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The Woerden 7: an oar-powered Roman barge built in the Netherlands.
This paper presents a Roman ship that was excavated in 2003 near the castellum Laurium (Woerden, the Netherlands). The ship, called the Woerden 7, was built in 162/163 AD and shows all the characteristics of a Roman barge or cargo ship of the Zwammerdam type. There are, however, two remarkable aspects, which make the Woerden 7 stand out. First, it was found to have had a oar arrangement, which presumes that the ship could be moved by manpower (upstream). Second, next to woods from German soil, Dutch oak woods had been used in the primary construction of the ship. This demonstrates that the ship was probably built on a yard somewhere in the Dutch river area. These findings have shed new lights on river transportation and shipbuilding along the limes of Germania Inferior.

Der Woerden 7: ein geruderte römisches Prahm erbaut in den Niederlanden
Dieser Artikel stellt ein römisches Schiff vor dem in 2003 in der Nähe des Kastells Laurium (Woerden, Niederlande) ausgegraben wurde. Dieses Schiff, Woerden 7, wurde 162/163 nach Chr. gebaut und hat alle Kennzeichen eines römischen Prahm oder Frachtschiffs vom Typ Zwammerdam. Es gibt allerdings zwei Besonderheiten bei Woerden 7, nämlich die Anwesenheit eines Ruderapparats an Bord und die Feststellung, dass ausser ‘deutschem’ Holz auch ‘niederländische’ Eiche in der Primärkonstruktion verbaut wurde. Das deutet darauf hin, dass Woerden 7 auch per Ruder (stromaufwärts) fortbewegt werden konnte und dass das Schiff wahrscheinlich in einer Werft irgendwo im Stromgebiet der Niederlande gebaut wurde. Das wirft ein neues Licht auf Flusstransport und Schiffsbau entlang des untergermanischen Limes.

Le Woerden 7: un chaland romain à rames construit aux Pays-Bas
Cet article présente un bateau romain, déterré en 2003 à proximité du castellum Laurium (Woerden, Pays Bas). Le bateau, surnommé le Woerden 7, a été construit en 162/163 après J.C. et représente toutes les caractéristiques d’un chaland romain ou cargo du type Zwammerdam. Deux particularités cependant en font un navire hors du commun; d’un part la présence d’une installation pour la propulsion par rames, d’autre part l’emploi dans la construction de chêne « hollandais » en combinaison avec du chêne « allemand ». Cela démontre que le bateau pouvait être propulsé par force humaine – du moins en aval – et qu’il était probablement construit sur un chantier naval, situé quelque part le long du Rhin sur le territoire hollandais.

The Woerden 7, an oar-powered Roman barge built in the Netherlands: Some details of the excavation at the *Nieuwe Markt* in Woerden (Hoochwoert)

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1. Introduction

In 2004 excavations in the centre of the Dutch town of Woerden drew to a close, marking the end of a large-scale archaeological survey of a Roman military settlement known as *Castellum Laurium*[2] (fig. 1). The excavations formed part of the *Hoochwoert Project*, which involved the expansion of Woerden's town centre and the construction of an underground car park, the *Castellum Garage*. Earlier excavations suggested that the Rhine once flew through the survey area *Nieuwe Markt*. As happened several times before in Woerden, Roman ships could thus be encountered. This expectation was fulfilled once more and the resulting excavation in the autumn of 2003 of a ship, known as the Woerden 7, was a great success, drawing thousands of visitors.[3]

The excavation yielded an amount of information. One feature in particular stands out, consisting of a number of wash strakes, light planks nailed against the top of the hull. Such planks have been encountered before, for instance in the Roman pram De Meern 1, excavated just before the Woerden 7.[4] Unknown so far in this type of vessel, are the oar locks in the wash strakes, only preserved in the starboard side aft. The tantalizing question of the function of these – *rowing* oars, (additional) *steering* oars or both – will be discussed below.

Another important issue are the spectacular results of the analyses of the wood samples, taken from nearly all parts of the Woerden 7. We will start however with a brief summary of the research methods and of the most important finds.

2. The discovery of the Woerden 7

On Monday June 30, 2003, ship remains were discovered at the Nieuwe Markt in Woerden at a depth of approximately three meters below ground level, directly below the medieval rampart and moat. This first led to the presumption that the ship dated to the Middle Ages, confirmed by some of the invited maritime archaeologists from the Dutch National Service for Cultural Heritage (Rijksdienst voor het Cultureel Erfgoed - RCE). After re-examination however, it became clear that the remains belonged to the (heavily damaged) forward part of a Roman barge of the *Zwammerdam type*.[5] The last remaining sceptics could be convinced by the provisional dendrochronological analysis of two of the ship's floor timbers, which post-dated to AD 130 and 138. As sapwood was lacking, some 20 years must be added to these dates, giving a *terminus post quem* date of approximately AD 150-160.[6]

3. The excavation

In anticipation of the excavation, all parties concerned agreed that the Woerden 7 would be investigated as thoroughly as possible. This meant completely dismantling the ship, which, while precluding the possibility of

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[1] The authors respectively served as director of the Woerden 7 excavations, senior maritime archaeologist (Rijksdienst voor het Cultureel Erfgoed (RCE, Amersfoort) and municipal project manager. The other members of the field team were E. Blom (field archaeologist, ADC-Archeoprojecten, Amersfoort), A. Veenhof (field technician, ADC-Archeoprojecten), Y.E. Vorst (dendrochronology specialist (RCE), W. Derickx (land surveyor, RCE), J. Quik (excavation assistant) and B. de Wit (machinist). They were joined by amateur archaeologists G. van Dijken, C. Doedijns, H. Kooiman, M. Scheer and H. van Uunen of the Woerden Archaeological Working Group. Archaeological materials specialists M. van Dinter (physical geography), E.A.K. Kars (stone and ceramics), P. van Rijn (wood) and C.G. Wiepking (ceramics) also closely participated in the project.

