HIDDEN DATES. DENDROCHRONOLOGICAL RESEARCH ON MEDIEVAL CHURCHES IN TRANSYLVANIA*

István Botár, András Grynaeus, Boglárka Tóth**

Keywords: dendrochronology, medieval churches, Transylvania, historical roof, medieval architecture.

Abstract: Dendrochronology is a dating method which uses tree ring data of living trees and tree ring series measured on historical and archaeological wood. In optimal circumstances dendrochronology can produce absolute dating with a half-year accuracy. Due to research carried out by our team, initiated in 2003, we can use now two master chronologies to date oak and fir structures in Transylvania for the period between the 13th and 19th centuries, a couple of absolutely dated series for the 12th to 14th centuries, and also some floating series for the late migration period (7th – 8th centuries) and Roman period. The article presents a few case studies of dendrochronological research on medieval churches from this region (Dârjiu, Târgu Mureş, Cetatea de Baltă, Bistriţa, Sibiu). During these campaigns of fieldwork and following analyses we successfully dated more medieval roofs and later renovation phases. So far the earliest dated roof is the structure above the Evangelic church in Sibiu, where the timber material comes from trees felled at the middle of the 14th century. The method is also used to date art objects (altar panels) and wood installations (painted ceilings, furniture).

To extend the validity of the present chronologies, both in time and space (in Moldova and the Romanian Plain), stronger archaeological involvement will be needed.

Rezumat: Dendrocronologia este o metodă de datare care se bazează pe analiza seriilor inelelor anuale măsurate pe copaci vii și/sau a inelelor elementelor de lemn din structuri istorice și din complexuri arheologice. În cazuri optime analizele dendrocronologice pot să furnizeze datări absolute pe ani calendaristici cu o precizie de jumătate de an. Ca urmare a cercetărilor anterioare în Transilvania putem utiliza două cronologii master pentru datarea elementelor de lemn din stejar și brad care acoperă secolele XIII – XIX, și în același timp avem câteva serii datate pentru secolele XII – XIV, respectiv serii flotante pentru epoca migraţiilor târzii (sec. VII – VIII) și epoca romană. Articolul prezintă succint câteva cercetări dendrocronologice efectuate în biserici medievale din Transilvania (Dârjiu, Târgu Mureș, Cetatea de Baltă, Bistriţa, Sibiu). În cursul acestor cercetări am reușit să datăm momentul construirii mai multor șarpante istorice medievale, cât și intervenţiile ulterioare. Cea mai timpurie șarpantă identificată până acum este șarpanta bisericii evanghelice din Sibiu, la care au fost folosiţi copaci tăiaţi la mijlocul secolului al XIV-lea. Metoda poate fi utilizată și pentru datarea unor piese de artă (panouri pictate, altare) și instalaţii din lemn (tavane pictate, mobilier).

Pentru extinderea cronologiilor, atât geografic (în Moldova și Câmpia Română), cât și cronologic va fi nevoie de contribuţia mai accentuată a arheologiei.

Dendrochronology is the most precise dating possibility for building- and field archaeology. In comparison with other methods such as C14, dendrochronology can produce in optimal circumstances absolute dates with half year accuracy. The method is based on some simple principles. The geographical principle is based on the observation that the reactions of the trees located in the same area and from the same species to environmental influences (most importantly to humidity and temperature) are very similar, so their annual ring width series are alike. In good years the annual ring width will be wider, during bad years narrower. Measuring the ring widths of a tree or a wood element one can get a sample series, a diagram which reflects the succession of climatic events and at the same time the "history" of the tree. This series can be compared with other series obtained from other trees or timbers, and contemporary series from the same region and species should have good correlation and parallel diagrams on graphical outputs. It is also possible to join series obtained from older trees / wood elements with the existing series if they have a minimum of 30 common rings / years overlap. The joining process can be hypothetically continued to the past combining each time older and older series from historical and archaeological samples and achieving an "infinite tree" which contains the ring width data of the present and old trees (Fig. 1). If the reconstructed database has good replication, so each year / ring is represented by the data of more samples, this series can be called local chronology. A local chronology will help us date wood samples with uncertain or unknown chronology. Therefore, we need to measure the ring widths of the sample (timber from a Roman well, coal from a rampart, medieval painted panel, etc.) and to find the exact match of its diagram with the existing chronology. If the sample contains the last ring under the bark, we can date the felling year of the tree; if the outermost rings are missing we can give a *post quem* dating. In the absence

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** *István Botár,* Szekler Museum of Ciuc, e-mail: botaristvan@yahoo.com; *András Grynaeus,* Hungarian Dendrochronological Laboratory, e-mail: dendro@ludens.elte.hu; *Boglárka Tóth,* University of Szeged, Transylvanian Dendrochronological Laboratory, e-mail: dendrolabor@gmail.com.

