European Journal of Science and Theology, October 2014, Vol.10, No.5, 227-242

DENDROARCHAEOLOGY SEEN AS INSTRUMENT FOR DATING ECCLESIASTICAL ITEMS

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(Received 31 August 2013, revised 1 July 2014)

Abstract

Knowing the growth and formation pattern of trees has been always essential, especially when the correspondence between the anatomic elements and the environment factors was studied. An important feature in the wood formation consists in differentiation between the early wood and the late wood, which formed together the yearly radial growth ring. The macroclimate has decisively influenced the beginning and the end of the vegetation period, as comparing to the regional climate and the microclimate, which induces variations of the yearly ring width. More rings of low width, together with others bigger, will induce a new pattern, founded to the trees within a region. The correspondence of time series resulted from measuring the rings width will be carried out upon basis of such model, procedure known under the name of cross-dating. The mode of gathering and processing the biological material and eventually of using it within the dating process is analyzed in detail in this study. Theological importance of this science derives from answers that dendrochronology can offer to support biblical writings. Understanding the theoretical basis, not presented in detail so far in any specialized study, facilitates knowledge of the influence of environmental factors on cultural heritage, with direct implications on human spirituality. The need of such presentation derives from many assigned questions, regarding the dating of items, and especially the way such process is carried out, since not any wood item can be placed certainly in space and time, by means of the dendrochronological method.

Keywords: dendroarchaeology, dating, standardization, cross-dating, sapwood

1. Introduction

The dendrochronology history has started, in accordance to most of the author's opinion, with the American astrologer Andrew Ellicott Douglass, at the beginning of XXth century, when he tried to determine a connection between the radial growth pattern of trees and the solar phenomena. The dating method based upon the rings template conceived by him, known under the name of 'Douglass method', is quite well-known nowadays [1].

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The used methods have progressed in time, starting from the simplest ones up to those very complicated, which take into account advanced statistics. The easiest method also belongs to Douglass, which assumes cutting the wood under analysis with a very sharp blade, and then visually, one can see very small rings or very big rings, marked on a graph-paper. More observations of this type are compared, thus resulting in a cross-dating of the analyzed proofs. More accurate results and largely used are achieved when the proofs are measured by special instruments. It is considered that the pressure induced by the climatic factor is not identical for all the regions, and therefore, the last method is preferred, by which the measurements are compared graphically.

Investigating the climate as a determining factor on a large scale, relative to the width variation of the year growth ring, has enriched dedroclimatology with a dating technique, by offering an analysis method based on studying the indicator or event years [2-4]. Such years have usually occurred on large intervals, and superposing of at least two periods of this type has become necessary for an accurate dating. As result, the wood pieces that are submitted to the dating process should have a minimum number of growth rings (50 according to the foreign specialty literature) [5, 6]. Not all the wood species can be dated, and they should certainly own distinct anatomic growths, as well as an extended ecological areal. The trees should be able to adapt, on both the open fields (meaning the meadows) and massive fields (meaning the forests) vegetation conditions, as well as to the inferior voidable positions (co-dominant or dominated trees). As regards the last issue, one might say that the most sensitive trees to the climatic influences are those that vegetate in the upper stage of the dominant trees. They are specifically focused on the necessary growing resources. In contradistinction to these, the trees from inferior stages contain within the ring features more related to competition and ecology, but less related to climatology.

Regularly, the last growth rings show different characteristics as comparing to the others, and they are softer because the sap passes through here; such group of rings is known under the name of ‘sapwood’. This group emphasizes an essential part within dating, since this type of wood has usually a constant number of rings, which vary on large regions. In this way, the provenience of wood can be determined, and when this is partially eliminated, one might estimate the number of rings that lack, for an accurate dating. The alburnum is eliminated most of the times when the wood is processed, since a debilitating region is produced on joint, due to the fact that the wood is less dense, less elastic and less vulnerable towards the aggressive action of the external factors.

