Water Hist (2014) 6:51–71
DOI 10.1007/s12685-014-0097-3

The Fossa Corbulonis between the Rhine and Meuse estuaries in the Western Netherlands

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Received: 29 January 2013 / Accepted: 22 January 2014 / Published online: 5 March 2014

Abstract A few classical sources mention the construction of a canal by the Roman general Corbulo between the estuaries of the rivers Rhine and Meuse in the Netherlands around 50 AD; the Fossa Corbulonis. The location of this feature has been subject to speculation for a long time, but in recent years, various archaeological investigations have established the presence of a canal just behind the beach barrier, roughly between the current towns of Leiden and Naaldwijk. Furthermore, dendrochronological and C14 dates support the identification of this canal as the canal dug under orders of general Corbulo. The various research campaigns have shown that the canal is only partially artificial. Certain parts of its course have been established by connecting existing waterways, thus negating the need for manual labour. Roughly in the middle of the trajectory, indirect evidence for the presence of a dam and a possible portage have been found, indicating an understanding of water management on the part of the Romans.

Keywords Roman limes · Canals · Transport · Water management

Introduction

When the Romans ventured into the northwest of Europe under the leadership of Julius Caesar and his successors, they must have been taken aback by the landscape they faced upon entering the lands of the Chauci and the Frisians in what are now the Netherlands. The enormous morass, crisscrossed by a staggering number of streams, will have put the

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prowess of the Roman engineers to the test. Still, they set forth to organize the area like they were used to by building roads, fortifications and even a few towns.

The nature of the landscape in the Netherlands also forced the Romans to take up water management to a certain degree, by fortifying existing streams and rivers and building dams, but also by constructing canals. Only two are known by name in the Netherlands. Firstly, the Fossa Drusiana, which is mentioned by Suetonius (Vita divi Claudii 1.2) and Tacitus (Ann 2: 8). Both authors refer to the construction of a canal under the command of general Nero Claudius Drusus in 12 BC, but the exact geographical location of the canal is unknown. The second canal is the Fossa Corbulonis, which will be discussed in detail below. It is very likely however, that there would have been more, possibly smaller or shorter canals the existence of which was never mentioned by the Classical authors and which are extremely difficult to find.

This paper discusses the investigation of the Fossa Corbulonis, of which the (general) location has been discovered and which has been subject to a considerable number of archaeological investigations by augering, remote sensing and excavation. We present a synthesis of the research conducted in the last decades, with a special focus on the town of Leidschendam-Voorburg, situated between Leiden and The Hague, where the majority of fieldwork has taken place, but this paper will show that this is largely due to contextual circumstances.

The various excavations and other investigations from the last decades were interesting, but the different projects were all relatively small in scale, thus yielding results that often appear to have only fairly local significance and the resulting data were published in varying forms of completeness. The results of the 2004 and especially 2006 excavations gave grounds to a reassessment of all the available data in order to generate an up to date synthesis about the Fossa Corbulonis.

The first archaeological clues for the presence of a man made canal, tentatively suspected to be the Fossa Corbulonis, date to the early 1960s near the Roman fort of Matilo (Leiden). Some indirect clues for the presence of a Roman canal were reported near the fort (Bogaers 1962), but convincing evidence for the fact that the Fossa Corbulonis actually existed was not unearthed until 1989.

The paucity of physical evidence for the canal is largely due to its rather elusive nature. While it is more than 30 km long, the width is only a few metres. The only information about the trajectory was the reference to the Rhine and the Meuse estuaries. Despite its length, the canal is therefore a relatively small archaeological feature to find.

A further complication is the fact that the canal is probably only partially man-made. Rather than digging the entire stretch, Corbulo's engineers connected stretches of natural waterways to form a continuous canal. Even the man-made sections are probably at least in part formed by re-excavating natural channels. It is no coincidence that the majority of sightings of the canal are located in the area of Leidschendam, where the canal was dug into the underlying peat, making it relatively easy to distinguish from natural channels.

Historical evidence

Classical sources

The Fossa Corbulonis is mentioned in only two (remaining) classical sources: the *Annals* by Publius Cornelius Tacitus (Ann 11: 18–20) and the *Historia Romana* by Lucius Cassius Dio (Hist Rom LXI 61 30: 4–6). Tacitus and Dio probably based their stories on the

memoires of general Gnaeus Domitius Corbulo and the *History of the German Wars* by Pliny the Elder,[1] both lost to posterity. In the Annals, Tacitus writes that Corbulo becomes the new legate for Germania Inferior in 47 AD and pacifies the province, which at that time is in considerable upheaval due to plundering bands of Chauci, using the lands of the Frisii north of the Rhine as their base. Corbulo seeks out and defeats the pirates with the help of the Fleet of the Rhine and has their leader Gannascus, a Cananefate, executed. He also orders the construction of a fortification in the heart of Frisian territory (probably Flevum, near present day Velsen) to maintain control of the area. The Chauci are outraged by the execution of Gannascus and the situation threatens to escalate into full scale war.

Emperor Claudius orders Corbulo to withdraw his troops to the left bank of the Rhine, possibly because he was busy planning his invasion of Britannia and did not wish to risk the possibility of war on two fronts, or perhaps he was jealous of the military success of his general. Obediently, Corbulo beat the retreat and subsequently decided to occupy his troops by having them dig a canal with a length of 23.000 *passus*. The canal was intended to connect the estuaries of the Meuse and Rhine, so as to avoid the dangers of the North Sea. Even though Corbulo was not allowed to wage war, Claudius awarded him with a triumph in Rome for his troubles.

Cassius Dio's depiction of the events is essentially the same, except that Dio is of the opinion that the canal was constructed after Claudius awards Corbulo his triumph and reinstates him as general of the army. Dio also mentions another reason for the construction of the canal: '*to prevent the rivers from flowing back land inwards and causing floods, due to the tidal activities of the ocean*'.[2]

The canal was constructed in, or within a few years from 47 AD. Corbulo's predecessor Quintus Sanquinius Maximus dies in 47, thus opening a position as legate of Germania Inferior, which was subsequently awarded to Corbulo.

Modern sources

The exact location of the Fossa Corbulonis has been subject to debate for centuries. In the past, the canal has been identified as the river Lek, a channel in the Rhine-system on the border between the present-day provinces of Gelderland and Utrecht in the centre of the Netherlands. Even a stretch of the river Waal between the modern cities of Nijmegen and Rossum has been suggested (Hermans 1839). However, since the beginning of the twentieth century, most scholars agree that the canal must be situated close to the coast (Fig. 1). The assumption is that the Roman engineers connected a tidal creek of the Meuse system, part of the so-called Gantel system, in the south, to a tidal creek of the Rhine system in the north (Beekman 1916; Holwerda 1923; van Liere 1948; Pons 1957). This means that the canal crosses the modern-day region of the Westland to connect with the Rhine somewhere to the east of Leiden, close to the Roman fort of Matilo. An extant canal, the Vliet, is believed to form the northern stretch of Corbulo's canal.