[2] See for an overview of excavations in and around the castellum in Woerden, Haalebos 1986; Vos et al. 2003, 51, fig. 1; Van Enckevort et al. 2006, 110-111; Blom / Vos 2007, 409-421; http://www.woerden7.nl.

[3] In fact the wreck represents Woerden's sixth Roman vessel. The name Woerden 7 is due to a duplicate entry (the ship fragments Woerden 2 and Woerden 6 belonging to a single vessel) in NAVIS, the international database of ancient European ships. For more information about other ship remains from Woerden, see http://www.woerden7.nl and http://www1.rgmz.de/Navis/home/frames.htm.

[4] Morel 2007.

[5] De Weerd 1977; 1988; 1990; 2001.

[6] A number of timbers where sapwood was still present have since been dated to the winter of AD 162/163 (Vorst 2005, 12-17; Blom / Vorst / Vos 2007, 350-353, 377-380).

conserving the vessel in its entirety,[7] presented a rare opportunity to examine this particular type of vessel. Mechanical drilling was used to determine the exact position of the Roman ship. Based upon these measurements, a cofferdam was built around the ship and fitted with a drainage pump. A hydraulic excavator removed the bulk of the soil covering the ship, which was then divided into five segments of five meters each. These were excavated down to the timbers of the hull, largely by hand. A small excavator was used to remove the soil between the ship and the coffer dam. From then on, the larger excavator was fitted with a so-called 'clam bucket' and employed from the sidelines (fig. 2).
The actual excavation started at the stern.[8] The relevant structural elements, the driftwood and dislodged constructional elements surrounding the ship were recorded with a *robotic total station* and afterwards drawn by hand as definite field drawings (fig. 3). In order to prevent further decay during excavation, a sprinkler system was installed to keep exposed wood wet. Unfortunately, most of the wood was severely degraded by bacteria and subsequently invaded by fungi.[9]

4. Description of the Woerden 7

4.1 General information (plate 1)

The Woerden 7 belongs to a family of flat-bottomed Roman *prams* or *barges*, of which the most famous examples were discovered in the early 1970's, just outside of the castellum *Nigrum Pullum*, near the Dutch town of Zwammerdam (province of Zuid-Holland). The six ships – three barges and three dugouts – have since gained fame throughout Europe.[10] All Zwammerdam-type vessels are of a comparatively simple construction, with a flat bottom and more or less vertical sides (fig. 5 and 6).
As found, the Woerden 7 measured 4.7 m across, with a preserved length of roughly 25 m, since the ship was not preserved in its entirety. Over the centuries, the fore end of the ship came to rest slightly above the groundwater table, causing its almost complete decay. Comparison of the position of the mast step with that of the Zwammerdam 6, indicates that the original length of the Woerden 7 *could* have been 29.60 m, or 100 Roman feet *(pedes Monetales).* Forty-three floor timbers remained intact. At their highest point, the sides of the ship were no higher than 1 meter.
A keelson runs above the centerline of the Woerden 7, made up of two separate beams, connected by a horizontal halved joint and fastened with nails. For (yet) unclear reasons, it is remarkably long, measuring precisely 14.80 m or 50 *pedes Monetales*. It is possible that there is a relationship between the length of the keelson and that of the mast, but this cannot be conclusively shown. Grooves cut in the underside of the keelson at regular intervals allow it to fit tightly over the ship's frames. At the level of the 35th frame, the keelson thickens to form a mast step, to accommodate the mast heel. In most cases, the mast is located at two-thirds of the length of the ship, counted from the stern.
The bottom of the ship contains ten strakes, each consisting of a row of planks placed end-to-end and fitted together with scarf joints and iron nails. The longest of these planks measures over 14 meters. Analysis has shown that a number of the planks were taken from the same tree.[11]
The bottom strakes and side strakes of the ship are joined by long, L-shaped 'chine blocks', hewn from a single hollowed-out log, having a more or less dugout-like appearance.
Floor timbers or frames are placed at right angles to the strakes, spaced at intervals of 30-35 cm. The frames are rectangular in section, between 20 and 30 cm broad and approximately 15 cm thick, spanning the entire breadth of the ship. Each frame is provided with a naturally grown knee, formed where a tree branch split off from the main trunk. These are alternately placed on port or starboard side, but twice however, three knees were placed in a row. Only in one instance, an individual futtock instead of a grown knee was used. The knees (and the single futtock) provide support to the sides.