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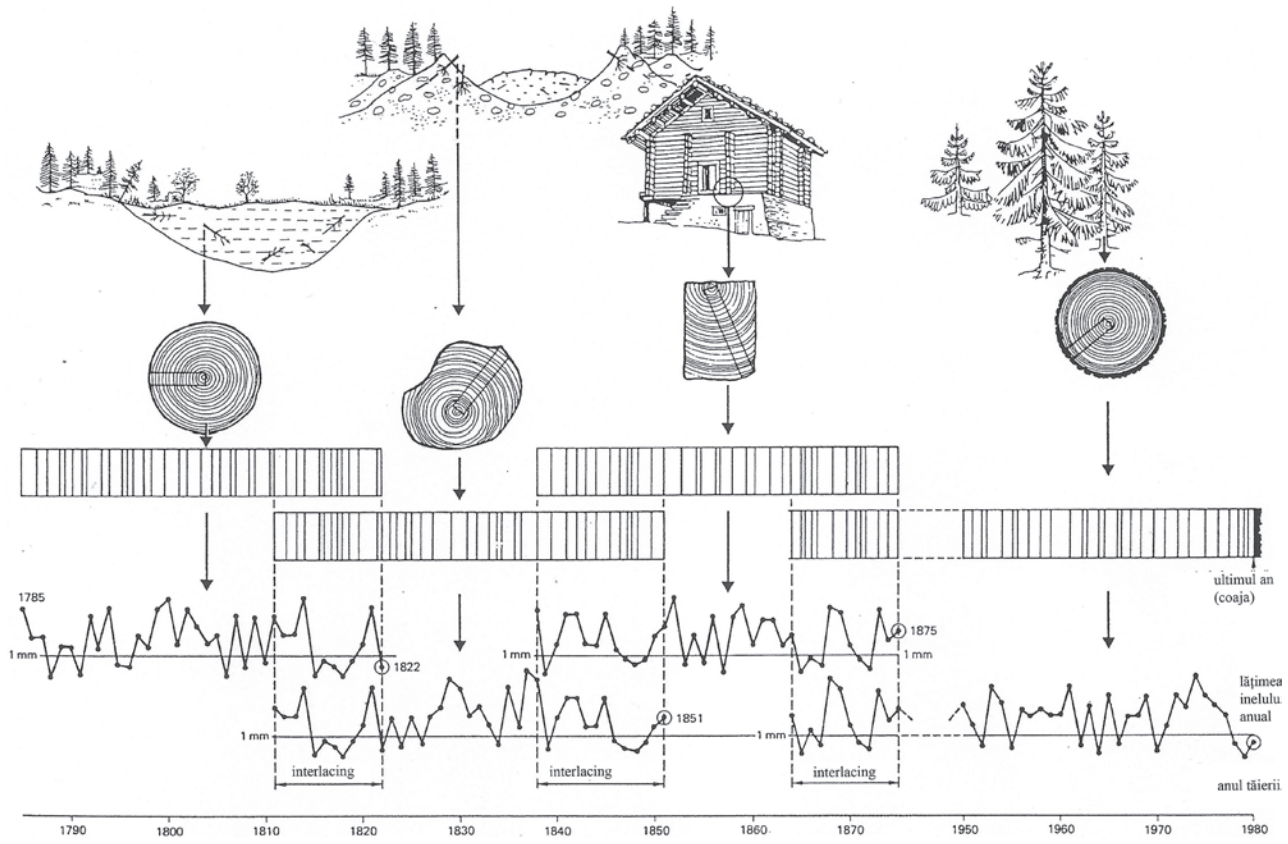

Fig. 1. The principles of dendrochronology (after Schweingruber 1983, p. 85).

of an absolutely dated local chronology, a relative date can still be achieved – for example, are the burnt wood remains of a Roman fortress contemporary with the wood elements of a well from the neighbouring civil settlement.[1]

These would be the main principles, but the reality is a bit more complicated. The ring widths are influenced by more local factors, which remain unknown during the sampling: individual localisation of the tree (grouping, altitude, exposition, etc.), competition. To exclude these peculiarities, the analysis should use more samples from the same structure or archaeological context, thus mediating the different series, a mean value being probably much closer to the chronology then individual series. In the western part of Europe dendrochronology is used and developed since decades, and it is a regular part of the research regarding archaeology and monument protection-restoration. Its efficiency can be very well illustrated by the fact that even prehistoric sites are often absolutely dated, and in some cases even the exact provenance of the wood material can be identified.