[1] J Lendering; personal communication.

[2] The different reasons mentioned for the construction of the canal (1: occupying the legionaries, 2: avoiding the dangers of the North Sea, 3: water management) have been subject to heated debate in the past. Central to these discussions were possible mistranslations and copy-errors of the original texts (Lichtenauer 1935; Hettema 1936; Stolte 1943).

Fig. 1 Location of the research area (*red box*) in the Netherlands. Scale 1:5.000.000

Archaeological evidence 1989–1999

Fieldwork

In 1989, a chapter of the Netherlands' Amateur Archaeological Society (AWN) worked together with the Netherlands' Cultural Heritage Agency (RCE) to dig a number of test trenches at a site called Rietvinklaan in the town of Leidschendam (Fig. 2: site 4; Fig. 5: "Historical evidence" section). A feature was found and was interpreted as a canal with a width of 12–13 m and a flat base. East of this canal, a natural channel was found. In and around the canal, several shards of hand made and wheel-turned pottery dating to Roman times were collected. Approximately 120 m north of this site, the AWN dug another trench, also containing a section of the canal. In this trench, the east side of the canal was reinforced with timbering.[3] Subsequently, a geophysical campaign was launched on

[3] Seven of the posts were examined by RING (Jansma 1995; RING report number 1990029). Only one post yielded the exact date of the cut, spring of the year 50 AD.

several sites in Leidschendam in 1990, but it proved virtually impossible to distinguish between natural channels and possible man-made features based on the resistivity-measurements alone (Hessing 1991; van Veen and Lenselink 1990).

In 1991 the RCE attempted to trace the route of the canal by means of test trenches but they found that the trajectory of the canal did not follow a straight line. However, due to very wet circumstances, the observations were severely impaired by flooded trenches and collapsed sections. The sections, such as they were, mainly revealed part of the western bank of the canal. No evidence for reinforcements was found (Fig. 2: sites 7, 8 and 9).

A possible portage

Test trenches by the RCE in 1992 revealed a striking constriction in the canal. The width of the canal decreases to only 4.5 m. Above this narrow section, a layer of laminated sand was interpreted as evidence for a post-Roman, natural channel. In a later phase of the campaign, a large section of the canal was excavated (Figs. 3, 5: "Archaeological evidence 1989–1999", "Archaeological evidence 2004–2006", "Discussion" sections). The narrow part of the canal is reinforced with timbering on both banks over a length of approximately thirty metres (Hessing 1993). The wood used in the timbering could be identified as *Quercus*, *Fraxinus* and *Alnus*. A single post, collected from the test trenches was dated through dendrochronology to 48 AD plus a maximum of 3 years (RING report number 1992039).[4] A further ten posts from the later excavation were subject to dendrochronology (RING report number 1995028) and were all dated to the spring of 50 AD (Visser 2006).

The southern part of trench 11, where the reinforcement of the banks is lacking, shows the canal to widen to more than 6.5 m. Unfortunately, local circumstances prohibited a complete excavation of the entire constricted part of the canal, but based on the southern approach and its similarity to later, historic parallels, the constriction is interpreted as the entrance to a portage (Daams and Kort 1988). These were common in the coastal area of the Netherlands up to the 19th century, where water management catchments caused variable water tables in adjacent streams, whether natural or man-made. Because of the paucity of evidence, it cannot be excluded however, that this feature could be interpreted as the entry to a lock or even a secondary canal. It may actually be technically difficult to haul a flat bottomed boat over a portage without breaking it.

In 1993, a pond was constructed at the Schoorwijck care centre in Leidschendam. The digging exposed the western bank of the canal (Fig. 2: site 10), the southernmost observation, before the canal presumably veers off towards the southeast and continues its route in the course of an older, natural channel.

The last observations from the 1990s date to 1996 and 1999. The 1996 investigations revealed a feature that was assumed to be the canal or possibly a reused natural channel (Fig. 2: site 12; Fig. 5: Sect. 12), but ^{14}C dates of wood found in the feature suggest that it dates to the Late Iron Age (van Heeringen 1997). Excavations in 1999 at roughly the same location appear to corroborate this (de Jonge 2000).

[4] These reports are available online: http://dendro.dans.knaw.nl (Jansma et al. 2012).

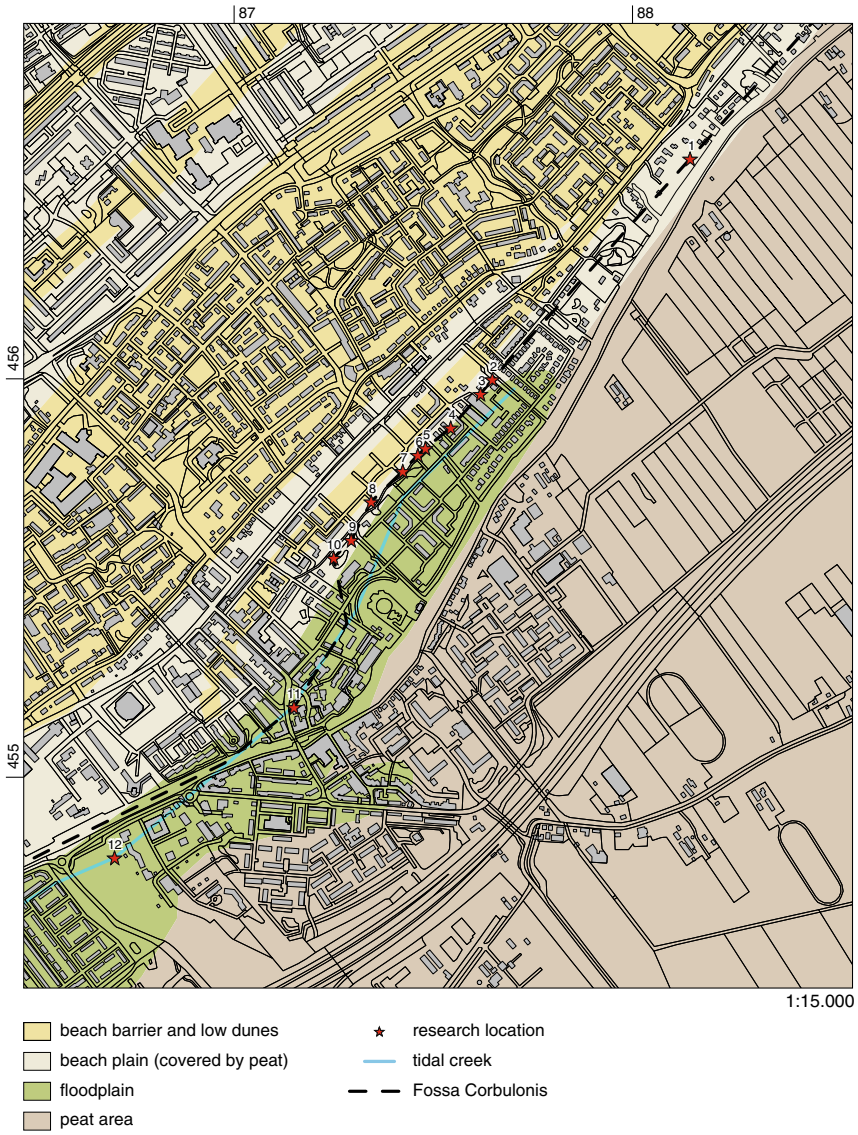

Fig. 2 The area of Leidschendam with the route of the canal and the research locations. See Table 1 for explanation and sources. *Scale* 1:15.000

