pieces may often have been imported from aboard, or fashioned locally under directions of a well-paying customer. Strong influences naturally came to Denmark from German and the Netherlands (Windisch-Graetz 1983: 146), but recurring references to Danzig furniture and *Prussian chests* (Nyrop 1879: 141) suggests import and inspiration from further east as well. There does not seem to have existed a branch of specialised chest-makers during the 17th century (Barrot 2011: 60), perhaps sustaining a reliance on import, and meaning that evidence of a particularly Danish style may be very elusive. If anything, the diverse collection of furniture thus supports the idea of shipboard furniture as a somewhat elitist preoccupation, adopting a range of regional styles. Taken to a completely unsubstantiated extreme, one might conclude that what has been recovered is a large Scandinavian pine chest, a smaller Prussian oak chest, a cabinet fashioned in Copenhagen and a rudimentary storage chest nailed together by one of the four carpenters nominally working aboard the ship (Holck 1943: 489)!

5.2.5. Personal belongings

5.2.5.1. Tobacco pipes

The single most frequently occurring artefact of a more personal character is the clay tobacco pipe, and in total six more or less complete pipe bowls were recovered along with some 16 separate stem fragments and one nearly intact pipe. Tobacco only appeared in Denmark around 1600, and the pipe making industry was then still in its infancy – in fact, only a single pipe maker is known to have operated anywhere in the country during the 1640s, in Elsinore north of

Copenhagen. The king, who was in strong opposition to the new trend, did his best to contain the advance of smoking during his reign, to the extent of completely prohibiting pipe smoking first on his Norwegian warships in 1619, and later the entire combined navy in 1625, under penalty of keelhauling. While the king does seem to have to have changed his mind by 1640, after having discovered the beneficial properties of tobacco on both 'morale and health', the Danish industry remained miniscule and the vast majority of pipes smoked on land and indeed aboard the king's ships were more than likely imported (Bardenfleth 2002).

Three of the bowls (X55, X87 and X140) carry the EB mark on their heel which points to the Netherlands as an origin for at least part of this import. The initials may refer to Edward Bird, an English-born pipe maker who moved to Amsterdam sometime before 1630 and here established a shop which soon grew to be one of the biggest in the city. It is furthermore clear that his pipes were regularly traded far afield, some as far as North America, and may have been a common occurrence among Danish sailors during the period since similarly marked pipes were recovered from the wreck of *St. Sophia* (Bergstand and Arbin 2003: 63). Although Edward himself dies in 1665, his son Evert takes over the father's business, and may have continued to employ the EB mark. The last historical trace of the family dies out in 1683, and a reasonable dating for the mark thus spans the years 1630 to 1683 (Hall 1996: 282-3; Duco 1981: 399-400).

The only other bowl with any discernible marking (X124) is decorated with six raised dots on the side of the bowl, arranged so the five form a polygon with the last dot in its centre, most probably a stylised rendition of the Tudor Rose. This motif seems to remain in fashion for the better part of the seventeenth century and well into the next, and sheds little new light as to the provenience of the pipe, but do seem to relegate this otherwise unmarked specimen to a class of lower quality

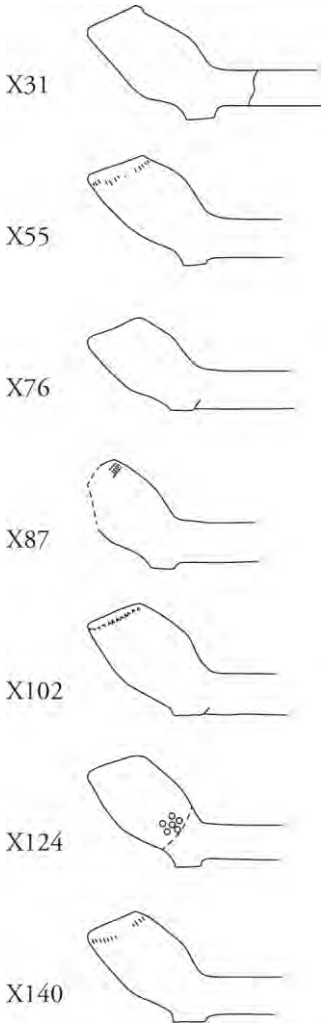


Figure 45: Clay tobacco pipe bowls. Scale 1:2.

Figure 46: Fig X. Heel stamp from pipe X140, attributed to Edward Bird. Scale 2:1.

pipes (Atkinson and Oswald 1972: 177, 377).

An examination of the shape of the bowls seems to support a Dutch origin for not just the pipes attributed to Edward Bird, but also those with no recognisable markings. Although X55 and X102 are slightly more bulbous than the rest, there are generally strong similarities to an example attributed to Edward Bird before 1645 (Duco 1981: 257). When compared to a general stylistic chronology, the pipes seem to reflect the Dutch style of sometime around 1630-40 (Atkinson and Oswald 1972: 176). The pipes made by Edward Bird were however no fashion accessories, nor known for their high quality, but rather ordinary pipes for ordinary people. A measure of stylistic conservatism is therefore quite reasonably to be expected, not least given the sizeable trade network and foreign customers, thus perhaps accounting for the slightly early dating (Duco 1981: 374).

Figure 47: Stem of pipe X76 with floral motif.

The collection of stem fragments, despite their greater numbers, hold little potential for refining the answers granted by their companion bowl fragments. While some of the stems connected to EB stamped bowls display a repeated decorative motif of fleurs-de-lis framed in diamond shapes, care should be taking in attributing other stem fragments with this motif, even in a similar execution, to Edward Bird. While this may well be the case, the motif is one of the earliest used decoratively on clay pipes in Holland, and gained popularity in a number of different areas (Duco 1981: 248-9, 377). Similarly, the extensive floral motif of X76 is known from Amsterdam during the same period, but seems difficult to attribute any more precisely (Duco 1981: 251)

Dating pipe fragments on the basis of the diameter of the stem bore is at best a debated approach, at least in isolation and concerning such small quantities, but may nonetheless offers a final independent hint at the validity of the previous assumptions. The fragments have not been measure with a resolution beyond 0.5 mm, but the majority seem to measure close to 3.0 mm, which according to Harrington's method puts the collection in the bracket between 1620 and 1650 (Orser 2004).

5.2.5.2 Clothing and accessories

Recovered textiles from historical wrecks are a special area of interest and not too many experiences on this topic are available (Jakes/Mitchell 2014). So far, the textile finds from Lindormen can be defined through preliminary inspection during and after lifting and some observations during the first stages of the conservation process in the lab. Additional information was produced through x-ray imaging and a state-of the-art high resolution CT scan was carried out on one textile-iron concretion (X 176). It is therefore currently possible to roughly characterize the textile finds from Lindormen, whereas a more thorough investigation (after conservation) would provide deeper insights into the used material, production techniques and quality of the textiles.

Most of the textile find consist of dozens of small fragments, mostly with signs of burning, from a coarse, simple woven fabric. Microscopically produced images show that the textile fibers are of plant origin, pointing to hemp or flax as source. Some sewn edges of cloth are visible, pointing out the former position of the fragments along the seam. Most of these textile fragments should derive from the burning sails of the ship, falling in pieces together with rigging down into the ship.

Opposite to the widely found coarse fabric, sometimes there are fragments of a much finer cloth, produced from much thinner yarn. The weaving pattern is mostly just as simple as in the coarse cloth. Anyhow, in some instances the weaving with single strands of yarn, alternating one by one, is added up by weaving double strands, alternating two by two. The fragments of much finer textiles seem to derive from shirts or other garments.

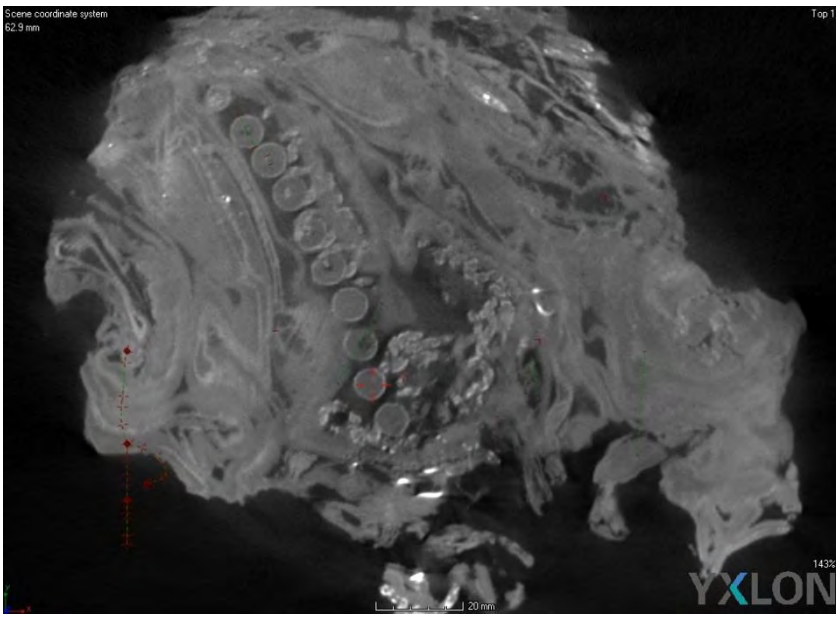


Figure 48: CT-Scan of item X 176: a row of flat buttons and twirled embroidery loops attached to an officer´s shirt become visible. Some metal clasps are also present.

A very fine example of such a garment is an officer´s shirt, which fully corroded to a massive concretion under the influence of iron oxide (fig. 48). The concretion is so solid that is nearly impossible to open it up without destroying the whole thing. Nevertheless, state-of-the-art computer tomography carried out by Yxlon Co. revealed, that the shirt is highly decorated with twirled embroidery loops, accompanied by a row of buttons along the opening at the front.

Another fine textile find is item X 166 (fig. 49). It seems to be custom made rectangular bag from sailcloth, the long sides and one small side sewn together, whereas the other small side is left open. Along this opening there is some decoration attached, e.g. twirled threads laid in loops. The cleaning process in the laboratory revealed, that on these threads tiny glass beads are attached (fi.50). It is worth noting, that no women were present on board, which means that the masculine fashion in the baroque era comprised highly decorated items, which nowadays would not be expected on board of a man-of-war.

Whereas the find was found pitch black due the lack of oxygen where it was deposited, later on the embedded iron content from nearby finds turned the cloth rusty red.

Figure 49: Textile find X 166. Custom made handbag, presumably from sailcloth, with decorated opening.

Figure 50: Bag X 166 with tiny glass beads on the decorative threads around the opening.

5.2.5.3. Footwear

In addition to the finds of clothing and accessories, fragments of at least four individual pieces of footwear were recovered.

The most well-preserved piece is an almost complete composite sole recovered from Trench 1 with the intact heel still attached, but with none of its upper structure preserved (X91). The sole is almost symmetrical along its longitudinal axis, is 23.5 cm long and up to 8.5 cm wide with some narrowing at the waist, and ends in a somewhat narrow but rather flat toe. No less than three separate layers make up the out- and midsoles, with a finer insole constituting the topmost layer. Towards the toe, the upper layers have eroded away exposing a number of smaller pegs, presumably connecting the soles. Traces of stitching are apparent along the entire perimeter of the insole, and remains of thread are preserved in places, particularly in the heel area. On the bottom of the outsole, a narrow groove mirrors this stitching pattern. The outsole is also decorated with an incised pattern of lines and arcs, although this decoration remains partly covered by an apparent repair patch extending diagonally across the forefoot. It seems clear that this patch never extended much beyond its preserved dimensions, and thus never constituted an actual sole, although it does appear particularly thorough for a repair: not only has it been pegged to the outsole at short intervals, but with the groove around the outsole extending across the patch it also appears to have been stitched through the other sole layers. Given this level of attention, it might even constitute a more proactive attempt to improve the sturdiness of the sole. The heel is clearly composed of several thin layers held together with pointed wooden pegs inserted from below, and follows the outline of the sole. It is thus up to 7 cm wide and 8.5 cm long, and the slightly wedge-shaped profile gives it a height between 2.5 and 3 cm to the bottom of the sole. Other footwear related finds consist largely of more or less intact examples of disarticulated heels (X141, X159 and X164). Although X91 appears to represent the largest heel dimensions in the assemblage, the remainder exhibit a very similar shape and preserved height of up to 3 cm.