In Romania there were more initiatives in dendrochronology, but earlier researchers focused mainly on its application in forestry science and climate reconstruction. The first main achievement in the field of built heritage was made by a Swedish project during which more wooden churches from Maramureş were successfully dated by Ólafur Eggertsson in the '90s. Transylvania has a great potential for dendrochronological research due to the high number of preserved medieval and historical buildings, which still have their original roof structures and wood installations (ceilings, furniture, altarpieces).

[1] For principles of dendrochronology see: Flechter 1978, Schweingruber 1983, Eissing 1996, Popa 2004.

Our team has been involved in dendrochronological research for a decade, and in 2007 we founded a laboratory in Miercurea Ciuc (Harghita County). Since then the laboratory systematically collects and analyses recent material and wood samples from historical monuments (roofs, towers, installations) and archaeological sites.[2] At present we have dated series and chronologies in Transylvania for oak (*Quercus sp.)* and fir (*Abies alba Mill.)* for the 13th to 19th centuries, and some other dated series from the 12th to 14th centuries. There are also some floating series from the late migration period (7th – 8th centuries) and Roman period. The Transylvanian Dendrochronological Laboratory regularly cooperates with other laboratories and dendrochronology researchers from Europe, so there is a real possibility to analyse and compare tree ring data, even series, from prehistoric times with external chronologies.

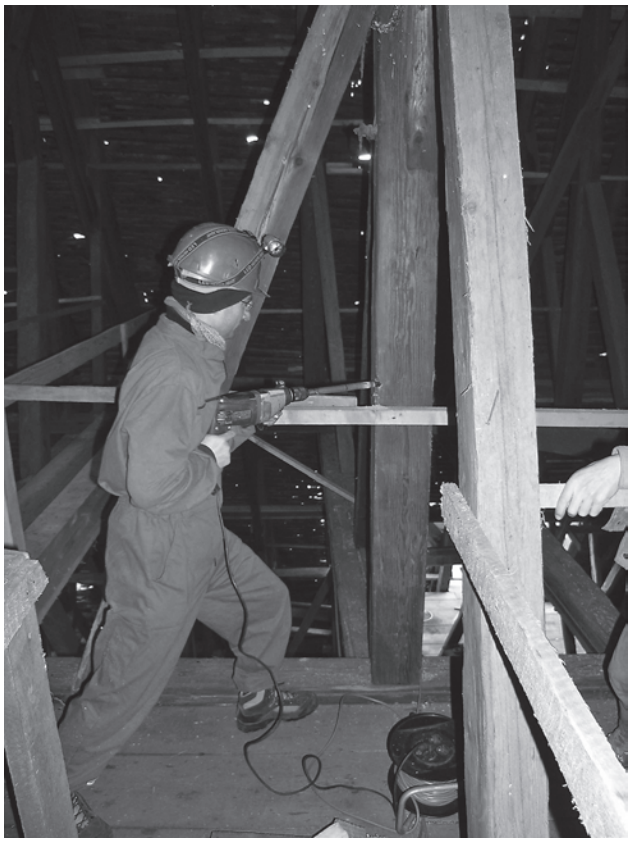

Fig. 2. On site sampling.

In historical structures the sampling is made mostly using a special core driller that has no effect on the timbers status (hole diameter 20-25 mm, Figs. 2-3). The *in situ* timbers are chosen after on-site inspection, to have as many rings as possible, and usually a number of minimum six samples are collected from a structure. If the roof has more periods, or later interventions can be noticed, naturally the number of samples will increase. The measurement and analysis is made afterwards in the laboratory. In some cases, such as art pieces, drilling is naturally excluded. In these situations ring widths will be documented with a scale-loupe or with a digital microscope camera, and the data is processed later on in laboratory.

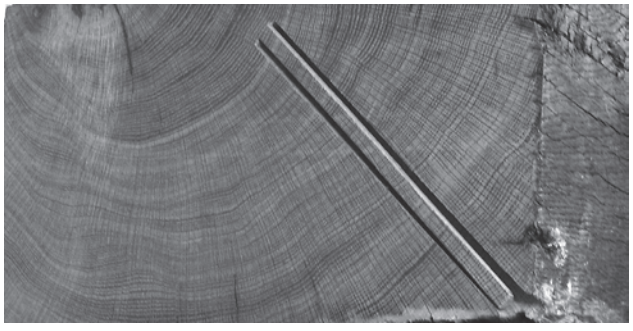

Fig. 3. The position of the drilled core sample on a timber.

