Lost on their way to Africa: on the provenance of brass rod ingots produced for eighteenth-century AD slave trade found on shipwreck Paal 27.1 on the island Terschelling, The Netherlands

Heidi E. Vink and Tobias B. Skowronek

Abstract: Where did the (metal) trade wares used in the Transatlantic slave trade come from? Nowadays, we have come to understand quite a bit about the routes and relationships of peoples and wares involved in the slave trade. Much less is known about where materials for items were sourced and products were made, before being shipped to Africa. In this chapter, we present a case study of the shipwreck Terschelling Paal 27.1 and its associated artefact assemblage. Due to the cargo of—amongst others—specific glass beads and brass ingots with lead seals attached to them, we believe we have identified one of the few ships known in the world to have operated in the eighteenth-century slave trade. The shipwreck and ingots provide a unique opportunity to answer questions on trade product provenance, since ingots mirror the primary composition of metals sourced at certain locations. Through archaeological, historical and metallurgical analyses, we were able to trace the copper to Falun, Sweden and the zinc (calamine) to Stolberg, southwestern Germany. The inscriptions on the seals might point to a particular firm in Stolberg as the production location of the brass. The results testify to the enormous scale at which ingots were used in the African slave trade and link the ingots to a long history of ingot trade since pre-Portuguese contacts with West Africa.

Introduction

Following a northwestern storm in July 2012, a birdwatcher named S. van Dijk from the Dutch Forestry Commission found a shipwreck drifting in the North Sea surf near beach marker 27 on the island of Terschelling, The Netherlands (Figure 14.1). Upon closer inspection, van Dijk could not believe his eyes: there were artefacts lying on top of the shipwreck. This was a surprising find, since other wrecks found within the high-energy environment of the (Frisian) coasts have been mechanically beaten by waves and are typically found stripped of artefacts. As these conditions were rapidly affecting this particular wreck, van Dijk quickly collected some smaller finds as he saw them disappearing in the waves, and he notified the local cultural history museum, Museum ‘t Behouden Huys (MTBH). The museum staff responded and had the wreck fragment pulled up onto the beach. The wreck was photographed, and the remaining artefacts were collected (Figure 14.2), cleaned and stored. None of the artefacts were subjected to conservation treatments.

As prescribed by the Dutch Monuments Law (1988), since 2015 renamed the Dutch Heritage Law, the find was reported to the Cultural Heritage Agency of The Netherlands (Rijksdienst voor het Cultureel Erfgoed; RCE). However, the wreck had already disappeared as a result of tidal action and beach-combing practices. Luckily, the artefact assemblage was still there to study: fragments of glass bottles and beads, stoneware sherds, clay tobacco pipe stems and a large collection of copper alloy rods and other metal objects. While the majority of artefacts were generic in terms of provenance or dating, the MBTH staff recognised the glass beads as having potential for typological analysis. The beads were macroscopically studied by Werkhoven et al. (2012), who identified them as a typical commodity amongst cargo on the first leg of the triangular Atlantic slave trade during the seventeenth, eighteenth and early nineteenth centuries. The beads were used for purchasing enslaved people or commodities on the West Coast of Africa.

Scholarly interest in the wreck find was initially limited. While the MTBH set up a small exhibit of the wreck find to introduce the public to the slave trade, the artefact assemblage was not fully studied. Five years later, however, an in-depth study and associated analyses were published on the wreck fragment, its site location and artefact assemblage (Vink 2018).

The artefacts and wreck were well preserved, with indications of mechanical rather than biological and/or chemical degradation. The sudden appearance of the wreck was similar to the situation of most wrecks on the Terschelling coast. The wrecks are buried in gullies in the naturally present or supplemented Holocene sands of the foreshore running parallel to the North Sea, only to recurrently appear for brief periods following northwestern storms. A few of them are known to move short distances (i.e. several metres), which calls into question the assumed relatedness of the wreck and artefacts. However, beyond their physical proximity, the
Figure 14.1. Map with find location. Figure by Vink (2023).

Figure 14.2. The shipwreck and its artefact assemblage. Photograph by F. Schot, former curator of the Terschelling Museum ’t Behouden Huys, and used with permission.
large quantity, homogeneity and volume of the (metal) artefacts make it likely they were related to the wreck on which they were found.

The present study builds on Vink’s 2018 study by subjecting the brass rods/ingots to metallurgical sampling and analysis. Based on the results, we demonstrate the rods have distinct trace-element and isotopic signatures, noting alloys can represent multiple ore sources, extraction and production techniques and might also have been re-smelted prior to being loaded into the ship. We have also identified the rods as the commodity referred to in historical sources as ‘coppers’ or ‘Guinea rods’, items used as a barter commodity on the West Coast of Africa (Alpern 1995; Evans 2015). While the other artefacts in this assemblage have been found across the globe and in nautical, maritime and indirect maritime contexts, the ingots highlight our interpretation that this ship and its cargo were related to the Transatlantic slave trade, one of few thus identified to date. While the pre-modern period can be challenging to study because of its increasingly diverse trade relationships, written sources also become increasingly available. Connecting the results of our analysis to historical sources provides us the opportunity to look closely at ore sources, fabrication locations and techniques, and consider the organisation of industries, institutions and relationships behind the trading of metals and enslaved people. We looked beyond the historical period of the slave trade, at the technological history of other (brass) rods/ingots, in order to place the ones studied here in a wider chrono-spatial perspective.

The wreck

The wreck was photographed from several sides on the day it was pulled onto the beach in 2012 (see Figure 14.2). In these photographs, some constructional features such as framing, planking and fastenings are distinguishable. Overall, the wreck seems well preserved. While the hull has obviously been fragmented, it still appears to hold some structural integrity in terms of the connecting elements and the wood still being able to carry substantial weight. Most timbers show their original surfaces, on which saw and adze marks are still visible. Some edges appear mechanically affected, and some elements appear broken off. The metal artefacts likely had a preserving effect on the timbers, but we suspect the wreck fragment was also buried for a long time.

