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Provenance and Production: Casks in the Dutch Archaeological Context

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Abstract

The Late Medieval and Early Modern periods in the Netherlands are marked by an upsurge in the production, use and repurposing of casks in cities. This is inextricably linked with the growing marine and riverine trade markets and the increase in artisan production. Casks have been found on shipwrecks, where they were used as containers for merchandise (primary purpose) and in urban areas, where they were repurposed as shafts for wells or cesspits (secondary purpose). As a result, the initial production phase of the lifecycle of casks often remained undetected. This study aims to generate an overview of the dendrochronological studies conducted in the past decades by Dutch dendrochronologists on casks from Dutch archaeological context, in which the felling year of the wood used to construct the casks can be dated from the 12th to 18th centuries, to gain insight into their production by coopers. The first objective is to better understand the diverse provenance areas detected in the coopers' timber, after which the diachronic developments in the use of the timber from specific provenance

areas can be addressed. The main objective is to assess whether it is possible to distinguish locally produced casks from casks used to import merchandise, which was successful in some cases. In addition to the dendrochronological and archaeological data, archival sources were used to contextualize and substantiate the analyses and interpretations.

Keywords

archaeology – archival sources – casks – dendrochronology – timber – oak – provenance

1 Introduction

1.1 *Casks in an Archaeological Context*

Casks have often been found in archaeological research in the past several decades. The majority of these casks have been found in urban archaeological context and have been repurposed as shafts for wells or cesspits. Archaeologists study the contents of these casks, often filled with feces and household waste, because much information about the users can be retrieved from them. However, little attention has been paid to the casks themselves. Nevertheless, a study of the wood used in their construction can provide insight into their primary purpose as containers for shipping merchandise. The first step to achieve this primary purpose is the production of the casks. This paper is focused on this initial phase in the lifecycle of casks.

A striking example is an 18th-century cask repurposed as a well shaft found in the Dutch port city of Vlissingen (Fig. 1). The VOC (*Verenigde Oost-Indische Compagnie*) mark on the cask shows that it was related to the Dutch East India Company. In the well, a rare Asian stoneware jar was found. This type of pottery was used as a shipping container and was probably picked up by a sailor or trader as a curiosity. In addition, a wooden toy boat approximately 15 cm long was found in the well. Finds such as these suggest that the youth in Vlissingen were familiar with maritime life. The VOC sign on the cask underlines the maritime connection of the user of the cask. However, because of the lack of research about the cask itself, it remains unclear where this cask was constructed.

In maritime archaeological context, casks serve their fundamental function as containers for transporting goods. The research on these casks provides the opportunity to look into both the casks and the goods that were transported in them. Shipwrecks in Dutch waters have been mapped and partially

FIGURE 1 A well in Vlissingen, Netherlands, and its contents. Left: The well. Top right: VOC etched on staves. Bottom right: An Asian stoneware jar and a wooden toy boat (Oosterbaan & Griffioen 2015)

investigated by the Cultural Heritage Agency (Cultural Heritage Agency 2020). In totality, this inventory includes 218 shipwrecks that date back to the modern period alone.

1.2 *Lifecycle of Casks*

Before casks are found by archaeologists, they have already undergone a lengthy lifecycle (Fig. 2). First, trees are felled and partially dried, after which the raw timber is shipped or cut into planks or boards. The raw timber is suitable to be transported with timber rafts, which is mainly done via rivers. The transport of the planks and boards can also be done on seagoing ships. In the archival sources, boards designated for cask production are registered as clapboard, which are small boards of split oak used to make cask staves.

The clapboard is then shipped to cooperages, where it is used to make casks. The casks are then filled, most often with fish, wine, or beer, to be transported to their end destination. Other merchandise such as meat, gunpowder and spices were also packed into the casks. Casks were often used as packing material multiple times. Before they were put back into use, the casks often had to be repaired or refitted in the cooperages. When the casks were no longer needed for trade, some were repurposed as shafts of cesspits and wells.

Traces of the different phases are evident in the form of marks left on casks. Coopers marked their casks when they were assembled to quantify their production. When used to transport goods, they were marked to indicate their content, ownership, quality and quantity.