Archaeological evidence 2004-2006

Fieldwork

After a few years of relative silence, two new investigations were launched into the Fossa Corbulonis. In 2004, the local AWN chapter excavated the northernmost of the sites discussed here (Fig. 2: site 1), exposing the canal again (Vos et al. 2007). In 2006, an

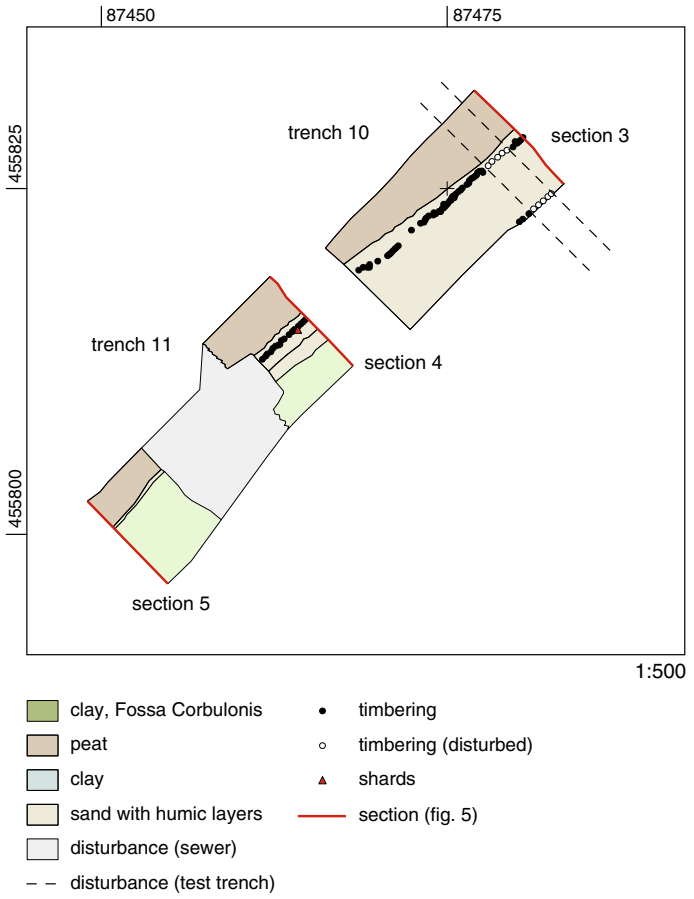

Fig. 3 Site 5 and 6: plan view of trenches 10 and 11 in 1992. *Scale*: 1:500

excavation by the authors, then working for RAAP Archaeological Consultancy, followed an earlier augering campaign during which the canal was discovered (Fig. 2: site 3). In the cores, the canal's only difference in appearance compared to a natural channel was the flat base. The laminated sediments, that had eventually refilled the canal, looked exactly like the sedimentation of a natural channel. The results of the two excavations are generally similar, which is not surprising, since they are situated in relatively close to each other, so the results are discussed jointly below.

Surrounding landscape

A range of analyses conducted by specialists were used during the investigations, including geological, pollen, macroscopic botanical remains and diatom analysis, thus providing a detailed picture of how the surrounding landscape looked during the time Corbulo's legionaries dug the canal and the period it functioned (Vos et al. 2007; Kort and Raczynski-Henk 2008).

As a result of the gradual rise in sea level since the beginning of the Holocene, the western part of the Netherlands behind the coastline gradually filled up with a layered

sequence of clay deposits transported westward by fluvial processes and peat deposits, growing locally under the influence of ground water tables pushed ever higher by the rising sea (Berendsen 2008). Towards the Roman era, the coast in the research area consisted of a more or less continuous beach barrier, covered by dunes. This limited marine influence on the hinterland, thus enabling the growth of considerable peat beds (Theunissen et al. 2011). From the Late Iron Age onwards, the water table rose to an extent that small streams began to bisect this peatland that covered most of the hinterland behind the coastal zone. Towards the first century AD, the influence of the sea increased in the form of openings in the beach barrier and a tidal creek system cutting into the peatland from the southwest and depositing clay (de Groot et al. 2011). This is the so-called Gantel system which has been partially integrated into the Fossa Corbulonis. Vegetation was of a relatively open type and was occasionally subject to flooding by brackish water. Diatoms, foraminifera, pollen and seeds from various species of plants (*Salicornia sp., Aster tripolium, Triglochin maritima, Bolboschoenus maritimus, Atriplex littoralis*) indicate temporal brackish conditions in an otherwise predominantly freshwater environment. Some evidence of agriculture on the nearby beach barrier has been found (Vos et al. 2007).

Landscape setting

The results of the 2004 and 2006 investigations were similar in terms of the setting of the canal. The canal runs parallel to the beach barrier that lies at a distance of several dozens of metres to the west of it. To the east of the canal, evidence for a natural channel was found. The activity if this tidal creek can be dated to after the beginning of the fourth century BC.[5] A thin layer of clay overlying the levee and the infill of the channel was date *ante quem* to between 32 BC and 126 AD (Kort and Raczynski-Henk 2008).[6] Stratigraphically, the canal cuts into the deposits belonging to and overlying the channel, so presumably the creek was inactive by the time of the canal's construction.

The canal was cut into the peat deposits with relatively steep sides and a flat base, whereby the engineers took care not to breach the sands of the beach barrier which continues underneath the peat deposits (Vos et al. 2007; Kort and Raczynski-Henk 2008). It appears that the location of the canal was selected to ensure the presence of enough peat to enable the engineers to dig the canal without disrupting the underlying sediments.

Sedimentation of the canal

The sediments that ultimately filled the canal were studied in great detail in 2004 and 2006. The lower part of the sediments consists of clay with fine layers of sand, indicative of gradual and continuous sedimentation without anthropogenic interference like dredging. The absence of gyttja-like sediments at the base of the deposits suggests that there was never any stagnancy and that the current must have been strong enough to clear away any microscopic botanical

[5] This date was obtained from a peat sample taken from peat deposits under the levee of this channel. Utc Nr 14751: 2,286 ± 39 BP, giving a calibrated range of 403–207 BC. All samples are calibrated with 2-sigma standard deviation using the Oxcal 4.1, IntCal09-curve.