While contemporary Danish reference material is very limited, footwear fashion generally seems to follow a more or less common Northern-European, and particularly Scandinavian, chronology (Jäfvert 1938: 45). A number of comparable features—some more decisive than others—may thus aid in the dating of the assemblage, and of X91 in particular. The shape of the sole offers the first suggestions, since a general transition from rounded to more squared and narrow toes seems to have occurred during the 1630s (Jäfvert 1938: 52), judging not least by the examples recovered from the *Vasa* (Swann 2001: 105-6). While the toe of X91 cannot be considered rounded, it does not conform to the entirely squared fashion apparent in the 1650s either (Jäfvert 1938: 56-7; Swann 2001: 106),

yielding a tentative dating somewhere in between. Similarly, X91 does not seem to suffer from the excessively narrow waists popular in the first quarter of the century (Swann 2001: 109), thus supporting this estimate. Furthermore, similar decorative patterns of arcs and lines on the outsole are well-known in examples from the period 1620-1650 (Swann 2001: 120-1). Finally, the presence and size of the heels offers a valuable addition. Separately fashioned heels, rather than simply wedge-shaped soles, seems to gain in popularity as well as size through the 1620s and 1630s (Jäfvert 1938: 52; Swann 2001: 104), until by the 1650s a clearance of as much as 7 cm might be encountered (Goubitz et al. 2001: 92, 95). The more moderate, but apparently fairly common, heels recovered from the wreck site thus again suggest a dating between 1620 and 1650.

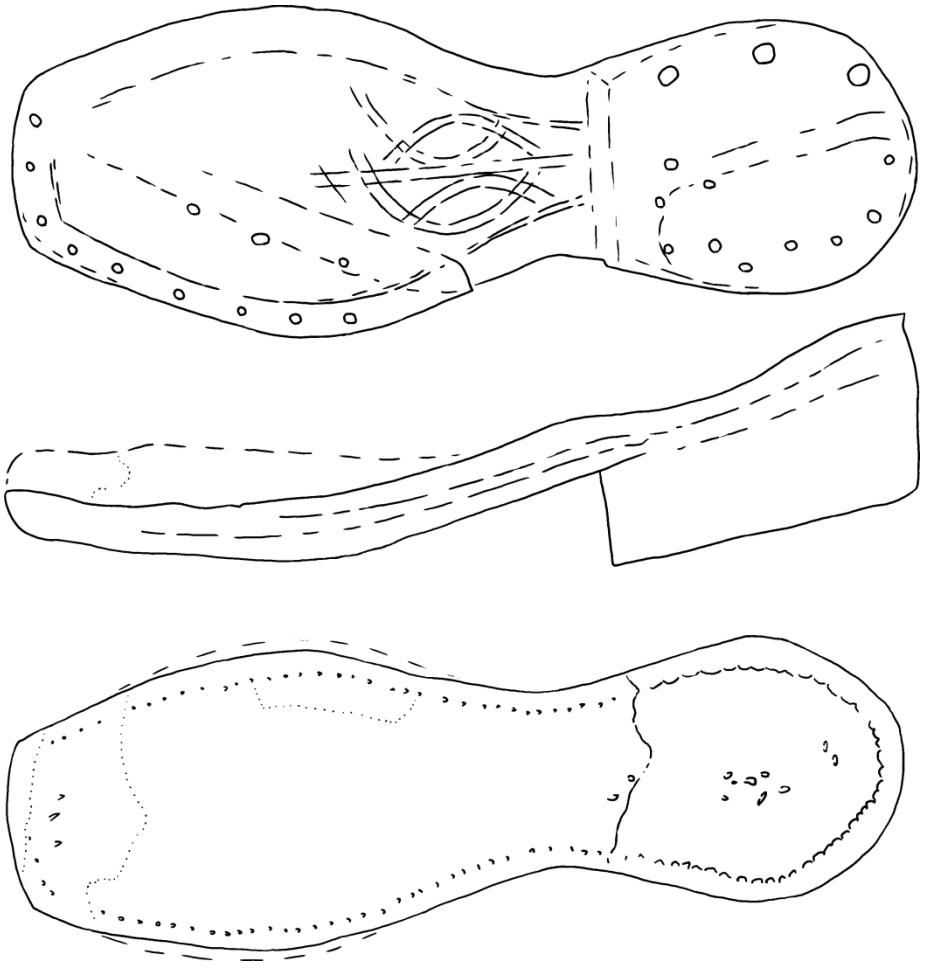


Figure 51: Footwear X91. Scale 1:2.

Turning the question around and assuming that the footwear was indeed manufactured in the early 1640s, one might reasonably expect moderate heels to have gained a broader acceptance than as a statement of avant-garde fashion, and thus perhaps explaining the apparent shipboard popularity. Even so, it does not

seem reasonable to conclude that a piece like X91 might have been worn by any common sailor—although the heel may have been more accessible than earlier (Hocker 2011: 114), such workmanship and detail almost certainly came at a price, and the owner is probably more likely to be found higher up along the chain of command. The piece was discovered within close proximity to the remains of one of those not fortunate enough to survive the day of battle (X56), and may well have belonged to this individual. The length of X91 does however roughly translate to just a Continental size 35 or UK size 3 (assuming that the uppers did not extend much beyond the outline of the sole), and thus to a rather small foot—similar sizes recovered from *Lossen* even led archaeologists to speculate whether they were in fact boys' shoes (Molaug and Scheen 1983: 220).

It remains unclear which type of footwear X91 and the other fragments in fact represent. Some recovered leather fragments may point to high boots (X62), but even if this holds true for that particular lot, any of the other pieces may equally well belong to simple latched or indeed buckled shoes.

5.2.5.4. Fishing equipment

Since the provided shipboard diet was based almost exclusively on preserved goods, those with time to spare presumably engaged in more or less recreational fishing to supplement the ship's stores of dried and salted provisions. Two finds recovered together from Trench North seem to confirm such practice, constituting an almost complete set of hand-line fishing equipment.

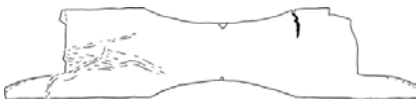


Figure 52: Winder X169. Scale 1:5.

One part of the setup is a simple wooden winder (X169). This 27 x 6.5 cm solid pine board is fashioned with a narrow waist and a pair of protruding horns each end (although only two are preserved), allowing line to be wound around lengthwise in a secure manner. When recovered, fragments of a 2 mm wide line were still attached to the winder. The design—although still in use today—is rather rudimentary, and seems to attest to the secondary importance of the fishing activity. More complex winders of a composite construction—where a wooden frame carrying the line can rotate freely around a handle, allowing the line to be deployed and retracted much more efficiently—certainly predate the wrecking of *Lindormen*, and were evidently in use in Scandinavia during the early 17th century (Stenbock 1916: 105; Cederlund 1966: 66). The simple winder may of course have been a compact spare, or a replacement piece produced onboard—or simply be indicative of the means (or

skill) of its owner—but nonetheless seems to remain a functionally inferior alternative.

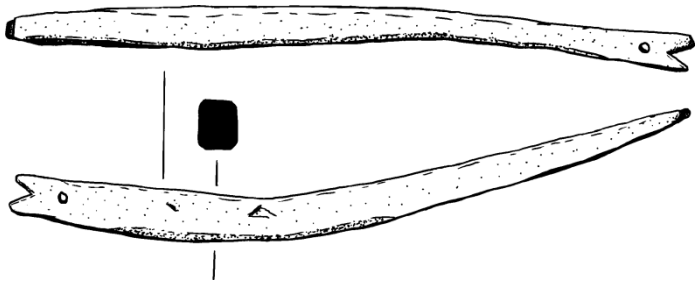


Figure 53: Fishing sinker X171. Scale 1:2.

A lead sinker (X171) was recovered along with the winder. The slender piece is 18 cm long with an up to 1 x 1.2 cm rectangular cross section and a slight chamfer on most edges. There is a slight curvature along both axes, and each end narrows and terminates in a V-shaped cut.

Figure 54: Modern sinkers and lures collected on and in the sediment.

Before the cut is a 3 mm hole through the sinker, giving the impression of a double-headed fish albeit with heads offset 90 degrees from each other. Numerous sinkers and lures from the 20th and 21st century were encountered at the site—their recent or not quite so recent date rather obvious—and some of these had in fact penetrated the sediments to surprising depths, introducing a risk of contamination. However, the peculiar shape of X171 and its proximity to the winder renders a 17th century dating of the entire context more plausible. Sinkers of similar proportions are known from the period and have, in connection with the winder, been associated particularly with cod fishing (Molaug and Scheen 1983: 302; Cederlund 1966: 67).

5.2.6. Osteological material

5.2.6.1. Human remains

The loss of *Lindormen,* as with most shipwrecks, also spelled tragedy for a large number of her complement. The number of casualties from the preceding battle added to those who simply lost the fight against fire and water are thought to

amount to about 50 men—a ratio of one life lost for every three survivors—so it was no surprise to encounter human bone remains among the wreckage.

The most interesting discovery was made in Trench 1. Here, approximately 1 m below the sediment surface, more than 50 bones or fragments (X56) were encountered in a constellation leaving no doubt as to their belonging to the same individual. The assemblage includes bones of all body parts excluding the extremities, from a fragment of the top of the cranium to the tibia of the lower leg, and are the only human remains to have undergone detailed analysis (Groβkopf 2013). The pelvis shape indicates a male individual, and growth patterns through the skeleton suggest a rather seasoned sailor around 30 years old at the time of death, or perhaps slightly younger. Based on intact bones from arms and legs, his height is estimated to have been in the region between 160 and 165 cm, probably making him somewhat shorter than the majority of the crew (Hocker 2011: 113). Visible traces the vertebrae suggest that his low stature may have been further exacerbated by a spinal condition (Scheuermann's disease), giving him a slouched or even hunchbacked appearance.

Several bones show degenerative changes which, given the age of the individual, may well reflect a life of hard physical labour. This may render a position among the higher spheres of the ships' hierarchy unlikely, but does not necessarily point to a common sailor either. If the recovered shoe (X91) did indeed belong to this man (his slight stature perhaps explaining the small size), then a relatively well-paid position as gunner or non-commissioned officer might perhaps be a more, or at least equally, appropriate guess.

The circumstances of the man's death and his ending up on his back in the hold are naturally difficult to establish. It is clear, however, that the skeleton sustained fractures in at least two separate incidents. The first occurred around the time of death, and resulted in the lengthwise fracture of the left upper arm. A significant force must have been required to affect such damage—the left lower arm is not represent among the recovered material, but it may well also have been damaged or even severed—and it seems likely that the same event was the cause of death. The other incident(s) evidently occurred post-mortem, and appears not less violent: the right lower arm was fractured, and the skull largely crushed. Parts of the upper body including the skull fragments were discovered underneath one of the recovered bronze guns (X121), suggesting a likely cause of the trauma.

Figure 55: Bones X56 laid out.

Many of the bones exhibit varying degrees of discoloration, but this seems more likely to have been caused by biological processes in the sediments rather than by any factors related directly to the events in 1644. Likewise, the few discernible occurrences of cut marks have probably been inflicted during or after recovery. A distinctly blackened area of the cranium may, however, have been caused by exposure to high temperatures around the time of death, and the presence of several small beads of melted bronze embedded in the rear of the cranium seems to support this hypothesis. Assuming a relation to the post-mortal skull trauma, the bronze traces furthermore indicate that both the fatal and subsequent incidents occurred while the ship was still afloat. Conceivably, the man was killed on the gun- or upper-deck during the battle, and subsequent either placed in the hold intentionally, or simply left to drop through the levels of the ship—along with the guns—as the decks disintegrated.

Four additional bones presumed human were recovered: two ribs in Trench 1 (X145), perhaps rightfully belonging to X56 as well, and another two ribs (X198) from the area immediately around the rudder south of the wreck.

5.2.6.2. Animal remains

Concentrations of animal bone material were encountered—unsurprisingly—in the lower layers of the galley and Trench 1, with a particularly high concentration in the NW corner of the trench. Fish bones account of the vast majority of the recovered bones, and are dominated almost entirely by remains of Atlantic cod (G*adus morhua*). Also represented are haddock (*Melanogrammus aeglefinus*) and an unidentified flounder (*Pleuronectidae*), perhaps plaice, although these account for a negligible amount in both absolute and relative terms. Only four individual mammal bones were discovered, hereof two in the galley area, all bovine and presumably from cattle.

