

PROBLEMS OF ABSOLUTE TREE-RING DATING OF THE OLDEST BOATBUILDING RELICS FROM POLAND

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Abstract. The present paper discusses differences between the results of radiocarbon and dendrochronological dating of boatbuilding relics from the area of Poland. In the case of logboats, limitations in a precise determination of the time of their use, due to the technique of their manufacture, the state of their preservation and the preferences of certain tree species at the construction of logboat, are indicated. The example of a wreckage of an early medieval plank boat discovered at Łąd demonstrates that, because of extensive processing of the organic material used for its construction, accurate and precise determination of the chronology could be possible only on the basis of selected samples. The chronology of this object was corrected to the years after 1125 AD. The teleconnection with regional chronologies reveals that the wood used for construction of the boat from Łąd came from vicinity of Wrocław.



1. INTRODUCTION

Among the earliest boatbuilding artefacts from before the 13th century discovered so far in the area of Poland two basic groups may be distinguished: logboats and plank-built boats. The earliest logboats discovered in Poland are related to an earlier phase of the Funnelbeaker Culture and may be determined to have originated in the years 4830 ± 30 BP (Szymczak, 1998). Along with rafts, logboats constitute initial forms from which plank boats were built in the early Middle Ages. In spite of the fact that more perfect means of water transportation have been developed, logboats are still used for fishing in some places at the Bug river today.

The major obstacle in the studies on boats was the problem to determine the time and place of their origin. The logboats and early medieval plank-built boats collected in Polish museums come mainly from accidental discoveries. They were found in water bodies or in their surroundings without any accompanying artefacts that could help to determine the time of their origin by means of archaeological methods. A lack of chronological determinants in the surroundings of the boats made it necessary to apply absolute dating methods.

Before the World War II nautical objects were dated on the basis of geological and palinological examinations. It was Hugon Gross who tried to determine the chronology of some logboats from the area of Mazury and Pomerania by means of palinological analyses (Bohnsack, 1938; Gross, 1938). E. Ostendorf (1934,

1942) determined the moment of plank-built boats sinking in the Łebsko lake and Gdańsk-Orunia on the basis of geomorphologic factors. The places of boatbuilding and the boatbuilding tradition were subjects of lively discussions between Polish and German boatbuilding historians for many years (Lienau, 1934; Smolarek, 1969).

The development of radiocarbon dating permitted that method to be used to determine the chronology of boatbuilding artefacts in the 1980s (Smolarek, 1986; Filipowiak, 1988). It is characteristic for the ¹⁴C analysis that age limits resulting from the inaccuracy of ¹⁴C isotope concentration measurement, the isotopic fractionation factor and the calibration curve indeterminacy are somewhat shifted on a scale of calendar years. Owing to a careful selection of samples intended for dating and having eliminated systematic laboratory errors it is possible to arrive at small error values of designation (Pazdur *et al.*, 1979).

Soon afterwards dendrochronological analysis started to be used in investigations of early medieval plank-built boats and in recent years also logboats gathered in Polish museums have been included in such investigations. Aside from precision, the advantage of dendrochronological dating is also a possibility to determine the place of origin of wood. Under favourable circumstances the performed analyses may provide information on the technique of building and the time and place of repairs made to wooden boats or ships (Bonde and Jensen, 1995; Bridge and Dobbs, 1996).

Despite the development of absolute dating methods, no dating analyses with respect to some nautical artefacts have been made in Poland so far. The time of origin of some boats is based on a single result of radioactive carbon dating. Thus, problems with the interpretation of the achieved results occur, especially in respect of artefacts originating in historical periods where precise determination of chronology is needed. Dating of one artefact with the application of various methods often rendered divergent results. Comparing series of radiocarbon dating with the results of dendrochronological analyses carried out on several early medieval plank-built boats shows that the greatest conformity of both dating methods relates to samples taken from boat seams, and considerable difference are related to wood samples (Filipowiak, 1996). In the literature concerning the issue in question it is fastenings and strake seams that are considered to be the best material for dating with the employment of the ^{14}C method as they were the final products used in the building of a plank-built boat (Pazdur *et al.*, 1994).

Basing on selected examples of dendrochronological analyses of nautical artefacts and considering the knowledge on the earliest boatbuilding techniques we would like to indicate some problems in determining absolute chronology in respect of logboats and plank-built boats.

To the present day, following a query conducted in Polish museums it has been possible to determine the number of collected in Polish museums logboats to be about 200 of which 30 are ethnographic artefacts, the builder of which is known. So far, 63 logboats from the Polish collections have been dated using the dendrochronology (Krapiec and Zielski, 1999). The dating results show that from among a large number of boats gathered in Polish museums most come from the medieval period and modern times and only exceptional specimens come from earlier periods.