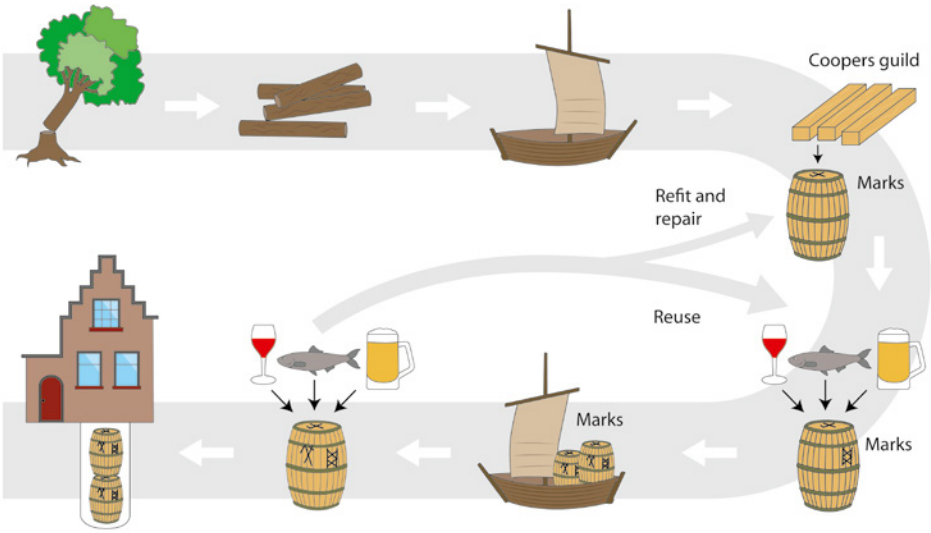

FIGURE 2 A schematic overview of the lifecycle of casks

1.3 *Production of Casks*

The research of casks in both maritime and urban archaeology can provide insight into the phases of their usage as a container and their repurposing. The production of casks is, however, harder to unravel using archaeological data. The cooperages are hardly ever noted in archaeological research. An overview study of archaeological indicators of artisanal production in Dutch cities from the Late Medieval and Modern periods locates only one cooperage in the Netherlands (Blonk-van den Bercken *et al.* 2020). However, dendrochronological and archaeological data of casks found in urban and maritime archaeology can be used to provide insights into the production phase of casks.

1.4 *Research Questions and Design*

This paper is focused on the production of casks excavated in Dutch archaeology. To gain insight into this specific phase of the lifecycle of casks, both dendrochronological and archaeological data were used. Archival sources were used to contextualize and substantiate the interpretation of the archaeological and dendrochronological data but they are not part of the dataset itself.

The main objective of this study was to assess whether it is possible to distinguish casks produced in the Netherlands from imported casks. To address the main objective, two sub-questions were considered:

– Which provenance areas can be detected in the timber used to produce the casks identified in the Dutch archaeological context?

– What diachronic patterns can be detected in the provenance areas of the coopers' timber?

2 Dataset

2.1 *Source Material*

To better understand the production of casks, both archaeological and dendrochronological data were used. The first step in this study consisted of identifying the parts of the casks, such as staves and heads, found in Dutch archaeological studies that could be dated from the 12th to 18th centuries. Only heads and staves that had been dendrochronologically analyzed were incorporated into the dataset.

This resulted in a dataset of 946 dated tree-ring series. This dataset can be accessed at 10.6084/m9.figshare.21666575/. A tree-ring series represents an individual stave or a head plank. For each tree-ring series, the following items were provided (if available): the timber species; total number of rings; the number of sapwood rings and the dates of the oldest and youngest ring, corresponding to the Student's t-values (Hollstein 1980); the percentage of Parallel Variation or Gleichlaufigkeit (%PV); the overlap between the reference data and the tree series (OL); the deduction of the felling year (*terminus post quem* if only heartwood was present or an estimated felling year based on sapwood calculations) and an established provenance of the timber.

The estimated felling years in the reports were used. If these were unavailable, the calculation of the sapwood statistics of Hollstein (1980) or Wazny (1990) was used. The dataset of the final list of 946 dated tree-ring series consists of dendrochronological data contributed by four dendrochronologists: Ing. Petra Doeve MA (BAAC), Ir. Sjoerd van Daalen (Van Daalen Dendrochronologie), Em. prof. dr. Esther Jansma (Cultural Heritage Agency) and Dr. Marjolein van der Linden (Biax Consult).

These data were supplemented with data from archaeological project reports. The archaeological data on the casks' parts consisted of length, width, thickness, holes, marks, date of the contents and find location.

2.2 *From Tree-Ring Series to Casks*

To identify individual casks, the staves and heads were then matched to one another. Of the 946 records 357 casks could be identified. The archaeological data was predominantly used in this matter because it determined which heads and staves were found together.

2.3 *Dating Accuracy*

The individual casks were then dated using the dendrochronological dates of the tree-ring series. Either the estimated felling interval (if sapwood was present) or the earliest estimated felling date (if sapwood was absent) was used for this. Of the 357 individual casks, only 57 casks (16%) contained at least one tree-ring series with sapwood. For comparative reasons, the estimated felling date and earliest possible felling date were merged and grouped into time periods. In some cases, casks without sapwood were considered to have zero sapwood rings for the purposes of estimating a felling interval (van Daalen 2021). In such a way, the grouping of tree-ring series with and without sapwood into timeslots is unlikely to misrepresent actual age distributions. However, this needs to be acknowledged when interpreting the data.

2.4 *Provenance*

To determine the provenance of individual casks, the data from the records of the individual staves and heads were used. When analyzing the dataset, only the provenance areas to which more than five casks could be linked were included. Therefore, the casks made with timber from western Austria, southern England and southern Scandinavia were disregarded because less than five casks contained tree-ring series, indicating a provenance from these areas. The number of casks connected to these provenance regions was too low to execute a reliable analysis.

2.5 *Timber Species*

The individual casks were mostly made of heads and staves of a single timber species. The coopers mostly used oak for the production of casks — in the dataset, 97.8% of the tree-ring series consisted of oak (see Table 1). In only 16 out of 357 casks, species other than oak were identified. Thus, this study focused only on oak.

TABLE 1 The timber species of the coopers' timber

Timber species	Number of tree-ring series	Percentage
Oak (*Quercus* spp.)	925	97.8%
Silver fir (*Abies alba* Mill.)	9	1.0%
Spruce (*Picea abies* Karst.)	7	0.7%
Scots pine (*Pinus sylvestris* L.)	5	0.5%
Total	946	100%

2.6 *Sample Size*

The dataset consisted of 357 casks from Dutch archaeological context dating from the 12th to the 18th century. Even though general patterns can be extracted from this dataset, the dataset represents a relatively small number of the total number of casks that were circulating during this period.