[7] Due to the risk that the bacteria present on the Woerden 7 could spread to other ships already deposited there, the RCE decided not to move the remains of the Woerden 7 to the National Field Depot in Nijkerk for preservation.
[8] This was not only technically speaking more practical, but in Holland shipwrecks are usually documented starting at the stern and moving toward the bow.
[9] Degradation analysis of the materials, including wood and iron, was done by H. Huisman (RCE).
[10] De Weerd 1988; Bockius 2000. See Haalebos 1977 for the castellum.
[11] See Vorst 2005, 33-48; Blom / Vorst / Vos 2007, 382-390.

The floor timbers are fastened to the bottom with two countersunk nails in each strake from above. In turn, the strakes are nailed to each *second* frame from below. Although the fore part is missing, probably both extremities of the strakes were capped by so-called 'prow blocks', also fastened with 'iron nails'.
V-shaped notches, known as 'limber holes', are cut into the undersides of the floor timbers, exactly above the seams between the strakes. Though the seams were caulked, water still could seep up between the strakes, decaying the frames above. The limber holes allowed air to circulate and prevented the frames from rotting away.
A long, wooden beam was mounted across the middle of the knees on both sides of the ship. This beam, known as an 'inwale', has been partially embedded in the knees. Illogically-placed notches on the reverse of the inwale seem to have no function and may indicate that the wood had originally been used for other purposes.
The construction of the ship – and in particular the use of L-shaped chine blocks, floor timbers with grown knees and futtocks to connect the flat bottom with the sides – is typical of Roman barges of the 'Zwammerdam type'. The crossed timbers at the rear of the ship are, however, rarely encountered. Besides the Woerden 7, only one other Roman ship, the Zwammerdam 6, is known to have had a similar construction, in this case both at stem and stern. In all likelihood, also the Woerden 7 was provided with crossed timbers in both ends of the ship.

4.2 Iron fittings and repairs

All wooden hull components are connected with large-headed iron nails of differing lengths and thicknesses. The shipbuilders employed nails of very hard iron up to 60 cm long, in order to secure the fillers between the bottom and sides (fig. 7). These areas show additional iron clamps on both the inside and outside of the hull, as well as U-shaped brackets over the sides. The floor timbers were fastened to the strakes with nails approximately 10 cm in length. These were apparently made of softer iron, as they often curled before completely piercing the strakes. The nails connecting the individual planks in a strake to one another, were also clearly made of softer material. They tended to bend and curl back on themselves halfway through the next plank, making them in fact act as staples. This was certainly intentional, since it improved their joining capacity.
Seams between the bottom planks and the joints between the chines and the sides, were caulked with plant-based materials, held in place by hundreds of tiny caulking nails, inserted from the underside of the ship. These nails were, in turn, covered by protective strips of wood, but only in the ship's fore and aft.
The Woerden 7 presented remarkably few repairs and mainly to the bottom of the ship's hold. A new plank had been inserted from below and secured with nails and caulking. The dates for the wood used correspond with those for the rest of the ship. This suggests that the repair was carried out while the ship was still being built, likely due to a defect in one of the strakes.

5. Some special aspects of the Woerden 7

5.1 The oar arrangement, windlass and mast locker

Some insight into to the way in which some Roman cargo vessels were propelled can be concluded from the Woerden 7's most distinctive characteristic, its till now unique arrangement for oars, suggested by indications on two of the ship's timbers. The first consists of a beam running along the starboard side of the ship in which dovetailed notches were cut (fig. 8).[12] These notches were certainly used to secure removable planks, which may have served as benches for the crew to sit on while handling the oars. During the excavation, this notched beam has therefore been christened the 'rowing bench support beam'. Of the rowing benches themselves, only small, displaced fragments were found. The benches were presumably either removed from the ship before it sunk or washed away afterwards.
Another indication to the use of oars is formed by a plank running along the ship's gunwale, with holes at regular intervals and its upper edge worn in places, forming a series of shallow depressions. This plank, known as a 'wash strake', shows the position of the oars and the way in which they were mounted. They rested in the depressions along the edge of the wash strake, apparently caused by wear. The oars were probably once secured by ropes or leather straps, looped through the holes in the wash strake, called 'oar ports'.

[12] This beam was missing on port.

An almost complete windlass was present in the stern of the Woerden 7, very similar to the one found in the Zwammerdam 6.[13] Removable wooden spokes could be placed into two square holes in the spindle of the windlass, in order to handle it for coiling or tightening ropes. The spindle was held in place by two mounts, more or less semicircular pieces of wood with a hole in the middle in which the spindle rotated. These mounts were nailed to the sternpost and to one of the crossed floor timbers. One of the mounts was found *in situ*, while the other lay approximately 17 meters away, outside the starboard side of the ship at the level of the mast step. Immediately in front of the mast step, spanning the space between keelson and port side, four small planks were found. These were lined up one above another and forming a bulkhead, still some 50 cm high. The planks were nailed against uprights, inserted in the keelson and underlying frame (fig. 9). The top of this partition was once, most likely, nailed against the mast thwart, situated somewhat higher. Although the mast thwart itself has not survived, it is obvious that it spanned the whole breadth of the ship at gunwale level – as is clear from a notch in the inwale – holding the mast in place. Apparently the surviving planks, along with the mast thwart, once formed a storage locker, located in front of the mast and stretching from side to side. This locker, made of ash, would have provided a small closed space to store supplies and inventory. A similar mast locker was found aboard the Woerden 1.[14]

5.2 Artefacts

It was expected, that the finds in and around the ship might shed some light on the reason why it went down. Such an analysis, however, requires much reservation, as artefacts may have drifted in from elsewhere. The finds of the Woerden 7 did not allow any conclusion in this respect, but they provided some support to the current opinion that it sunk somewhere between AD 175-200. Some of the artefacts that seem to support this possibility are discussed below.