In order to understand efficiently the dating by means of dendrochronology, which signifies the most accurate method known up to present, it is necessary to provide the necessary knowledge related to the anatomy, auxology, ecology of trees, as well as elements on Mathematics and Information statistics. As conclusion, exposing in detail the dating phases will

always be beneficial on understanding the specific procedures, therefore opening the future progress lines.

2. Gathering the proofs

Gathering of proofs signifies a completely different process for the living wood as comparing to the archaeological wood, and has a special part, since non-meeting of principles will affect directly the quality of the achieved results. The growing cores of the living trees are extracted from 0.30 cm height from soil, analyzing the part with the highest physiological vitality of the tree, in order to achieve proofs on sizes as closer as possible to the marrow. In the situation of gathering two cores from the same tree's trunk, the proofs are aimed to be in antipodean plan. The cores are stored in especially conceived paper tubes, and then transported and dried.

After drying, these are placed on special wood supports, by sticking with adhesive, later on being polished with abrasive tapes of various granulations, in order to achieve a flat surface and a good image of limits relative to the year growth rings.

As regards the archaeological wood, this process is more complex, since the material used derives from various sites of different features. On starting an efficient dating, it has become impetuously necessary to extract proofs with the marrow and the crust non-altered, when they exist. An especial attention should be paid to the alburnum, since it has various structural characteristics as compared to those of the heartwood, thus determining a risk of deterioration in case of extraction. The archaeological wood may have various proveniences, starting from the trees found on open field or on hydrophobia, up to the wood used on constructions, tools, art items, supporting pylons, etc. The wood might prove primary functions, such as the wood buildings, or might have a secondary feature, thus being able to ensure a supporting function, as met within the old Moldavian monasteries buildings – a wood structure within the wall, upwards of which the stone brickworks were poured – depending on this, the easy way on gathering growth proofs will result. The most secure method on dating consists in gathering the cross-section growth cores, in the fibre direction.

In some cases the necessary objects on dating could not support any deterioration or gathering of growth proofs, respectively. In such situation, non-destructive methods will be used. Such objects are specific to museums, painted tableaus, frames, musical items, iconostasis or wood icons, etc. Methods that include the gathering of proofs with special drills by using water or without water, X-rays analysis, ultrasonic analysis, or high resolution scanners, 'the lifting' procedure or taking pictures with high performance cameras are the most used procedures on achieving information about the material submitted to analysis. Amongst all used procedures, the only one that can be hardly understood refers to 'the lifting', since it assumes applying an especial adhesive over the wood that has to be dated. This is moulded to all anatomic components of the wood, and such 'mask' is taken away from the wood after drying, thus

measuring the rings or even the anatomic elements, as for instance, the cells. Such procedure is ideal for those species of porous wood (e.g. oak).

The samples might reach the laboratory, under any forms: wood cores or slices, registrations of density, photographs or models glued together, the latter being non-destructive methods used in the case of high value objects. Analyzing subsequently the wood proofs, one should mention that they can be in dried or wet state, as well as solid wood or in a strongly depreciated state. In this way, potential dendrochronological studies will help to distinguish from the proof all the specific or private features, not necessarily those coming from the variations of the growth ring.

Preparing the archaeological wood is different from one method to another, as regards the non-destructive methods, measuring all the registrations from a 1:1 scale on densitometry, the photographs or the adhesive cast, but the most often choice is represented by processing the raw state wood. Since the essential aim consists in extracting the specific growth features on the pattern, it has become essential that the growth rings should be very visible. Many specialists in the field have proposed various methods of processing the wood proofs, in accordance to their gathering or drying. The following question might occur: why don't we let the wet proofs to dry? The answer is that once the wood is taken away from the anaerobic environment after hundreds or thousands of years, in contact with the air, the wood might suffer irreversible changes within its mechanical structures quite rapidly (few days). For this reason, the wood should be dated in its wet state. As regards the wet wood, the cutting or planning technique is preferred, by moving away the visible structures of wood, under the level of the individual cells. Cutting is carried out by special blades very well sharpened, which ensure a great visibility on the resulted area. The dried wood sample is processed identically with that derived from the living wood, by polishing with abrasive tapes. After polishing, the proofs are submitted to a strong air spray, in order to take away the very fine dust and sawdust, resulted by polishing, from the vessels' interior and from the limit between the early wood and tardily wood, deposits formed as result of passing from an area of hard wood to an area of softer wood.