In addition, it is important to realize that a large part of the dataset consists of casks that were repurposed for use as well as cesspit shafts. The data showed that only casks with a diameter of more than 45 cm were repurposed this way. This means that not all casks circulating between the 12th and 18th centuries were included in this dataset because smaller casks were not suitable for such repurposing.

3 Results

The results of the study are presented in the following three sections. The first two sub-questions focus on the diversity of the provenance and diachronic patterns of the wood. The main objective of this study is to assess whether it is possible to distinguish locally produced casks from imported casks used in trade. This research question will be addressed in the final section.

Archival sources were used to contextualize and substantiate the interpretation of the archaeological and dendrochronological data with regard to the research questions. The relevant archival sources will be addressed in each section separately.

3.1 *Provenance of Coopers' Timber in Dutch Archaeological Context*

Of the 357 individual casks, the provenance of 288 could be established using dendrochronological data. To this end, seven frequently recurring provenance areas were assigned (Fig. 3). The extent of the provenance areas was determined by combining the provenance analysis of the timber with the catchment areas of the rivers the timber was transported along, either as (semi) raw material or completed casks.

The outlines in Figure 3 are estimated boundaries. Adjacent areas may share tree ring characteristics that make a distinction between them arduous and even the boundaries are not well-defined. Especially the Meuse and Rhine valleys, and to a lesser extent adjacent Germany, can be hard or impossible to distinguish. Additionally, the use of local wood cannot be ruled out but is strenuous to detect due to the relative proximity of major timber-supplying areas.

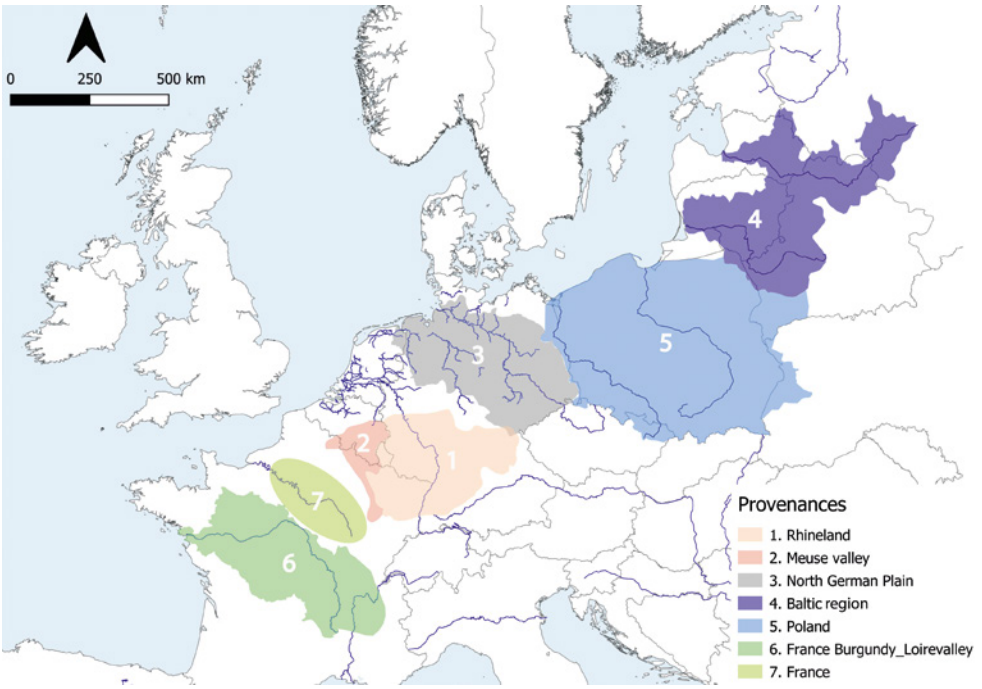

FIGURE 3 The provenance areas of cask timber (n = 288) projected onto a map of present-day Europe with the main rivers used for timber transportation. Only frequently detected provenance areas are mapped.

The seven frequently recurring provenance areas of coopers' timber are Rhineland, Meuse valley, north German plain, Baltic region, Poland, France Burgundy/Loire valley and France. These provenance regions are also known for Late Medieval and Early Modern period timber imports to the Netherlands for buildings, infrastructure, ships, furniture and art objects (Jansma 1995; Jansma *et al.* 2004; Domínguez-Delmás & Berselaar 2009; Domínguez-Delmás *et al.* 2011; Borghaerts 2021).

However, the areas of origin of timber imports for other purposes also include regions that do not occur within the coopers' timber. The most notable absent area is southern Scandinavia. Oak from southern Scandinavia was imported to construct ships, buildings and their foundations (Domínguez-Delmás & Berselaar 2009; Borghaerts 2021), however, was rarely used in cooperages. The Scandinavian timber is found in cities along the coast or in cities with good access to waterways, so it could have been available for coopers in these cities as well. The coopers apparently had a clear preference for wood from specific provenance areas. As such, timber from southern Scandinavia either did not meet their preferences or was unavailable to them.

The seven frequently recurring provenance areas can be divided into two main categories, those that were connected to the Netherlands by either river trade or by sea trade. Timber with a provenance in the Meuse valley and Rhineland (Fig. 3, Areas 1–2) was often used for the production of casks (see Table 3). These areas were connected to the Netherlands by river trade and could have supplied the coopers' timber or complete casks with merchandise. Timber from these areas was also used for other purposes, such as both buildings and, to a lesser extent though, also for furniture or art objects from the Late Medieval period onwards (Domínguez-Delmás & Berselaar 2009).