A concentration of tuff and ceramics lay on the floor of the hold, presumably the remnants of a hearth. This conclusion is supported not only by a number of comparable examples on other ships of this type, but also by burning marks on several of the pottery items. Charred pieces of wood were also found among the remains of the hearth and a number of frames just underneath it were also (superficially) charred by fire.

Particularly striking is the presence of ceramic objects, associated with a Roman *hypocaust*. These include multiple square tiles measuring 22 cm across and fragments of *tubuli*, hollow pipes used to circulate hot air in the walls of the hypocaust.

Practically nothing of the ship's inventory seems to have been preserved. The only (nearly) complete pottery vessel found aboard was a Samian ware dish, type Dragendorff 18/31. The remaining ceramics only consist of potsherds of uncertain origin. They may be fragments from pottery originally belonging to the Woerden 7, or they may have drifted in from middens surrounding the castellum, having been carried along by the Rhine and deposited in their present location.

Approximately halfway along the ship's length, several large chunks of basalt and tephrite were found, probably from quarries in Central Germany near Koblenz and Mayen. Though the basalt had not been manufactured, the tephrite clearly was and may (once) have served as a grindstone. The primary question regarding these stones is: cargo or ballast? The answer is far from clear. It is even possible that neither option is correct, and that the stones were only deposited after the Woerden 7 had already sunk, perhaps having been discarded in the river.

Only one metal object was found on board the Woerden 7: a whetting anvil, which could have been used to sharpen blades or forge nails. After the ship had been completely excavated, a number of fishhooks were also found in the sand underneath.

Seven leather shoes were discovered on the bottom of the Woerden 7 against the starboard chine block, in the same area as the oar arrangement. It is therefore possible that the two are connected in some way. Perhaps the shoes were old and worn-out, and had been discarded there by the oarsmen. The shoes date to around AD 180,[15] which might – but only if the shoes undoubtedly belonged to the inventory – (post)date the sinking of the ship, and thus its lifespan.

[13] See De Weerd 1988, 161 and fig. 87 for the Zwammerdam 6 windlass. For proposed reconstructions, see Bockius 2002c; 2002d.
[14] Haalebos 1996, 483.
[15] Van Driel-Murray 2007.

6. Other Roman shipwrecks in Woerden

Roman shipwrecks have been discovered in Woerden before. Their find spots provide an indication of the (former) beds of the ancient Rhine and eventual other streams (fig. 10).[16] The distinguishing features of these other ships are summarized briefly below.[17]

The grain transporting barge Woerden 1, was discovered in 1978 near the former St. Joseph's boarding school in the Groenendaal area of Woerden.[18] The excavation was limited to a segment roughly ten meters in length. The ship was approximately three meters wide at its widest point at the mast thwart. Dendrochronology was used to date the ship's timbers to AD 169. Artefact found aboard the ship date to between AD 175-200, indicating that the Woerden 1 must have sunk near the turn of the 3rd century.

The Woerden 2/6 is another Zwammerdam-type cargo ship.[19] It was first discovered in 1988 during soil decontamination operations at the gas plant on the Oranjestraat in Woerden.[20] When clean-up operations were continued ten years later, workers encountered the ship once more. The Woerden 2/6 measured 3.1 m across, with a length of approximately 14 m. It had a flat bottom, with L-shaped chine blocks on both sides. The sides were heightened to roughly 1.2 meters by wooden planks nailed to the chine blocks. All timbers were secured with heavy nails.

The Woerden 3, an extended dugout with heightened sides supporting a mast thwart, was also discovered during the 1998 gas plant clean-up operation. Though the total length was not recorded, the distance between the mast and the bow was 3.5 meters. Paired frames were nailed to the side walls. The vessel bears many striking similarities to the Zwammerdam 3.

Very little is known about the Woerden 4. The vessel was mentioned in 1823 by Caspar Reuvens, the world's first professor of archaeology. Reuvens received a letter from a local official who had found a reference to the ship in written sources from 1576. According to this account, workers in the area had stumbled over the remains of a Roman ship while erecting new defensive fortifications known as the 'Holle Bolwerk'.

The Woerden 5 is a small dugout, equally found in 1998 during the renewed soil decontamination operation at the Oranjestraat gas plant. Holes had been drilled in the sides to allow water to circulate, so obviously the vessel was (re?)used as a fish well, to keep the catch alive. [21] A late 2nd-century Samian ware bowl was found in the immediate vicinity of the ship.