2. DENDROCHRONOLOGICAL ANALYSIS

Logboats also remain an especially difficult case for dendrochronological analyses. The limitation concerning the application of that method is not only connected with the ways in which it is employed. Although there are boat fragments with full log sections preserved, the number of rings available for analysis may not be sufficient for dendrochronological dating. A sequence of annual growth represents only one tree. A single sample is subject to many individual reactions of a tree to environmental conditions both relating to the climate and being of local nature such as e.g. pest attack, anthropogenic factor influence. It must be also remembered that it is sometimes impossible to determine the age of a sample even if it has an appropriate number of growth rings. The number of such samples that are not dated by means of the dendrochronological method varies from a few to more than a dozen percent.

Despite numerous limitations relating to the specificity of the examined objects, owing to dendrochronological analyses it has become possible to determine the age of most of the logboats made from oak and pine. The examination results of a boat extracted from the Nida river near Pińczów may serve as an interesting example (Fig. 1).

A sample in the form of a section showing a sequence of annual ring growth from pith rings to the most external ones, i.e. the latest rings, was taken from the logboat stern part for dendrochronological analyses. Following the annual ring growth width measurement taken in the Dendrochronological Laboratory of the University of Mining and Metallurgy in Cracow it was determined that there were 237 rings in the sample. Neither in the examined sections (nor in any other part of the logboat) did the sapwood survive. Taking sapwood ring growth into account it may be supposed that the oak from which the logboat was made was at least

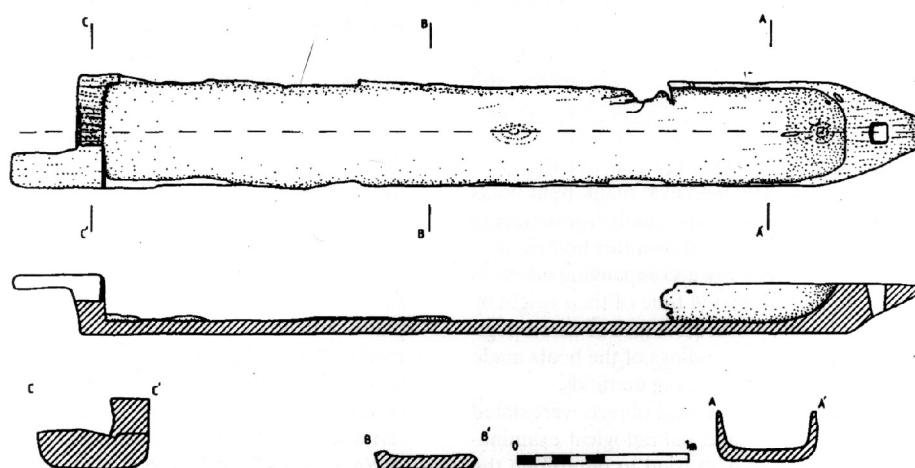


Fig.1. Logboat from Pińczów dated after 1220 BC.

250 years old. On the basis of a comparison of the ring growth sequence received from the logboat with the southern Polish standard of black oaks it was established that it covered the period from 1466 to 1230 BC. The similarity of the dendrogram made for the logboat (DPIN1) to a standard curve of oaks from the Vistula river valley in the area surrounding Cracow is very high ($t=9.8$) which proves local origin of wood. The dating of the last preserved growth ring at 1230 BC shows that it was made after 1220 BC as at least 10 years corresponding to the minimum number of sapwood rings must be added. Notwithstanding its being unquestionable, the dendrochronological dating was additionally "confirmed" by radiocarbon designation, the result of which was: 3130 ± 70 BP (Gd-11301). The sample for ^{14}C analyses was taken from external boat parts.

Most of the plank-built boats discovered in Polish lands come from Pomerania and the period of their use falls between the 9th and 13th centuries. The need to confront archaeological material with historical sources was caused by the necessity to precisely determine the period when particular objects were used. For that purpose some artefacts were dated with the use of radiocarbon and dendrochronological methods. Nevertheless, the interpretation of the achieved results did not permit to finally solve the issues relating to the time and place of building individual boatbuilding artefacts (Filipowiak, 1996).

The remains of a plank-built boat discovered by the Poznań Archaeological Museum expedition in Łąb in the Warta river in October 1983 may serve as an example of difficulties with respect to dating (Zeylandowa, 1984).

The boat from Łąb is the first wreck of a plank-built boat built on a T-shaped keel with the bottom and boards overlapping that was found distant inland. The wreck was discovered at the outer line of an embankment surrounding the stronghold at the depth of 1 m below the original surface of the ground. The wreck measuring 8.5 m in length and about 2 m in width was located parallel to the embankment line with its bow facing the east. A considerable part of the left bottom side, the left board section from the stern to the beam and fragments of three bottom strakes of right board plating survived from the boat. Presently the wreck is reconstructed at the exhibition of the Polish Maritime Museum in Gdańsk.