Since the Late Medieval period the Netherlands also relied on timber imports by sea trade, from areas such as the north German plain, Poland and the Baltic region (Fig. 3, areas 3–5). However, timber for construction was mostly imported from the north German plain (Adam 2015), but apparently, casks made of this timber are rare — the dataset showed only 15 casks of timber that could be connected to this area.

The Baltic region is the most common provenance among the sea trade import (58 casks, see Fig. 4). Studies showed that in the Netherlands timber from the Baltic region was used for shipbuilding, panels, sculptures, altarpieces and other wooden works of art (Jansma *et al.* 2004; Domínguez-Delmás & Berselaar 2009; Fraiture 2009). The timber from these areas had specific characteristics, which made it popular among artists and shipbuilders. Its slow growth led to a homogeneous, fine grain, which ensured that the timber remained stable (Domínguez-Delmás & Berselaar 2009). Baltic timber was also used in other European countries because of these specific characteristics. In England, timber from this region was popular for panel paintings (Hillam & Tyers 1995; Daly & Tyers 2022).

The provenance areas of oak for casks and oak used for other purposes do not overlap completely. The provenance areas within the current boundaries of France (Fig. 3, Areas 6–7) do not appear in the dendrochronological studies of oak used for other purposes, based on the experience of dendrochronologists in the Netherlands. This suggests that there was no large-scale trade of French oak in the Netherlands.

While the provenance of the oak used for casks can be determined from Dutch archaeological sources, this does not directly provide insight into where the oak was processed into casks. The timber could have been made into casks in the provenance area or elsewhere before it got shipped to the Netherlands in the form of a cask. The timber could also have been transported to the Netherlands as a semi-finished product, that is, clapboard, to continue the production of casks in the Netherlands. Thus, archival sources were used to gain insight into the import of timber to be used by coopers specifically.

3.1.1 Provenance Areas of the Timber Used by Coopers in Archival Sources

The large-scale transport of coopers' timber to the Netherlands appears in archival sources in the Late Medieval period. The trade of coopers' timber was recorded in the registers of the toll stations along main rivers in the Netherlands and can therefore account for the timber import from the provenance areas of Rhineland and the Meuse valley (Fig. 3, Areas 1–2). The records of the Lobith toll station along the Rhine, mention the passage of *claphout* (clapboard) on several ships on the Rhine in 1438 (Weststrate 2007). However, the number of ships on which *claphout* was registered as cargo is limited in the toll records of stations along the main rivers in the Netherlands. This is probably because of the way the cargo was described in the toll records. Timber was mostly documented as the more generic *Holt* (wood). The size of the timber or why it was being imported cannot be deduced from this term.

In approximately the same period, a document dated 1454, listing tariffs levied on Hanseatic merchants at toll stations in Holland, mentions clapboard specifically, which makes it plausible that this product was shipped along river systems to ports in the province of Holland (Weststrate 2007).

The provenance areas that depended on sea trade to import coopers' timber to the Netherlands are also present in archival sources. Timber transported from the Baltic region and Poland (Fig. 3, Areas 4–5) was registered in the Sound toll register. This register recorded the transport of merchandise from the Baltic Sea region to the North Sea from 1497 onwards. The transport of timber used by coopers in the Dutch Republic was also recorded (see Table 2).

TABLE 2 The transport of klapholt as merchandise recorded in the Sound toll register

Region	**Percentage and number of ships passing through the Sound 1497–1634 (region as home port of the captain)**	**Percentage and number of ships passing through the Sound 1634–1857 (region as destination)**
Dutch Republic	80.4% (919)	48.7% (6288)
Great Britain	3.6% (41)	30.3% (3918)
Atlantic coast of France, Spain and Portugal	0.5% (6)	15.8% (2048)
North Sea (German/Danish coast)	5.0% (57)	3.0% (383)
Denmark, Sweden, Norway, Iceland, Greenland	0.5% (6)	1.2% (158)

TABLE 2 The transport of klapholt as merchandise (*cont.*)

Region	Percentage and number of ships passing through the Sound 1497–1634 (region as home port of the captain)	Percentage and number of ships passing through the Sound 1634–1857 (region as destination)
Baltic region	9.9% (113)	0.8% (101)
Other	0.1% (1)	0.2% (27)
Total	100% (1143)	100% (12923)

Klapholt was designated as the Danish translation of clapboard.

SOURCE: STR-ONLINE (2017)

This table shows the percentage and number of ships transporting clapboard through the Sound. On these ships, clapboard was shipped to different destinations, with the specific purpose of selling it to coopers. In the periods 1497–1634 and 1634–1857, the Dutch Republic was the main destination for coopers' timber.

Specified provenance areas also appear in the next phase of the transport of coopers' timber. When it arrived in the Netherlands, the timber was sold to coopers. Much of the timber was specifically ordered, but some of it was sold at timber auctions, according to the archival records of the Zaandam timber auctions in the period 1655–1811 (Schillemans 1947). The registers specify Rhineland, the port of Hamburg and several ports along the Baltic Sea as the provenance of the coopers' timber (Fig. 3, Areas 1, 3–5).

In the archival sources mentioned above, several provenance areas are documented that have also been identified through dendrochronological research. However, France is the only exception; French timber is not found in dendrochronological studies of oak used for other purposes than the production of casks. This indicates the absence of large-scale transport of oak from France to the Netherlands in the Late Medieval and Early Modern periods. Therefore, casks made of French timber were probably produced in France and contained French products destined for the Netherlands.