The Woerden 8 consists only of several frame components, found in the hold and under the stern of the Woerden 7 in 2003. They clearly belonged to a round bottomed vessel, different from all others found in Woerden. The frames and the (missing) hull planks were not fastened together with iron nails, but with rather thin wooden pegs, a typical Mediterranean construction technique often used in galleys: fast, oared warships, also bearing a mast and a ram. The smaller river galleys, as the Woerden 8 must have been, were usually propelled by around 20 rowers. In general, these vessels were between 15 and 20 m long and three meters wide and often used to patrol the Rhine. Such a Roman galley was discovered in the Dutch town of Vechten at the end of the 19th century, but otherwise no other remnants are known from the Netherlands.[22] Several excellently-preserved galleys, however, have been discovered in Germany, near Mainz and Oberstimm.[23]

7. Interpretation and reflection

7.1 Rowing or manoeuvring?

After presenting the physical characteristics of the Woerden 7, we can return to the questions raised in the introduction. To begin with, a closer look will be taken at the oar arrangement, which prompted to rethink some current views on how Roman barges were propelled. The rowing benches of the Woerden 7 not only open up discussions on such topics as the ship's intended life span, the reuse and possible sale of ship timbers, and the scuttling of ships to serve as reinforcements to the riverbank, but also about the ability of (certain) Roman barges to sail both up- and downstream. To say that these were able to sail downstream would be stating the obvious;

[16] For the find spots of the Woerden ships and the reconstructed former river bed of the Roman Rhine, see Van Dinter 2007.
[17] See also http://www.woerden7.nl; Haalebos 1996; Bockius 2002a, 30-35.
[18] See Bockius 1996; Haalebos 1996.
[19] As stated in note 3 in the introduction, ship fragments Woerden 2 and Woerden 6 belonged to a single vessel.
[20] See Bockius 2002a, 35-36.
[21] The fish well Zwammerdam 5 is a good and in many ways comparable example of a reused dugout (De Weerd 1988, 83-92).
[22] Bockius 2002b, 60-62.
[23] Bockius 2002c; 2002d; 2002e.

they simply drifted by the natural current of the river and could eventually increase their speed through the use of sails.
Ensuring that the cargo reached its destination was largely a matter of navigational skill. Once the ships had arrived, however, the real question was if it was worth the trouble of sending them back upstream to reload. The great value of the Woerden 7, is that the ship gives important new information about certain aspects of river transport in the northern provinces of the Roman Empire.
While wooden ships sometimes had a surprisingly long lifespan,[24] it is clear that river barges were often used for a single voyage before being disassembled at destination and sold as lumber alongside their cargo.[25] In France, along the Garonne, this happened till quite recently and was called `*vente en dechirure*' (sale to tear up). Besides long-lasting barges as De Meern 1, it can be expected that at least a number of Roman barges were used as 'packaging' for the cargo, mainly stone and other building material from Germany, transported by the Roman army to the Netherlands. These ships would drift and sail with the current towards their destination, where they would be unloaded and then sold for `dechirure'.
Another presumption challenged by the Woerden 7, was that of Rhine transport as an exclusive one-way traffic, since some archaeologists assumed that the Roman barges were only able to sail downstream. The Rhine's strong current would have made it impossible for them to navigate back upstream. Despite the fact that Roman barges were fitted with sails, these were thought to have been suitable only for manoeuvring over the broad, meandering river and not for sailing against the current. This presumption, however, is already convincingly refuted by G. Moeyes, at least for the Roman barge De Meern 1. In addition he concluded that this type of vessel could also easily be punted, hauled and rowed, although De Meern 1 itself was not equipped with an oar arrangement.[26]
There is, of course, no hard evidence that the oar arrangement of the Woerden 7 was used to propel the ship upstream, nor that it was even used for rowing at all. While it is certainly possible that oars were used to row ships like the Woerden 7 up against the current, we believe that, at least in this case, their primary function was to help keep the ship on course in the wide, fast-flowing river.
Off all the other excavated Roman barges, only the Zwammerdam 6 possessed a similar oar arrangement, although not recognized as such. This is quite understandable, since the determining element, the wash strake with its oar ports, was gone and the benches thus were (logically) interpreted as deck beams.[27] The presence of an oar arrangement on the Woerden 7 is not only an important fact in itself, it also shows that new discoveries necessitate a re-evaluation of old excavations. The Woerden 7 oar arrangement, on the other hand, would without awareness of the Zwammerdam 6 example (though incomplete), to easily have been presented as `unique'.[28]
Although oar arrangements are thus demonstrated by two Roman cargo vessels found in the Dutch Delta, firm indications are still lacking about their use: rowing upstream, (extra) steering or both? This should represent an important issue for future investigation.

7.2 Dendrochronology and dendroprovenancing

Another significant issue concerns the analyses of the ship's timbers.[29] Archaeologists not only seek to date wood by dendrochronology, but also to determine its origin by dendroprovenancing, i.e. to establish where the trees had grown, used for the construction of the ship. This has given interesting information about where the Woerden 7 was built.
As mentioned previously, it was sometimes thought that the wooden barges only served as 'packaging' for the cargo, while it is not always possible to determine precisely what cargo they were carrying. In addition to food,

[24] See for instance Jansma / Morel 2007, 321, 335.
[25] We know from more recent sources (Arnold 1992; Provost 1995) that river barges often made only a single run. They would be dismantled upon reaching the destination, and the ship's timbers would then be sold alongside the cargo. We may therefore assume that these ships served primarily as packaging material for the more valuable cargo they carried. This may also have been the case in Roman times, as indicated by the use of second-hand wood from ships in building other structures. Another known possibility is that the ships were intentionally scuttled in order to shore up the riverbanks.
[26] Moeyes 2007.
[27] De Weerd 1988, 161 and fig. 85.
[28] A conclusion to often made.
[29] This has led to spectacular results. However, it is obvious that these results were only possible due to the enormous number of samples, which were taken from virtually all of the ship's timbers. For more details, see Vorst 2005; also presented in Blom / Vorst / Vos 2007.