The depth and concentration of the fish finds makes a natural deposition unlikely, and the presence of freshly caught fish or remains in the hold during the wrecking incident seems equally unlikely. Like the cattle—which for obvious reasons is exempt from these considerations—the fish can only be assumed to have belonged to the ship's provisions. Mammalian meat and fish constituted major parts of the navy diet, and it is not surprising that cod and beef are particularly well-represented. Barrels of pork were probably also stowed in the hold, but with a market price more than twice that of the beef, only in a corresponding ratio of about 1:2. The stores of wet-salted fish were made up of equal measures of herring and cod, both numerous in local waters, but since a significant volume of the latter was also carried in a dried state, cod would have far out-numbered the oily competitor. In addition to these meats, a navy ship would have carried supplies of butter, cereal, peas and bread, but their perishable nature obviously render these groups unlikely archaeological encounters (Holck 1943: 491).

There is little evidence to suggest which type of preservation the cod had undergone. Furthermore, the bone material appears evenly distributed between vertebrae and various elements from the skull, indicating that the fish were preserved whole, or gutted at most. This is somewhat puzzling since a minimum of cleaning, including beheading, might be expected prior to both salting and drying, but historical source do suggest that fish might well have been dried whole in previous centuries (Magnus 1555: II/VI, XX/XXVI). Paired with the notion that haddock is believed less suitable for salting (Davidson 1979: 60), this would point to drying as the more likely method of preservation, although by no means conclusively so.

The days for the week have traditionally been associated with particular types of food. Sundays, Tuesdays and Thursdays seem to have been considered *flesh-days* in the 17th century navy, with beef and pork being served, whereas fish constituted the central ingredient for the remainder of the days (Barfod 2004: 58). The 13th of October 1644 was a Sunday (Bauer 1868), and thus under ordinary circumstances

probably a flesh-day. While the sample of recovered cattle bones is very limited, it is—if not statistically convincing—at least interesting that the main concentration occurs in the galley, which (with the exception of a simple fragment) is otherwise free from bone material. With *Lindormen* weighing anchor at around 10 in the morning, and the men struggling at their action stations until struck by *Meerman* mid-afternoon, it is however uncertain whether any hot food was prepared during the ship's last day afloat. The beef remains may indicate that the flesh-day was indeed observed and a corresponding meal prepared—perhaps before the events of the day had yet become inevitable—but there is of course no indisputable indicating that the bones were in fact cooked on the 13th.

5.3. Dating and provenience

All sources seem to confirm the assumption that the wreck is Peter Michelsen's *Lindormen,* finished 1626 and lost 1644.

The dating is unanimously supported by the rich material recovered. The footwear—and particularly the apparent popularity of moderate heels—suggests a *terminus post quem* of around 1620, and a somewhat less dependable *terminus ante quem* around 1650. This interval is tightened to 1630-1650 by the recovered tobacco pipes, which yield a very rigid dating based on the both their shape and the assumed attribution to Edward Bird. The collection of bronze guns gives an indisputable earliest dating at 1629, and makes a dating before 1670 very likely. Additionally, although such pieces might often have been claimed as trophies by opposing forces, they strongly suggest that the ship is a Danish naval vessel.

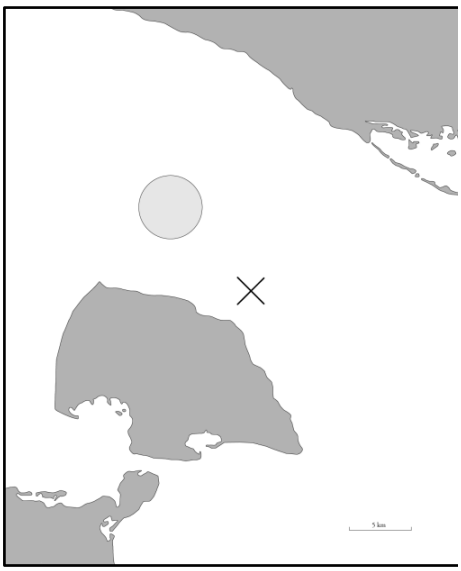


Figure 56: Wreck site location (cross) and the area in which Lindormen is expected to have sunk (circle). After Försvarsstaben 1944.

Samples from the hull structure were taken for dendrochronological examination at several points during the investigation process. They were all analysed by Dr. Karl-Uwe Heußner at the Deutsches Archäologisches Institut. The majority of the samples attest to a felling date after 1560, with some samples pushing the date closer to, or even past, 1600. Curiously, a single sample with remains of bark suggests a dating of 1635, but it seems warranted to discard this singular outlier as perhaps indicative of a later repair. The analysis also reveals that the wood was sourced

from two different areas, the majority of the samples from southern Norway or western Sweden, and others from northern Germany. All samples are oak, and there seems no correlation between the function of the wooden element and its provenience. Both the dating and origins of the wood clearly support the identification.

Even disregarding the more or less decisive archaeological and dendrochronological results, the nature of the wreck itself strongly points in the direction of *Lindormen*. The wreck site is located less than 7 km from the area estimated in 1944 from the reports of the battle (Försvarsstaben 1944: 134-5), and the size of the ship suggests a vessel with some historical trail, for which *Lindormen* seems the sole contender—the only remotely possible alternative is the somewhat smaller *Delmenhorst* which was lost during the same battle, but which was beached and burnt off Lolland in the north of the belt. Thus, with the fact that preserved dimensions of the ship and its elements is so closely reflected by the documentary evidence, the identification of the wreck as that of *Lindormen* seems irrefutable.

5.4. Historical context

The Sound Toll for traffic passing through Danish waters, and through Øresund in particular, had been a vital and direct source of income for Danish monarchs for centuries. With Danish control of almost the entire shoreline of Kattegat and Skagerrak, the guns at Elsinore sovereignly regulated access to the Baltic and its natural riches, where, in turn, foreign vessel enjoyed a level of protection.

While smaller traders from nations with fewer geopolitical aspirations had settled for the logic of the Toll, and would for a long while, the influential Swedish neighbours were growing impatient with the Danish dominance. Because of the intertwined history of the two kingdoms, the legal status of Swedish vessels in regards to the Toll was by no means clear, and seems largely to have been dependant on the whim of the reigning Danish monarch—as long as he was assured that Danish rule of the seas would remain unchallenged, concessions might be made. Through the first decades of the 17th century, however, such assurances were growing evermore faint for Christian IV. Sweden was regaining its position as a military and political contender to rival the somewhat fragile Danish reign, and with the successful Swedish intervention in the Thirty Years' War during the 1630s—and thus suddenly with a significant military presence on the Continent—Danish countermeasures had to be employed.

The Sound Toll, which had allowed Denmark to reach its current position, was tightened further in order to maintain this position. Now, Swedish vessels were no

longer offered discounts or concessions, and the toll itself was raised with a twofold aim: firstly, the increased flow of income would allow Danish defences to be rebuilt and expanded, as well as accelerating the production of ordnance. Secondly, the Swedish—against whom these initiatives were clearly intended—would be forced to cover a significant part of the expenses.

With the Danish supremacy already heavily begrudged, the somewhat desperate attempt at increasing the revenue of the Toll proved disastrously counterproductive. Not only was the irony of the initiative probably not lost on the Swedes and no doubt aggravated the anti-Danish sentiment, but it also hit Sweden at a particularly tender nerve: the blooming gun trade with the Netherlands.

Late in the year 1643, Swedish forces invade and occupy large parts of Denmark, with contingents from both the Continental battlegrounds and, somewhat later, from the Swedish mainland. The esteemed Dutch merchant and gun trader Louise De Geer, who was deeply involved in the lucrative Swedish industry, manages to assemble a Dutch fleet to support the Swedes at sea while both the Danish and Swedish main fleets are being prepared. In May 1644, this Dutch fleet arrives in the waters along the Danish west coast, where a single Danish squadron commanded by the King himself waits. Although outnumbered and outgunned, the larger and more heavily armed Danish naval vessels are more than a match for the interimistic Dutch fleet. Severely damaged after two failed attempts to break through, the support fleet is eventually forced to retreat entirely.

Through June, however, both Scandinavian main fleets are finally equipped, and on the 1st of July they meet at Kolberger Heide between Denmark and Germany. The Danish king is injured, but despite the apparent superiority of the Swedish fleet, casualties are low and the result remains largely undecided. Though the two fleets keep in contact over the summer, by August it seems that—for that season at least—the most serious threats have passed: the Swedish army is withdrawing from the Danish mainland to fight on other fronts, and the Swedish navy has returned to its base in Stockholm. Consequently, the Danish main fleet returns to Copenhagen, leaving only a minor fleet of 17 ships to cruise Fehmarn Belt—merely as a precaution, and seemingly with its usual complement of soldiers redeployed against the Swedish army still present in the east.

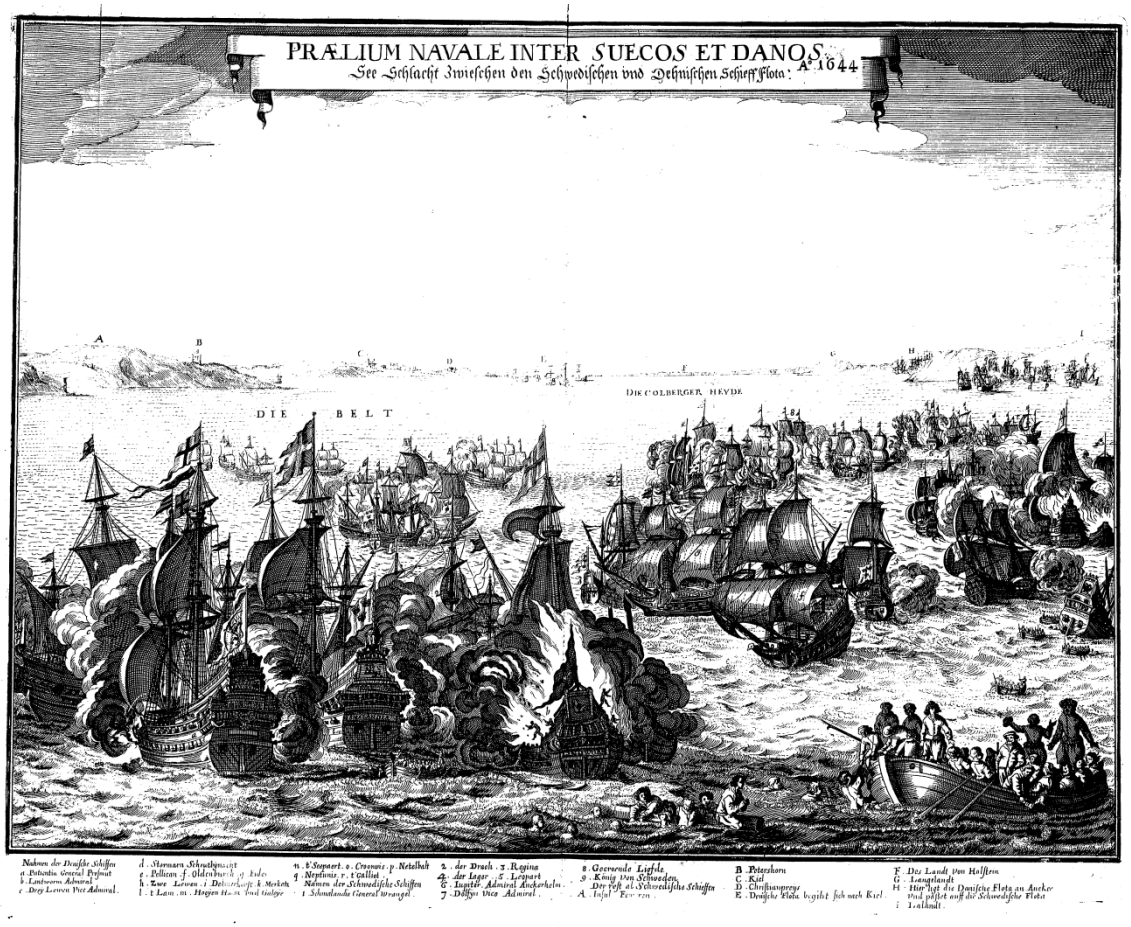


Figure 57: The action of October 13th 1644, with Lindormen ablaze in the very centre. Engraving from the works of contemporary German chronicler Matthäus Meriam (1651).