3.2 *Diachronic Patterns of the Provenance of Coopers' Timber*

Of the 357 casks in the Dutch archaeological records that have been dendrochronologically researched, the provenance area of 288 could be established. The felling interval or earliest possible felling dates have been determined and

Terminus post quem (grouped in 20 years): Provenance:	1100-1119	1120-1139	1140-1159	1160-1179	1180-1199	1200-1219	1220-1239	1240-1259	1260-1279	1280-1299	1300-1319	1320-1339	1340-1359	1360-1379	1380-1399	1400-1419	1420-1439	1440-1459	1460-1479	1480-1499	1500-1519	1520-1539	1540-1559	1560-1579	1580-1599	1600-1619	1620-1639	1640-1659	1660-1679	1680-1699	1700-1719	1720-1739	1740-1759	Total
1. Rhineland	3	1	1	1	0	0	0	0	0	0	7	2	7	7	6	2	3	2	3	1	3	5	3	7	5	1	3	0	1	2	0	0	0	76
2. Meuse valley	0	0	0	1	1	0	0	1	4	9	3	4	1	3	2	3	1	0	1	0	3	3	4	7	6	4	0	0	0	0	0	0	0	61
3. North German plain	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	1	0	1	0	0	3	0	1	0	2	2	2	0	0	0	0	15
4. Baltic	0	0	0	0	0	0	0	0	0	0	1	0	2	2	4	5	2	0	1	3	3	4	3	7	5	6	1	3	1	3	1	0	1	58
5. Poland	0	0	0	0	0	0	0	0	0	2	3	1	0	7	1	2	1	0	1	0	1	1	2	1	1	1	2	0	1	0	1	0	0	30
6. France Burgundy and Loirevalley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	1	2	0	0	0	0	0	1	0	0	10
7. France	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4	4	2	0	1	2	1	1	0	18
Multiple provenances	0	0	0	0	0	0	0	0	0	0	0	3	1	0	0	1	2	1	0	0	0	2	0	1	0	1	1	0	0	1	0	0	0	16

FIGURE 4 The provenance areas of casks in the Dutch archaeological record in 20-year periods

are organized in 20-year periods in Fig. 4. Several patterns are evident in the diachronic data of the provenance of the timber used for casks. These patterns show the development of trade networks of which the Netherlands was a part.

3.2.1 River Trade

Large-scale trade via the major rivers commenced in the High Middle Ages, which was evident in the presence of casks made of timber from the Meuse valley and Rhineland, beginning in the 12th century (see Fig. 4). In the 12th and 13th centuries, these two areas accounted for 81.5% of the provenance areas of casks in the sample of the study (see Table 3).

TABLE 3 Overview of provenance areas grouped by river trade and sea trade in 200-year periods

Type of trade	Provenance areas	1100–1299	1300–1499	1500–1699	N_total
River trade	Meuse valley, Rhineland	81.5% (22)	58.6% (58)	42.2% (57)	137
Sea trade	Baltic region, Poland, north German plain	14.8% (4)	39.4% (39)	41.5% (56)	99
Sea trade	France, France Burgundy_ Loire Valley	3.7% (1)	2.0% (2)	16.3% (22)	25
	Total	100% (27)	100% (99)	100% (135)	261

The river-trade import of timber for other purposes than cask construction to the Netherlands from the Early Medieval period onwards has been demonstrated in several studies based on dendrochronological data (Jansma *et al.* 2016, 2017; Van Lanen *et al.* 2016). Additionally, in archaeological studies focused on the spatial distribution of artifacts in the Early Medieval period, river trade was demonstrated meticulously. To elaborate, Kemme (2021) concluded that the Rhine was the main artery for the timber trade in the Early Medieval period, although, in the 10th and 11th centuries, timber was also transported through the Meuse.

3.2.2 Sea Trade

The casks in the Dutch archaeological record provide evidence of the growing importance of the Hanseatic League in the late 13th century. This alliance of trading cities via the Baltic Sea can be connected to the provenance areas of Poland, the Baltic region and the north German plain. Casks made from timber from these areas account for 39.4% (1300–1499) and 41.5% (1500–1699) of the provenance areas in casks found the Dutch archaeological studies (see Table 3).

The beginning of the import of timber from Poland, the Baltic region and the north German plain is also evident in the provenance analyses of oak used for other purposes. Timber from the Baltic region and Poland was imported to the Netherlands from the 14th century but was of particular importance at the end of the 16th and 17th centuries. This diachronic pattern is also present in the provenance analyses of timber used by coopers.

Casks made of French wood appear in the Dutch archaeological record as early as the late 15th century (see Fig. 4). Their relative share in relation to the total number of casks increases to 16.3% in the period 1500–1699 (see Table 3). As French timber is uncommon in the Dutch dendrochronological record (see Section 3.1), it can be identified as entering the Netherlands as complete casks that were used to import French products. This import was predominantly concentrated in the late 16th and early 17th centuries.

3.2.3 Diachronic Patterns of the Transportation of Coopers' Timber in Archival Sources

The timber trade via river is registered in the records of toll stations along the main rivers of the Netherlands, and they show growth in timber transport. The number of rafts of timber registered by the Nijmegen toll station on the Waal in 1550 doubled that of the rafts registered by the Lobith toll station on the Rhine in 1400 (Weststrate 2017).

The sea trade in coopers' timber also shows diachronic patterns. The transport of coopers' timber from the provenance areas of Poland and the Baltic region was registered in the Sound toll register (see Table 2). At the end of the 15th century, the majority of ships carrying clapboard were destined for the Dutch Republic. Although the relative share of coopers' timber exported to the Dutch Republic decreased after the second quarter of the 17th century, the absolute number grew exponentially. In the period 1497–1634, a total of 919 ships with clapboard cargo and with a Dutch captain passed through the Sound. In the subsequent period 1634–1857, ships carrying clapboard with the Dutch Republic as their destination accumulated 6288 record mentions.