such as the grain found aboard the Woerden 1,[30] it may be presumed that it largely consisted of bulk goods, primarily building material for the Lower Rhine frontier area. Since the Netherlands has no natural sources of stone, brick, tuff and basalt were valuable commodities that had to be brought in from upstream and were used to build the castella in the Lower Rhine area. Recent excavations in the Dutch town of Alphen aan den Rijn (province of Zuid-Holland) determined that starting in AD 160, castellum walls, gates and important buildings of wood were gradually rebuilt in stone.[31] It is appealing to see a direct correlation between this renovation programme – as such already an important motivation for transport – and the dates established for at least some of the Roman shipwrecks in the Lower Rhine area. Until recently, it was assumed that the barges were built near the source of the raw materials, owing to a lack of data. It makes indeed sense to take for granted that the 'packaging' for stone is made as close as possible to their quarries, the nearest of which are found in the eastern Eifel region near Koblenz and Mayen. The once extensive volcanic activity there left rich stone deposits behind, of which basalt and tuff were most valued by the Romans. They extracted these and other types of stone in both surface and underground mining operations.

It was therefore a great surprise that not all the wood of the Woerden 7 originated from Central Germany. Some timbers correspond closely to oak from the peat marshes of the western Netherlands. Significantly, these timbers certainly are no later repairs, but essential structural components, applied together with `German' wooden components during the initial construction of the ship (fig. 11). This is confirmed by the corresponding felling dates for both the Dutch and the German wood: autumn/winter of AD 162-163. The wood furthermore appears (rather) `fresh', meaning that the ship was built shortly after the trees being felled.

Could it be that certain parts were missing from the supply of German wood, and that the shipbuilders were forced to make use of local Dutch materials? Because of the specific position of the `Dutch components' within the hull construction, it is more likely that Dutch wood had special properties, for instance a better resistance against structural pressure, that made it more suitable in certain cases than German wood.[32]

7.3 A `Dutch' shipyard along the Rhine?

What can the above information tell about where the Woerden 7 was built? Although more than 80% of the wood is German, only the option that the ship was built in the Netherlands seems realistic. An assumption that the ship was built in Central Germany, using some Dutch wood transported upstream, is not plausible. From the Middle Ages till late in the 19th century, not only shipbuilding wood, but practically all wood imported from central Germany was *floated* to the Netherlands. It is most likely that this was also the case in Roman times. Wood can only be floated downstream, never upstream. It is therefore far more likely that a `Dutch' shipyard – probably situated along the `Roman' bank of the Rhine – acquired German wood for building (at least) the Woerden 7.

There are some additional (indirect) indications that the ship was of 'Dutch' design. As discussed earlier, the Woerden 7 bears a great resemblance to another ship from the Lower Rhine area, the Zwammerdam 6. While this ship was of more modest proportions than the Woerden 7, the similarities between both vessels are striking (fig. 12). Of all the barges known from the northwestern provinces of the Roman Empire, these two are most alike. There are of course other barges with similarities to the Woerden 7, but (so far) only the Zwammerdam 6 shares specific, but non-characteristic, details, such as crossed timbers fore and aft as well as the oar arrangement i.e. the combination of horizontal beams with dovetail notches for rowing benches and wash strakes with oar ports. Both ships, in fact, resemble one another so closely, that they could be seen as sister ships, originating from the same shipyard. The location of this shipyard however, and of shipyards anyway, remains a mystery. Given that Dutch wood was used for a number of essential structural components of the Woerden 7, it can be supposed that the shipyard was located somewhere in the present-day Netherlands, presumably – also for the

[30] The Woerden 1, with its cargo of grain from Gallia Belgica, most likely made its way to the Rhine via the Scheldt River and the 'Fossa Corbulonis' (Corbulo's Canal), among others. This also calls for a renewed look into the question of upstream travel by Roman barges in general (see Haalebos 1996).

[31] Polak / Kloosterman / Niemeijer 2004.

[32] Further research is needed here. Probably some answers will come from the research programme 'Arts and crafts in Roman shipbuilding: raw materials management, construction technology, use and disposal of barges in the Lower Rhine region in the Roman period' sponsored by the Dutch organisation for Scientific Research (NWO). This research programme will focus on the design and construction, intended function, actual use and disposal of Roman period barges in the catchment basin of the Rhine, Meuse and Scheldt in the Middle Roman period.

sake of security and accessibility – near a Roman fort along the Rhine in the provinces of Utrecht and Zuid-Holland.
This leaves the intriguing question of the ship's intended function and the purpose of the oar arrangement? In other words: what was the Woerden 7 (and its `sister ship' the Zwammerdam 6) built for? If the ship was ever used to transport stone from the Eifel region – or any other load from upriver of Woerden, for that matter – then it must have moved upstream at least once in order to pick up its cargo. Of course, this is not to say that the ship necessarily covered enormous distances, but it is possible. Or did the 'bulk goods' consist not of raw materials, but of cattle or people?[33] In any event, the archaeological record is silent regarding the techniques used to transport the Woerden 7 upriver. Unclear remains for the moment, if rowing or additional steering in the sometimes wild rapids of the Rhine, played a major role – together with sailing and/or punting – in the propulsion of the Woerden 7.

