

# Dendroprovenancing ship's timbers. A pilot study on a Dutch 18<sup>th</sup> century 'ventjager'

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## Introduction

The general consensus among archaeologists is that at from the year 1200 onwards, and possibly even earlier, Dutch indigenous oak forests were so severely depleted that wood had to be imported. A project involving both RING (the Dutch Centre for Dendrochronology) and the NISA (Netherlands Institute for Ship- and underwater Archaeology, Lelystad), which is part of the National Service for Archaeological Heritage Management (ROB, Amersfoort), has been initiated to find some first answers to the question of the origin of wood used in Dutch ships.

Our study is based on the fact that differences in climate, soil conditions and other environmental circumstances cause trees to grow at different rates. These differences are recorded in tree-ring sequences, and can be used to establish the exact provenance of timber. Our subject was an 18<sup>th</sup>-century shipwreck of a 'ventjager', which was found and excavated in 1971 near Swifterband (NL) and is now on permanent display at the NISA building in Lelystad. The aim of our study was to establish the construction date of the ship and to determine the origin of the ship's timbers.

## Material and methods

A 'ventjager' is type of a ship with a bun (i.e., a cargo hold with holes for water circulation, that is sealed from the rest of the ship), which allowed live fish to be brought from fishing boats to the market on shore (Beylen, 1970); selling provisions to the fishermen was done as a side business. The living room under the deck suggests that the crew of two men at the *ventjager* also lived on the ship.

The studied ship is 15 meters tall and largely intact, except for the mast and a large part of the board side of the hull (Vlierman, 1987). Except for four spruce (*Picea abies*, L. Karst.) timbers, the complete ship was made of oak (*Quercus spec.*), allowing for dendrochronological research as well as dendroprovenancing.

All timbers of the *ventjager* were sampled and the tree-ring pattern of each timber was measured and dated using standard dendrochronological methods. After dating, the measurements were clustered in order to obtain groups of similar measurements. The degree of similarity in a group of measurements can be estimated by calculating the (average) correlation coefficient. We have assumed that a group of measurements with an average correlation coefficient of 0,55 or higher originated from the same region. The value of 0,55 has been derived from research on bog oaks; since bog oaks are nearly always found on the exact place as where they grew, they indicate what average correlation

coefficient can be expected from indigenous oaks that have grown on the same site. The growth patterns of bog oaks from the same site are characterized by average correlation coefficients of  $> 0,52$  (Jansma, 1995, chapter 5).

The mean curves of clusters of measurements were compared to all available chronologies from Europe, even though they were already dated. Of the matching chronologies, only the chronology representing the smallest known region of origin was refined by clustering the measurements that were used to make the chronology, so that the average correlation coefficient of the remaining cluster(s) was 0,55 or higher.

The final step was to add this refined group of measurements of the reference chronology to the cluster associated with the mean curve. The average correlation coefficient of the combined groups was computed to find out whether the tree-ring patterns were sufficiently similar. It was assumed that if the average correlation coefficient was 0,55 or higher, both groups originated from the same site; if the average correlation coefficient was lower than 0,55, we assumed a different origin. This procedure was repeated for all clusters.

To find out if certain regions within Europe provided more timbers of specific qualities or dimensions than others, each timber in the shipwreck was classified according to the shape of the timber. Four different classes of timbers were distinguished: (1) Beams; (2) Planks; (3) Curved timbers; (4) Repairs and small timbers (van Yk, 1697; Witsen, 1671). Next, the occurrence of classifications within the clusters was analysed.

We used standard dendrochronological measurement equipment including a microscope, measurement table and a PC, as well as a light table. Computer programs TSAP, CATRAS and COFECHA (Rinn, 1996; Aniol, 1987; Holmes, 1984) were used as analytical tools. Apart from the measurement series on the *ventjager*, our data consisted of all European chronologies available through the RING archive (Table 1).

Table 1: European master chronologies (after Jansma et al. 2002)

country	region covered by the chronology	CATRAS code used by RING	author(s)	first year	last year
Belgium	Meussevalley	MAAS672M	Hoffsummer 1989	672	1986
	paintings Flemish Masters	FRFLEMST	Lambert and Lavier, unpub.	1169	1518