From seven close-up photographs, a total of 32 frames were counted. At least three different types of frames were present, namely floors and first and second futtocks. The frames are fastened with tree nails to a single layer of future. The present study builds on Vink’s 2018 study by subjecting the brass rods/ingots to metallurgical sampling and analysis. Based on the results, we demonstrate the rods have distinct trace-element and isotopic signatures, noting alloys can represent multiple ore sources, extraction and production techniques and might also have been re-smelted prior to being loaded into the ship. We have also identified the rods as the commodity referred to in historical sources as ‘coppers’ or ‘Guinea rods’, items used as a barter commodity on the West Coast of Africa (Alpern 1995; Evans 2015). While the other artefacts in this assemblage have been found across the globe and in nautical, maritime and indirect maritime contexts, the ingots highlight our interpretation that this ship and its cargo were related to the Transatlantic slave trade, one of few thus identified to date. While the pre-modern period can be challenging to study because of its increasingly diverse trade relationships, written sources also become increasingly available. Connecting the results of our analysis to historical sources provides us the opportunity to look closely at ore sources, fabrication locations and techniques, and consider the organisation of industries, institutions and relationships behind the trading of metals and enslaved people. We looked beyond the historical period of the slave trade, at the technological history of other (brass) rods/ingots, in order to place the ones studied here in a wider chrono-spatial perspective.

The artefact assemblage

Vink’s 2018 study identified the artefacts as specific types of glass beads, glass bottle fragments, Frechen and Westerwald stoneware sherds, clay tobacco pipe stems, copper alloy cauldrons with iron handles and copper alloy rods bound together with copper alloy wire and lead seals (Figure 14.3). The majority of these objects are dated generically to the European pre-modern period, and they also seem likely to have been made in northwestern Europe.

- Glass beads. About 1 kg of glass beads was saved from the waves (Figure 14.3A). Some were broken, and the majority showed slight surface weathering. Based on morphological analysis using the Kidd and Kidd (1970), Karklins (1985) and Dubin (1987) methodologies, the beads have been identified as comprising at least seven distinct groups (Vink 2018: 50–55, 73–75; Appendix G). The majority (over 90%) are white beads of the type historically known as ‘galet blanc’ (van der Sleen 1967: 84; Opper and Opper 1989: 50–55, 73–75, Appendix G). The majority showed slight surface weathering. The remaining beads (and six groups) are black, green, green and red, white and red, white to black and a single red bead with a floral decoration. Their shapes are characterised as circular, oblate, tabular, barrel-shaped and truncated. In terms of production, the beads are drawn and double wound, and a few might have even been mould-pressed. While all the types are slightly variable in size, it is interesting to note the greatest variability occurs in the white beads. Some of the bead types represented in this assemblage are known to have been produced in Venice or in Dutch cities such as Amsterdam and Middelburg (Alpern 2021).
According to books written by Venetian merchants of the time, it appears these beads were made in varying sizes by type, with each size being traded for a particular but limited range of commodities in West Africa (Karklins 1985). The single bead with floral decoration has undated and unprovenanced parallels in Mali, Congo and Persia (Werkhoven et al. 2012), but it might have been made in (or inspired by) the Near East or Egypt (Dubin 1987: 35, 37, 113–120). Galet blanc have been identified in shipwrecks and other archaeological contexts across the globe (Dubin 1987: 38–46; Opper and Opper 1989: 16–18; Perttula and Glascock 2017: 524–529).

- **Glass bottle fragments.** The eight glass bottle fragments show a slight iridescence and originate from at least five dark green, square-sided blown and mould-pressed bottles with tapered sides (Figure 14.3B) (Vink 1995: 22–23; Dutch Museum of Ethnology 2017: 58). According to books written by Venetian merchants of the time, it appears these beads were made in varying sizes by type, with each size being traded for a particular but limited range of commodities in West Africa (Karklins 1985). The single bead with floral decoration has undated and unprovenanced parallels in Mali, Congo and Persia (Werkhoven et al. 2012), but it might be made in (or inspired by) the Near East or Egypt (Dubin 1987: 35, 37, 113–120). Galet blanc have been identified in shipwrecks and other archaeological contexts across the globe (Dubin 1987: 38–46; Opper and Opper 1989: 16–18; Perttula and Glascock 2017: 524–529).

![Figure 14.3. A) All retrieved beads; B) glass bottle bottom fragment; C) Frechen stoneware fragment; D) decorated pipe stem; E) cauldrons with handle remains; F) bundle of rods with wire and seal. Photographs by Vink (2018).](image-url)
• Stoneware sherds. Nineteen fragments were found. The bottles were wheel-thrown, fired through oxygenated and reduced conditions and exhibit the general characteristics of Rhenish stoneware (Vink 2018: 6-45; 68-71; appendix D). The majority of sherds are salt-glazed stoneware whose mottled exterior surfaces identify them as either made in Frechen or as Bartmann jugs (Gaimster 1997; Linaa 2017). Two fragments are incised with lines, one of which resembles the number ‘4’. The other sherds with incised lines is unique among the assemblage in being Westerwald and possibly datable (Figure 14.3C). It is decorated with coloured and incised foliage, characteristics which provide a rather broad terminus post quem manufacture date of 1650–1725 AD (Hume 1969; Gaimster and Hook 1995: 69; Gaimster 1997: 40–41, 167, 253, 302, 311, 344; Gawronski 2012). Rhenish potters expanded from Germany’s Rhine River valley to other regions of Europe in the eighteenth century (Baaden et al. 1990: 34, 40; Steen 1999; Skerry 2008: 32), contributing to finds of Rhenish stoneware across the globe (see, for example, Gaimster 1997: 122–123; Bröker 2008; Gilmore and Reese 2017: 599, 614).