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Bibliography

Arnold 1992: B. Arnold, Batellerie gallo-romaine sur le lac de Neuchâtel, Tomes 1/2. Archéologie Neuchâteloise 12/13, (Saint-Blaise 1992).

Blom / Vos 2007: E. Blom / W.K. Vos, Synthese. In: E. Blom / W.K. Vos (eds), Woerden-Hoochwoert. De opgravingen 2002-2004 in het Romeinse Castellum Laurium, de vicus en van het schip de 'Woerden 7'. ADC Monografie 2 (Amersfoort 2007) 409-429.

Blom / Vorst / Vos 2007: E. Blom / Y. Vorst / W.K. Vos, De 'Woerden 7': een Romeinse platbodem. In: E. Blom / W.K. Vos (eds), Woerden-Hoochwoert. De opgravingen 2002-2004 in het Romeinse Castellum Laurium, de vicus en van het schip de 'Woerden 7'. ADC Monografie 2 (Amersfoort 2007) 349-402.

Bockius 1996: R. Bockius, Zur Rekonstruktion des römerzeitlichen Plattbodenschiffes aus Woerden. Jahrbuch RGZM 43.2 (Mainz 1996) 511-530.

Bockius 2000: R. Bockius, Antike Prahme. Monumentale Zeugnisse keltisch-römischer Binnenschiffahrt aus der Zeit vom 2.Jh.v.Chr. bis ins 3.Jh.n.Chr. Jahrbuch RGZM 47 (Mainz 2000) 439-493.

Bockius 2002a: R. Bockius, Die Prähme von Woerden. In: A. Mees / B. Pferdehirt (eds), Römerzeitliche Schiffsfunde, in der Datenbank "Navis I". Kataloge Vor- und Frühgeschichtlicher Altertümer 29 (Mainz 2002) 30-35.

[33] See also Bockius 2000, 478-479, 485 note 66.

Bockius 2002b: R. Bockius, Das Wrack von Vechten. In: A. Mees / B. Pferdehirt (eds), Römerzeitliche Schiffsfunde, in der Datenbank "Navis I". Kataloge Vor- und Frühgeschichtlicher Altertümer 29 (Mainz 2002) 60-62.

Bockius 2002c: R. Bockius, Modell von Schiff Mainz 6. In: A. Mees / B. Pferdehirt (eds), Römerzeitliche Schiffsfunde, in der Datenbank "Navis I". Kataloge Vor- und Frühgeschichtlicher Altertümer 29 (Mainz 2002) 200-205.

Bockius 2002d: R. Bockius, Modell von Schiff Oberstimm 2. In: A. Mees / B. Pferdehirt (eds), Römerzeitliche Schiffsfunde, in der Datenbank "Navis I". Kataloge Vor- und Frühgeschichtlicher Altertümer 29 (Mainz 2002) 206-213.

Bockius 2002e: R. Bockius, Die römerzeitlichen Schiffsfunde von Oberstimm in Bayern. Monographien RGZM 50 (Mainz 2002).

De Weerd 1977: M.D. de Weerd, Römerzeitliche Transportschiffe und Einbäume aus Nigrum Pullum/Zwammerdam (Z.-H.). In: D. Haupt / H.G. Horn (eds), Studien zu den Militärgrenzen Roms II. Vorträge des 10. Internationalen Limeskongresses in der Germania Inferior, Bonner Jahrbücher, Beih. 38 (Bonn 1977) 187-198.

De Weerd 1988: M.D. de Weerd, Schepen voor Zwammerdam (unpubl. diss. University of Amsterdam 1988).

De Weerd 1990: M.D. de Weerd, Barges of the Zwammerdam type and their building procedures. In: S. McGrail (ed.), Maritime Celts, Frisians and Saxons. CBA Research Report 71 (London 1990) 75-76.

De Weerd 2001: M.D. de Weerd, Römische Schiffsfunde von Zwammerdam: Lehren aus einer alten Grabung. Skyllis, Zeitschrift für Unterwasserarchäologie 4-2, 96-110.

Haalebos 1977: J.K. Haalebos, Zwammerdam-Nigrum Pullum; ein Auxiliarkastell am niedergermanischen Limes. Cingula 3 (Amsterdam 1977).

Haalebos 1986: J.K. Haalebos, Ausgrabungen in Woerden (1975-1982). In: C. Unz (ed.), Studien zuden Militärgrenzen Roms III, 13. Internationaler Limeskongress in Aalen, Vorträge, Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg 20 (Stuttgart 1986) 169-174.

Haalebos 1996: J.K. Haalebos, Ein römisches Getreideschiff in Woerden (NL). Jahrbuch RGZM 43-2 (Mainz 1996), 475-509.

Jansma / Morel 2007: 15. Interpretatie, discussie en conclusies van het onderzoek. In: E. Jansma / J.-M.A.W. Morel (eds), Een Romeinse Rijnaak, gevonden in Utrecht-De Meern. Resultaten van het onderzoek naar de platbodem ‘De Meern 1’. Rapportage Archeologische Monumentenzorg 144 (Amersfoort 2007) 321-336.