The applications of dendrochronology for archaeology are well known in Europe, still they are unknown or at least not used in Romanian archaeology. It is an almost general opinion that in our climate wood could not be conserved during the last centuries or wood remains have not enough value to be excavated, deposited and restored. Naturally, this is false. Even if the great majority of the historical wood materials vanished in the soil, yet in wet conditions (wells, foundations, piles) or carbonised (burnt wooden houses) many wood remains come to light continuously. The only criterion for a dendrochronological analysis is that these findings should preserve at least 30 consecutive annual rings. This apparently seems to be an obstacle, but a 10 cm wide coal from an archaeological context can contain 50 to 100 rings. Unfortunately wood and coal are still neglected during excavations, although recent initiatives demonstrated that dendrochronology can bring essential information. Timbers discovered

[2] The projects were supported by the Hungarian Scientific Research Found (OTKA, projects: F043167, 100984).

Fig. 4. Unitarian church of Dârjiu (photo: Sófalvi András).

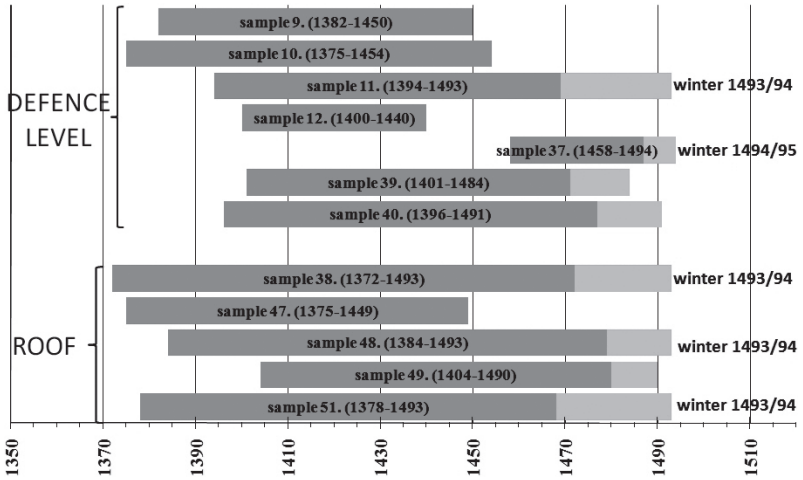

Fig. 5. The chronological positions of the samples from the defence level and roof structure of the chancel in Dârjiu.

during the preventive excavations in the historical centre of Bucharest were dated using North-Balkan chronologies to the beginning of the 18th century.[3] A burnt pile from Lazuri (Satu Mare County) proved to be contemporary with a piece of coal from the ramparts in Harghita Mountains, dated by C14 to the 7 th – 8th centuries. The first sign for the presence of the Franciscan Friary in Târgu Mureş is a dendro-sample from an excavated complex dated to 1301 by the Transylvanian chronology.[4] Besides dating, dendrochronology could produce new data regarding history of forests, forestry, climate, commercial connections, provenance, etc. Therefore a systematic collection and analysis of the material would be necessary.

After this introduction in the following pages we present case studies of recent dendrochronological activity in Romania.

The ***Unitarian church in Dârjiu*** (Hung.: Székelyderzs) is unique among the medieval churches in Székely Land, having a defence upper floor similar to those of the Saxon fortified churches (Fig. 4). Despite the close analogies, many scholars – based on uncertain historical data – shared the opinion that this structure was made after an invasion and destruction by fire at the beginning of the 17th century. To verify this hypothesis we collected several samples between 2006 and 2013, from the timbers of the defence floor and roof structures above the nave and chancel. It emerged that the defence level is contemporary with the roof itself, but two major periods could be distinguished. The wood material of the structures above the chancel was felled in the winter of 1494/1495, and those above the nave five years later in the winter of 1499/1500[5] (Fig. 5). These dates indicate the completion of the Gothic re-building process started in the '90s of the 15th century, as marked on an epigraphic inscription on one of the south buttresses.[6] One has to conclude that at Dârjiu the defence floor and roof provide the date for the end of the Gothic building process of the church, so the defence floor is not a late copy of the similar Saxon defence floors but

[3] Mănucu-Adameşteanu *et alii* 2007, pp. 190-192. We wish to thank Thomasz Wazny (University of Arizona) for his contribution.
[4] We have to thank Ioan Stanciu (Cluj-Napoca), András Sófalvi (Odorheiu Secuiesc) and Zoltán Soós (Târgu Mureş) for their collaboration.
[5] For details see: Botár, Grynaeus, Tóth 2013.
[6] Entz 1996.