[6] A bone sample collected from the top of the clay layer overlying the levee. Utc Nr 14675: 1,946 ± 35 BP.

remains, yet not so strong as to also erode the clay deposits. This process may have occurred over a period of several decades.[7] The density of the sandy laminations decreases towards the top canal fill, culminating in a layer of clayey peat, consistent with a fining upward sequence. At this point, the canal was certainly no longer navigable.

An older canal

The 2004 excavations showed no evidence of dredging or re-cutting of the canal. The most surprising result of the 2006 campaign was therefore the discovery of a second, older phase of the canal. The infill of this older phase contained a few shards of wheel-turned Roman pottery, unfortunately too generic to be useful for dating. After this phase, during which the canal completely silted up, a second canal was dug immediately to the east (Fig. 4). On top of the infill of the older phase, a layer of sods was piled up at some point accompanied by a small ditch on its west side. These features have been interpreted as a towpath and drainage ditch. The ditch is located approximately 6.5 m from the west bank of the younger phase of the canal.[8] Apart from the sods, no evidence for pavement of any kind (gravel, rubble, et cetera) was observed.[9] A thin layer of sand was documented, but it cannot be ruled out that this was deposited on the path by wind from the adjacent beach barrier.

The youngest phase of the canal contained timbering which was dated to 50 AD. No dates were obtained for the older phase, but the presence of the Roman pottery in the infill is evidence that it must have been open during the Roman period. Based on the date of the timbering and the fact that the younger phase is partially superimposed on its predecessor, the older phase must predate 50 AD. Judging by the evidently natural sedimentation of the older phase and the years this would have taken, it seems highly unlikely that the older phase can be dismissed as an ‘experiment’ or a ‘mistake’ of Corbulo’s engineers.

It is possible that the older phase of the canal was in use during the reign of Emperor Caligula (reign 37–41 AD).[10] The fact that there are no historical sources referring to this possibility is not surprising: after Caligula was murdered, the Roman aristocracy (including his less than objective biographer Suetonius) severely distorted Caligula’s legacy. Although widely thought to have been subject to *damnatio memoriae*, Caligula was probably spared this fate (Winterling 2003). This did not prevent his statues to be destroyed and many coins bearing his likeness to be melted down. There is a growing amount of evidence that Caligula was active in Germania Inferior, especially along the Rhine, probably connected to his desire to conquer Britannia. The construction of a predecessor to Corbulo’s canal could be part of this scheme.[11]

[7] P Vos en H Weerts; personal communication. There is no reliable evidence for the rate of sedimentation. It is quite possible that the silting up of the canal happened over a period of only 1 or 2 years. Rapid sedimentation is probably connected to the position of the canal between two river estuaries, causing sediments transported by tidal action to be deposited right at this location.

[8] A width of six metres was also reported during research at Wateringse Veld in The Hague (Waasdorp 2003) and alongside the Sir Winston Churchilllaan in nearby Rijswijk (Dorenbos et al. 2009).

[9] Gravel was discovered in 2006 (Vos et al. 2007), but remarkably it was situated to the east of the canal.

[10] See de Kort 2009 for further information on this subject.

[11] Although no solid evidence for this hypothesis exists apart from the Iron Age dates on wood samples mentioned above, an alternative providence of the earlier phase of a canal cannot be excluded. Local inhabitants obviously faced the same problems the Romans encountered when they came to the area and it is not impossible that they took the first steps towards water management.

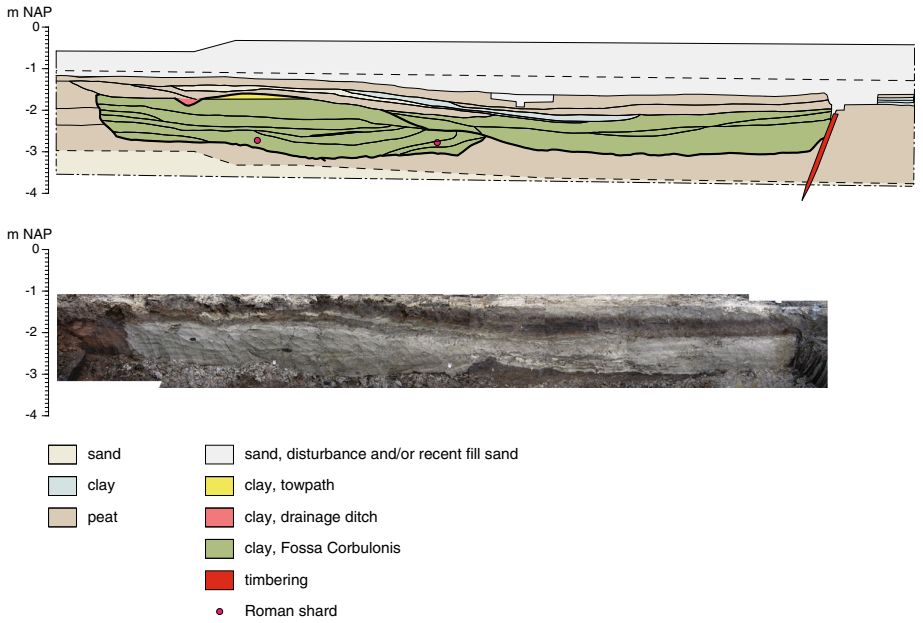

Fig. 4 Site 3: north section of trench 1 in 2006. *Scale*: 1:150

Timbering in the canal

Both in 2004 and 2006, timbering was found against the east bank of the canal, consisting of pointed oak posts. Based on the shape of the wood, the posts were probably cut from small trees of local provenance, presumably the beach barrier just west of the canal (van Rijn 2006). One post from the 2004 trench was dated and yielded a date of spring or summer 50 AD (Hanraets 2004). Four posts were dated in 2006, giving two dates in spring or summer of 50 AD and two dates in the spring of 50 AD (Hanraets 2006). The steep and sharply cut banks in the area of the timbering indicate that they were installed during the construction of the canal, rather than during subsequent repairs.[12]

Obsolescence

So far it has proven impossible to obtain a convincing date for the moment the canal fell out of use. A ^{14}C obtained from a bone fragment in the top of the clayey infill of the canal gives a range of 39 BC to 242 AD and is therefore of little use.[13] The peat overlying the infill was dated between 259 and 541 AD, which is most likely far too old.[14] The canal was probably navigable for several decades and an end date most likely lies somewhere between 100 and 150 AD (Vos et al. 2007). This means the canal was already obsolete by

[12] Contrary to Brandenburgh and Hessing (2005) who state that the canal was constructed in 47 AD and subsequently repaired in 49 AD with the use of timbering.