• Clay tobacco pipe stems. Fragments of 30 ‘neatly broken off’ pipe stems were collected, ranging in length between 12 and 11.56 mm (Figure 14.3D). Three of them carry the words ‘in Gouda’, revealing the Dutch city in which they were produced, and they are also decorated with bands of an impressed ‘ladder pattern’ (Vink 2018: 45–47, 71–72, Appendix E). Unfortunately, these characteristics could not pinpoint their date of manufacture.

• Copper alloy cauldrons with iron handles. The largest artefact category in terms of volume was the copper alloy cauldron, identified by their fabric and corrosion product colours. Thirty-one were found in total. They had been stacked into piles which ranged from two to five cauldrons each, sometimes of different sizes, and they were stuck to each other by corrosion products and encapsulated sand (Figure 14.3E) (Vink 2018: 57–63, 75–77). The cauldrons used to have two iron lugs attached by riveting nails, with a hanging element in between. Only a few of these heavily corroded iron elements were found. The cauldrons were hammered out of thin plates, and have outwards folded rims. On the interior bottoms, some silverish circular and smooth lines are visible, but what they are and how they were made remain unclear. The cauldrons range in diameter from 36 to 42 cm, with one exception which is 31 cm. Another object which had washed ashore is a copper alloy open-shaped ‘pan’ with a diameter of 116 cm; it has tentatively been identified as belonging to the wreck assemblage.

The cauldrons are a well-known artefact category found across the globe. They are—amongst others—found in shipwreck contexts dating to 1600–1800 (Cook et al. 2016: 375; Beattie-Edwards 2018: 159, 171, 176). In England, a few publications on the metallurgical analysis of such cauldrons are available, and they list a significant number of European finds and their extraction and manufacture areas, highlighting a flourishing period of mining and trading (non-ferrous) metal (Day and Tylecote 1991; Dungworth and Nicholas 2004; Payton et al. 2014). A ‘list of trade goods’ culled from multiple historical sources spanning several centuries shows a wide variety of copper and brass wares was shipped to Africa in this period (Alpern 1995: 15–16). This evidence is consistent with the results of metallurgical analyses of ingots and finished products recovered during archaeological investigations of pre-modern shipwrecks (Skowronek 2021).

• Copper alloy rods with wire and lead seals. Five hundred and forty-five copper alloy rods—an astonishing number—was retrieved from the shipwreck fragment. All were well preserved, with little corrosion. Most were packed in fifteen bundles of 30, though there were also two bundles of 31 rods, and bundles were tied together with two or three copper alloy wires and lead seals (Figure 14.3F) (Vink 2018: 64–67, 77–84, Appendix H). The rods measure in length between 94 and 103 cm, and they are circular to oval in cross-section with a diameter of 7–9 mm, with acentric facets at their ends. Fabrication marks drawn longitudinally are visible to the naked eye. The rods are held together by copper alloy wires twisted around them several times. The wires measure only a few mm in thickness. Lead seals with depictions were found attached to five of these wires. A sixth detached seal was also retrieved from the wreck. The seals are similar in appearance to cloth seals of the period (see, for example, Egan 1994; Elton 2017), and they can be described as single discs with flat attachment rings. They are identical in appearance and measure 3 × 4 cm, including the attachment ring. On one side, they depict a tree with the letters T and P standing on either side of the tree trunk; on the other side, they depict a double-headed eagle (Figure 14.4). Both sides have pearled rims.

Figure 14.4. The lead seal depictions. Photographs by Vink (2018).
Rolls of wire have been found in other (shipwreck) contexts of the seventeenth and eighteenth century. These include the Dutch merchant ship *Vrouw Maria* (1771) and a seventeenth-century wreck near Leasö in the Baltic region (Cederlund 1983: 22–23; N. Eriksson 2022, personal communication), as well as the French barque-longue *La Belle* (1685) wrecked in Matagorda Bay off the Texas coast (Jones 2017: 551–552). In Europe in the seventeenth and eighteenth centuries, wire was used to manufacture pins for sewing clothes. Pin manufacturing has been documented in England, France, Sweden and the Hamburg area of Germany (Caple 1992; Jones 2017: 551–552). In very rare cases, wire has been related or attached to objects such as seals. An example is a seal with the word ‘drat’; the term usually refers to cloth thread, but in this case may refer to wire instead (Koppmann 1878; Egan 1994: 122). This specimen has monograms related to a family on it, and it was found on a wire-drawing mill. Another example is a seal with leftover wire which was excavated in Amsterdam (AmH 13-11-1975), although it is unclear whether the wire represented the commodity or an attachment medium.

The seals found in the wreck assemblage have no exact parallels, though examples of similar designs are known. Seals with stylised depictions of trees and eagles are common; examples include contemporary and modern (heraldic) family-, city-, country- and empire seals, coats of arms, coins and more. The combination of a tree and double-headed eagle is also found on the modern coat of arms of the Dutch city ‘s-Hertogenbosch. A seal with a tree and double-headed eagle was reportedly found in or near this town, but it has not yet been published; it may date to the late eighteenth century or later (E. Nijhof 2020, personal communication).

**Materials and methods**

In 2019, the authors were granted permission by the MTBH staff to use invasive techniques to obtain samples from the rods and cauldrons in order to determine the chemical composition of the rods. Eleven copper alloy rods were sampled by one of the authors (Skowronek), taken from three different bundles (Table 14.1). Additionally, five of the cauldrons were sampled. The dimensions of both types of artefacts appear rather normalised indicating pre-industrial manufacture.