Fig. 6. The Gothic chancel and north tower of the Calvinist (Franciscan) church in Târgu Mureş.

Fig. 7. The medieval roof of the chancel in Târgu Mureş.

a contemporary solution. This information may have a major impact on our understanding of the social and economical relations of the builders, because even though the architectural solutions have more analogies among the Saxon fortified churches, those have a different historical background.

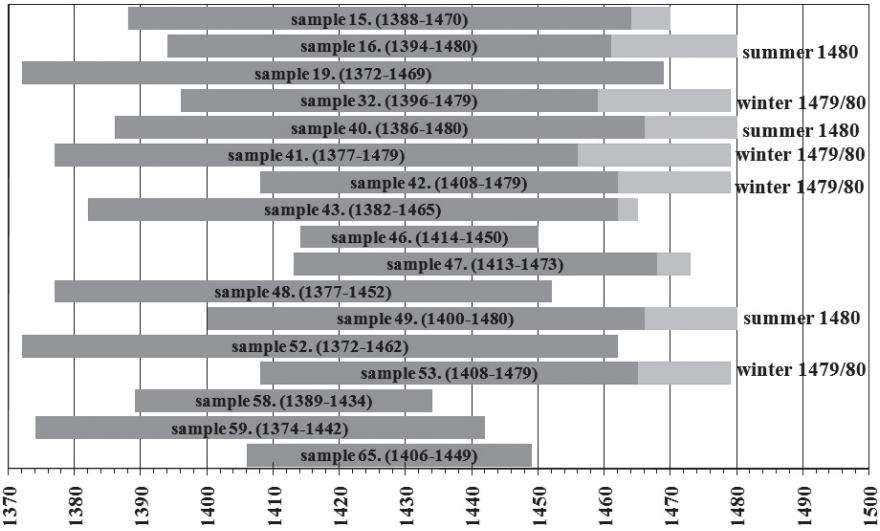

Fig. 8. The chronological positions of the samples from the original roof structure of the chancel in Târgu Mureş.

During the course of the dendrochronological research in the ***Calvinist (former Franciscan) Church in Târgu Mureş*** (Hung.: Marosvásárhely) we managed not only to date the building year of the roof, but also the time and character of a later restoration. The church is easily accessible, however no one mentioned the Gothic shape of the chancel-roof (Figs. 6-7). After repeated sampling and on-site investigations performed between 2010 and 2013, we know quite clear now the history of the structure. The original roof above the chancel was probably built in 1480 since the timbers were made from trees cut in the winter of 1479/1480 and the summer of 1480 from an old forest (with trees often older than a hundred years) (Fig. 8). Even if the written records do not mention works around the church in this period, the dendrochronological data suggests a major intervention on or related to the chancel. Such huge roofs are in many cases contemporary with newly enlarged Gothic walls, and this possibility may not be excluded in the case of Târgu Mureş. It is not our role to decide if the building history of the church is accurate or not, but still

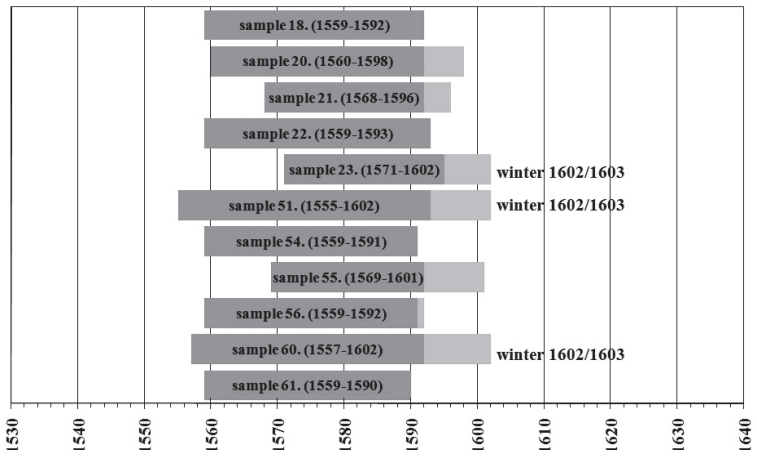

Fig. 9. The chronological positions of the samples from the restored parts of the roof structure of the chancel in Târgu Mureş.