The Danish appraisal of the event was, however, far from accurate. In fact, a new Dutch support fleet had already been dispatched, and the Swedish fleet in Stockholm was not just preparing for winter, but also for a final action of the season. On the eve of the 11th of October, the combined fleet of 42 ships appeared in southern Danish waters. Despite the decidedly bleak odds, the Danish commander Pros Mund seemed determined to engage the overwhelming enemy fleet, but the lateness of the hour meant that any action had to wait until dawn. However, the morning of the 12th brought only poor weather, and both fleets hesitantly remained at anchor only a couple of kilometres apart in Fehmarn Belt.

Although no Danish accounts of the ensuring battle seem to have survived, the general outlines are quite clear. Around 10 in the morning of the 13th of October 1644—with the poor weather passed and a slight wind from the west—both fleets weigh anchor, and the battle begins. The coordinated and orderly beginnings quickly descend into separate skirmishes, and the massively outnumbered and undermanned Danish fleet suffers greatly under the enemy's guns and boarding

parties. Although it has been claimed that the first half of the 17th century was 'barren in tactical innovation' (Glete 2000: 38), the regular sacrificing of burning ships as giant incendiary devices was becoming a staple of naval warfare. Thus, sometime mid-afternoon, *Lindormen*, flagship of the second squadron under Joachim Grabow, is hit and set alight by the Swedish fire ship *Meerman*. She has already had her main topmast shot off, and before she finally explodes and sinks, witnesses claim to see Admiral Grabow being rescued from the bowsprit after offering his purse as an incentive for the enemy to launch their boats. Most of the complement is saved and taken prisoner, but an estimated 50 men go down with the ship.

Inevitably, the 13th proved an almost total defeat for the Danish fleet. A huge part of the navy was lost, and to make matters worse, the majority of the lost ships were now flying Swedish colours. As a direct consequence of this shift in power, Denmark lost the position ahead of its sister-nation, could no longer dictate the terms of the Sound and would later be forced to relinquish territories in the Baltic and present-day Sweden (Glete 2000: 36-8, 114-5, 127-9; Bergersen 1953: 168-192; Försvarsstaben 1944: 137; Probst 1996: 228-51).

In the long term, the captured shipboard ordnance turned out more valuable than the ships themselves. The captured ships were rather old, and were almost all discarded by the late 1650s. Conversely, many of the more than 250 tons of captured bronze guns had a long service life in the Swedish navy (Glete 2010: 559).

5.5. Wreck condition

The majority of the wreck is buried in the sediment mound, and the stratigraphic pattern suggests that this has been the case for a longer period of time. Since it is clear that the hull of *Lindormen* sustained heavy damage before sinking, it is of course important, insofar as possible, to differentiate between the state of the wreck in 1644, and the factors subsequently acting upon the remains. Many of the exposed elements are charred, and their vertical state of preservation forms a rather irregular pattern, particularly on the western side. Charred surfaces must necessarily be considered very close to their original extents, and it seems that at least part of the wreck's current state must therefore reflect that of 1644: rather than just having been cut down by erosion, the formation process also saw the well-preserved, albeit damaged, hull simply being filled by sediments.

Samples were collection from the hull and the finds, and subjected to analyses in both Denmark and Germany, dealing primarily with microscopic condition assessment (Gregory 2013) and the examination of macroscopic borers (Hoppe

2012) respectively. Together, the two approaches offer an appraisal of both the condition and threats to the wreck.

The penetration tests conducted on-site indicate that the wood is generally preserved in a structurally excellent condition, with densities approaching that of fresh oak. Similarly, damage from microorganisms—mainly fungi and erosion bacteria—is very limited, and seems only to have impacted the outermost few millimetres of the wooden surfaces. Damages from organisms requiring an oxygenated environment seem the most extensive, but the impact may curiously have been lessened by what appears to be tar absorbed in the wood cells.

Finds of shipworm (*Teredo navalis*) are surprisingly rare, while the majority of all the structural deterioration seems to be caused by unexpectedly huge numbers of gribbles (*Limnoria lignorum*). The low population and few traces of shipworm—otherwise rather well-known in the Baltic—may partly be a matter of timing: while finds recovered from deep within Trench 1 show clear traces of gribble attacks, which must necessarily have occurred between the time of sinking and the first sedimentation, these layers show no signs of shipworm. Although the sample is rather limited, it might suggest that shipworm were simply not present in the area in the 17th century. Exposure experiments furthermore indicate that shipworms are unlikely to settle on surfaces that are charred, or which have already been attacked by gribble, perhaps making it difficult for the relative latecomer to gain a foothold at the site. It is not unlikely, however, that a significant volume of previously exposed un-charred remains have already disappeared on this account.

All analyses suggest that the wreck is exceptionally well-preserved, and to a surprising extent relative to the 1644 remains. It appears that the relatively large extent of the wreck is mainly due to a rather quick sedimentation, and the inhospitable environment offered by the charred wood surfaces. The fact that the un-charred wood has furthermore avoided any serious deterioration on a cellular level does, however, raise certain issues: results from the exposure experiments show that shipworms find wood panels cut from samples of the wreck very attractive, to the extent of surpassing the popularity of the fresh pine samples included as experiment controls. Any exposure of un-charred wood—due to changes in current patterns or otherwise—would thus clearly be very vulnerable to rapid destruction by macroscopic borer populations, and shipworms are presently known to pose a threat to cultural heritage as well as functional structures in the area. Given the wreck's location on top of, rather than embedded in and flush with the bottom, such an exposure might include the preserved hull more or less in its entirety. Additionally, the extensive gribble population is unlikely to decrease under the present conditions, and their steady degradation of the elements already exposed will without doubt continue.

While the wreck is well-preserved, it is thus by no means stable and remains vulnerable to continuous degradation by gribble and infestations by shipworm. The latter would clear be disastrous in conjunction with further exposure, but the unpredictable distribution and intensity of populations also renders the shipworm a threat to the site in its current state.

6. Protection

6.1. Conservation

All recovered finds are treated by the central conservation laboratory at the State Archaeological Museum (Archäologisches Landesmuseum Schloss Gottorf) in Schleswig. For first treatments on board, proper transportation and the final work in the laboratory, a French conservator who is specialized in maritime artefacts was employed and equipped with special instruments, e.g. for electrolysis.

The wooden finds are being saturated with a solution of Polyethylene Glycol of 15% in the first and 40% in the second stage, followed by shock frosting and vacuum drying. During saturation, the concentrations of the solution as well as the temperatures are constantly monitored. The rudder, being the largest object, had to be cut in five pieces to undergo the conservation treatment. Due to the long duration of the saturation process, several wooden finds were still in conservation at the time of finishing of the report. The textile and leather finds have been cleaned through rinsing with demineralized water. Fragile pieces were placed in microperforated polypropylene bags and further cleaned with an airbrush, adapted to a supply of demineralized water. In some cases, a bath in a solution of 4% EDTA was necessary. After cleaning, the finds have also been treated with Polyethylene Glycol and freeze dried (Colson 2013). All other finds, including metal, brick, ceramics and bones, had to be desalted and dried in a controlled environment. For conservation of the large bronze objects, a system was installed to conduct electrolysis for the reduction of metal oxides. The conservation of the cannons was also still in progress. After conservation, all finds are handed over to the archaeological depot at the State Archaeological Museum for permanent storage, scientific research and exhibition.

6.2. In situ preservation

Not all recovered finds were taken ashore for conservation and storage at the State Museum. A number of wooden elements, including documented timbers and single barrel staves, were redeposited in Trench 1 prior to filling for in-situ preservation.

The protection of cultural monuments was the primary target of the archaeological assessment of the Fehmarn Belt fixed link area and the subsequent examination of the Lindormen wreck. Since the wreck is not located in the immediate construction area, a full scale excavation including the salvage of the entire wreck was not necessary and in-situ conservation is possible. To preserve the wreck as a monument, protective measures to minimise the impact of the excavation, the upcoming construction works and of biodegradation had to be taken.

At the conclusion of the investigation, several tons of sand and gravel were distributed on the site. This material was mainly used to fill the excavated areas, but also to provide an immediate measure of protection for exposed hull and cable remains. Approximately 10 tons were distributed along either hull side, leaving the steep transition on the western side somewhat softened.

During the investigation, several samples of underwater flora and fauna, as well as wood samples were taken on the wreck site to conduct a biological assessment of the wreck mount and to determine the threat of wood degrading organism to the wooden remains. The wreck is found to be infested to a medium degree by the shipworm *teredo navalis* and to a high degree by the gribble *limnoria lignorum*, which are both degrading those exposed wooden parts of the wreck, which are not covered by sediments or protected through charring. There is no doubt that parts of the wooden hull have already been destroyed by the macroborers and any exposed part is threatened to be completely degraded. Therefore a dense covering of the wreck was strongly recommended (Hoppe 2012). An assessment of further wood samples by the National Museum of Denmark found also that those woods which were covered by sediments are in good condition and suitable for in-situ preservation, while the exposed, especially the uncharred woods are being degraded (Gregory 2013).

In consequence of these assessments, a complete covering of the wreck was deemed the best solution to prevent further biodegradation to the ship timbers and provide a protection against accidental damage to the wreck during the nearby construction activities of the Fehmarn Belt tunnel. As a side effect, looting of the wreck by sports divers would also be prevented. In May 2014, the wreck was covered with 3300m^3 of sand and 750m^3 of coarse gravel, creating an artificial mount of two layers. These works were carried out under supervision of the ALSH and Femern A/S by Peter Madsen Rederi A/S. Based on the bathymetric mapping, the sand was distributed in small, precisely placed batches from a specialized ship with the help of a DGPS positioned grab dredge. The sand was distributed evenly and without loss to sedimentation or damage to the wreck this way. In a second step, the layer of gravel was added to the cover, serving to prevent erosion of the sand mount and creating a basis for biological activity and the quick growing of a reef.

Figure 58: Sand is deposited from the vessel M/V Merete Chris onto the wreck.

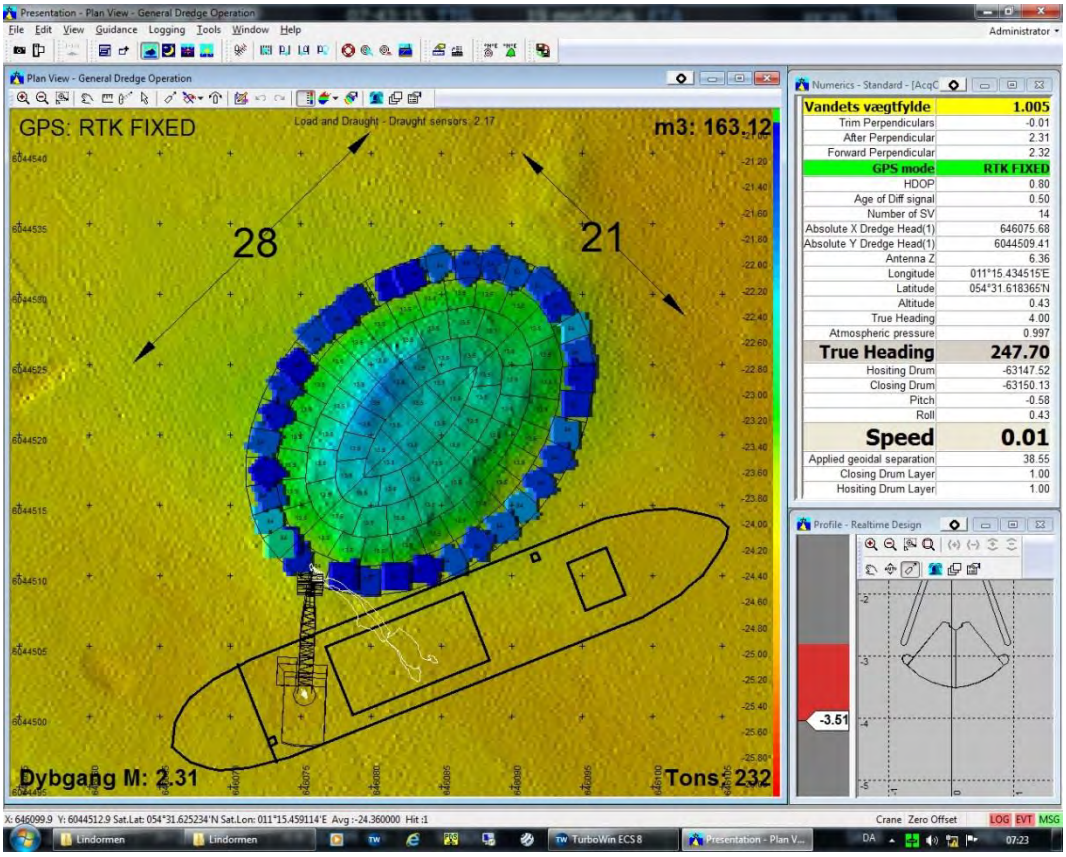


Figure 59: The positioning system of the crane on vessel "Merete Chris" allowed to deposit the sand grab by grab with high precision, giving a good visualization to follow up the overall progress from day to day.