Archival sources also provide insight into the import of timber from the north German plain to the Netherlands. Adam (2015) showed that the earliest mention of the timber trade via the Elbe dates back to 1325. Furthermore, the export of timber from the north German plain gained momentum in the late 17th century and continued until the 18th century. The growing share of the timber import from this provenance area is also reflected in the share of this timber in the timber auctions in Zaandam. The percentage of timber traded through the city of Hamburg, the trading hub for timber from the north German plain, compared to the timber from Rhineland grew considerably.

The revenues of the timber from the north German plain grew from 4.7% in 1675–1679 to 51.5% in 1680–1684 (Schillemans 1947).

3.3 *Imported Casks or Imported Coopers' Timber*

The diversity in the provenance areas of the timber used for casks does not determine where the timber was processed into casks. The timber could have been used to produce casks in the provenance area or it could have been transported to another location where the casks were produced. The casks showing multiple timber provenances (Fig. 4, bottom row) shows us something about the transport of the coopers' timber. In these cases, imported timber from several provenance areas was either mixed during transport or at the cooperages before it was used to produce casks.

Of only 16 of the 357 casks, different provenances in one cask were detected. This accounts for only 4.5% of the casks, but several factors need to be considered. First, the dendrochronological research was conducted on more than one stave of a cask in only 182 of the 357 casks. Hence, in 175 cases, only one tree-ring series was analyzed, which makes it impossible to determine whether the timber in those casks came from multiple provenance areas. The relatively small number of staves that have been dendrochronologically analyzed, is caused by archaeologists are usually interested in dating the wells and cesspits for which the casks has been repurposed. To achieve this, often only one stave was selected to be dated dendrochronologically.

Second, provenance was identified in only 288 of the 357 casks. In the timber used for the other 69 casks, no provenance could be detected, which also makes it impossible to determine whether the timber in those casks came from multiple provenance areas.

The third factor to take into account are the repairs made to casks, which could account for the multiple provenance areas detected in a cask (Fig. 5, left). In some cases, a broken stave could have been replaced by a new one, though this is less likely when multiple provenance areas are detected in multiple staves of one cask (Fig. 5, right).

When the first two factors were observed are taken into account, the average occurrence of multiple provenance areas in a cask resulted to be 12.7% (see Table 4). Table 4 shows the cases in which multiple provenance areas were detected in at least one stave. When seven or more parts (heads and staves) of a single cask were dendrochronologically analyzed, the percentage of casks with multiple provenances was over 18%.

As stated, it is important to note that many of the casks could have been repaired or refitted. The same calculation was executed to analyze multiple provenance areas in multiple parts (heads and staves); the average occurrence

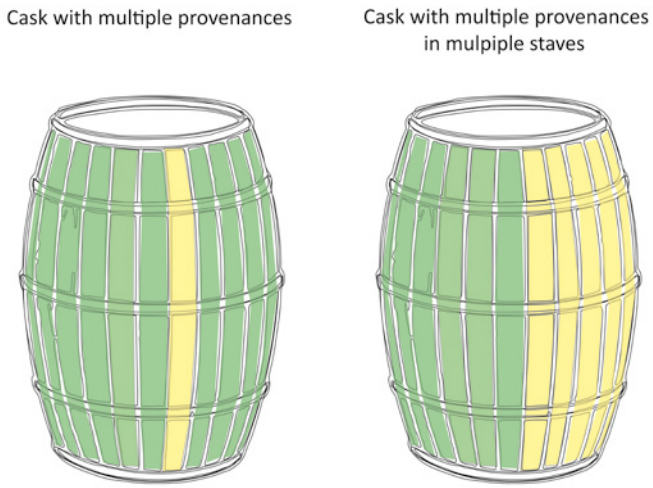

FIGURE 5 Casks made of timber from multiple provenance areas. (Left) A cask with timber from several provenance areas, where at least one stave is from a different provenance area than the rest. (Right) A cask with multiple staves from different provenance areas. The yellow and green colors indicate timber from different provenance areas.

TABLE 4 Occurrence of multiple provenance areas in a cask, with at least one stave per area (Fig. 5, left)

Number of cask parts dendrochronologically analyzed	Number of casks whose provenance could be established	Number of casks with multiple provenances with at least one stave per area	Percentage
1 or more	288	16	5.6%
2 or more	157	16	10.2%
3 or more	92	9	11.1%
4 or more	65	7	10.8%
5 of more	57	7	12.3%
6 or more	45	7	15.6%
7 or more	33	6	18.2%
8 or more	25	4	16.0%
9 or more	21	3	14.3%
10 or more	18	2	11.1%
11 or more	14	2	14.3%
12 or more	8	1	12.5%
		Average	12.7%

TABLE 5 Occurrence of multiple provenance areas in a cask, in multiple staves per cask (Fig. 5, right)

Number of cask parts analyzed dendrochronologically	Number of casks whose provenance could be established	Number of casks with multiple provenances in more than one stave	Percentage
1 or more	288	4	1.4%
2 or more	157	4	2.5%
3 or more	92	4	4.3%
4 or more	65	4	6.2%
5 of more	57	4	7.0%
6 or more	45	4	8.9%
7 or more	33	4	12.1%
8 or more	25	4	16.0%
9 or more	21	3	14.3%
10 or more	18	3	16.7%
11 or more	14	2	14.3%
12 or more	8	1	12.5%
		Average	9.7%

was 9.7% (see Table 5). The percentage of casks also increased considerably when seven or more parts (heads of staves) were dendrochronologically analyzed.