Fig. 10. The Calvinist church in Cetatea de Baltă.

we have to mention that in our opinion there is no sufficient and convincing data to exclusively connect the actual chancel with the year 1400 of the written records.[7] In the future one has to rethink the interpretation of these works and the building history of the Franciscan church from Târgu Mureş.

Some other elements were made from trees felled in the winter of 1602/1603 brought from a much younger forest (mean age of the trees around fifty years) (Fig. 9). These elements, located on the north-west side of the roof and the longitudinal beams connected with the damaged trusses, document a restoration process. There is written evidence that at the beginning of the 17th century the whole town was attacked and the north bell tower near the chancel was burnt. We presume that the fire and probably also falling elements from the tower destroyed partially the medieval roof of the chancel. Some trusses had to be restored and damaged beams were replaced. It is very interesting that the carpenters of the early 17th century respected the exact shape of the preserved trusses, and even the newly carved assembly marks are quite similar with the medieval ones.[8]

A later intervention was also documented in the roof of the Calvinist church from ***Cetatea de Baltă*** (Hung.: Küküllővár) (Fig. 10). The original trusses have no tie-beams, these being substituted by trimmers because of the higher level of the Gothic arch. The structure is made of oaks cut during the winter of 1422/1423 (Fig. 11). Today the chancel has a flat ceiling. In the actual roof however there are two beams, similar to tie-beams, which obviously could not be part of the structure and the analysis revealed that they come from trees felled around 1590 – 1594 (a more precise dating was not possible because of the lack of the exterior rings). The observation, the dating and the position of the elements lead to the conclusion that the arch had to be demolished before this date. Similarly to the previous sites, in this case too dendrochronology brought significant data for the building date of the Gothic chancel and even for the next major intervention related to the demolition of the arch.

The previous roofs were made of oak (*Quercus sp.*). The other commonly used species in the medieval times was silver fir (*Abies alba Mill.*), that can be found both in north and south Transylvania. We managed to date two major structures built of fir.

7 Entz 1996, pp. 74-75.
8 For details see: Botár *et alii* 2013.

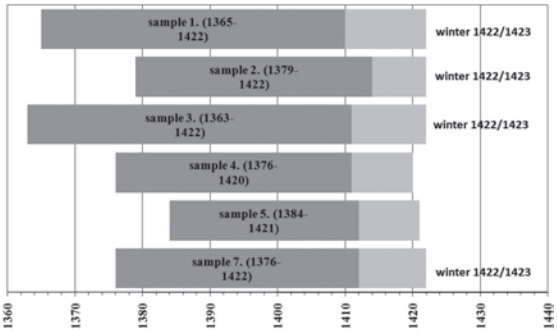

Fig. 11. The chronological positions of the samples from the original roof structure of the chancel in Cetatea de Baltă.

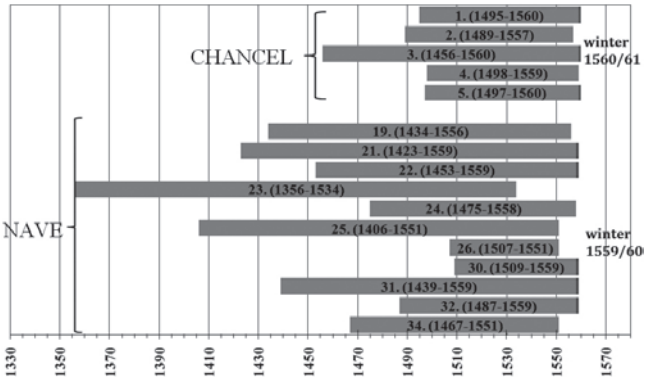

Fig. 12. The chronological positions of the samples from the original roof structures of the chancel and nave in Bistriţa.

In the absence of a local chronology for fir, in 2009 we had the task to achieve a relative dating of the roof of the ***Lutheran church in Bistriţa*** (Germ: Bistritz, Hung: Beszterce), and to answer the question: are the roof structures of the nave and chancel contemporary or not.[9] The analysis gave a positive answer: the two structures have only one year difference in the felling date of the timbers. The attempt to date the series with the local chronologies of the Rodna Mountains failed, probably because the Rodna chronology was made from high altitude material,[10] and the timbers of the roof were brought probably from a lower forest nearby the town. After some months the relative dating was transformed into an absolute one thanks to the generous help of Tomasz Wazny, who successfully dated our Bistriţa series with the South Poland chronology. The wood material for the roof of the chancel was felled during the winter of 1560/1561, and those from the nave in 1559/1560 (Fig. 12). The dates are in perfect match with the historical and epigraphical data (Fig. 13). The Bistriţa case had two major conclusions for the dendrochronological research. First, it revealed that carpenters used fresh wood for these structures, so that earlier presumptions about long stored and accumulated materials seem to be inaccurate in our regions. At the same time the Bistriţa local chronology was the first dated sequence which could be used for other fir structures.