[13] UtC13890: 1,900 ± 60 BP.

[14] UtC 13858: 1,693 ± 50 BP.

the time the stone phase of the *civitas* Forum Hadriani (Voorburg) was initiated,[15] but it may have served as an important gateway during the earliest phases of settlement there (Fig. 6). The presence of numerous archaeological sites along the southern leg of the canal suggests that the section south of Forum Hadriani may have been navigable considerably longer (Waasdorp 2006).

Two fragments of wood from the ditch and the path were dated to between the end of the first and the beginning of the third century AD, which is too broad to use for an end date for the canal, but it does fit the estimate given above.[16]

Discussion

Physical properties of the canal

The 1989–2006 campaigns show that (at least in the Leidschendam area) the Fossa Corbulonis was cut into the peat and ran parallel to the beach barrier situated several dozens of metres to the west (Fig. 2). On average, the width of the canal varies between approximately 12–15 m and the bottom lies between 2.2 and 3.5 m below NAP (Amsterdam Ordnance Datum) (Table 1). Interestingly, the depth relative to NAP increases with the lateral distance from the proposed portage. In a few locations, the old surface of the Roman era was preserved, which allows for an estimate of the average canal depth of circa 1.4 m.[17] The banks of the canal usually slope at a rather flat angle, with the exception of the locations where they were reinforced with timbering, but the interface between the peat and the clay deposits marking the canal are always very sharply defined. The base of the canal is generally completely flat. This, together with the properties of the laminated clayey sediments in the canal, suggest not only a relatively low current, but is also a further indication of the absence of repairs and/or dredging of the canal. The peat overlies sandy coastal deposits, but these were never affected by the construction of the canal, even though sometimes only a very thin layer of peat is preserved between the bottom of the canal and these sandy deposits. This indicates that the Roman engineers deliberately avoided hitting these layers, presumably to prevent water seepage, allowing the diggers to work in dry, or rather less wet circumstances, as the later excavators found out to their dismay. It appears that the Roman engineers preferred the relative density and firmness of the peat over sandy deposits, which makes sense when digging in a waterlogged environment such as Zuid-Holland, whether in Roman times or in the present day. On the western side of the canal, a single indication for the presence of a possible towpath and drainage ditch was found.

[15] The southern part of the canal has been (kept) open for a longer period of time, as indicated by the recent discovery of a dock at Forum Hadriani (Voorburg). Two construction phases have been identified: around 159 and 218 AD.

[16] Wood from the ditch alongside the towpath: UtC 14713: 1,833 ± 29 BP; wood from the surface of the towpath: UtC 14674: 1,876 ± 34 BP.

[17] The compaction of peat however can be considerable. Drainage of the land and loading by natural deposits and, more recently, with sand for urban development, make it difficult to give good estimates. Because of that, the original depth may have been greater. Even the longitudinal form of the bottom of the canal may be very different.

Table 1 Properties of the canal at the various research sites (Fig. 2), ranged from north to south

Site nr. (in Fig. 2)	Fig. 5 section nr.	Trench	Section	Minimal width (m)	Base of canal (m. below NAP)	minimal depth (m)	Timbering	Roman surface intact	Source
1	1	1	N	14.5	−3.5	2	East	Yes	Vos et al. (2007)
2	–	9	–	13	–	–	East	Yes	Hessing (1990)
3	–	1	N	10	−3.17/−3.08	1.5	East	Yes	de and Raczynski-Henk (2008)
4	2	4	N	12	−2.5	1.3	None	Yes	Hessing (1990)
5	3	10	N	>2.75	–	0.8	Both	No	Hessing (1993)
5	–	X	S	4.6	−3.2	1	Both	No	Hessing (1993)
6	4	11-II	N	>5.50	–	0.9	Both	No	Hessing (1993)
6	5	11-I	S	>5.80	−2.81	1	None	No	Hessing (1993)
7	6	7-I	N	14	−2.65	1.1	None	No	Hessing (1992)
7	7	7-II	N	12.5	−2.9	1.3	None	No	Hessing (1992)
9	8	5	N	12.5	−2.3	1.2	None	No	Hessing (1992)
9	9	4	N	>9.50	−2.2	1.25	None	No	Hessing (1992)
10	–	–	–	–	–	–	–	–	observation at Schoorwijck
11	10	3	N	8	−4.88	2.1	None	Probable	Griffioen and Hoogendijk (2011)
11	11	4	S	8	−4.88	2.1	None	Probable	Griffioen and Hoogendijk (2011)
12	12	1	N	18	−3	0.75	None	No	van Heeringen (1997)

Portage

The proposed portage is a remarkable feature. By constructing one or more dams in the canal, differences in water level, but also a constant water level could be guaranteed. This would also help in preventing the canal from silting up. Of course, the same effect can be realised by building one or more locks. Remarkably, sandy deposits were found at the top of the canal fill of the canal, where elsewhere, finer grained, clayey deposits are the norm (Fig. 5: "Archaeological evidence 1989–1999", "Archaeological evidence 2004–2006", "Discussion" sections). This could indicate that one of the possible dams broke suddenly and with considerable force.

As is mentioned before, it is hard to estimate the original depth of the base of the canal due to subsidence of the peat. The differences in depth nevertheless are remarkable. In the 1991 trench no 11 the base of the canal was found to be at 2.81 m—NAP (Table 1; Fig. 2: site 6). In the 1989 trench no 4 the base was measured at 2,50 m—NAP (Table 1; Fig. 2: site 4). These two sites are located immediately south and north of the assumed dam in the canal. Towards the north, the depth of the canal relative to NAP increases. The northernmost trench, dating to 2004 gives a depth of 3.50 m—NAP for the base of the canal (Table 1; Fig. 2: site 1). In the opposite direction from the possible dam, the southernmost observation of the canal, trench 4 from 1991, is shallower at 2,20 m—NAP, supporting the theory that a difference in water tables had to be overcome (Table 1; Fig. 2: site 9). Even though the bottom of the canal at site 11 was measured at 4.88 m—NAP (Table 1; Fig. 2: site 11), this is probably caused by the fact that the canal opened into a natural, presumably deeper creek (Griffioen and Hoogendijk 2011).

If this is the case, the Roman engineers hydraulic understanding is impressive. One way to attest the presence of the proposed dam in the canal would be to conduct an extensive augering campaign between sites 4 and 5. If the canal ends at a dam, the peat deposits in which the canal has been dug should still be present at the location of the dam.