Approximately 100 mg of pure metal was obtained for each sample, using a 1.5 mm High-Speed-Steel (HSS) drill bit attached to a portable Dremel. The chemical composition of the samples was measured at the material science laboratory of the Deutsches Bergbau-Museum (German Mining Museum) in Bochum using a Thermo Scientific ‘ELEMENT XR’ high-resolution, inductively coupled plasma mass spectrometer (HR-ICP-MS). For trace elemental analysis, the BAM-376 copper standard was used, as was a BRASS STANDARD. Lead isotope ratios were obtained using a multi-collector mass spectrometer (MC-ICP-MS) and a Thermo Scientific ‘NEPTUNE’ at the Goethe-Universität, Frankfurt am Main.

**Analytical results**

The results were consistent with the assumption the rods and containers were made of brass. Brass is defined as an alloy of copper and zinc in different ratios to each other. The analytical results on the chemical composition from the ICP-MS analysis are listed in Table 14.2. The trace elements, including lead, did not jointly exceed more than 2 to 3 wt-%. The cauldrons and rods showed a similar compositional trend with trace elemental patterns appearing as highly standardised. Zinc amounts had mean values at around 27 wt-%, with a single exception which reached up to 30.4 wt-%. Lead amounts were slightly higher in the cauldrons, reaching up to mean values of 1.7 wt-% to 2.3 wt-% in rods. The tin values, on the other hand, reached up to 0.18 wt-% in two cauldrons, and were therefore much higher than those of the rods.

The normalised chemical composition of the rods and cauldrons was also reflected in the lead isotopic ratios (Table 14.3). All samples demonstrated remarkably constant values in all three lead isotope ratios: $^{206}/^{204}Pb$, $^{207}/^{204}Pb$ and $^{208}/^{204}Pb$. However, two rods (samples TMs-1 and TMs-8, which were taken from different bundles) showed different isotopic ratios and represented outliers from the main cluster, forming their own group as their isotopic ratios were similar.

**Raw material sources**

Ingots are generally thought to represent a unique source of information as they are not yet transformed into other products. Care should be taken with the choice of metal, as it may not always be possible to trace the source of the metal. The use of lead isotopes to determine the origin of metals can be problematic due to the variety of sources and potential for contamination. Lead isotopes are not always a reliable indicator of the origin of metals in all cases, and other methods such as optical microscopy or radiocarbon dating may be necessary to supplement lead isotope analysis.
interpreting results of objects made from alloys in general and brass here in particular; their trace elements and lead isotopic ratios derive from the copper and zinc sources (Bougarit and Thomas 2015; Merkel 2018). Furthermore, metallurgical processes such as smelting and diffusion also affect the chemical composition of objects (Pernicka 1999). These processes have become increasingly complex since the Renaissance period (Hauptmann et al. 2016: 183).

Table 14.3. Lead isotope ratios for rods (Tms-1 to Tms-11) and containers (Tpot 1 to Tpot 5) as measured by MC-ICP-MS including standard deviations (2σ).

<table>
<thead>
<tr>
<th>ID. No.</th>
<th>Ag</th>
<th>Sn</th>
<th>Sb</th>
<th>Te</th>
<th>Bi</th>
<th>P</th>
<th>S</th>
<th>Fe</th>
<th>Co</th>
<th>Ni</th>
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<th>Se</th>
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<th>Zn</th>
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<td>TMs-1</td>
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<td>88</td>
<td>154</td>
<td>6.4</td>
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<td>149</td>
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<td>442</td>
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<td>53</td>
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<td>84</td>
<td>538</td>
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<td>64</td>
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<td>296</td>
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</tbody>
</table>

Until the mid-eighteenth century AD, brass was not produced using metallic zinc but by using calamine ores. Since metallic zinc was sparsely known in pre-industrial Europe, the process of brass manufacture depended largely on the presence of calamine ores. Calamine is a zinc-bearing rock dominantly built of minerals like Smithsonite Zn\(_2\)(CO\(_3\))\(_2\) (zinc carbonate) and Hemimorphite Zn\(_4\)(OH)\(_2\)(Si\(_2\)O\(_5\))\(_2\)\(_2\)O\(_2\) (zinc silicate). The process of melting copper with calamine to brass is called
the cementation process. While it was first thought the maximum content of zinc would lie around 28% using this process, several experiments by Werner (1970), Haedecke (1973), Doridot et al. (2006), and Craddock (2018) pointed out a higher maximum zinc content could be achieved of up to 30 to 33.3% using historical ‘recipes’, citing scholars from the eighteenth and nineteenth centuries. With the change of copper production by a coal-fuelled ‘Welsh’ smelting process in Britain (Evans 2015: 2–3) and the recognition of metallic zinc in the eighteenth century, higher zinc amounts and an even more homogeneous standard composition for brass could be produced.

Where were all the raw materials sourced? With the diversification of metallurgical processes starting in the fifteenth century around the time of discovery voyages and the large social, economic, scientific, political, and religious changes taking place within Europe, there was a coinciding spread of metals around the world, and an increase in their production. Major copper deposits in Europe are located at the Inntal Valley in Austria, Mansfeld in central Germany, and the Slovak Ore Mountains (specifically Banská Bystrica) (Hauptmann et al. 2016: 191–194). They are estimated to have produced some 500 tonnes annually in the sixteenth century (Westermann 1986: 196–197). Archaeological half-fabricates made from Slovakian copper have been found in fifteenth- and sixteenth-century ships from Portugal and other nations wrecked off the coasts of Europe and Africa (Mirabal and Arnold 1970; Maarleveeld 1988; Alves 2011; Kluger 2015; Hauptmann et al. 2016; Možejko and Ossowski 2017; Skowronek et al. 2021; Vink and Skowronek in preparation). The objects are rectangular or circular plates or ingots known as ‘Reißscheiben’, and half balls also known as ‘halbgossenkugeln’. In six of seven cargoes, some of the artefacts also bear the famous Central-European Fugger family ‘trident’ trademark.