country	region covered by the chronology	CATRAS code used by RING	author(s)	first year	last year
Germany	Ardennes-Eiffel area	AE1250MM	Hollstein 1980	94	1756
	Central Germany	WD400STD		400	1975
	central-southern Germany	EUBIG2ST	EU Contractnr. ENV4-CT95-0127	-681	1994
	Ems/Weserarea	EW1313MM	Hollstein 1980	1313	1617
	Hamburg	HAM1080M	Eckstein and Wrobel, unpub.	1080	1967
	Netherl. central-northern Germany.	EUBIG1ST	EU Contractnr. ENV4-CT95-0127	-971	1995
	lower Rhine	NR1326MM	Hollstein 1980	1326	1631
	Nedersaksen general	SAX959MM	Leuschner, unpub.	959	1873
	Nedersaksen heartland	NSSUB6HL		881	1992
	Nedersaksen coastal area	NSSUB7HL		865	1992
	Nedersaksen northwestern mountain area	NSSUB4HL		875	1992
	Nedersaksen eastern heartland	NSSUB5HL		880	1992
	Nedersaksen southern mountain area	NSSUB1HL		915	1873
	Nedersaksen Weserberg area 1	WBL1004M		Delorme 1972	1004
	Nedersaksen Weserberg area 2	NSSUB3HL	Leuschner, unpub.	915	1991
	Nedersaksen western heartland	NSSUB9HL		876	1992
	lower coastal area	NKU1082M	Eckstein and Wrobel, unpub.	1082	1972
	eastern Frysia	OFR18MMM	Leuschner, unpub.	18	1992
	Rhine-Main area	RM1250MM	Hollstein 1980	440	1787
	Saar-Mosel area	SM1250MM		730	1975
	Sleeswijk Holstein	SH436MMM	Eckstein 1970	436	1968
	Westerwald Sauerland	WS1368MM	Hollstein 1980	1368	1773
	Westfalen	WF1260MM	Tisje, unpub.	1260	1972
southern Germany	ZD631MMM	Hollstein 1965; Hollstein, unpub.	631	1950	
southern Germany ( <i>laat</i> )	ZDLLAATT	Becker 1995	1300	1950	
UK	General UK	ENG500MM	Baillie and Pilcher 1982	500	1981
	Baltic wood 1	GBBALTI1	Hillam and Tyers 1995	1156	1597
	Baltic wood 2	GBBALTI2	Hillam and Tyers 1995	1257	1615
	London	GBLONDON	Tyers, Hillam and Groves, unpub. (1994)	413	1728
	northern UK	GBNORTHC	Hillam and Groves, unpub. (1994)	1192	1663
	northern England-Wales	GBNORTHM	Hillam and Groves, unpub. (1994)	440	1742
	northern-central UK	EUBIG3ST	EU Contractnr. ENV4-CT95-0127	-991	1992
	southern UK	EUBIG4ST		-191	1990
	southern UK	GBSOUTHM	Hillam and Groves, unpub. (1994)	406	1594

country	region covered by the chronology	CATRAS code used by RING	author(s)	first year	last year
France	Bourgogne	FRBOURST	Lambert, Lavier and Bernard, unpub. (1994)	681	1991
	Fontainebleau	FRFB1531	Pilcher (gepubliceerd via de ITRDB)	1531	1979
	northern France	FRNO1274	Divers, unpub.	1274	1984
	Eastern France	FROO1360	Divers, unpub.	1360	1970
	Eastern France, Besancon	FREASTST	Lambert and Lavier, unpub. (1992)	582	1991
	Paris region	FRPARDST	Lambert, Lavier and Bernard, unpub. (1994)	848	1597
	Paris region	FRPAREST	Bernard, unpub. (1994)	1618	1984
	Western France	FRWESBST	Lambert, Lavier and Doucerain, unpub. (1994)	1093	1912
Netherlands	various construction wood	NBH1036M	Eckstein <i>et al.</i> 1975	1036	1972
	central Netherlands	NLCENTRAL	Jansma 1995	1023	1666
	northwestern Netherlands	NLNORTHERNM		1041	1346
	paintings Dutch Masters	SCH1115M	Bauch <i>et al.</i> 1972; Eckstein <i>et al.</i> 1975	1115	1643
	Twente 1	NTWE1357	Tisje, unpub.	1357	1724
	Twente 2	DV1272MM	De Vries, unpub.	1272	1578
	Twente-Westfalen	NLWF1040	Tisje, unpub.	1040	1972
	Zeeland/West-Vlaandere	NLZEELAN	Jansma, unpub.	824	1251
southern Netherlands	NLSOUTHERNMM	Jansma 1995	427	1752	
Baltic	central Poland	POLWSTDM	Krapiec, unpub. (1996)	449	1410
	north-western Poland	EUBIG7ST	EU Contractnr. ENV4-CT95-0127	813	1995
	eastern Poland	EUBIG8ST	CT95-0127	770	1995
	eastern Pommeren	POL996MM	Wazny 1990	996	1985
	Poland	POLZWSTD	Krapiec, unpub. (1996)	1319	1994
	Wolin	POL1554M	Wazny 1990	1554	1986
Denmark and Sweden	Denmark and southern Sweden	EUBIG5ST	EU Contractnr. ENV4-CT95-0127	?	1974
	northern Sweden	EUBIG6ST	CT95-0127	660	1991

## Results and interpretation

A total of 127 samples were taken from the *ventjager*, of which 103 (excluding double measurements) could be dated. The samples date between 1174 and 1696 AD. If this latest date is corrected for missing sapwood, the earliest possible construction date of the *ventjager* is 1705.

