**Pentti Zetterberg**

# DENDROCHRONOLOGICAL DATING OF THE TIMBER OF THE MEDIEVAL STONE CHURCH OF LEMPÄÄLÄ IN SATAKUNTA, SOUTHERN FINLAND

**Tree-rings providing an exact dating and environmental data from the 13th to the 15th centuries.**

*Abstract*

The tree-ring dating of the timber structures of the medieval stone church of Lempäälä indicates that seven of the eight sample timbers of pine (*Pinus silvestris L.*) were felled in the period between the summers of 1503 and 1504. The dating is in agreement with previous views regarding the church and provides additional details. One of the sample timbers was dated to renovations and repairs carried out in the early 19th century. This partly decayed timber was felled in the period 1810–1825.

The tree-rings of the timbers provide data on the preceding centuries as far back as the beginning of the 13th century. The 14th and 15th centuries display several changes of growth that can be seen uniformly in all of the samples. These were probably linked to weather conditions of the period. The tree-rings also permit datings to within a year of outside damages to the logs.

The material presented in this connection has been linked with corresponding samples from nearby areas to form a uniform and absolute tree-ring calendar for pine extending back in time nearly 800 years. Old pine material from Southern Finland from as far back as the 13th and 14th centuries can now be dendrochronologically dated to within a year.

*Pentti Zetterberg,* University of Joensuu, Karelian Institute, Section of Ecology, Laboratory of Dendrochronology, P.O. Box 111, SF-80101 Joensuu.

## INTRODUCTION

The medieval stone church of Lempäälä in Satakunta, Southern Finland, has been dated to the early 16th century on the basis of architectural features. This dating is also supported by archaeological finds from beneath the floor of the church (Hiekkanen 1986). In connection with the excavation of the church samples of the wall-plate timbers were also taken in order to obtain an exact dating for the time of construction (Hiekkanen 1983). The following dendrochronological results support previous datings and provide further detail. The stone church of Lempäälä is the oldest building dated with this method in Finland. The tree-rings of the timbers also provide data on the growth environment of the trees as well as weather conditions in the centuries preceding the building of the church.

## METHODS AND MATERIAL

In dendrochronological dating the tree-rings make it possible to define when the samples were standing timber for the last time. The last tree-ring gives the last year when the tree was still living and when it was felled for use. Dendrochronological datings were made of eight samples of timber from different parts of the church. The location of the sample timbers is shown in Hiekkanen's (1988) article in this volume which also presents further details of the history of the church (see also Hiekkanen 1986).

Small sections of the timbers were sawn (Hiekkanen 1986). These were used for determination of species and dating at the Laboratory of Dendrochronology of the University of Joensuu.

The methods and principles of dendrochronological dating are presented in further detail elsewhere in this volume (Zetterberg 1988a) and the dating of timber buildings is discussed in connection with work carried out in Northern Karelia (Zetterberg 1986).

Reference material for dating is provided by so-called 'tree-ring calendars' or tree-ring chronologies of the mean yearly diameter growth of pine compiled from an extensive material on the basis of previous datings. These chronologies extend from 1407 to 1984 in SW Finland and from 1305 to 1814 in Eastern Karelia (author's unpublished material). The chronology for SW Finland is to a large degree based on material from Renko (Zetterberg 1988 a, 1988 b) and the old timber church of Loppi (Zetterberg 1988 c).

*Table 1.* Statistics of the tree-rings of timber from the medieval stone church of Lempäälä. Shown on the right is the dendrochronological age of each sample. See text.

| Sample code | N:o of rings | Mean ring width | Stand. dev. | 1.-ord auto-corr. | Mean sens. | First year | Last year |
|---|---|---|---|---|---|---|---|
| R598:14 | 210 | 102.8 | 73.2 | .931 | .175 | 1596 | 1805 |
| R598:15 | 234 | 95.6 | 68.9 | .946 | .177 | 1267 | 1500 |
| R598:18 | 227 | 95.5 | 77.9 | .971 | .161 | 1277 | 1503 |
| R598:19 | 201 | 96.5 | 73.2 | .948 | .186 | 1285 | 1485 |
| R598:29 | 253 | 83.3 | 73.7 | .960 | .181 | 1251 | 1503 |
| R598:32 | 215 | 93.4 | 81.0 | .970 | .146 | 1286 | 1500 |
| R598:33 | 304 | 71.9 | 51.1 | .961 | .163 | 1202 | 1503/5 |
| R598:34 | 212 | 97.0 | 75.1 | .950 | .196 | 1292 | 1503 |