The average occurrences in both cases suggest that at least 9.7% of the casks were made with imported timber. This is considerably higher than the 4.5% accounted for. The mixing of different timber shipments by coopers is not only reflected in a diversity of provenance areas but also in the non-matching felling intervals of the timber within one cask suggesting that several timber shipments were stockpiled before assembly. In Van Daalen's (2021) study, a control group of 117 staves of 13 casks was dendrochronologically analyzed, of which 20% consisted of casks with non-matching felling intervals.

The casks with multiple provenance areas show that some of the timber was transported before assembly. The actual portion of the casks made with imported timber is probably much higher than the casks with multiple provenance areas account for as locally produced casks were also made from imported timber with matching provenance areas.

It is uncertain where the casks with timber from multiple provenance areas were made, but it is clear that these casks date back to the 14th century (see Fig. 4). This coincides with the growing demand for timber import to the

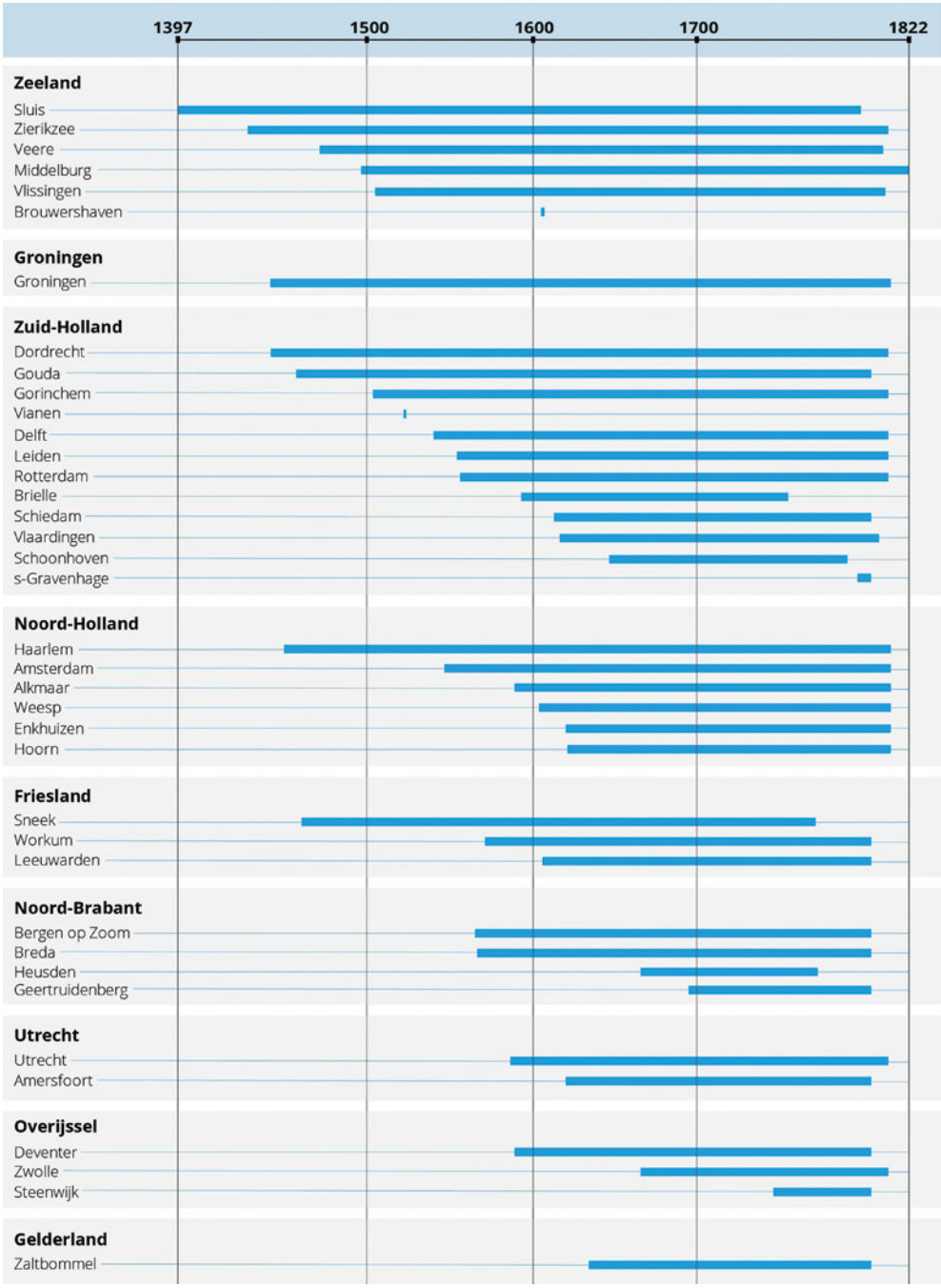

FIGURE 6 Date ranges from the earliest mention to the abolishment of coopers' guilds in the Netherlands by present-day provinces of the Netherlands (DataverseNL 2012)

Netherlands, which is also reflected in the establishment of cooperages in the Netherlands (Fig. 6), as corroborated by archival sources.