Out of the 103 dated measurements, 3 clusters were formed (Table 2). Per cluster there is a different distribution of timber classes. The wood was not randomly applied: a closer look reveals that the wood from one batch has been processed in several different places, and not evenly throughout the ship (Fig. 1).

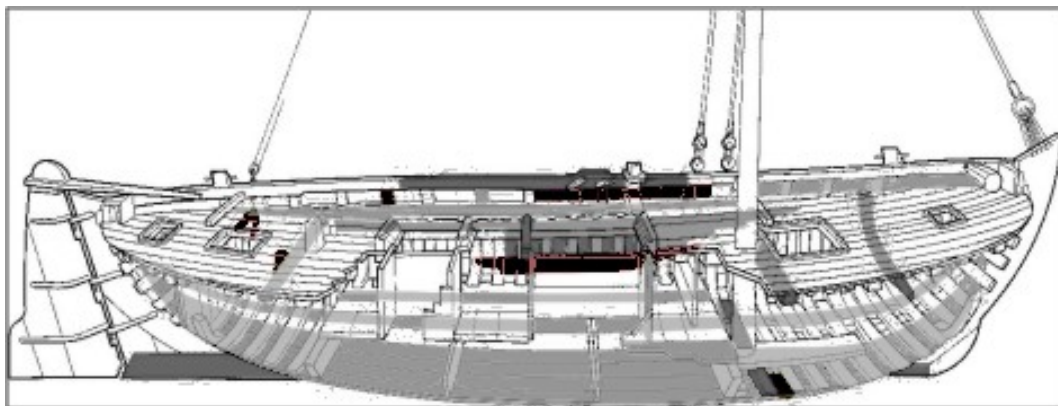
We were able to determine the provenance of two out of three clusters. The timbers in cluster1 originally grew in the area around Hannover (D); the timbers in cluster2 were derived from the area around Liege (B) (Fig. 2). The region of origin of the measurements in cluster 3 could not be determined, due to a regularly occurring growth reduction that most likely has been caused by the cockchafer (*Melolontha melolontha*) (Schweingruber, 1988). The

resulting signal (periodicity) in the ring widths made it impossible to date the measurements with any of the chronologies.

*Table 2: Nr = number of measurements; r = average correlation coefficient within the cluster; Chron. = matching reference chronology; PV = Percentage of parallel variation ('Gleichlaufigkeit'); P = significance level of the found level of PV.*

	<b>Nr.</b>	<b>First and last year</b>	<b>R</b>	<b>Chron.</b>	<b>St-value</b>	<b>PV</b>	<b>P</b>
Cluster1	11	1571-1660	0.554	Sax959	10.65	82.8	0.001
<b>Cluster2</b>	11	1368-1668	0.593	Wd400std	10.98	70.3	0.001
<b>Cluster3</b>	18	1435-1570	0.629	N/A	N/A	N/A	N/A
<b>Rest</b>	63	1174-1696	<0.55	N/A	N/A	N/A	N/A

After clustering, a group of 60 measurement series remained that did not contain sub-groups of measurements with an average correlation coefficient > 0,55. Assuming that this lack of common signal is not caused by measurement errors and/or incorrect dating, this implies that this group reflects extremely varied growth conditions. In other words, the series in this group originate from widely different regions.



*Figure 1: Distribution of the timbers from the three clusters. The timbers marked in black belong to cluster 1, the timbers marked with middle-grey are part of cluster 2 and the timbers marked with the two light-grey colours are part of cluster 3.*

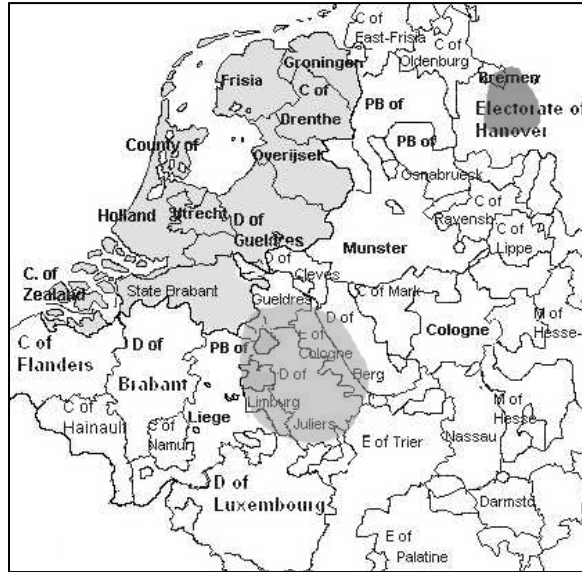


Figure 2: Map of the Netherlands and surroundings at the beginning of the 18th century. The area shaded in dark grey (without borderline) indicates the region of origin of cluster1. The area shaded in light grey (without borderline) indicates the region origin of cluster 2.