## TREE-RINGS INDICATE THE AGE OF CONSTRUCTION TIMBERS

All of the samples were of pine (*Pinus silvestris L.*) and could be dated. In four samples the time of felling the tree could be defined to within a year. In the other samples the original surface layer of the timbers had worn off or had been carved. In these cases the last tree-ring indicates the year prior to which the timber could not have been used for construction. Table 1 presents the results of the dendrochronological dating of the material from Lempäälä. The datings of seven of the samples consistently indicated the same date – the tree-rings end in the very first years of the 16th century. In three of the samples the year 1503 is uniformly the last year of growth. In two of these (R598:34 and R598:18) the original surface of the log had been preserved and in the third (R598:29) the surface was most probably the original one. Thus, the dendrochronological age of the timbers from the church of Lempäälä can be defined as the year 1503.

The trees in question were felled for use between the summers of 1503 and 1504.

Because of wear and/or carving of the surface three of the timber samples cannot provide datings that are as exact as the above. Due to the surface structure of the timber the number of tree-rings that have disappeared in two of the samples (R598:15 and R598:32) can be estimated as only a few in number, whereby their dendrochronological ages (the last tree-ring in both cases was from 1500) are in excellent agreement with results from the other timber samples. Judging from the surface structure of sample R598:19 a clearly larger number of tree-rings is missing in this case. However, the properties of the tree-ring series of this sample show that it is from the same log as sample R598:34. The other sample indicates that the number of missing tree-rings is 18 and the tree-rings end at the year 1485. These samples were from the same log or it is also possible that two logs were carved from the same tree. Sample R598:34 was taken approximately 1.0–1.5 metres higher up from the same log as R598:19. In the pith section of the former the tree-rings begin to appear seven years later than in the latter. Also the pith cells of the log indicate that sample R598:34 was taken from closer to the crown of the tree.

The tree-rings of the partly destroyed surface part of log R598:33 differed from the other log samples and suggest two alternate dates – the last tree-ring of the log is either from 1503 or 1505. Other datings are not possible in this connection.

Of interest is also the differing dating of log sample R598:14 with its last tree-ring dating to 1805. A considerable part of the original surface layer of the log is lacking in the sample and the year when the tree was cut can only be estimated. The most probable period is from 1810 to 1825. The log dates from repairs and renovations carried out in the church at least three hundred years after its original period of construction.