By two centuries later in the seventeenth century, a major shift had taken place, and the majority of the total copper production now occurred at the volcanogenic copper deposits of Falun in Sweden (Figure 14.5). This location continued to produce more than 1000 tonnes annually until the end of the eighteenth century (Lindroth 1955). Additionally, Japanese copper flooded the market from the mid-seventeenth century onwards via the Dutch trade (Glamann 1958, 1977). All these copper deposits (see for smaller ones Hachenberg 1990; Hauptmann et al. 2016: 193–194) were considered as possible sources for the brass rods and cauldrons studied here.

Calamine deposits were located in Aachen/Stolberg and Goslar in Germany, Kelmis/La Calamine in Belgium (a

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Figure 14.5. Current-day map showing the locations of pre-modern period major copper deposits and calamine sources. Figure by Vink (2023).
few km from Aachen-Stolberg), Upper Silesia in Poland and the Peak district, Mendip Hills and a few locations in Cornwall and Wales in the UK (for smaller deposits, see Hachenberg 1990) (Figure 14.5). Of these, the Rhine-Meuse area with La Calamine and Aachen-Stolberg deposits significantly produced the most brass (see below) and calamine, especially between the seventeenth and nineteenth centuries.

Brass production

In terms of production, much more (up to twice as much) calamine than copper was needed to create brass through the cementation method (Pohl 1977), with the aforementioned final zinc content ending up at around 30%. Many brass production locations were therefore located near the calamine sources (Hachenberg 1990). Interestingly, the brass workers in the Aachen-Stolberg region called themselves ‘Kupfermeister’, meaning ‘masters of copper’, since they were not yet acquainted with metallic zinc (Kellenbenz 1970).

The Rhine-Meuse area with the Kelmis/La Calamine/Altenberg and Aachen and Stolberg deposits flourished in terms of brass production, starting in the fifteenth century and possibly earlier (Brown 1673; Willers 1907; Rehren 1999; Gorecki 2000). The deposits at Kelmis had a massive secondary alteration zone where non-sulfidic zinc occurred in the form of calamines (Copolla et al. 2008). Approximately 2 million tonnes of calamine with significant low lead amounts were mined there during the nineteenth century, hinting at the size of this giant deposit (De Jonghe 1998). The Kelmis/Altenberg deposit contained lower lead amounts than the one at Aachen-Stolberg (Gussone 1964; Krahn 1988; Redecke 1992; De Jonghe 1998; Chatzialidou 2009). The former nonetheless remained important while Stolberg took over (Peltzer 1908), since both England (Morton 1985) and Sweden (Forsgren 2010) became large producers of brass in the eighteenth century, both sourcing their calamine from Kelmis.

Sweden’s brass works at Nyköping, Norrköping and Skultuna together produced such high amounts of brass, the country could export more brass than raw copper in the mid-seventeenth century (Kumlien 1977). In England, British slavers began to exploit calamine deposits in the Peak District in Derbyshire. Later on, Bristol and Birmingham became major production centres for brass used in the slave trade, best expressed by manillas carrying the name ‘Birmingham-Manillas’ (Denk 2017). The Bristol brass industry of the eighteenth century relied on calamine mined at the Mendip Hills, and might have been built up with the help of Kupfermeister from Stolberg (Day 1984).

Smaller amounts of brass were also produced at copper mining centres such as Goslar (Krünnitz 1802; Peltzer 1908) and near Baltic ports of Danzig and Lübeck, sourcing their calamine from non-sulfide deposits in Upper Silesia (Boni and Mondillo 2015).

Interpreting results: provenance of the rods and cauldrons

As said above, the interpretation of trace elemental values and lead isotopic ratios is challenging since they are influenced by ore sources and metal production techniques. An interesting metallurgical process may further complicate the picture. During the Renaissance and early new era, lead was intentionally added to Central European copper ores low in silver in order to separate silver from copper using the so-called Saigerprozess (Suhling 1976; L’Heritier and Tereygéol 2010). In a case study, Hauptmann et al. (2016) have demonstrated 60 copper ingots deriving from the Saigerprozess have mean lead values above 1 wt-% and their extraordinarily homogenous lead isotopic ratios strongly overprint any lead isotope ratios of the copper ore, thus pointing definitively to the lead source.

In this study of brass rods and cauldrons, we argue against an interpretation of ‘Saigercopper’ and interpret the isotope signature as representative of the calamine source. This is due to the following two observations. Firstly, the rods and containers have trace elemental (As, Sb, Ni, Bi) values similar to both copper slab ingots of the later Mediaeval and early new era objects known as Reißscheiben originating from Sweden (Werson 2015) and Swedish copper ingots dating to the seventeenth century from a shipwreck in the German River Elbe (Althoff 1999; Rehren 1999). While arsenic and antimony strongly correlate with the trend expressed by Swedish copper ingots (Figure 14.6), nickel contents appear elevated (Figure 14.7). However, we must also take into consideration lead-zinc deposits can contain some few hundred ppm of nickel, as is found, for example, at the Diepenlinchen deposit at Stolberg (Chatzialidou 2009). Correlation between nickel and zinc amounts has been observed in plants growing on calamine grounds (Richau and Schat 2009). We therefore argue the elevated nickel amounts are derived from the calamine ore.

Swedish ingots are low in lead (with mean lead values under 0.5 wt-%) (Figure 14.8), as the Saigerprozess was not commonly used in Sweden (Irsigler 1979). As shown in Figure 14.9, the objects studied here have no similarities with the copper ingots found on the sixteenth-century shipwreck of the Bom Jesus in Namibia which Hauptmann et al. (2016) provenanced to Banská Bystrica in Slovakia. Copper produced at Mansfeld is of different composition too, being higher in arsenic and nickel and extremely low in bismuth (Skowronek et al. 2021). The different trace elements rather seem to point to Falun, Sweden as the source of the copper. Falun copper was traded throughout Europe, and brass fabricators in the Aachen-Stolberg area specifically bought Swedish copper from the seventeenth century onwards when the Mansfeld copper production declined (Malynes 1629; Peltzer 1908).