Moeyes 2007: G. Moeyes, 7.4. Laadvermogen en vaareigenschappen. In: E. Jansma / J.-M.A.W. Morel (eds), Een Romeinse Rijnaak, gevonden in Utrecht-De Meern. Resultaten van het onderzoek naar de platbodem ‘De Meern 1’. Rapportage Archeologische Monumentenzorg 144 (Amersfoort 2007) 151-174.

Morel 2007: J.-M.A.W. Morel, 6.3. De romp. In: E. Jansma / J.-M.A.W. Morel (eds), Een Romeinse Rijnaak, gevonden in Utrecht-De Meern. Resultaten van het onderzoek naar de platbodem ‘De Meern 1’. Rapportage Archeologische Monumentenzorg 144 (Amersfoort 2007) 99-122.

Polak / Kloosterman / Niemeijer 2004: M. Polak / R.P.J. Kloosterman / R.A.J. Niemeijer (eds), Alphen aan den Rijn-Albaniana 2001-2002. Opgravingen tussen de Castellumstraat, het omloopkanaal en de Oude Rijn. Libelli Noviomagenses 7 (Nijmegen 2004).

Provost 1995: M. Provost, Le Val de Loire dans l'antiquité. Gallia Beiheft 52 (Paris 1995).

Van Dinter 2007 : M. van Dinter, Landschap. In: E. Blom / W.K. Vos (eds), Woerden-Hoochwoert. De opgravingen 2002-2004 in het Romeinse Castellum Laurium, de vicus en van het schip de 'Woerden 7'. ADC Monografie 2 (Amersfoort 2007) 123-142.

Van Driel-Murray 2007: C. van Driel-Murray, Leren schoenen van de 'Woerden 7'. In: E. Blom / W.K. Vos (eds), Woerden-Hoochwoert. De opgravingen 2002-2004 in het Romeinse Castellum Laurium, de vicus en van het schip de 'Woerden 7'. ADC Monografie 2 (Amersfoort 2007) 403-408.

Van Enckevort et al. 2006: H. van Enckevort / T. Hazenberg / W.K. Vos / E.P. Graafstal / M.Polak, Die Grenze in den Niederlanden. In: G. Klose / A. Nünnerich-Asmus (eds), Grenzen des Römischen Imperiums. Zaberns Bildbände zur Archäologie (Mainz 2006) 105-111.

Vorst 2005: Y.E. Vorst, De constructie en herkomst van de Romeinse platbodem 'Woerden 7'; een studie van jaarringpatronen en bewerkingssporen (unpubl.thesis University of Amsterdam 2005).

Vos et al. 2003: W.K. Vos / E. Blom / A. Veenhof / T. Hazenberg, De Romeinse limes tijdens Caligula: gedachten over de aanvang van het castellum Laurium en onderzoeksresultaten van nieuwe opgravingen aan het Kerkplein in Woerden. Westerheem 52, 2003, 50-63.

http://www.woerden7.nl

http://www1.rgmz.de/Navis/home/frames.htm

Figure captions

Fig. 1: The location of the excavations within the Woerden – Hoochwoert project. The green rectangle indicates the position of the Roman castellum (phases II through IV). The red line is the outline of the new underground car park, the *Castellum garage*. Archaeologists have surveyed nearly the entire car park area. The star indicates the position of the Woerden 7. The inset shows Woerden's location along the limes.

Fig. 2: The Woerden 7 excavation in full swing (photo: courtesy of M. Scheer, Woerden).

Fig. 3: One of the definite field drawings, showing the ship's stern with the crossed timbers and the windlass spindle and mount (drawing by J.-M.A.W. Morel, based on the digital recording by W. Derickx; both RCE, Amersfoort).

Fig. 4: Once the wood was exposed to air, it could be seen that the timbers affected by bacteria were gradually invaded by white fungi (photo: courtesy of Hazenberg Archeologie, Leiden)

Fig. 5: Aerial view of the Woerden 7 (photo: courtesy of Hazenberg Archeologie, Leiden).

Fig. 6: Cross-section of the starboard side of the Woerden 7 (photo: courtesy of ADC ArcheoProjecten, Amersfoort).

Fig. 7: An iron nail 60 cm long was used to fasten this L-shaped chine block to the filler (photo: courtesy of Hazenberg Archeologie, Leiden).

Fig. 8: A close-up of the oar arrangement. The original position of one of the oars is symbolised by a shovel (photo: courtesy of Hazenberg Archeologie, Leiden).

Fig. 9: A number of uprights belonging to the mast locker, visible on the starboard side at the level of the mast step (photo: courtesy of Hazenberg Acheologie, Leiden).

Fig. 10: Distribution map of the Roman ships found in Woerden (drawing: Hazenberg Archeologie, Leiden).

Fig. 11: Timbers made of Dutch oak (drawing: Y. Vorst, published in Vorst 2005, 48 fig. 5.11 and Blom / Vorst / Vos 2007, fig. 18.50).

Fig. 12: The two `sister ships'. The aerial photo is of the Woerden 7 and the drawing depicts the Zwammerdam 6 (photo: courtesy of Hazenberg Archeologie, Leiden; drawing from De Weerd 1988, fig. A).

Plate 1: Final technical drawing of the Woerden 7 (drawing by J.-M.A.W. Morel (RCE, Amersfoort).