7. Conclusion

The aim of the Fixed Link to connect Denmark and North Germany found its counterpart in the successful collaboration of Viking Ship Museum Roskilde and Archäologisches Landesamt Schleswig-Holstein within the Fehmarn Belt-Project. During the course of state-of-the-art investigations, it was possible to positively identify the wreck as that of "Lindormen". The documentation of the visible surface and two small excavation trenches revealed many interesting details about the ship´s construction, manning and way of life on board a 17th century Danish warship. The inferno, in which the ship was, when it sank, is clearly visible by the molten bronze guns, charcoaled timber and sailcloth as well as by a human skeleton of one of the approx. 50 casualties. The hardship of the daily life on board for the average sailor, only eased by tobacco, alcoholic drinks and occasional fishing, is opposed by rather luxurious finds of officer´s textiles and furniture. The investigations touched merely the Lindormen´s surface; most of it is still preserved. And the preservation conditions are now much better than for most of the other wrecks in the south-western Baltic Sea. Thanks to the Fixed Link Fehmarn Belt Project, it was possible to cover up the wreck with sand and gravel, allowing long-term protection.

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Catalogue of Finds

The following section contains a complete and illustrated catalogue of those of the recovered finds which were ultimately accessioned. There are therefore several interruptions to the numerical sequence, arising both from subsequently discarded finds, and from samples subjected to destructive analysis.

Where finds are recovered from a location outside the two trenches, a general indication of the find place is given. The exact position can be found on the site plan.

The majority of the entries are accompanied by photographs, and additional illustrations of many artefacts can be found in the relevant sections above.

X1 Location: Bow area

Length of cordage, 24 cm long and Ø 5.5 cm. Z-twist of three strands Ø 3 cm, each of yarns Ø 0.2-0.4 cm. Imprint suggests that the hawser formed part of a larger cable.

X4 Location: Stern area

Iron hemisphere with triangular protrusions, presumably part of a chain shot. The edge is slightly damaged in one place, but with no other grooves or marks. Ø 12.7 cm.

X6 Location: Bow area

Wooden deadeye with significant damage and only two recognisable holes. Score of trapeze-shaped section, 2.5-4 cm wide, and 1.9 cm deep. Evidence of fire damage and some encrustation. 21.5 x 17.3 x 7.4 cm.

X7 Location: Trench 1

Heavily concreted iron element, apparently containing a hinge locked in an L-shape. 9.5 x 11 x 7 cm.

[No picture]

X8 Location: South of galley

Fragment of larger ceramic vessel. Grey material and outside surface, and light-yellow with traces of soot on the inside.
Very smooth, even in fractures. No decorations, but traces of turning across the inside. No original edges. 12 x 8.5 x 0.3 cm, reconstructed external Ø 22-24 cm.

X11 Location: Trench 1

Two pieces of heat-damaged bronze, up to 8 cm.

[No picture]

X12 Location: Galley

Flat fragments of bronze or copper with consistent thickness. Some deformation but little evidence of heat damage. Presumably cookware.

[No picture]

X14 Location: Trench 1

Heavily damaged piece of wood, with a groove to accommodate an iron rod. 16 x 12 x 3.5 cm.

[No picture]

X17 Location: Trench 1

Conical sounding lead with some wear, the top third more than the rest. One transverse hole near the top, and at very top what appears to be another hole which has been torn open. Narrow triangular recess in the bottom face, 0.6 x 1.4 cm, 0.5 cm deep. Overall 4.6 x 14.2 cm.

X18 Location: Trench 1

Fragment of bronze sheave. About 50% preserved but with some deformation. The asymmetrical section is probably a result of heat-damage. 13 x 7.5 x 3 cm, internal Ø 2 cm.

X20 Location: Trench 1

Iron sphere, presumably ball from grape shot. Ø 4.8 cm.

[No picture]

X21 Location: Outside south-east

Three iron hemispheres, presumably one half of a scissor shot, and two halves of chain shots. All with some corrosion and several non-functional holes or channels Ø 1.5-2.5 cm, presumably from marine borers.

The scissor shot (left) has a Ø 2 cm countersunk hole to accommodate a transverse bolt fixing the two original halves together. Remains of the blade itself are hardly preserved at all, but its 3.9 x 2 cm channel across the flat face is recognisable. Ø 12.4 cm.

The first chain shot (centre) has a 0.7 cm wide groove of semi-circular cross section crossing its outside, and the flat face has traces of triangular recesses to accommodate a partner. These are offset 30° counter-clockwise from the groove. On the outside, 0.8 cm from the edge and perpendicular to the groove, is a 1.4 x 1.4 cm hole. The hole is 5.3 cm deep with no narrowing, and runs at a 30° angle to the flat face. There are traces of internal barbs. Ø 13.4 cm.

The second chain shot (right) is similar to the first, but features a 1 cm wide groove, and a 2 x 2 cm hole 1 cm below the edge.
The hole is 4 cm deep with decreasing height, and runs parallel to the flat face. There are no traces of internal barbs. Ø 12.3 cm.

X23 Location: Stern area

Iron sphere, presumably cross-bar shot. 2 x 2 cm hole through the centre, with internal barbs. Slight trace of a line around the outside, perpendicular to the hole. Ø 11.5 cm.

X24 Location: Stern area

Two connected iron fragments, presumably part of a chain shot, but with a hollowed-out centre. 45% of the circumference remains, and the hollow centre leaves a wall-thickness of 2.3-3 cm.
A 0.8-0.9 cm wide groove crosses the outside, and a single 1.5 cm wide triangular protrusion is preserved on the remaining flat face, offset 20-25° from the groove. 13.5 x 9 x 6.5 cm, reconstructed Ø 14 cm.

X25 Location: Galley

Heavily corroded piece of leather. Roughly rectangular in plan view, but with some curvature in profile. 15 x 6 x 0.7 cm.

X26 Location: Stern area

Head of humanoid bronze figurine, belonging to the cascable of bronze gun X120 but recovered separately. Oriental female with a rather full face and intricate hair. Damage from heat on the left side of the head and on the neck. 8 x 5.5 x 5.3 cm.

X28 Location: Trench 1

[No picture]

Bone fragment, cattle. 17 x 4 x 1 cm.

X29 Location: Stern area

Conglomerate containing a loose iron shot Ø 5.4 cm and textiles. 40 x 27 x 16 cm.

[No picture]

X31 Location: Stern area

Two connected fragments of a clay tobacco pipe. No decoration or marks. Stem 6.5 x 0.9 cm, hole Ø 0.2 cm. Bowl length 3.5 cm, Ø up to 1.9 cm and 1.5 at the mouth.

[No picture]

X34 Location: Trench 1

Three heavily corroded metal objects, up to 11 cm.

[No picture]

X35 Location: Trench 1

Pieces of melted bronze, some bluish and some with charcoal imprint. Up to 9 cm.

[No picture]

X36 Location: Trench 1

Lot of bluish bronze or copper sheathing, with evidence of limited heat damage. Some edges are bent in a U-shape to accommodate an element 2.5-3 cm thick. Some occurrences of 0.3 cm round nail holes. Up to 16 x 15 x 0.3 cm.

X37 Location: Galley

Fragments of cloth and cordage. One small knot, but mostly loose strands. Some Z-twist Ø 1.5 cm of three strands Ø 0.7 cm.

X38 Location: Trench 1

Sample of cordage from coil, 23 cm long and Ø 2.5 cm. Z-twist of three strands Ø 1.5 cm, each of 10+ yarns.

X40 Location: Galley

Fragments of medium-coarse textile. Three lots, 30 x 10, 25 x 14 and 15 x 15 cm.

X41 Location: Galley

Bone fragment, cattle.

[No picture]

X42 Location: Galley

Lot of pale yellow bricks and fragments, up to 22 x 10.5 x 4.5 cm.

X43 Location: Trench 1

Fragment of wooden barrel hoop, with possible original cut on one edge. 17.4 x 2.8 x 1.3 cm.

X44 Location: Trench 1

Fragment of wooden treenail, almost hexagonal in section. Slightly conical with some charring at the wider end. Some biological damage. 18.2 x 2.7-3.2 cm.

X45 Location: Trench 1

Single-sheaved wooden rigging block, with preserved cordage through and around, discovered alongside the almost identical X46. Rounded outline with chamfered edges and a 15.5 x 3.1 cm sheave-hole. Strop scores cut top and bottom, with an additional perpendicular score at the bottom. 22 x 14.5 x 8.4 cm.

X46 Location: Trench 1

Single-sheaved wooden rigging block, with preserved cordage through and around, discovered alongside the almost identical X45. Rounded outline with chamfered edges and a 14.2 x 3.1 cm sheave-hole. The preserved working line is Ø 2.5 Z-twisted of three strands, but the strop appears plaited of four similar strands. Strop scores cut top and bottom, with an additional perpendicular score at the bottom. 20 x 12 x 8 cm.

X47 Location: Trench 1

Piece of cordage recovered near blocks X45 and X46. Ø 2.5 Z-twist of three stands Ø 1.2 cm with overhand knot or half hitch. Appears to have been tied around a round object Ø 2.5.

X48 Location: Stern area

Fragment of bronze gun barrel. Somewhat irregular bore with fairly sharp edges. Wall thickness 6.5 cm, with no obvious marks. 33 x 14 x 8 cm, and an estimated internal diameter of 12.2 cm.

X49 Location: West side

Fragment of bronze gun barrel with smooth eroded edges. Wall thickness 6 cm, with no obvious marks. 34 x 19 x 9.5 cm, and an estimated internal diameter of 16.8 cm.

X50 Location: Trench 1

[No picture]

Fish bones, attributed mainly to cod.

X51 Location: Trench 1

Fragment of wooden barrel hoop. 19.8 x 2.7 x 1.1 cm.

X52 Location: Trench 1

[No picture]

Iron sphere, presumably small round shot. Poorly preserved and with no visible marks, Ø 6.6 cm.

X53 Location: Trench 1

Piece of cordage with several loose strands, up to 14 cm long and Ø 2.5. The most intact piece is completely solidified. Z-twist of three strands Ø 1.5, each of yarns Ø 0.2-0.3 cm.

X54 Location: Trench 1

Folded piece of lead, with a material thickness of 0.2 cm. 4.4 x 2.5 x 1.5 cm.

X55 Location: Trench 1

Fragment of clay tobacco pipe with bowl and part of stem preserved. The stem is stamped with a motif of a fleur-de-lis inside a diamond, repeated at least twice although only one is preserved in its entirety. The heel is marked with the encircled letters EB, and there is rouletting around the mouth of the pipe. Stem 5.3 x 1 cm, Ø 0.3 cm hole. Bowl up to Ø 1.8 cm, 1.5 cm at the mouth.

X56 Location: Trench 1

Human skeleton, including bones from a leg through to the cranium.

X59 Location: Trench 1

Two bronze pieces, one completely melted and one heat-damaged.

X60 Location: Trench 1

Piece of wood, completely charred and with no original edges. 52 x 5 cm.

[No picture]

X61 Location: Trench 1

Two stem fragments from clay tobacco pipes, with no original ends. One is broken off with a hint of the heel, and with a long chip at the opposite end. 9.3 x 0.9, Ø hole 0.3, and the other 8.9 x 0.9, Ø hole 0.3 cm.

[No picture]

X62 Location: Trench 1

Lot of leather fragments, several with original edges and stitching. Perhaps some suggestion of footwear.

X63 Location: Trench 1

Five fragments of wooden barrel hoops, one with some remains of bark. Neither has any recognisable curvature. 13,6 x 2.9 x 1.3 cm, 14.5 x 2.8 x 1.2 cm, 11.5 x 2.1 x 0.9 cm, 6.4 x 2.0 x 0.9 cm, and 6.7 x 2.1 x 1.0 cm.

[No picture]

X64 Location: Trench 1

Lot of fish bones, attributed mainly to cod.

[No picture]

X66 Location: Trench 1

Strands of cordage, Ø 1.1 cm. Originally Ø 2 cm Z-twist of three strands.

X67 Location: Trench 1

Fragments of textile found near the skeleton. Mix of fine and coarser weaves.