Secondly, if we assume Swedish copper was used, the high lead content as observed in the lead isotope ratios of the brass rods and containers probably derives from

"Lost on their way to Africa"
Figure 14.6. Arsenic/antimony plot for Terschelling brass rods and containers in comparison to Slovak copper ingots found on the sixteenth-century shipwreck *Bom Jesus*, Namibia (*Hauptmann et al.* 2016), and Swedish copper ingots found on a shipwreck in the Baltic sea (*Mönchgut_92*) (*Werson* 2015) and in the German river Elbe (unpublished). A strong correlation of As and Sb is apparent, as is an overlap with Swedish copper ingots. Figure by Skowronek (2023).

Figure 14.7. Arsenic/nickel plot. Nickel values of rods and containers are some few hundred ppm higher than in Swedish copper ingots, with mean values below the Slovak copper. We interpret this nickel deviation as influenced by the calamine ore used for the brass. Figure by Skowronek (2023).
Figure 14.8. Silver/lead plot. Swedish copper ingots are generally low in lead as the saigerprozess was not commonly used on low-silver copper ores occurring at Falun. The Terschelling brass rods and containers have high lead amounts, which can be explained by the calamine source. Figure by Skowronek (2023).

Figure 14.9. Antimony/bismuth plot. Low bismuth values have been detected in the brass studied here, as compared to the Swedish copper slabs. Figure by Skowronek (2023).
the calamine source. When the lead isotope ratios of the objects are compared to those published for European calamine ores, a striking similarity with calamine from the Aachen-Stolberg area is evident (Figures 14.10 and 14.11). The two outliers might indicate re-melting of scrap pieces of household brass, as von Pöllnitz (1998; Morton 2019) noted when visiting Stolberg in 1737.

**Discussion: ingots as commodities**

As pointed out, Swedish copper and Rhenish calamine were traded as raw materials all over Europe. Based on the materiality of the rods and cauldrons alone, it is difficult to determine the location of the brass works where these ingots and finished objects would have been made. It is even more difficult to say what products the rods would be made into, or where the ingots and cauldrons were on their way to. Having established a link between some artefact categories in the assemblage and the Transatlantic slave trade, and having determined the ore sources of the brass objects, we have the opportunity to consult specific archival sources. Moreover, the lead seals attached to the bundles of rods might reveal additional historical information.

The brass rods studied here are not the only archaeological artefacts published. A few case studies of chemical analyses of older archaeological specimens are known. They date from roughly the Viking age to the early Mediaeval period, and they are sourced to different ore locations (see Monod 1969; Darmoul 1985; Sindbaek 2003; Baylet et al. 2014; Merkel 2018). They also have different dimensions and cross-sections than the ones studied here. The publication by Monod (1969) is particularly interesting, as it discusses a supposed camel caravan disaster site from the twelfth century AD at Ma’aden Ijafen in the Saharan desert of Mauritania. Triangular rods of approximately 70 cm long are discussed as a commodity in the metal trade which took place for an extended period of time across the sub-Saharan. Prior to the Portuguese, metals in general had already reached West Africa via Venice, which traded metals with Alexandria and Mallorca, amongst others (Braunstein 1977; Denzel 2004; Elbl 2007). At this early point in time onwards, rods were supposedly already the most sought-after metal half-fabricate in the sub-Saharan trade (Elbl 2007). The brass rods at Ma’aden Ijafen have a lead isotopic ratio characteristic of the Harz mountains (Willet and Sayre 2006; Bayley et al. 2014), most likely deriving from Goslar, central Germany. These accounts indicate early long-distance trade of brass made from European deposits, which is in accordance with written sources (Braunstein 1977; Bingener 1998).

Around the mid-fifteenth century, the Portuguese discovered the main commodities traded by trans-Saharan Berbers were copper and brass for gold and slaves (Klein 1999; Evans 2015: 2; Morton; 2019). They established their first fort in sub-Saharan Africa, São Jorge da Mina,

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**Figure 14.10.** Lead isotope ratios for the studied brass rods and containers as compared to European calamine sources used for brass making in the pre-modern era. The homogeneity of the analysed samples suggests a single source, the Aachen-Stolberg region. However, note the two outliers. Data sources: Aachen-Stolberg: Caquet 1983; Bielicki and Tischendorf 1991; Krahn and Baumann 1996; Durati-Müller 2005; Bode 2008. Peak District/Mendips: Rohl 1996. Goslar: Lévêque and Haack 1993. Upper Silesia: Zartman 1979; Clayton et al. 2002. Figure by Skowronek (2023).
Lost on their way to Africa in 1482, and soon after the quantities of brass shipped to Africa reached new dimensions (Teixeira da Mota 1969). With the discovery of the New World, the demand for enslaved Africans as a work force rose exorbitantly, and the Transatlantic slave trade was established. Amongst other commodities, brass and copper would remain important trade objects. Rods and their fabrication techniques started to appear on lists of commodities and other historical sources.

As discussed above, a shift took place in the locations where copper was mined during the centuries following the first Portuguese voyages to the east. At first, the majority of copper was sourced from Central Europe, but by the seventeenth century, Falun had become the primary mine for copper. Interestingly, the brass producers in the Aachen-Stolberg region were aware of the qualities of copper from the different regions, and from written sources, we know they actually preferred Mansfeld copper due to its purity (Westermann 1971).