The roof of the ***Lutheran church of Sibiu*** (Germ: Hermannstadt, Hung: Nagyszeben) is a complicated structure with several different parts[11] (Fig. 14). The building phases are reconstructed mostly based on indirect written records (donations, statements) and art historical observations.[12] Up to this day, the earliest roof structure in Transylvania dated by the dendrochronological method belongs to this building. In this case some more on-site investigations are necessary to finalise the report. Even so, the dendrochronological data are clear and illustrate the development of the building phases. More secondary re-used elements from the chancel roof were dated in the winter of 1338/1339, so, probably, a previous roof existed at that time above the chancel. The roof above the crossing was made from trees felled in 1351-1353, and a decade later the roof of the nave was finished too, with trees cut in the winters of 1362/1363 and 1363/1364 (Fig. 15). By the end of the century a major intervention occurred. The chancel got a new roof in which more elements of a previous structure were reused, and the other roof parts were strengthened with new elements and additional longitudinal structures. These interventions used trees cut around 1393-1396. The roof of the Ferula could be dated to 1457-1459, and the south secondary nave got its roof between 1517-1519. It is not our task to confront the dendrochronological data with the building history of the church, however we think that the roof dating may correlate with the building phases. The felling dates of timbers used in roof structures provide more direct and precise dating for corresponding building parts below as the indirect and accidental written sources.

[9] The research was conducted due to the request of Imola Kirizsán (Utilitas SRL, Cluj-Napoca), responsible for the restoration process.
[10] We wish to thank Ionel Popa (Câmpulung Moldovenesc) for his kind cooperation.
[11] Szabó *et alii* 2007.
[12] Entz 1996, pp. 64-65.

Fig. 13. Dated inscriptions on the west portal of the Lutheran church in Bistriţa.

More than providing information for building dates and phases, the long local chronology and the different types of roofs offer the possibilities to define the typological and technical development of medieval carpentry. All this research underlines the huge importance and potential of historical wood structures, which have to be protected as much as possible during everyday use and restoration works.

Besides dating, dendrochronological research brought useful data regarding the typo-chronology of the roofs. Many roofs from the Sălaj region were thought to be medieval due to their "Gothic" shape. After research carried out in the churches from Crasna (Hung: Kraszna), Horoatu Crasnei (Hung: Krasznahorvát), Tăşnad (Hung: Tasnád), Arduzel (Hung: Szamosardó) and Pir (Hung: Szilágypér) we found out that these structures were built in the 17th to 18th centuries. It is a strong warning that because of the archaism in carpentry traditions, dating based just on the typology of the roofs and trusses can be accepted only with precaution.