In the first study concerning the artefact in question the determination of the region and century of the boat's origin is described as one of the most important issues of the investigation concept concerning the artefact from Łąb (Smolarek, 1985). On the basis of the analysis of the boat's structure and interpretation of the entire finding it was indicated that the boat originated from the end of the medieval period-perhaps the 13th century. The boat age measurements taken by the Gliwice Radiocarbon Laboratory with the employment of the ^{14}C method gave slightly different results. The conventional radiocarbon age was determined as 1120 ± 70 BP (Gd-2230), and the calendar age as 970 AD or 900 AD where the final error in respect of each

of the specified dates may be estimated as ± 90 years. The results have been adopted in the literature concerning early medieval Slavonic boatbuilding.

In 1996 seven samples from the planks and the central keel part were taken for dendrochronological analyses (Fig. 2a). Following examinations carried out at the Dendrochronological Laboratory of the University of Mining and Metallurgy in Cracow the construction of the boat was determined to fall in the years following 1125 AD. The obtained growth ring sequence on the basis of the samples from the boat is 234 years old and represents the period of 891-1115 AD. The actual year of cutting the trees determined by the dendrochronological method is not included in the ^{14}C dating range.

The keel of the Łąb boat was made entirely from one oak trunk and survived in the length of 7.2 m. The sample taken from the keel central part shows that the element was made from trunk pith parts (Fig. 3). The Łąb wreck keel was given a shape close to the letter T in such a way that the pith centre went centrally through a plane between the keel arms and beam. It was of much practical importance as the keel so shaped had the least tendency to change its size as a result of warping. Depending on its location in the cross section, wood either swells or shrinks as a result of changing dampness. The change in size is the largest in the tangential direction and the smallest alongside. The described processes are least visible in trunk pith parts. It is also at that place that the natural durability of oak wood is the longest. High density wood and wood coming from the trunk central part saturated with heartwood substances undergo destruction processes in a much slower way.

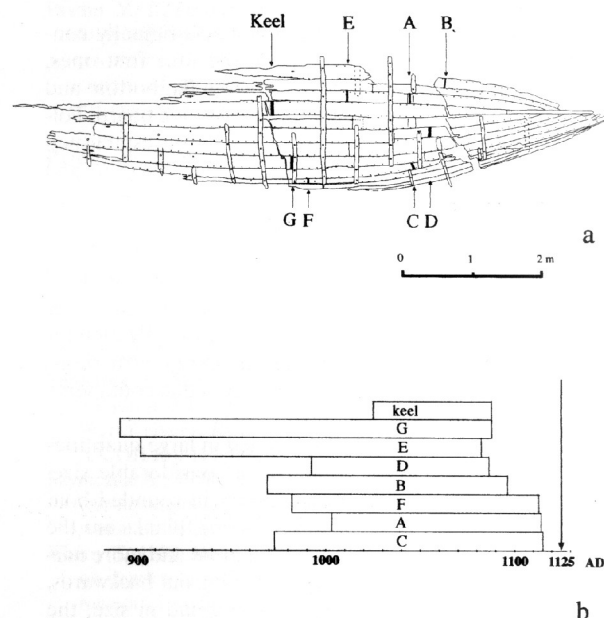


Fig. 2. a – wreck found in Łąb with indicated sampling for dendrochronological dating. b – bar diagram which shows the position of the dated dendro-samples from the Łąb wreck against the time scale.

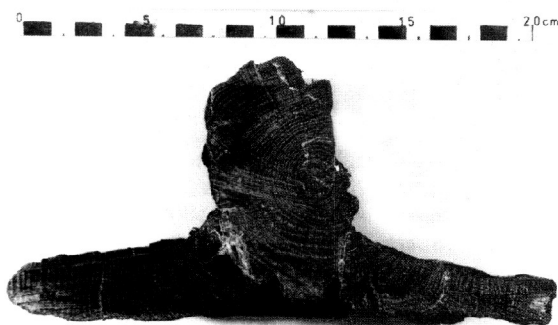


Fig. 3. Cross section of keel from Ląd wreck fitted into parent log.

Wood durability is also highly influenced by lignin whose greater presence in the wood of older trees is the reason that such wood is more durable as a structural material. The observed keel orientation against the parent log is also important as far as resistance at the joining points with strakes. The treenails fastening the garboard strake were in a tangential position to the keel horizontal part arms. Such a position provided better protection against possible tearing of the element in question.

Stems, i.e. keel extensions at the stern and bow were fastened to the keel. In the boat wreck from Ląd only the stern frame was preserved. The fragment of the heavily damaged element is 1.32 m long and triangle-like in cross section.