In a few Dutch records of the later seventeenth century, the rods and their dimensions are listed, and it becomes clear the rods themselves were exchanged for enslaved Africans (Ratelband 1953; Alpern 1995). The listed rods were also circular in cross-section, and they are described as being available in several sizes and lengths: in 1668, Dapper mentions a type of rod with a weight of 1.3 lbs (604 g) and length of 34 inches (86 cm) for the first half of the seventeenth century. Ratelband (1953) mentions two types for the later seventeenth century: one about 40 inches (102 cm) length and 1 lbs (453 g) in weight, and the other of the same length but weighing around 1.6 lbs (755 g). The first sort described by Ratelband is therefore somewhat in accordance with the measured dimensions of the rods studied here (see Table 14.1). Furthermore, information on the amount of rods paid for enslaved people is even available. Davies (1957) points out that by 1678, a female slave cost 30 rods and a male slave 36 rods, with some fluctuations in these costs over the years. While an unambiguous date for the Terschelling wreck and its artefact assemblage may never be known, it is shocking to remember the bundles studied here contained around 30 rods each, with implications for the number of people who would be purchased for slavery.

In addition to brass and copper ingots, brass reached Africa also in the form of copper (alloy) ‘manillas’, a type of bracelet or arm rings in various shapes, sometimes looking like twisted rods (Dapper 1668). Names for the rods for the African trade are ‘Guinea rods’, ‘coppers’, or even ‘negroes’ (Morton 1985; Herbert 1984; Alpern 1995; Berg and Berg 2001; Evans 2015; Denk 2017). Spiral money forms like the so-called ‘nt-chang’ of Cameroon (Denk 1983) might also very well have been made from rods. This aligns well with the description of rods by the Swedish traveller Angerstein (Berg and Berg 2001), who visited brass works in England and pointed out the importance of the rods’ ductility when they were prepared specifically for the trade on the ‘Guinea Coast’. This

Figure 14.11. Lead isotope ratios. See Figure 9 for comments and data sources. Figure by Skowronek (2023).
observation fits well with other historical observations that manillas were specifically made in conformance with certain requirements demanded by the African market (Curtin 1975; Herbert 1984; Alpern 1995; DeCorse 2021; Skowronek et al. 2023).

It is, as Herbert (1984) put it, hard to visualise the millions of rods and manillas which had reached the African continent by the time the slave trade ended. A recent effort by Skowronek et al. (2023) discusses the identification of the metallic sources of the so-called ‘Benin bronzes’, brass and bronze manillas retrieved from a number of shipwrecks and terrestrial sites dating from the sixteenth to the nineteenth centuries. From a large number of samples, a complex picture emerges of pre-modern experimentation with chemical compositions, preferred chemical compositions for certain types, and uses of finished products; a wide range of metallic sources; and mixing of ores from different sources but also the mixing (re-smelting) of objects.

**Discussion: the lead seals**

Proceeding with the substantiated assumption the rods were made from calamine sourced from Stolberg, it is fortunate to have historical sources of the *Kupfermeister* families available to consult. In the seventeenth and eighteenth centuries, around 40 families were active in brass works at Stolberg. Assuming the brass was produced there and the monograms were related to family names, we find only two families starting with ‘P’ were active, and none with ‘T’ (see Figures 14.3F and 14.4), namely, the Prym and Peltzer families (Day 1984: 51). Continuing this line of enquiry, no first names starting with ‘T’ are found in the Prym family, while there were several ‘Theodors’ in the Peltzer family, all active as *kupfermeister*. Coincidentally, the Peltzer family weapon includes three trees (Macco 1901). While this evidence is not compelling, it is interesting to look at the individual Theodors. One born in 1644 (who was also a mayor of Stolberg) bought a brass mill called ‘Die Weide’ (‘the willow’) in 1723 from the Lynen family. He died in 1738, and Die Weide passed to his son Heinrich (Macco 1901, 1907). Heinrich had the monograms *TP* and *MP*, belonging to his parents, incised into the stones over the entrance to the building. In 1738, another Theodor Peltzer was born, and he was also an owner of Die Weide (Schleicher 1965). The building remained in possession of the Peltzer family until 1805. It was damaged in the Second World War, but the stones with initials were recovered and reused in the new building, which still stands today (Day 1984: 48). It remains debatable whether the tree depicted on the seals studied here show a willow with a thick stem and branches sprouting from the top; nonetheless, the privy seal might be tentatively interpreted as belonging to an eighteenth-century member of the Peltzer family.

Besides the possible German production of brass, we must also take the extensive copper and brass works of England and Sweden into account, and remember, we also have two outliers (Figures 14.9 and 14.10). These outliers point to a younger mineralization than a Rhenish source. Ingots made from English lead ingots cluster near these outliers. Calamine was imported via the Dutch Republic from the Aachen-Stolberg area to England and Sweden, and copper was imported from Sweden to England as well. In England, investors in slaving often had shares in copper and brass works (Evans 2015: 3). Of these, Thomas Patten is a well-known ‘TP’. He established a copper and brass company at Bank Quay, Warrington near the Peak district (Morton 1985).

**Conclusions**

In this paper we have pointed out the explanatory power of a combined archaeological, historical and scientific approach towards the recently established interest in metal trade during the period of the Transatlantic slave trade (sixteenth to nineteenth centuries AD). The amounts of metals shipped from Africa to Europe are often largely underestimated, and would likely have ranged up to several hundreds of millions of tonnes. Their fabrication as exchange currencies also remains poorly studied, especially from a material science point of view.

We have used this case study of brass rods found on a shipwreck on the North Sea coast of the Dutch island of Terschelling to explore the composition and provenance of one of the exchange currencies used in the slave trade. We want to highlight our observation of continuity in trading brass rods with Africa since the early Mediaeval period, as well as their mass production during the era of the Transatlantic slave trade.

The rods studied here have trace element values similar to Swedish copper ingots found on two shipwrecks dating to the post-Mediaeval era and highly homogenous lead isotopic ratios consistent with calamine ores from Aachen-Stolberg, and two from England. Besides the ingots being rare examples of metal ingot commodities used in the slave trade, they are also surprisingly rare examples of ingots or objects consisting (partly) of Swedish copper (Skowronek 2021 and Skowronek et al. 2023). Due to the advanced state of globalism by the eighteenth century, it is difficult to investigate who exactly made the rods. This may be solved by finding parallels to the seal marks described here.