3.3.1 Production of Casks in the Netherlands in Archival Sources

The production of casks in the Netherlands and the demand for imported oak are evident. The provinces of Zeeland and Holland began to develop prosperous commodity markets in the Late Medieval period (Dijkman 2011). Other provinces within the current boundaries of the Netherlands also began to develop commodity markets but were unable to correspond to the pace of the growth of the commodity market of 16th and 17th-century Amsterdam, in particular.

The merchandise of these markets, such as herring and beer, got shipped in casks that were locally made. The production of casks in these provinces is represented in the establishment of coopers' guilds, beginning in the late 14th century (Fig. 6). These coopers' guilds were mostly concentrated in the coastal provinces of the Netherlands, with the highest density in the province of Holland, where 18 of the 38 coopers' guilds were established.

It is safe to assume that at least some of the transported coopers' timber was shipped to the Netherlands because the production of casks in the Netherlands depended on timber import. After the Late Middle Ages, the local supply of timber was too scarce to meet the Dutch demand (Domínguez-Delmás & Berselaar 2009). The import of specific timber used by coopers would not have been an exception to this and was probably imported along the same trade networks as other shipped timber. The casks with multiple provenance areas found in Dutch archaeological records date back to the 14th century. This coincides with the establishment of coopers' guilds in the Netherlands, which makes it plausible that these casks were produced in the Netherlands.

A second argument for casks with multiple provenance areas being produced in the Netherlands is based on the specific detected provenance areas. Of the 15 casks with multiple provenance areas, nine were made of at least one stave of Baltic or Polish timber. The trade of timber in these areas is noted in the Sound toll register (see Table 2), which shows that the Dutch Republic was the main consumer of timber from these areas.

4 Conclusion

This study is focused on the casks in the Dutch archaeological record from the 12th to 18th centuries. These casks had a lengthy lifecycle before any

archaeologist documented them (Fig. 2). This paper is focused on the production of the casks and the specifics of the timber that was used for this purpose.

The main objective of this study was to assess whether it was possible to distinguish Netherlands's casks from imported casks. To this end, two preliminary topics were addressed: first, the provenance areas of the casks detected dendrochronologically in Dutch archaeological records from the 12th to 18th centuries; second, the diachronic pattern of the Coopers' timber. The dataset used for these purposes consisted of 946 records with samples of dated tree-ring series, among which 357 individual casks could be identified.

4.1 *Provenance Areas of Cask Timber*

In the dataset, casks were found that were made from the timber of nine different provenance areas. For some of these provenance areas, namely western Austria, southern England and southern Scandinavia, only a few casks could be identified. The analyses focused only on the provenance areas to which five or more casks could be linked (Fig. 3). Based on these findings, the casks were divided into two groups: casks used in river trade and casks used in sea trade. The casks that were used in river trade were composed of timber from the Meuse valley and Rhineland. The timber in casks used in sea trade originated from the north German plain, the Baltic region and Poland. Notably, casks constructed with wood from present-day France were also transported to the Netherlands by sea.

The transport of coopers' timber in the Netherlands in the Late Medieval and Early Modern periods also finds mention in archival sources. The shipment of clapboard, which was used by coopers to produce staves, was found registered in the records of toll stations along the main rivers in the Netherlands in the Late Medieval period. The sea trade of coopers' timber was documented in, for instance, the Sound toll register, where the shipments of clapboard from Poland and the Baltic region were also recorded. The different archival sources account for all the provenance areas detected in the casks dendrochronologically. The only provenance area within present-day France is absent in the archival sources, which might indicate the absence of a large-scale trade in coopers' timber from France to the Netherlands.

4.2 *Diachronic Patterns of the Provenance Areas of Coopers' Timber*

The diachronic patterns of specific provenance areas of the casks show the development of trade networks, of which the Netherlands was a part. Trade via the Meuse and Rhine is evident from the 12th century onwards, since casks made of timber from the corresponding provenance areas were found in Dutch archaeological records of this period (see Fig. 4). The trade on the Baltic Sea by

the Hanseatic League is evident in the provenance of the timber of casks since the 14th century. This is complemented by the trade in casks made with French timber after the 15th century (see Fig. 4 and Table 3).

4.3 *Imported Casks or Imported Coopers Timber?*

The main objective of this study was to assess whether it is possible to distinguish locally produced casks from imported casks used in trade. For this, dendrochronological data were studied in combination with archival material. In some cases, this led to a plausible result. Casks made of French timber containing French merchandise would have been transported to the Netherlands after the assembly. This conclusion is based on the absence of imported French timber in dendrochronological analyses conducted on timber used for purposes other than casks and the absence of French imported coopers' timber in archival material.

The dataset of dendrochronologically analyzed casks also showed that the timber used by coopers was shipped prior to production. Some analyzed casks showed multiple provenances in the same cask, which makes it plausible to assume that the original timber came from several locations (see Fig. 4 and Table 3). Archival sources were used to assess the location of the production of these casks. The casks made with timber from multiple locations date back to the 14th century. This coincides with the establishment of coopers' guilds in the Netherlands (Fig. 6). In addition, 60% of these casks contained timber from either Poland or the Baltic region. This timber was transported through the Sound, after which it was registered in the Sound toll register (see Table 2). The register shows that the timber that passed through the Sound was mainly destined for the Netherlands.

This study shows that the dendrochronological analysis of casks provides insight into the production of casks. This insight is supplemented by an analysis of data in combination with archaeological data and archival sources. The dataset of dendrochronologically analyzed casks is, however, limited. Hopefully, this study will encourage archaeologists to pay more attention to the dendrochronological analysis of casks. In particular, the analysis of multiple staves from one cask should be encouraged because of the additional information this can provide about their provenance, production and lifecycle.

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