Dating of the canal

Based on historical sources, it has traditionally been assumed that the Fossa Corbulonis was constructed in or just after 47 AD. The dendrochronology dates on several timbers from the canal range between 46 and 50 AD, but they should not be interpreted as the cutting date of the trees they come from, since in several cases an unknown portion of the sap-wood is missing (Table 2). A closer study of the tree rings suggests that all the timbers sampled come from trees cut down in the spring of 50 AD (Visser 2006; RING report numbers 1990029, 1992039, 1995028, 2004047 en 2006085).[18] Re-examination of the classical sources shows that this date fits well with the writings of Tacitus and Cassius Dio. Cassius Dio writes that the canal was constructed during Corbulo's *second* period of command of the army. Governorship was awarded for a period of 36 months, so this matches exactly with a date of 47 AD plus 3 years.

The investigations of 2006 have shown that the canal was dug in (at least) two phases. As a result of rapid sedimentation in the canal, it was necessary to recut (a section of) the canal. This second phase was dated to 50 AD. Other investigations have not shown evidence for a second phase, nor for the presence of a towpath. One of the reasons for this is

[18] Spring is not the best time of the year to cut timber. Vitruvius writes that the preferred time for loggingstarts in August but never in springtime (Vitruvius, de Architectura, Liber II, caput 9, 1). This could imply that the timber used in the construction of the canal derived locally, otherwise they would have better transported timber. Investigation of wood samples by Van Rijn (2006) supports this suggestion.

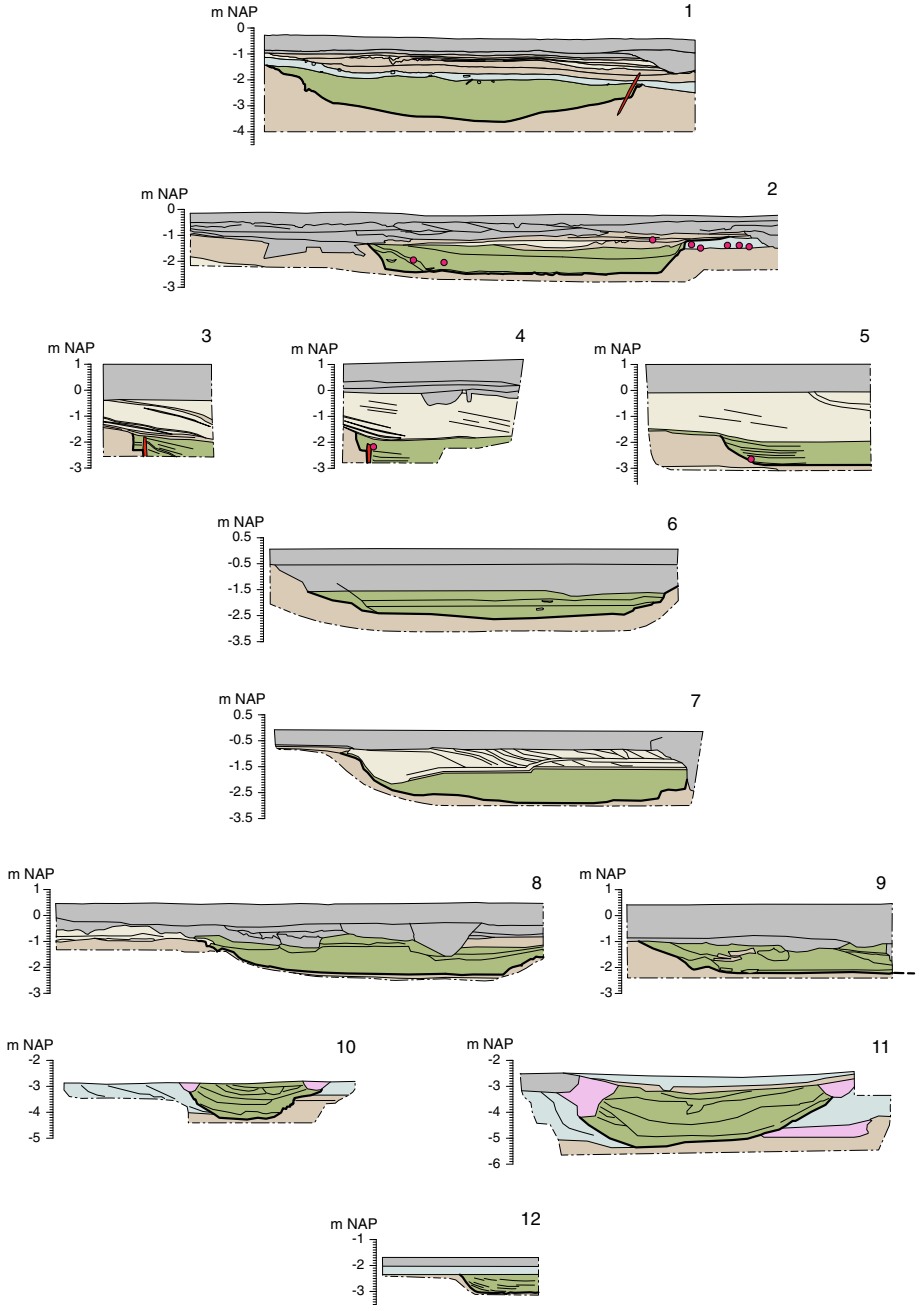

Fig. 5 For legend see Fig. 4. Simplified north sections of the research sites from Fig. 2 and Table 1. In some cases only south sections were available. These were mirrored for easy comparison. *Scale* 1: 250

Table 2 The dates obtained from the various sites (Fig. 2)

Site nr. (Fig. 2)	Dated material	Method	Context	Number of samples	ID	Date
1	Bone	AMS	Top infill	1	UtC13890	1900 ± 60 BP
1	Peat	AMS	Peat overlying infill	1	UtC 13858	1693 ± 50 BP
3	Wood	AMS	Ditch above older phase	1	UtC 14713	1833 ± 29 BP
3	Wood	AMS	Towpath above older pase	1	UtC 14674	1876 ± 34 BP
5	Wood	Dendro	Timbering	1	RING nr. 1992039	48 + max.3
5	Wood	Dendro	Timbering	10	RING nr. 1995028	Spring 50 AD
4	Wood	Dendro	Timbering	1	RING nr. 1990029	Spring 50 AD
3	Wood	Dendro	Timbering	3	RING nr. 2006085	Spring 50 AD
1	Wood	Dendro	Timbering	1	RING nr. 2004047	Spring 50 AD

that most trenches were only extended to 1 of 2 m beyond the sides of the canal, whereas the towpath was constructed approximately six meters from the bank.

It has also been shown that the canal was not constructed in a straight line, so it is possible that different phases of the canal were found during the earlier investigations but mistaken for the same one each time. The different phases do not necessarily overlap physically, as was the case in the single occasion when two phases were distinguished. Also, the choice of digging a new canal next to the old one may not have been the best one for the entire canal. We do not know why the Roman engineers did not simply choose to re-excavate the existing canal and they may have done so in other sections.