## Discussion

Based on observations on indigenous bog oaks from Dutch sites (Jansma 1995), we assumed that an average correlation coefficient over 0,55 or higher between series indicates that these series represent trees from the same site. Obviously, this is a generalization and does not take into account the immense variety of relationships between annual tree growth and environmental factors. In addition, this approach is quite rude in comparison to other statistical methods.

When we compared the *ventjager* clusters with the measurements within existing chronologies, we again used 0,55 as a threshold value for determining whether the two groups of measurements (those of *ventjager* and those used to compile the chronology) originated in the same region or not. By doing so, we ignored the fact that the size of one cluster, when added to another cluster, will influence the average correlation coefficient of the combined group.

The latest end date we found for the timbers is AD 1696. Based on this date, we estimated the earliest possible construction date as AD 1705. This estimation should be treated with some caution, because of the following reasons:

We could not estimate the number of missing rings to the bark with any certainty, because no sapwood was present on this piece of wood. This means that 1705 should be regarded as *the year after which* the trees were felled. How much later this happened, cannot be established dendrochronologically.

A dendrochronological date tells us when a tree died, and not when its wood was put to use. When interpreting a dendrochronological date, one should take into account that timbers may not have been processed directly after cutting and that therefore the felling date may predate

the construction date by some years. However, this last point does not weigh as heavily as one might think. Hollstein (1980) has shown that most oak timbers used in German buildings were processed within one year after felling. The reason is that when oak dries out, it becomes tough and therefore more difficult to saw or cut.

Our conclusion that the timbers in cluster1 originally grew in the area around Hannover (D) and the timbers in cluster2 in the area around Liege (B), is quite acceptable with regard to possible trade routes. Wood trade from the area around Hannover to the Netherlands was relatively easy to accomplish using respectively the Elbe river and the North Sea. The area around Liege is connected to the current Netherlands by the Meusse, and Jansma (1992; 1995) has already shown that oak from this area was used in the Netherlands in the 14<sup>th</sup> and 15<sup>th</sup> centuries.

## **Conclusion**

Our study shows that comparisons with refined reference chronologies do indeed result in more detailed assessments of the origin of the timbers. The results clearly show the varying geographical origins of the different timbers in the ship.

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## **References**

- Aniol, R.W. (1987): A new device for computer-assisted measurement of tree-ring widths. *Dendrochronologia* 5: 135–141
- Buis, J. (1985): *Historia Forestis, Nederlandse bosgeschiedenis part 2*. Dissertation Wageningen Agricultural "Hogeschool" 1985
- Cook, E.R. & L.A. Kairiukstis (1990): *Methods of dendrochronology : applications in the environmental sciences*.
- Holmes, R.L. (1984): *Users manual for program COFECHA*.
- Holstein, E. (1980): *Mitteleuropäische Eichenchronologie. Trierer dendrochronologische Forschungen zur Archäologie und Kunstgeschichte. Mainz am Rhein. Trierer Grabungen und Forschungen*.
- Jansma, E. (1992): *Dendrochronological methods of determining the origin of oak timber: a case study on wood from 's Hertogenbosch*. *Helinium* 32: 195-214
- Jansma, E. (1995): *RememberINGs. The development and application of local and regional tree-ring chronologies for the purposes of archaeological and historical research in the Netherlands*. *Nederlandse Archeologische Rapporten 19*, Dissertation Amsterdam University.

- Jansma, E., Sass-Klaassen, U., de Vries, D.J. & E. Hanraets (2002): Historische dendrochronologie in Nederland; de stand van zaken anno 2001. In: Praktijkboek Instandhouding Monumenten. Deel III - 4 / Diverse onderwerpen, aflevering 9, februari 2002. Den Haag: 1-15 (in druk).
- Rinn, F. (1996): TSAP V 3.6 Reference manual: computerprogram for tree-ring analysis and presentation. Bierhelderweg 20, D-69126, Heidelberg, Germany: 263 p.
- Schweingruber, F.H. (1988): Tree rings : basics and applications of dendrochronology. Kluwer Academic Publishers Group. ISBN 9027724458.
- Vlierman, K. (1987): Plaatsing, onderzoek and expositie van een 17de eeuwse ventjager, Lelystad.
- Van Yk, C. (1697): De Nederlandsche scheepsbouw-konst open gestelt. Amsterdam.
- Van Beylen, J. (1970): Schepen van de Nederlanden van de late middeleeuwen tot het einde van de 17<sup>e</sup> eeuw Amsterdam. P.N. van Kampen and zoon).
- Witsen, N. (1671): Aeloude and hedendaagsche scheepsbouw and bestier. Amsterdam.