X69 Location: Trench 1

Three fragments of earthenware. Bluish glaze inside and trace of brown glaze outside. One piece with rim. Up to 5 cm with a material thickness of 0.6 cm.

X71 Location: Trench 1

Circular wooden tripod seat with fragments of two Ø 3 cm legs. Partly burned and with some charring. Slightly conical section, with flat seat and convex bottom. 27.5 x 5.6 cm.

X72 Location: Galley

Lot of pale yellow bricks and fragments, up to 22 x 10.5 x 4.5 cm.

X73 Location: Trench 1

Wooden piece, almost entirely charred, with five holes Ø 1-1.5 cm at 8-10 cm intervals. One hole has remains of cordage. 59 x 6.5 x 3 cm.

X74 Location: Trench 1

Wooden piece, almost entirely charred. Four holes Ø 0.6-1 cm at 0.9-1.2 cm intervals. One hole has remains of cordage. Larger 7 x 2.5 cm hole near the end of the largest face. Trace of 0.7 x 0.7 cm iron nail, originally extending into this hole from the shorter edge. 63 x 8 x 4.5 cm.

X75 Location: Trench 1

Fire wood with some bark preserved. 46 x 12 x 7 cm.

X76 Location: Trench 1

Decorated clay tobacco pipe found near the skeleton, with remains of textile on the bowl. The stem is decorated with a 9 cm long floral motif and there is rouletting around the mouth. No other marks. Stem (incomplete) 12 x 0.9-1 cm, Ø 0.3 cm hole. Bowl up to Ø 1.9 cm, 1.5 cm at the mouth.

X77 Location: Trench 1

Lot of cordage and coarse textile found near skeleton. Several smaller cordage pieces Ø 0.4-0.9, Z-twisted of three strands Ø 0.2-0.5 cm, one preserved in a loose coil with evidence of hitches. One example of three-stranded plait. Some fragments with textile ribbons and knotting.

X78 Location: Trench 1

Smaller pieces of concretion.

[No picture]

X79 Location: Trench 1

Fragment of bronze sheave. About 80° preserved but with some deformation. The asymmetrical section is probably a result of heat-damage. 8.5 x 6 x 3.6 cm, internal Ø 2 cm, reconstructed external Ø 12 cm.

X80 Location: Trench 1

Wooden piece, heavily charred. Mushroom shape with a ball atop a short damaged shaft, fashioned in one piece. Slight narrowing between ball and shaft. 11.5 cm long, ball 5 x 6 cm, shaft Ø 3.6 cm.

X81 Location: Trench 1

Fragment of wooden barrel hoop with recognisable curvature. 18 x 2.6 x 1.2 cm, estimated internal diameter 77 cm.

[No picture]

X82 Location: Trench 1

Piece of dense textile with possible original edge. 15 x 12 x 0.1 cm.

X83 Location: Trench 1

Piece of cordage Ø 1.1 cm, Z- twist of three strands Ø 0.5 cm, each of three yarns. 12 cm long.

X84 Location: Trench 1

Piece of cordage Ø 2.5 cm, Z-twist of three strands Ø 1.3 cm, each of 12 yarns. 44 cm long.

X85 Location: Trench 1

Fragment of wooden barrel stave, with some charring and biological damage. Trace of 0.2 cm wide croze 4 cm from the end. 34 x 7.6 x 1.4 cm.

X86 Location: Trench 1

Hook of brass wire. 4.1 x 1.4 x 1.3 cm, wire thickness 0.2 cm.

X87 Location: Trench 1

Three fragments of clay tobacco pipes, hereof two connected bowl and stem fragments. The stem is stamped with a motif of a fleur-de-lis inside a diamond, repeated at least three times underneath one another, although only two are preserved in their entirety.

The heel is marked with the encircled letters EB, and there is rouletting around the mouth of the pipe. Stem 7 x 0.9-1.1 cm, Ø 0.3 cm hole. Bowl (damaged) length 3.1 cm, up to Ø 1.6 cm, and 1.5 cm at the mouth.

Unrelated stem fragment, 4.8 x 0.8 cm, Ø 0.3 cm hole.

X88 Location: Trench 1

Wooden treenail fragment of octagonal cross section. Charred both ends. 6.7 x 3.5 cm.

X89 Location: Trench 1

Fragment of iron sphere, presumably 25% of a cross-bar shot with a bar width in excess of 1.9 cm. 7.5 x 5.5 x 2.9 cm, reconstructed Ø 8 cm.

X90 Location: Trench 1

Plank of wooden chest, with some charring and fire damage. Presumably back plate, with dovetails and grooves for fitting a till on the inside. Top edge has a recess and the back side traces of iron strapping and nails. 94.5 x 30.5 x 2 cm.

X91 Location: Trench 1

Sole of leather footwear with heel, found near skeleton. Several layers are preserved, including the insole with clear traces of stitching and remains of cordage around the edge. Decorative pattern on the outsole, with a possible diagonal repair or reinforcement patch. Several instances of smaller and larger pointy wooden pegs in sole and heel. 23.5 x 8.5 x 1.5-5 cm.

X92 Location: Trench 1

Wooden handle with small pierced brass plate at the base, 0.7 cm x 0.7 cm, over a 0.1 cm hole. Handle of oval to round cross section with a central Ø 0.6-0.7 cm hole. Found near X90. 6.3 x 1.5-3.3 x 1.8 cm.

X93 Location: Trench 1

Wooden box and three small fragments, presumably related to lid X101. Recess for a sliding lid. Carved from one piece with the exception of a Ø 0.6 cm plug extending inwards from the back end. Single depression in the bottom. Found near X90. Externally 9 x 3.7 x 4 cm, internally 7.6 x 2.3 cm.

X94 Location: Trench 1

Fragment of wooden element, split lengthwise to reveal a 1.1 cm wide channel. One outside face is decorated with a slightly retracted convex band flanked by two fine lines, with a total width of 1.5 cm. Found near X90. 8.4 x 2.4 x 2 cm.

X95 Location: Trench 1

Concreted cylinder, perhaps a needle, with a small eye one end and flattening to a spoon shape the other end. A 1 x 8 cm piece of textile is attached through the eye, apparent wound with string for the first 2 cm. Found near X90. 6.3 x 0.4 cm.

X96 Location: Stern area

Two pieces of rather irregularly shaped ceramics. One appears to include the transition between a flat bottom and the side of a vessel, and the other part of a wide rim. 11 x 9 x 0.5-0.9 cm, and 12 x 7.5 x 0.8 cm respectively.

X97 Location: Stern area

Bone fragment, cattle, 10.5 x 4 x 2.3 cm.

[No picture]

X98 Location: South of wreck site

Remains of large stern rudder composed of two pieces. Heavily eroded, but with traces of pintles and nails. 615 x 97 x 40 cm.

X99 Location: Galley

Lot of medium-fine textile, 26 x 10 cm.

X100 Location: Trench 1

Eight pieces of deformed bronze or copper, some recognisable as sheathing and others entirely melted. Up to 20 x 9 cm.

X101 Location: Trench 1

Wooden sliding lid, most probably related to box X93. Flat bottom with slightly bulging top, chamfered front and back. Clear 1.5 cm wide recess to facilitate removal. Slightly narrower at the back, perhaps due to damage. 8.3 x 2.8 x 0.4 cm.

X102 Location: Trench 1

Clay tobacco pipe with rouletted bowl, and traces of a single fleur-de-lis in diamond motif on the stem. Stem 6.5 x 0.9-1.1 cm, Ø 0.3 cm hole. Bowl 3.2 cm long, up to Ø 2.1 cm, and 1.5 at the mouth.

X103 Location: Trench 1

Piece of cordage Ø 1.4 cm. Z-twist of three strands Ø 0.7 cm, each of 6 yarns. 9 cm long.

X104 Location: Trench 1

Concreted metal objects, up to 15 x 5 x 2 cm.

[No picture]

X105 Location: Trench 1

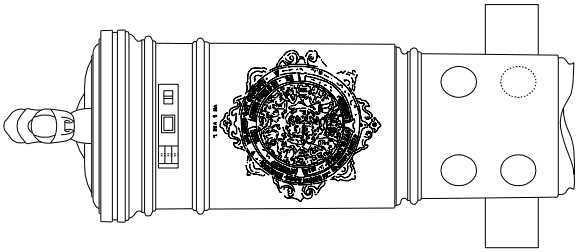
Stem fragment of clay tobacco pipe, stamped with fleur-de-lis in diamond motifs. Two of the stamps are aligned lengthwise, with a single stamp place more randomly either side. 5.2 x 0.8-0.9 cm, Ø 0.3 cm hole.

X106 Location: Trench 1

Oval wooden lid with carved decoration in linear patterns on top, presumably from bent-wood box. Slight fire damage.
Small treenails preserved along the edge. 11.4 x 7.4 x 1 cm.

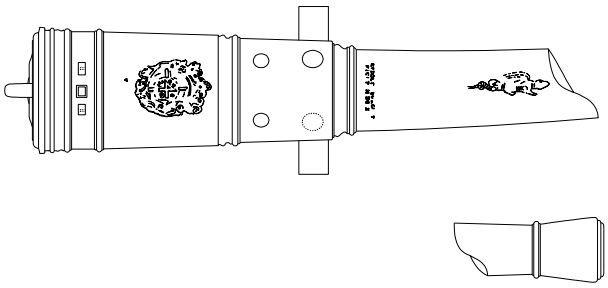
X120 Location: Stern area

Fragment of bronze gun, broken between second reinforce and chase, with the rear part preserved. Well-preserved with some damage to the dolphins. Cylindrical trunnions with a cascable shaped like a woman (see X26) holding a marine mammal. Large decoration attributed to Christian IV. 110 cm long, Ø vent 37.5 and Ø bore 13.0 cm. 850 kg.



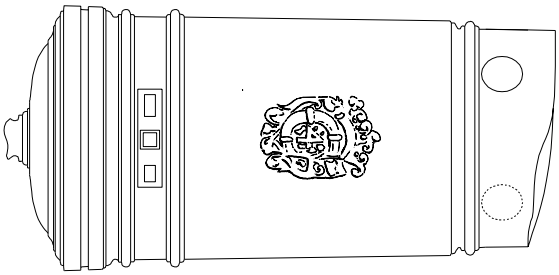
X121 Location: Trench 1

Two fragments of a bronze gun, found separately. Broken just before the cylindrical muzzle. Significant damage to the dolphins and cascable, and slight deformation of the chase. Decorated with a dragon in relief on the chase, and Christian IV's cypher on the first reinforce. Traces of incision referring to maker and date at the bottom of the chase. Length 204 cm, Ø vent 33.6 cm and Ø bore 11.0 cm. 700 kg.



X122 Location: Trench 1

Fragment of bronze gun, broken across second reinforce. Significant damage to the dolphins and the cascable. Decorated with Christian IV's cypher on the first reinforce. Possible but largely unintelligible lettering over the vent field. Length 90 cm, Ø vent 44.5 cm, estimated Ø bore 14.8 cm. 1000 kg.



X123 Location: Trench 1

23 fragments of wooden barrel hoops, a few with bark preserved. Up to 14.1 cm long, and all with a similar section of 2.5-3.5 x 1.1-1.5 cm.

[No picture]

X124 Location: Trench 1

Four fragments of clay tobacco pipes. Two connected stem and bowl fragments with traces of rouletting around the mouth, and decorative dots both sides of bowl. Stem 2.3 x 0.9 cm, Ø 0.3 cm hole. Bowl length 3.2 cm, up to Ø 1.9 cm, 1.5 cm at the mouth.
Two unrelated stem fragments, one 3 x 1 cm and the other 2.3 x 0.9 cm, both Ø 0.3 hole.

[No picture]

X125 Location: Trench 1

Two pieces of cordage Ø 1.3 cm, Z-twist of three strands Ø 0.7, each of six yarns. Combined length 15 cm.

X127 Location: Trench 1

Piece of fine textile.

X128 Location: Trench 1

Lot of wooden barrel elements, all head pieces damaged.

X128.1
Middle head piece, with three holes in the long edge (one with peg) and one in the short. 59 x 16 x 2 cm.

X128.2
Cant head piece, with one hole in the edge. 46 x 16.5 x 1.5 cm.

X128.3
Middle head piece, with three holes in the long edge and two in the short. Four plugged holes Ø 1-1.3 cm. Marked with a reversed S. 57 x 16 x 2 cm.