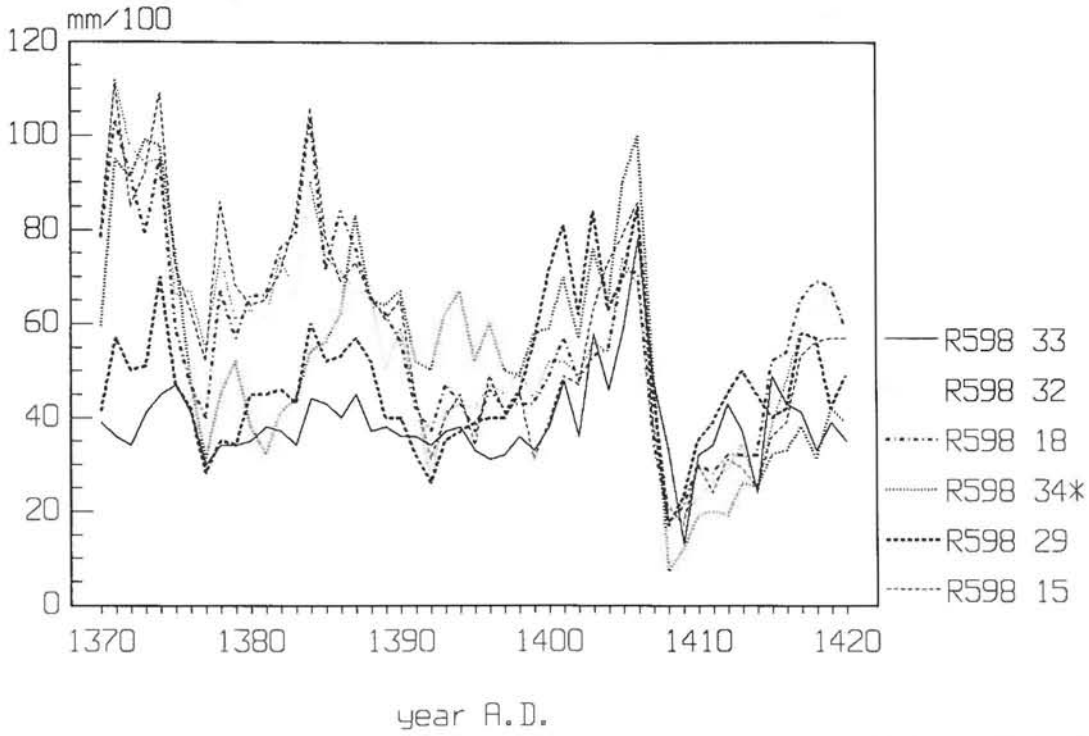


*Figure 1.* Width of the tree-rings in the dendrochronologically dated timbers of the medieval stone church of Lempäälä in the period 1370–1420. The sharp decrease of growth from 1405 to 1408 was most probably the result of poor weather conditions. Note also the uniform reduction of growth from 1374 to 1377 and the favourable year 1384.

* Sample R598:19 combined in the graph for sample R598:34.

## TREE-RING DATA ON ENVIRONMENTAL CONDITIONS IN THE 13TH–16TH CENTURIES

The tree-rings of the logs provide information on the period of growth of these trees which were felled in the early years of the 16th century. All of the trees were over 200 years old when cut and the oldest one was over 300 years old. The tree-rings of the timbers from the church contain data on the growing conditions of the trees and changes in these conditions from as far back as the early 13th century. In this respect the tree-rings provide a unique archive of data on the past fixed to absolute calendar years (see Zetterberg & Meriläinen 1988).

For example, the late 14th and early 15th centuries display distinct features that are common to the tree-ring series of all of the samples. From 1374 to 1377 the yearly diameter growth of most of the trees decreased considerably to approximately half of that recorded for the preceding period (Fig. 1). A similar, but even more dramatic decrease in growth occurred from 1406 to 1408 with a mean lessening of growth to approximately a quarter (Fig. 1). These differences of growth were the result of changes in the growth environment of the trees. The changes of the early 15th century were most probably caused by poor weather conditions, as the same phenomenon can be observed in other tree-ring materials over a very large area. It is interesting to note that tree-ring series from Northern Karelia and even Soviet Karelia of the same period indicate the same sharp decrease in growth (author's unpublished material). Similar uniform changes of growth rate observable in all of the samples can be noted from the 14th and 15th centuries as follows: in 1328, 1333, 1350 and 1369–1370 growth was slow in all specimens while in most trees a better growth period could be observed for the years 1303, 1384, 1406 (a good year in all specimens), 1434 and 1474. Especially the good years 1434 and 1474 and the poor years 1328 and

1333 can be observed in the material from a large area, even as far as Soviet Karelia (unpublished material of the author).

An especially clear indication of poor years of growth are the so-called missing tree-rings (see Zetterberg, 1988 a). The tree-ring for 1350 was lacking in two series and the year 1408 in one series of tree-rings. Missing tree-rings are a fairly common problem in the dendrochronology of Finnish pine. The missing tree-ring can be regarded as an extreme form of the thin tree-ring which is a good indication of a year of poor growth as in both of the cases presented above.

Generally speaking, variations in diameter growth indicate changes in weather over large areas in different years. Climatic data from periods as early as the above is available only in exceptional cases. Historical works usually observe only bad years in grain cultivation. These years often display clear links with reduction in the growth of pine. Cold weather in early summer can lead to poor grain crops as well as reduced diameter growth in the year concerned (see e.g. Eronen & Zetterberg 1986). The above-mentioned clear changes in yearly growth may provide interesting comparisons with historical data from the area in question.