For now, we suppose a manufacture origin in Stolberg, Sweden or possibly England. When this location is compared to where the shipwreck was found, the situation is puzzling. The port (or ports) of embarkation for the objects remains unknown. Based on logic alone, a British or southern Dutch port of departure makes less sense than, for example, a Swedish port of departure for a ship ending up on the Terschelling shore. And quite possibly, Africa was not the first destination of the entire voyage, as different commodities were generally loaded at several ports. Further complicating the picture is the slave trade’s involvement of many European powers (Portugal, Spain, France, Britain, The Netherlands, Denmark, and Sweden),
national trading organisations and foreign investors in European states. While in recent years, major efforts have been made in digitising archives such as the Sound Toll register, a lot of work still remains undone. ‘Brass’ (or described as copper) rods are not explicitly mentioned in the lists of commodities amongst the approximately two dozen copper and brass notations and ware specifications in several languages. In comparison, copper ‘kettles’ are already mentioned as early as the sixteenth century, and zinc ores are even mentioned in nineteenth-century voyages.

Moreover, more attention should be focussed on the first leg of the trade between Europe and Africa. Admittedly, the focus has quite logically and humanely always stressed the Transatlantic or ‘Middle Passage’ and Intra-American slave voyages. The use of archaeometallurgical methods and cross-referencing of those results to archival sources of—amongst others—ship’s cargo listings creates a strong potential to learn more about networks of transport and hubs and spokes. Such sources may paint a picture of a larger maritime landscape with overseas and inland waters connecting to hinterlands which we would not at first characterise as ‘maritime’. Along the way, we might gain a better understanding of the people who made and used metal objects and the social and economic contexts in which they lived and operated. As is tentatively demonstrated in this case study, it is sometimes even possible to zoom out from an unidentified ship and its wreck site to a large chrono-spatial scale, and to zoom in to a certain network or even a specific individual.

More efforts should also be made to look into the use of metal commodities and brass rods, particularly in Africa, as those are sparsely described in the literature. From an archaeological point of view, we have simply not found enough data to work with and compare, which might suggest other processes such as re-smelting were at play. But we need more than a couple of ingots. In future research, we will also need to focus on the different types of manillas, as they were a common currency in Africa. Together with the work carried out here and in the recent contributions by Rademakers et al. (2018, 2019), we might gain a better understanding of both the nature of the European metals traded and their impact on African cultures and peoples.

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Forgotten Wrecks of the First World War: examining the significance of merchant ship sites

Julie Satchell

**Abstract:** The large numbers of merchant vessels lost off the south coast of England during the First World War were investigated during a major study undertaken during the centenary of the war. This study analysed archaeological and historical data to understand how the collection contributes to the understanding of themes related to warfare, ship technology, international trade and personal experiences. Recognising that none of these merchant vessels are protected by heritage legislation, case study examples were used to test the application of the criteria for ascribing significance within the available protection mechanisms.

Detailed review of two average sized cargo vessels, *Eleanor* and *Camberwell*, and two larger passenger-cargo liners, *Medina* and *Alaunia*, considered their individual stories to reveal a range of rare, unique and highly significant attributes. The process revealed how current approaches to significance assessment struggle to capture elements related to late nineteenth- and early twentieth-century shipwrecks, particularly their international significance and their commemorative importance.

Introduction

During the First World War, the global transport and supply network which fed, fuelled and sustained civilian and military populations was key to supporting both Britain and the Central Powers. As a result, the most intense naval warfare took place in the English Channel, in the Western Approaches of the Atlantic and in the North Sea. A high proportion of ships lost in the area were merchant vessels (Friel 2003: 237; for further detail, see MacNeile Dixon 1917; Hurd 1921–1929; HMSO 1976).

This chapter explores the application of current UK approaches to the assessment of significance to First World War cargo wrecks and the effectiveness of this methodology to reflect fully the historical and social context of the ships. It utilises the results of the Forgotten Wrecks of the First World War project, which investigated a collection of over 1,000 wrecks off the south coast of England and demonstrated the diversity of ships and shipping and the magnitude of the conflict. Within the dense and complex dataset, there are many merchant ship losses which have historically been grouped together as ‘cargo vessels’. This somewhat reductive term masks the potential for these modern wrecks to add to the understanding of social, economic and political themes at a range of scales, from the perspective of individual vessels to the group value for informing on warfare tactics and outcome, as well as the movement of goods and people transnationally during conflict.

The ascribing of significance is examined through four case studies: the *Eleanor*, which carried a unique wartime cargo and held personal connections for commemoration; the *Camberwell*, which carried a cargo destined for British interests in India; the *Medina*, which carried a colonial Governor’s possessions and has been subject to modern salvage interests; and the *Alaunia*, which had an unusual engine type and had been involved with troop transport for Gallipoli and from Canada. They represent the merchant fleet which kept Britain running at a time when it was part of a global empire.

Each case study wreck provides a unique expression at a micro-level, with their physical remains providing perspectives different from the historical record. Research demonstrates how a more holistic approach to their interpretation can illustrate themes within the late nineteenth and early twentieth centuries, allowing them to be placed within their full historical context of the evolving systems of colonialism and capitalism, as well as reflecting developing ship technology. They also demonstrate issues related to heritage management of modern ships in UK waters; many historic wrecks are currently unprotected and vulnerable. The protective legislation which could be applied to these wrecks and the associated criteria for assessing significance are explored, highlighting areas within this system where modern ships are not well served.

**First World War wrecks off the south coast of England**

Between 2014 and 2018, a major study of First World War wrecks off the south coast of England was undertaken (Forgotten Wrecks of the First World War 2023). It coincided with the centenary of the war and aimed to...