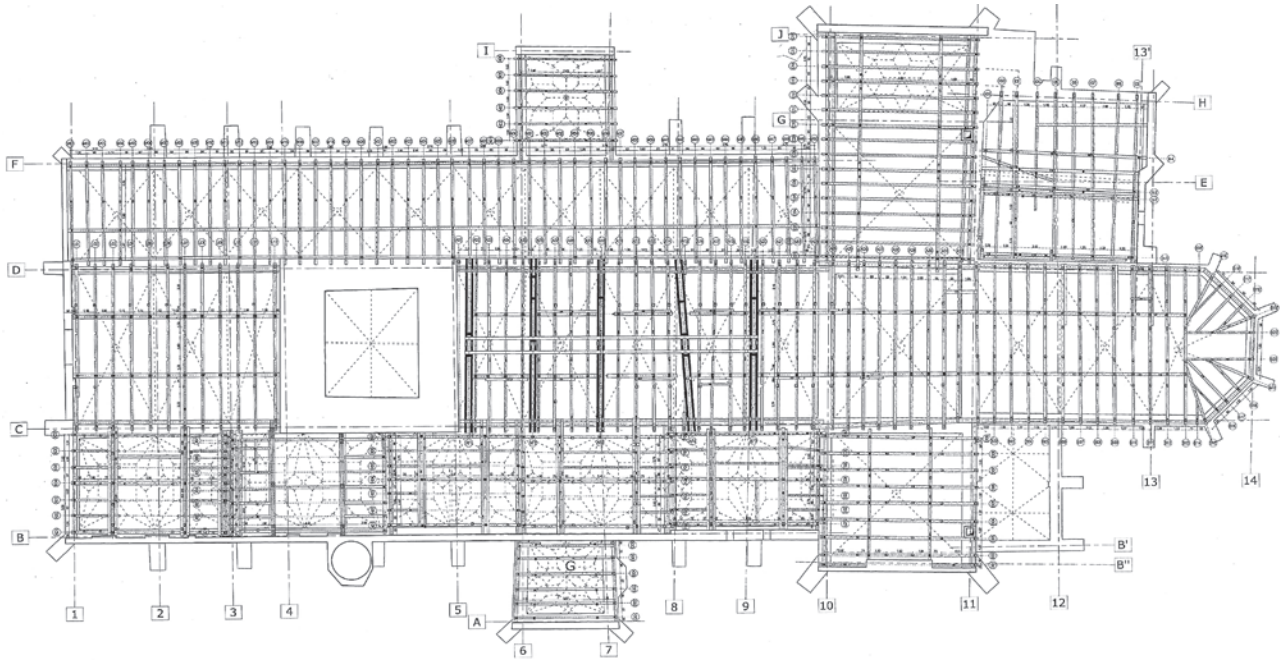

Fig. 14. Sibiu – Lutheran church, roof plan (after Szabó *et alii* 2007, fig. 2).

The dendrochronological activity is not limited only to architectural elements. Sometimes the dating of wood installations has additional results in art history as well. A first successful initiative of such a research on a medieval painted panel is already published,[13] and a new manuscript with a summary of these works

[13] Botár, Grynaeus, Tóth 2012.

regarding painted ceilings, baroque altars, medieval doors and breastworks is currently being prepared.

This short overview of recent dendrochronological research shows the great potential of the method for the history of architecture and art. Instead of indirect, more often later written records, or even total absence of information, tree ring analysis can provide sharp data regarding building dates, phases, internal chronology. Such information is essential before planning a restoration, so dendrochronology should become a mandatory part of the research protocols before and during interventions and research at historical monuments.

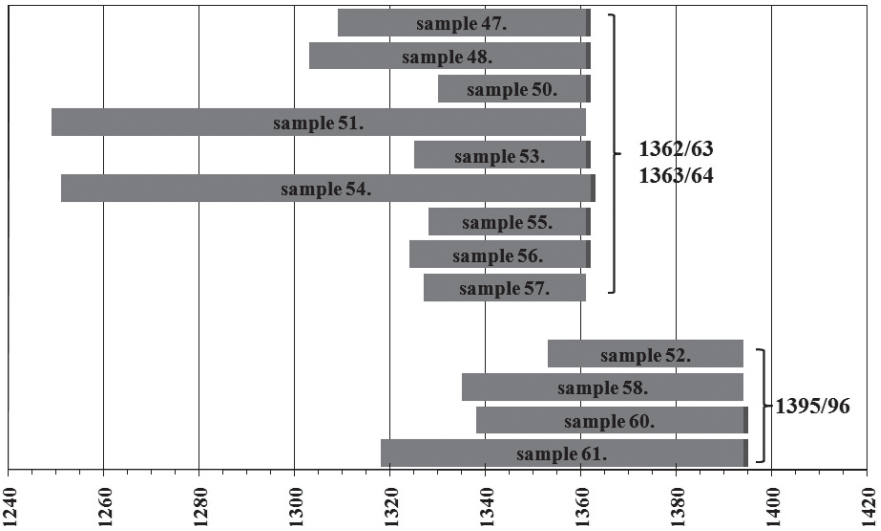

Fig. 15. The chronological positions of the samples from the original roof structure and later interventions of the nave in Sibiu.

The successful application of the method has been proven in several cases now, and the main task for the future is to extend the existing chronologies towards the first millennium and even to earlier periods. At the same time we would like to build valid chronologies also for the extra Carpathian regions in Moldova, Muntenia and Oltenia. For the development of research and enlargement of the databases, a much active collaboration is needed from the main factors of Romanian archaeology, museology and cultural heritage. Without these contributions the dendrochronological research will be limited to the medieval sites of Transylvania. We already lost decades, plenty of useful material, a huge amount of data, and it depends on all of us, those interested in cultural heritage, to change this situation for the benefit of the Romanian archaeology and history.

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