Tree-ring samples can also be used to date scars in trunks. For example damages caused by fire cause scars that can be precisely dated and thus give indications of the occurrence of forest fire. The two scars observed in the Lempäälä material were not caused by fire as, microscopic examination of the scars did not reveal traces of charcoal. One of the logs (R598:29) was scarred at some stage between the summers of 1374 and 1375. Log sample R598:14 which was from repairs carried out in the 19th century had been damaged after the summer of 1604 with abnormal scar growth in the tree-ring for 1605.

Other special features of the material include reaction wood found in sample R598:19 which came about when the tree righted its trunk after having been bent out of shape for some reason. This trunk had been bent between the summers of 1296 and 1297, as reaction wood had formed in the growth period of 1297. We may only guess at the reasons for the bending of the trunk.

Tree-rings may sometimes provide indications of the origin of the logs. In the material at hand sample R598:33 is of a tree that was probably cut in a different forest than the other log samples. Many of the features of its tree-ring series differ the other samples, although it grew and was felled at the same time as the other trees.

## LONG PINE CHRONOLOGY FOR SOUTHERN FINLAND

The tree-ring chronology for pine in SW Finland was formed by linking progressively older materials to each other. Previously published material from this area extends from the year 1539 to the present (Zetterberg, 1988 a). Recent dating of the timber church of Loppi extended the chronology to the year 1407 (Zetterberg 1988 c). The Lempäälä material can be linked to the above forming a combined tree-ring chronology for pine in Southern Finland from the year 1202 to the present. One of the main aims of dendrochronology in Finland is to form several long and uniform tree-ring chronologies suitable for dating purposes in different parts of the country. Considerable progress has been made in this respect in recent years. The tree-ring chronology for Eastern Finland and Eastern Karelia extends to the end of the 13th century, while the chronology for Ostrobothnia and the Kainuu region extends from the year 1500 to the present. In Western and SE Finland as well as Lapland the chronologies are being prepared at present. The chronology for Southern Finland is at present the longest tree-ring series for pine compiled in Finland for dating purposes.

The chronology for Southern Finland can now be used to date timber materials from as far back as the 13th and 14th centuries throughout the whole area.

The dendrochronological dating of the church of Lempäälä provided a clear leap backwards in time for the pine chronology. It also brought about new regional and chronological opportunities for applying the dendrochronological method in Southern Finland.

## REFERENCES


Eronen, M. & Zetterberg, P. 1986. Puulustot kertovat menneisyydestä (Tree-rings tell about the past). *Pohjois-Karjalan Luonto* vol. 15, pp. 15–19.

Hiekkanen, M. 1983. Lempäälän kirkko. Arkeologiset tutkimukset keväällä 1983. Archives of the Department of Monuments and Sites. National Board of Antiquities. Unpublished.

Hiekkanen, M. 1986. Archaeology of the medieval stone church of Lempäälä in Satakunta, Finland. *Fennoscandia archaeologica* III, pp. 91–101.

Hiekkanen, M. 1988. The dating of the nave of the church of Lempäälä and the medieval churches of the province of Satakunta. *Fennoscandia archaeologica* V. pp. 119–121.

Zetterberg, P., 1986. Dendrokronologisesti ajoitettuja rakennuksia Pohjois-Karjalassa (English summary). *Karjalan tutkimuslaitoksen julkaisuja* (Publications of Karelian institute), No. 75, 25 pp.

Zetterberg, P. 1988a. Dendrochronology and archaeology; dating of a wooden causeway in Renko, Southern Finland. *Fennoscandia archaeologica* V, pp. 92–104.

Zetterberg, P. 1988b. Dendrochronological dating of an archaeological site in Southern Finland. Proceedings of the Fourth Nordic Conference on the Application of Scientific Methods in Archaeology. Haugesund, Norway, October 7th–11th, 1987. *Norwegian Archaeological Review*. In print.

Zetterberg, P. 1988c. Lopen Vanhankirkon hirsien dendrokronologinen ajoitus. Dendrokronologian laboratorion tutkimusraportti, (an unpublished research report), 12 pp.

Zetterberg, P. & Meriläinen, J., 1988. Männyn ajantieto – puulustot kertovat (abstract in English: The pine chronicle – tree-rings as a source of ecological, environmental and historical information). *Luonnon tutkija*, manuscript.