Since the most believable dating emphasizes the year when the tree was cut, it has become essential to maintain the crust and the wood from the alburnum near the heartwood. Most often, the alburnum wood is taken away from certain environments, starting with the construction phase, or it is attacked by insects (the buildings wood), fact that creates difficulties in dating, for both wet and dried wood. After drying the wet wood, this will easily distort, because of the physical degradation of the entire proof or just because of the differentiated drying of the alburnum and heartwood. For this reason, it should be measured as fast as possible after drawing, and the pattern should be established.

3. Measuring the proofs

The radial growth width might be determined by means of the LINTAB digital positioner and TSAPwin software. The test precision might vary between 0.01 mm to 0.001 mm [7]. The individual values achieved by measuring can be saved in the standard format: Heidelberg (*.fh*), Tucson (*.rwl *.*), Excel CSV (comma separated) (*.xls,*csv, *txt) or matrix (ASCII) (*.txt *.*). Other used programs are CooRecorder and CDendro, which measure the scanned images.

The measuring procedures of the archaeological wood are as various as the preparation methods and in conclusion is indicated to measure each growth ring from the immediate surroundings of the marrow up to the last growth ring of the crust neighbourhood. In fact, the individual rings are measured on the radial section, but there is no comprehensible rule able to limit in any other way the measuring process. The factors that should be met are the following:

- The individual measurement of each ring should precisely reflect the relative width of the measured ring, up to the boundary with the previous ring. In order to accurately measure the growth rings, sometimes one should make high efforts, since the growths are reduced and it is difficult to establish the yearly limit of the radial growth (Figure 1a).
- The general pattern should reflect the measurement where the ring is the most characteristic (Figure 1b).

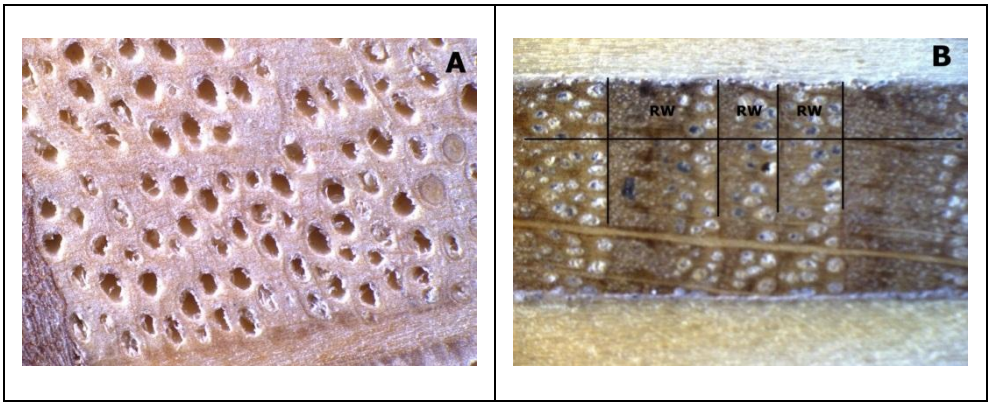

Figure1. Various aspects that should be taken into account within the measuring process: (a) radial rings of very low growth and non-materialized limit, (b) specific pattern, represented by the normal growth amongst which 2-3 rings of extremely low growth are interlaid.