Each board of the boat from Ląd originally consisted of seven strakes of which the four first ones, when counted from the keel, formed a flat bottom and the three remaining ones served as the side board. Following dendrochronological analyses it was established that the annual ring growth sequence was 224 years and the difference between the last dated growth rings obtained from planks was 33 years. There are from 95 to 198 annual growth rings in individual planks. When considering the fact that the sample width extended from 17.5 cm to 23.5 cm, we may say that the trees selected for building were characterised by slender trunks, regular structure and narrow growth rings. Thus, they constituted the best material that could serve for building a plank-built boat.

Straight going planks are needed in large quantities in the central part of a boat of a considerable size. Irregular plank forms are necessary in rounded boat parts and in stems. Generally speaking, planks are the widest in the waist and are getting more and more narrow towards the stern. Its stern sticking out backwards, the boat from Ląd being relatively small in size, the boat-builder who wanted to reach the stem with strakes and fasten them by means of suitably wide endings missed the sixth strake inserting its ending into an inlet of the fifth strake instead.

The analysis of board cross sections visible during sample taking permitted determining another regularity. The examined planks taken from all strakes are turned with their pith parts towards the hull's outside and the external parts come under the overlap of the next strake (Fig. 4). The probable reason for that is that the keel and the front and back parts of bottom planks are exposed to heavy friction over the bottom. The higher planks of the upper hull part are placed in the same way, the pith part turning inwards. It is because wood has the highest ability to bend in the outer parts of the parent log.

3. SUMMARY

Dendrochronological examinations confirm that notwithstanding the dating range in respect of the latest plank rings, the boat from Ląd was built from wooden elements cut down at the same time. Sample "A" taken from the right garboard strake convinces us about it. The latest growth ring determined to mean the year 1114 belongs to the latest dated rings from the wreck. Considering the fact that Slavonic early medieval boats were built using the shell technique the board from which the sample in question was taken was one of the first to be used for shell plating of the boat from Ląd.

In order to determine the place of origin of the wood from which the boat was made the obtained average curve was compared with chronologies from southern, central and eastern Poland (Fig. 5). The mentioned ring growth sequence from Ląd shows the greatest similarity to regional chronologies from the area of Wrocław ($t=7.3$) and Opole ($t=5.9$).



Fig. 4. Orientation of the tree rings in bottom planks from Ląd-wreck

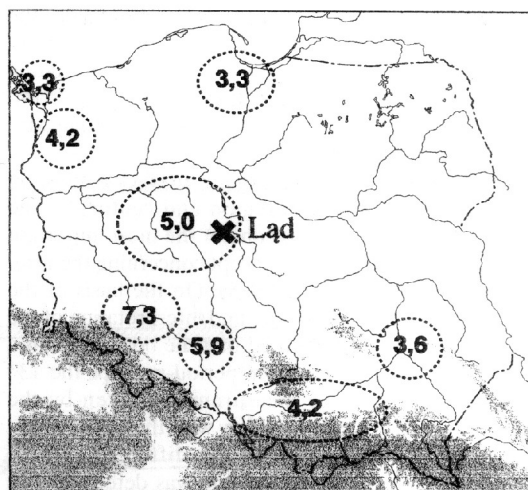


Fig. 5. Teleconnection of the samples from the Ląd-wreck and the series of regional chronologies for oak trees covering Poland.

It is thus indicated that the wood used for building the boat is of Lower Silesia provenance. The boat must have been built inland, most probably in the area of Wrocław.

The port in Wrocław had already existed since the 10th century (Każmierczyk, 1991). The Wrocław boat was found near a house construction at the depth of 1.7 m above the street level nearby two rows of piles in 1904. It was 10 m long and 1.4 wide. The site was located 400 m from the Oder's current riverbed whose course has been substantiated already since the 13th century in written sources (Ellmers, 1972). The boat was dated to originate from the early medieval period. Written sources from the 12th and 13th centuries say about navigation from the Baltic up the Oder and Vistula rivers and certify that there were also inland owners that send their ships down the rivers to sea-shores (Smolarek, 1969).

As far as artefacts originating from before the 13th century are considered the area of tree cutting corresponds to the place of boat or ship building. It was only in later periods that the transport of wood building material started to develop on a large scale. The earliest information on floating of timber on the Oder river comes from as early as the 1st half of the 13th century (Moździoch, 1992). Floating of timber on the Vistula river on a larger scale and export of timber to western Europe started at the late 14th century (Ważny, 1992).

The research made on the boat from Łąd shows that wood used for the building of watercraft was subject to considerable treatment. A precise chronology determination of nautical artefacts is possible only when a large series of carefully selected wood samples is investigated. The best material for dendrochronological analyses are potential planks of boat waist bottom strakes. It is only a larger number of analysed samples that makes it possible to draw reliable conclusions concerning the place of origin, time of building and period of boat usage. The chronology of some plank-built boats based on pre-war conclusions of German scientists or on single radiocarbon analyses requires verification basing on a series of dendrochronological analyses.

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