Route of the canal

Based on the information at hand, a reconstruction of the location of the Fossa Corbulonis can be postulated although several sections of the canal have thus far eluded discovery and are reconstructed on the basis of circumstantial evidence (Fig. 6). From Matilo, just east of present day Leiden, the canal follows the route of the extant Rijn-Schie canal. The Rijn-Schie canal connects with another modern day canal, the Vliet. The Fossa Corbulonis is thought to lie in the same location as the Vliet. It is uncertain whether the Vliet, which is Late Medieval in origin, was cut at exactly the same location of Corbulo's canal, The latter may have followed a natural waterway in this part of the area, which makes it difficult to identify. It is also unknown whether any kind of waterway, natural or anthropogenic, was visible in the time the Vliet was cut.

It is certain that the canal was entirely man-made in the Leidschendam area, cut into the peat beds between a natural creek and the beach barrier. This is also the only part of its entire length where the number and density of sightings allows for a relatively detailed and reliable reconstruction of the route (Figs. 2, 6). New research in 2011 (Griffioen and Hoogendijk 2011) suggests that towards the south, the canal merges into a natural channel and in relative obscurity somewhere between site 10 and 11 (Fig. 2).

Where the canal continues towards the Meuse estuary is still very uncertain. There are two possible variants for this southern stretch. One possibility is that the canal follows one of the creeks of the Gantel system, which opens into the Meuse estuary north of Naaldwijk, but an alternative route is postulated towards the south of Naaldwijk along the current

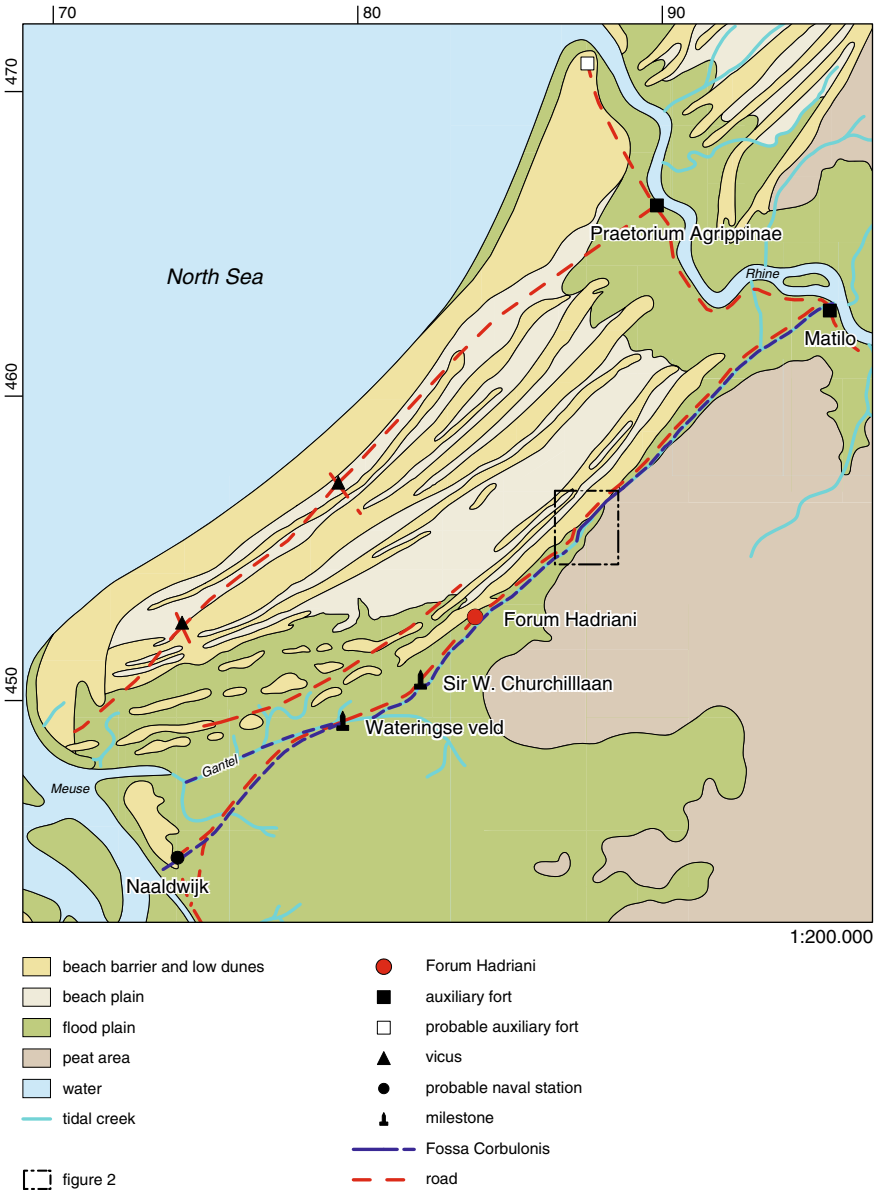

Fig. 6 Reconstruction of the location of the Fossa Corbulonis. Map after Vos et al. (2011), archaeological sites after Waasdorp (2006). *Scale* 1:200.000

Middelbroekweg and into the Meuse (Fig. 6). In 1997 the discovery of four Roman milestones in Wateringse Veld (The Hague) was headline news in the Netherlands. The milestones were discovered next to a Roman road and drainage ditch along the western bank of a natural channel (Waasdorp 2006). This reminds of the situation in Leidschendam, where the youngest phase of the canal was accompanied by a towpath and drainage

ditch on its western bank. The discovery of a bronze plaque suggesting the presence of a naval station in Naaldwijk could also be an indication that the Fossa Corbulonis connects to the Meuse here, rather than further to the west (Derks 2008).

Function of the canal

From an archaeological perspective it is difficult to discuss the first of the three options mentioned by Dio for the construction of the canal: to keep the troops busy. It was not uncommon for Roman generals to make their soldiers do heavy labour to keep them from getting bored and out of trouble (Faulkner 2008),[19] but it is impossible to support or dismiss this theory based on the archaeological evidence at hand. This is clearly more a matter for historians to debate over.

The suggestion that the canal was possibly used as an instrument for water management is interesting and supported by indirect evidence in the form of a possible portage or lock. It is important however, to distinguish between two different forms of water management relevant to this paper. Dio specifically states the canal is intended '*to prevent the rivers from flowing back land inwards and causing floods, due to the tidal activities of the ocean*'. This is water management in its strict sense; the canal apparently serves as a kind of pressure vent, diverting water backing up in the Rhine and Meuse away from low lying areas. The presence of laminated sediments in the canal are indicative of to it being subject to tidal action, but the amount of water pushed upstream during tidal activity seem to considerably supersede the the capacity of the canal. Conversely, the canal may have served as a means to drain the marshes on either side, thus enabling the local inhabitants to farm the area and live there.