These factors are known as a synthesis of the dating experience, thus representing an optimization of the radial growth ring pattern. Another procedural alternative consists in the analysis of two or more lines from the marrow and up to the crust, and their average is calculated afterwards. During the measuring process, it is important to mark the pattern of the regular intervals – usually at each ten rings, and then at fifty and one hundred – with the aim of

making easier a future checking, and in this way, avoiding the loss of some rings during the measurements.

After measurements, in the situation when no information programs are used, but micrometric graded rulers, the succession of numbers resulted are graphically collocated as relative to time axis. For dating, some operators use the growth series and the indexes series. Graphically, each individual proof will be illustrated with the scale on yearly level (starting from the zero value of the ring near the marrow) up to the maximum reached by the series (the ring neighborliness to the crust, if this exists). After the accurate dating, one might convert to the calendar year scale. The graphic might emphasize comments relative to the anomalous rings, issue rings, the position of heartwood and the alburnum, the numbers of rings within the heartwood and alburnum, the conditions of cutting the processed wood and transforming the rounded wood into a prism shape wood, respectively, etc.

After the proof has been drawn and prepared after the measurements, will result a succession of numbers and a graphic, and the proof can be stored within a warehouse (available for the wood dried proofs, photographs and even glue mould) for other future analysis. As regards the wet wood, the process has become more difficult, since the contact with the air will provoke sudden and irreversible changes. Even frozen, the samples will require funds, in order to pay for their storing, where the energy invoice will cost the most. Concerning the research in discussion, preservation of the archaeological wood is carried out within the History Museum of Suceava, and besides the procedures, this will need high expenditures and spaces of exhibition, points that might be seen as issues that should be solved.

4. The cross-dating

The cross-dating process is also known under the name of dendrochronology art, and it is carried out visually by means of the TSAPwin software, using the graphical comparison between series of individual radial growth and series of average growth. Statistically, the accurate positioning in time of each individual series is checked by means of the COFECHA [8, 9] software, and by analyzing the correspondence on periods interlaid on fifty years [8].

The essence of such dating process is represented by identifying the individual pattern of each series, which will be compared to other series pattern, or even to an average series. Most often, and especially within the chronologies on long time, one might distinguish certain similar areas to all series, and respectively, a limited reaction to the limitative environment factors, which will make easier the cross-dating process. In such cases, the cross-dating will be carried out visually by the graphic's analysis, and forming a master chronology can be built by means of superposing the similar pattern rings, in the relatively accurate position. The master conceived series relative to the restrained sites, where the variability is not too high, have the advantage on eliminating a great

part from the noise associated to the individual series, and accumulating a similar signal. The dating experience [10] tells us that the highest dating chances are related to the master series, conceived to homogeneous sites. Practically, the statistic programs are the most used, and calculate some correlation coefficients of very high frequency, year in year out.

Certain statistics, as the value of "the German coefficient on parallel variation" (*w*) [11] or the *t* coefficient value [12, 13] are very often used. There have been attempts on combining the two above described measures of correlation, in order to achieve a stronger position over the correlation. This idea signifies an aspect of dendrochronology, which is most often misunderstood. The results achieved by using the statistics software represent frequently just a guide, so as to notice the potential correspondences, though sometimes they are purely statistic and practically unreal. The correspondences between the rings growth pattern are not perfect, even in the situation of more proofs drawn from the same individual. The experienced dendrochronologists are looking for the suitability that they are willing to accept, based on experience, as an accurate positioning.

The misapprehensions between the statistics experts and the dendrochronologists are based on the following reason: the statistics experts talk about "the statistics tolerance and the signification level", and the dendrochronologists talk about statistics as a guidance book on finding the most significant relevance [14]. It goes without saying that there is no need of a high *t* correlation coefficient adequate to the minimal *p* statistics correlation, so that dating should be seen as absolute [10]. The secret of success consists in the operator's experience, as well as the repeated superposing of the dating series upwards of the reference series, as a replication form. It is not right that dendrochronologists should look towards a single matching or a single value of the correlation. Most often, the correlations are multitudinous, and a lot of practice should be carried out in order to make acceptable choices.