X128.4
Middle head piece, with two holes in the long edge and one in the short. Plugged hole Ø 1.5 cm. 54 x 13.5 x 2 cm.

X128.5
Stave, broken. Ø 1 cm hole near broken end. Marked with BF at the bilge. 0.2 cm wide croze 3.8 cm from end. 126 x 6.5-9 x 1.8 cm.

X128.6
Stave. 0.4 cm wide croze 3.6 cm from end. 123.5 x 7.2-8.8 x 1.5 cm.

X128.7
Stave, broken, with 5.8 x 5.7 cm square hole at the bilge. 79 x 9.2-10 x 1.5 cm.

X128.8
Two wooden bungs, square. 5.5 x 5.5 x 1.7 cm and 5.3 x 5.3 x 1.6 cm.

X128.9
Stave, broken, with traces of hoops. Mark with a reversed S at the bilge. 104 x 6.0-8.5 x 1.5 cm.

X128.10
Stave, broken. 79.5 x 6-8 x 1.5 cm.

X129 Location: Trench 1

Open metal ring or fitting, with bands of decoration, some slightly concave and other slightly convex. Large area with doubled diagonal cross-hatching. 2.7 cm with Ø 2.1 cm.

X130 Location: Trench 1

Fragment of wooden barrel stave, with 0.2 cm wide and 0.3 cm deep croze starting 4 cm from the edge. 7.4 x 4.7 x 1.3 cm.

[No picture]

X131 Location: Trench 1

Wooden handle with decorative brass elements. Slightly pear-shaped with a carved pommel, and traces of a 0.6 x 0.3 cm iron tang. One side is decorated with a whitish metal diamond surrounded by clusters of Ø 0.1 cm brass inserts, some of which are missing. 6.8 x 1.6 x 1 cm.

X132 Location: Trench 1

Two fragments of plain clay tobacco pipe stems. 3.5 x 0.8 cm and 2.8 x 0.7 cm, both Ø 0.3 cm hole.

[No picture]

X133 Location: Trench 1

Fragment of plain clay pipe stem. 8.6 x 0.6-0.8 cm, Ø 0.3 cm hole.

[No picture]

X134 Location: Trench 1

Lot of related ceramic sherds, almost constituting an entire jug with narrow opening and two horizontal handles. Outside partly glazed and decorated with ribbing and incisions. Reconstructed 17.5 x 16.6.

X135 Location: Stern area

Iron hemisphere, presumably part of a chain shot with some biological damage. A 1 cm wide groove of semi-circular cross section crosses the outside, and the flat face has traces of triangular recesses, offset 30° counter-clockwise from the groove. On the outside, 1 cm from the edge and perpendicular to the groove, is a 1.8 x 1.8 cm hole. The hole is 5 cm deep with no narrowing, and runs parallel to the flat face. There are traces of internal barbs. Ø 13.4 cm.

Picture to the left: Base of the shot with biological caused bore-holes on the front edge.

X136 Location: Stern area

Lead cube, with Ø 1.5 cm circular hole through the centre. Perhaps coak, but probably recent. 3.4 x 3.1 x 2.7 cm.

[No picture]

X138 Location: Trench 1

Hook of brass wire, flattened at the end. 3.5 x 1.3 x 1 cm, wire thickness 0.2 cm.

X139 Location: Trench 1

Two unrelated fragments of clay tobacco pipe(s). Stem decorated with four fleur-de-lis in diamond motifs arranged in a loose rhombus. 3.8 x 0.9, Ø 0.3 cm hole. Damaged bowl 2.5 cm long, Ø up to 1.7 cm.

[No picture]

X140 Location: Trench 1

Fragment of clay tobacco pipe. The heel is marked with the encircled letters EB, and there is rouletting around the mouth. Stem 2.1 x 1 cm, Ø 0.3 cm hole.
Bowl 3.1 cm long, Ø up to 1.7 cm, 1.4 cm at the mouth.

X141 Location: Trench 1

Two fragments of footwear. Heel in several layers with pointy wooden pegs. 5.9 x 5.7 x 1.3 cm.

Heel-end of sole with traces of stitching. 8.5 x 4.8 x 0.2 cm.

X142 Location: Trench 1

Piece of textile, with some concreted parts. 14 x 9 cm.

X143 Location: North of galley

Piece of fine textile, somewhat convoluted.

X144 Location: Galley

[No picture]

Fish bone, cod.

X145 Location: Trench 1

[No picture]

Two bones, presumably human ribs.

X147 Location: Galley

Wooden stick, faceted with sharped end. 7.6 x 1.2

X148 Location: Trench 1

Eye of brass wire. 2.2 x 1.6 x 0.2 cm.

X150 Location: North of galley

Lot of copper sheathing fragments. Some edges bent in U-shape. Single Ø 0.3 cm round nail hole. Material thickness 0.05-0.3 cm.

X151 Location: Trench 1

Iron sphere in four pieces, presumably cross-bar shot, with 3 x 3 cm hole through the centre. Two opposite inside faces show traces of barbs. Small angular cavity inside. Ø 9.5-9.8 cm.

X153 Location: Trench 1

Iron sphere, presumably scissor shot, with remains of the blades. Each blade is 4 cm wide and 1.8-2.0 cm thick, with a flat pentagonal cross section. The two hemispheres are slightly misaligned, and the blades are offset 1.4 cm at the shot surface. Countersunk 2 cm hole through both. Up to Ø 13.0 cm.

X154 Location: Trench 1

Three iron spheres, presumably one cross-bar shot Ø 9.5 cm with central 2.5 x 2.5 cm hole, and two solid shot of Ø 9.6 and 9.1 cm.

X155 Location: Trench 1

Six iron spheres, one with some damage. Presumably balls from grapeshot, with three balls Ø 4.9 cm, two Ø 5.0 cm and one Ø 4.8 cm.

X156 Location: Trench 1

Iron sphere, presumably round shot. Some remaining traces of casting. Ø 6.8 cm.

X157 Location: Trench 1

Iron sphere, presumably round shot. Some damage and traces of casting. Ø 9.6.

X158 Location: Trench 1

Lot of corroded iron fragments. Apparently more or less mechanical, including a freely rotating disc. Up to 17 x 9 x 12 cm.

[No picture]

X159 Location: Trench 1

Fragment of footwear, heel. Several layers with pointy wooden pegs. 5.5 x 5.5 x 3.0 cm.

X160 Location: Trench 1

Fish bones, cod and flounder.

[No picture]

X161 Location: Trench North

Wooden element, damaged with some charring. Dovetails along one the short edge and rebate along the long one. Partly preserved engraved symbols. 34.5 x 20 x 2 cm.

X162 Location: Trench North

Two pieces of cordage Ø 1.6 cm, Z-twist of three strands Ø 0.8 cm, each of 5+ yarns. Combined length 28 cm.

X164 Location: Trench North

Fragment of footwear, heel. Several layers with pointy wooden pegs. 6.0 x 5.1 x 2.6 cm.

X165 Location: Trench North

Fragments of medium-fine textile, 18 x 9 cm.

X166 Location: Trench North

Largely intact textile item, presumably a bag. Sewn with some seams showing and others hidden. Long strap of doubled textile, 0.5 cm wide. Fine Ø 0.2 cm cordage attached to strap, containing a multitude of knots and incorporating no less than five elongated eyelets. The string is decorated with clusters of very small yellow and green beads. 13 x 13 cm.

X167 Location: Trench North

Concretion with negative and remains of textile. 5.5 x 3 x 0.5 cm.

X168 Location: Trench North

Ceramic sherd with no original edges, decoration or glazing. 6.5 x 5 x 0.9 cm.

[No picture]

X169 Location: Trench North

Wooden winder with remains of Ø 0.2 cm cordage. 27.0 x 6.5 x 1.5 cm.

X170 Location: Trench North

Wooden piece, completely charred. 7.5 x 3.5 x 3.5 cm.

[No picture]

X171 Location: Trench North

Lead piece, rudimentary fish-shape, presumably sinker. Curvature on both axes, Ø 0.3 cm hole and notch each end.
18.0 x 1.0 x 1.2 cm.

X172 Location:

Bronze piece with some heat damage. Slightly bell-shaped, perhaps ordnance related. 8.5 x 7.5 x 6.5 cm.

[No picture]

X173 Location: Trench North

Two pieces of bronze, 2.8 x 0.8 cm and 3.0 x 0.7 cm.

[No picture]

X174 Location:

Iron sphere, partly hollowed-out by pseudo-square 4.5 x 4.5 cm hole. Perhaps round shot with significant damage. Ø 130 cm.

X176 Location: Trench North

Concretion with piece of textile. 35 x 23 x 20 cm.

X177 Location: Trench North

Two wooden fragments, completely charred. Up to 7 x 3 x 3 cm.

[No picture]

X178 Location: Trench North

Lead sphere, presumably ball from grapeshot, with several linear impressions. Ø 5.4 cm.

X179 Location: Trench North

Wooden stick, rounded but roughly worked. One original end preserved, terminates at a 30° angle. The other end broken and charred. 32.4 x 3.5 cm.

[No picture]

X180 Location: Trench North

Lot of wooden barrel elements. All head pieces are damaged, and intact staves have recognisable chiv and 0.3-0.4 cm wide crozes 3.5 cm from the ends.

X180.1
Stave, broken. 0.3 cm wide croze 3.7 cm from the end. Suggestion of 6.3 cm wide rectangular hole in fracture. 61 x 7.1-9.0 x 1.5 cm.

X180.2
Stave, broken. Suggestion of 5.5+ x 5.0+ cm rectangular hole in fracture. Internal curvature 60:2 cm. 65.5 x 7.0-9.1 x 1.7 cm.

X180.3
Wooden bung, square. 5.4 x 5.4 x 1.7 cm.

X180.4
Stave. Internal curvature 124:6.3 cm. 126 x 5.1-7.6 x 1.5 cm.

X180.5
Stave. Internal curvature 124:5.8 cm. 126 x 4.0-6.5 x 1.5 cm.

X180.6
Stave. Internal curvature 124:5 cm. 126 x 5.6-8.1 x 1.6 cm.

X180.7
Stave. Internal curvature 124:6.5 cm. 126 x 6.4-6.5 x 1.9 cm.

X180.8
Stave. Internal curvature 124.5:5 cm. 126 x 9.2-11.3 x 2.0 cm.

X180.9
Cant head piece, with two holes in the edge. One plugged hole Ø 1.5 cm. 44 x 17 x 2 cm.

X180.10
Middle head piece, with two holes in both edges. One plugged hole Ø 1.5 cm. 52 x 20 x 2 cm.

X180.11
Middle head piece, with two holes in the long edge and one in the short. 56 x 16 x 2 cm.

X181 Location: Trench North

Small hook of brass wire recovered from X176. 1.2 x 0.8 x 0.4 cm, wire thickness 0.1 cm.

X182 Location: Trench North

Three belt fittings in brass, recovered from X176. Two are apple-shaped, one with an additional smaller eye. 2.6 x 2.7 x 0.2 cm and 3.2 x 2.6 x 0.8 cm respectively.

One smaller baluster-shaped bar with some decoration, 2.5 x 1.3 x 0.9 cm.

X183 Location: Trench North

Two connected stem fragments of a clay tobacco pipe. Decorated with four fleur-de-lis in diamond motifs, three of which are somewhat overlapping. 7.9 x 0.9-1.1 cm, Ø 0.3 cm hole.

X184 Location: Trench North

[No picture]

Three ceramic shreds with traces of rudimentary decoration. Up to 6.5 x 1 cm.

X185 Location: Trench North

[No picture]

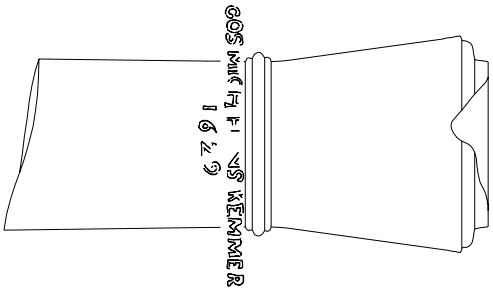
Lot of unrelated ceramic sherds, some with decorative incisions but few with original edges. Includes a single tripod leg, 6 cm long and Ø 1.3-3.0 cm. Sherds up to 7 x 6 x 0.7 cm.

X186 Location: Bow area

[No picture]

Small metal sphere. No holes or marks. Ø 1.0 cm.

X187 Location: Trench North



Fragment of bronze gun, broken at the upper chase with the conical muzzle preserved.
Details of maker and date in relief just below the muzzle astragal.
Muzzle somewhat compressed and face slightly damaged. 69 cm long, estimated Ø bore 14.5 cm.