The possible portage in the middle of the canal is a more indirect, passive way of water management. The engineers mapping the route of the canal would have come across the boundary between two drainage basins with differing water tables and provided for an interruption, a dam in the canal to prevent the upper drainage basin from draining into the lower one leading to possible disastrous consequences. The portage was then constructed to haul boats from one leg of the canal into the other.

This automatically leads to the last option provided by the classical sources, that Corbulo had the canal dug to enable the transport of goods and people between the Meuse and the Rhine without having to face the dangers of the sea. Both the towpath and the portage strongly support this theory and the nature of the landscape in this part of the Netherlands in the first century AD makes any type of transport by water far easier than across the land.

No evidence for any sort of vessel has been found in connection to the canal, but in Rhine channels at Zwammerdam, Woerden and De Meern, both towards the east, several boats of a type that was probably widely used in Northwest Europe in that time have been found. The length of the boats varies, but they have a flat bottom and straight sides. De Meern 1, found and salvaged in 2003 (Fig. 7) in a highly publicised excavation (de Kam et al. 2007) was 25 metres long and had a mast. These ships could sail, but were probably towed most of the time. Although De Meern 1 was made from local oak (Jansma 2007), several of these ships are built from oak from (Southern) Germany. It has been suggested that merchants would have the ship built along the Upper Rhine and load it with cargo, sail it down the river using the natural current, sell their wares along the way and eventually

[19] Even without the threat of boredom, the Roman legionaries traditionally doubled as a workforce (Goldsworthy 2003).

sell the wood from the boats as timber for construction. They would then make their way back home by other means and repeat the cycle. Not only does the local provenance of the timber used for De Meern 1 contradicts this suggestion, the use and repair of De Meern 1 for several decades also tells a different story (Jansma 2007).

Woerden 7, a patrol boat of the Roman army, but similar in construction to the cargo ships, was made of two sets of oak wood, the largest part from Germany in the Aachen—Trier region and a smaller portion from oak originating from the Lower Rhine in the Netherlands, suggesting the boat was built in Germany and repaired in the Netherlands later during its use (Blom et al. 2008).

Conclusion

Classical sources mention a Roman canal between the estuaries of the Rhine and the Meuse. The presence of such a canal was established archaeologically and dating evidence generally corroborates the attribution to general Corbulo, mentioned by Tacitus and Dio. Investigation of the canal is difficult, since it is partially constructed by connecting existing, natural waterways. This makes detection of the feature difficult, since the coastal area of the Netherlands is littered with ancient waterways from throughout the Holocene. Distinguishing the canal from the surrounding channels is problematic, especially since it often actually is a natural channel or, as it is probably the case in the southern stretch of its route, was cut into deposits belonging to a former tidal creek. Since the canal silted up gradually, its infill looks exactly like that of a natural channel. It is no coincidence that the majority of reliable sightings hail from a stretch of the canal in the town of Leidschendam. In this area, the canal was dug into peat deposits, making it easy to distinguish not only the clayey infill, but also to recognise the flat bottom of the canal, clearly distinguishing it from from a natural channel, which would have a more bowl-shaped outline.

The route of the canal is incompletely established. In the northern part, it is impossible to test, since it is believed that the route coincides with extant canals?, whereas the southern leg is believed to follow the course of a former tidal creek. Some clues have been found in Rijswijk and The Hague, but this requires further investigation. The middle part of the route is fairly well established by all the investigations in the Leidschendam area. It is clear that the Roman engineers strayed from their traditional penchant for straight lines in the planning of the canal's route. This is certainly in part due to the marshy, wet landscape in the area, which simply rendered such a strategy overly complicated, but it can also be attributed to the desire to avoid unnecessary work by linking up existing channels.

The construction of the canal is fairly simple. It is anywhere between 4.5 and 15 m wide, with sloping sides and a flat base. The depth is approximately 1.5–2 m deep. In several places, fortification of the banks of the canal have been found in the form of timbering, generally made of oak stakes produced locally. At the Rietvinklaan site, a towpath with adjacent drainage ditch was found, mirrored by the discovery of a natural channel, possibly part of the canal, with evidence of a road further to the south. Roughly in the middle of the route of the canal, there is some evidence for the presence of a dam and a portage for hauling vessels. This was possibly constructed on the watershed of the Meuse and Rhine flood basins, because of differing water tables, as evidenced by the fact that the depth of the base of the canal relative to sea level differs on both sides of the dam. Two adjacent channels were discovered at the Rietvinklaan, suggesting a reconstruction of the canal, relatively quickly after its initial construction. It is unclear whether the second phase

Fig. 7 A reconstruction of De Meern 1. Similar boats will have been used to travel up and down the Fossa Corbulonis. *Photograph*: Ton Penders (Cultural Heritage Agency of the Netherlands)

of the canal is a local phenomenon or whether this is the case over a greater length. Absence of similar observations in other sites may be the result of research strategies.

Dates from dendrochronological samples confirm the second phase of construction of the canal in, or shortly after 50 AD, which is consistent with the second tour of command of general Corbulo. There is no certainty until when the canal was in use. Evidence from various investigations suggest that the canal would have filled up with sediments due to its connection to two tidal rivers, but sedimentation rates are not certain and can vary greatly. Dates from radiometric samples vary widely and are therefore unreliable to establish a terminus ante quem. It is generally thought that the canal remained in use until approximately the middle of the second century AD, possibly longer for the southern part.

The main function of the canal was probably a vector for the transport of goods and people without having to venture on to the North Sea, which was too dangerous for the flat bottomed transport boats designed for use on rivers and canals. The dam in the canal suggests that the Romans were at least acutely aware of the importance of water management, since they recognised the difference between the flood basins of the two rivers connected by the canal. Whether the canal actually played an active role in diverting water from the rivers to prevent floods in case of extreme high tides or storm is a different matter. Compared to the rivers Meuse and Rhine, the canal seems rather puny. It may have functioned in the other direction, however, draining the marshes to make them more hospitable.

The Fossa Corbulonis fits into a much larger network of natural and man-made (or at least altered) waterways and roads. In this respect, it is interesting to note that in the Roman era, the large inlets characterising the coast of the south-western corner of the Netherlands did not yet exist, except for the estuary of the Scheldt (de Groot et al. 2011). The situation was therefore similar to the area between the Meuse and the Rhine Rivers. This could imply that the Fossa Corbulonis is only the northern leg of a longer system, also connecting the Meuse and the Scheldt rivers (de Bruin et al. 2012). No convincing evidence for such a canal, either in historic sources or in archaeological research has ever been found, but if transport of heavy goods is easier on water than it is overland, especially in

the absence of good roads, it is an interesting possibility, assuming that transport by sea was an undesirable option.

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