X188 Location: Trench North

Fragment of stoneware vessel, including intact rim. Discovered inside X187. 9.9 x 6.8 cm, inside Ø down to 4.5 cm.

X189 Location: Trench North

Wooden elements, all damaged. Presumably from furniture.

X189.1
Board, long edge chamfered both sides, with a 3 x 0.6 cm notch and strap traces. Three nail holes along short edge. 63 x 15 x 1.2 cm.

X189.2
Board, heavily damaged with only few recognisable features. 55 x 10 x 1.3-1.5 cm.

X189.3
Board, long edge with 2.6 cm long recess halfway through. Several nail holes along short side. 45 x 9.5 x 1.5 cm.

X189.4
Strip or batten of flat D-shaped cross section, with one nail hole near bevelled original end. 25 x 3.5 x 1.3 cm.

X189.5
Board, short edge with protruding lip and dovetails matching X161. 27 x 21 x 2.4 cm.

X190 Location: Trench North

Wooden elements, presumably from a single piece of furniture. All holes and dowels square c. 0.7 x 0.7 cm.

X190.1
Board with damage, all three preserved edges chamfered both sides to 0.6 cm. 56 x 28 x 1.6 cm.

X190.2
Panel with keyhole and traces of locking mechanism. Vertical groove near each end. 59 x 9 x 2 cm.

X190.3
Panel with three holes in one long edge. One short edge has an additional two holes, one still holding a dowel. The other terminates in a narrow central lip. 26 x 8 x 2.2 cm.

X190.4
Panel with five square holes in long edge, some still with dowels. 2 cm wide recess along one short edge, with perpendicular hole. 52 x 8.2 x 2.2 cm.

X190.5
Board, attached to X190.9 upon recovery. Holes along both short sides, four near one and two near the other. 54.2 x 23.3 x 0.8-1 cm.

X190.6
Panel with three holes in one long edge, and trace of a recess along the other. Short edge slants slightly. 27 x 12 x 2.2 cm.

X190.7
Panel, similar to X190.6.

X190.8
Board, chamfered on three edges of one side. Holes along both short edges, at least four near one and two near the other. 60 x 27.5 x 2 cm. Occurrences of small amounts of brass on both sides.

X190.9
Panel, attached to X190.5 upon recovery. Similar to X190.3, but with four holes in long edge. 25.8 x 8 x 2.4 cm.

X191 Location: Trench North

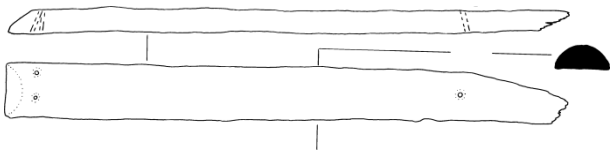
Pieces of medium-fine textile found on gun fragment X187.

X192 Location: Trench North

Concretion with piece of wood, related to X176.

X193 Location: Trench North

Strip or batten of flat D-shaped cross section, similar to X189.4. Two nail holes near bevelled original end, and one further towards damaged end. 31 x 3.5 x 1.3 cm.



X194 Location: Trench North

Lead object, conical with Ø 0.7 cm transverse hole. A Ø 0.2 cm brass extends from the larger face. Perhaps part of tap key, but probably recent. 3.0 x 1.5-1.7 cm.

X195 Location: Bow area

Two pieces of cordage Ø 11 cm, samples from coil. Cable, S-twist of three hawsers Ø 5.5 cm (see X1). Combined length 65 cm.

[No picture]

X196 Location: Stern area

Iron sphere, presumably ball from grapeshot. Ø 4.8 cm.

[No picture]

X198 Location: South of wreck site

Bones, two ribs found near rudder, perhaps human.

[No picture]

X201 Location: Trench 1

Wooden board, short edges chamfered both ends on one side. Single square hole 0.6 x 0.6 cm near intact short edge. 96.5 x 16 x 2 cm.

X202 Location: Stern area

Iron sphere, presumably ball from grapeshot. Traces of two non-parallel encircling lines. Recovered from concretion on gun fragment X120. Ø 5.8 cm.

[No picture]

X204 Location: East side

Fragment of bronze gun barrel with fairly sharp edges. Wall thickness c. 8 cm, with no obvious marks. 33 x 28 x 15 cm, and an estimated internal diameter of 15.1 cm.

X205 Location: Trench 1

Fragment of clay tobacco pipe bowl. Trace of mark on heel, but fragmentary and unclear. Recovered from concretion on gun fragment X121. Stem Ø 1.0 cm, with Ø 0.2 cm hole. Overall 3 x 3 x 1.5 cm.

[No picture]

X206 Location: Galley

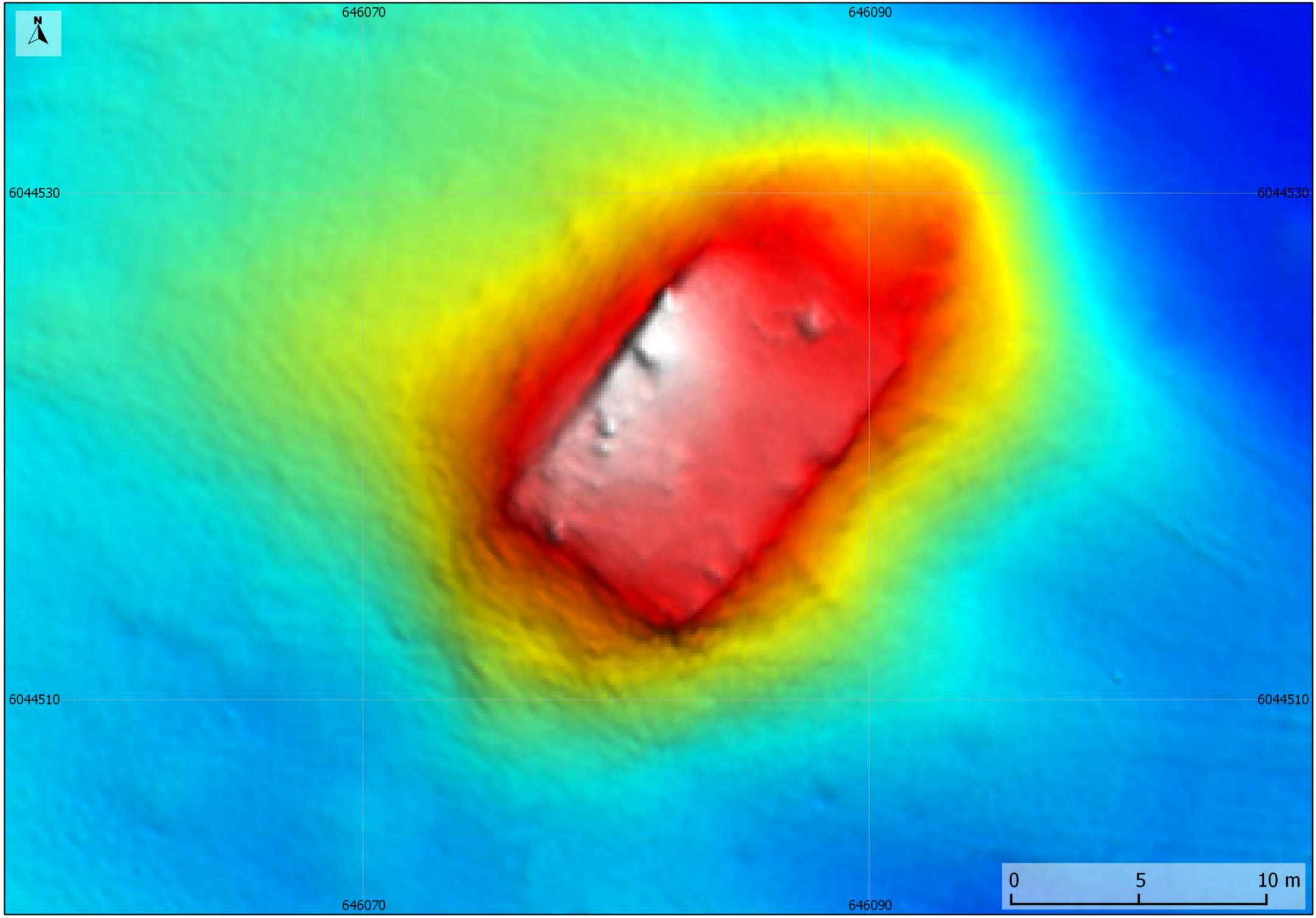
[No picture]

Bone, cattle.

X207 Location: Trench 1

[No picture]

Three fragments of bone, including one rib. Cattle.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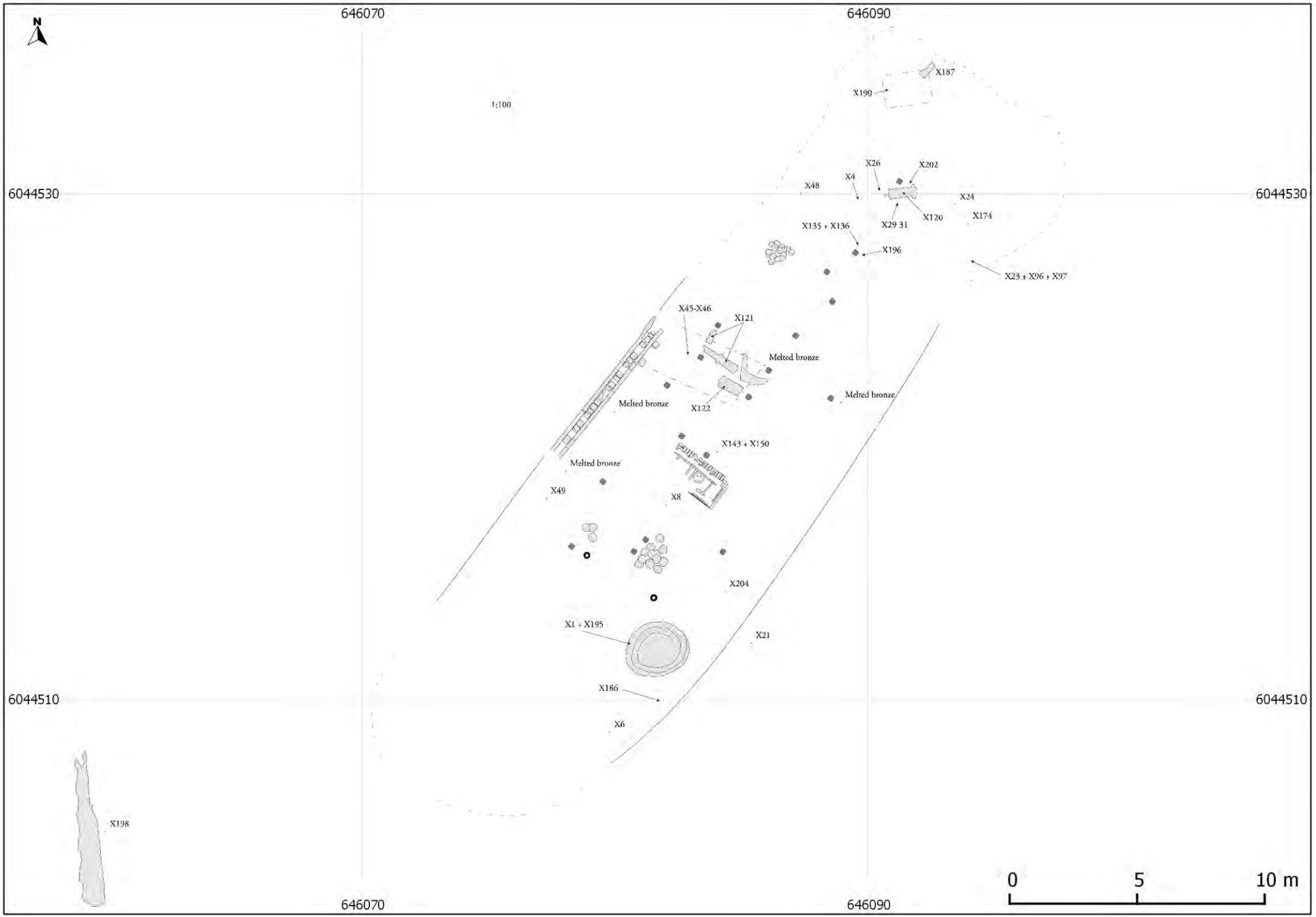
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