5. The standardization

In order to separate influences that condition the growth, the principle of standardization has been formulated, as well as studied within the specialty literature [1, 15, 16]. By this statistical-mathematical modelling, some undesirable influences can be eliminated, and one or more homogeneous factors can benefit of maximized effects. The trend induced by the age factor has been designed, thus emphasizing the low frequency or high frequency variance. The studies have shown that most of researchers used easy methods, most often without combining them with different filtering techniques over the undesirable variance. Standardization of the individual growth series was carried out in order to eliminate the non-climatic signal and to maximize the climatic information within the dendrochronological series. By standardization, one was able to achieve the initial growth series, within a series of stationary indexes, on average of value one and relatively constant variance.

As regards the establishment of average dendrochronological series from individual series formed from sequences of high growth variations induced by the age factor, the age influence can be found within the chronology trend [4, p. 148]. Concerning the heterocedastic growth series, one should establish the variance, in order to compare the growth sequences between trees of low growth with the trees of fast growth. The significance of such statistical procedure has determined ample studies in two ways, respectively: the stochastic procedure – different filtering functions are used for each tree, and the deterministic procedure – only one single function is used for all the trees [17].

The standardization method applied more and more often is based upon the stochastic filtering procedure on each individual series [18]. Relative to the individual series – which are different in age as comparing to each other – different functions and especially, the spline function [19], will separate the noise specific to each series, achieving the growth of common signal by its elimination, as well as a more clear emphasis of the climatic signal variance, within the resulted average series.

The climate varies to different temporal scales, and the sequences of trees growth will reflect an amalgam on various frequencies [17]. Different filters can be used in order to study the variance of a particular frequency, as well as the undesirable variances elimination. Depending upon the length of the used filter, the maximum measure is defined for the variance of the growth ring width, resulted in the indexes series. For instance, the high frequency of variance (intra-yearly) can be emphasized by using a low length filter, though the intra-yearly analysis will be impossible if high filters are used, which might eliminate the information at this level. Concerning the analysis on high decennial or multi-decennial periods on the climatic trend realignment, filters of long lengths are used, with coverage of at least one century [20, 21].

The statistics calculation can be carried out by means of the ASTRANwin software [15, p. 65], from where three series result: *standard* – the mean value of the growth indexes, by applying the bi-weighted robust mean, which includes the self-correlation between indexes; *residual* – achieved by applying a self-regressive model to the residual series, thus eliminating the self-correlation; *astran* – achieved by combining the theoretic self-regressive model with the residual series. In the situation of dating, the standardization is not used, and the individual growth series are compared to the reference series. R Gui statistics software [http://www.r-project.org/] is used more rarely, offering by means of 'detrendeR' package the possibility of calculating the indexes resulted by standardization.

6. Techniques of dendrochronological dating

Although the dating and cross-dating have the same principle in common, are distinguished by essence, since the cross-dating offers solutions of time positioning, for two series of individual growth, in contradistinction to dating, which is most often accomplished between two average chronologies, and more

rarely between the mean series and individual series, which are positioned in both time and space.

Cross-dating of series in time has been used in two periods of the analysis, such as the checking and elimination of the potential errors, in order to find the accurate time positioning of the dendrochronological series. After measurement, the cross-dating signifies an essential stage before starting the so-named analysis of the growth series. The significance of such stage should not be underestimated, since the measurements errors are eliminated by it, 'the false rings' are taken away and 'the lack rings' are inserted.

After eliminating the errors, an essential step is represented by the chronologies formation. These can be limited to that number of years for which the dendrochronological series are statistically well represented per each year, meaning the series mean; or all the series values can be included within their entire length, even if there is no good replication, meaning the extended mean.

The replication or repetition of proofs on the same signal is quite important. This will make possible the accurate determination of a chronology by replication, analyzed related to other chronology, thus emphasizing the secret of long chronologies formation in Germany and England. The primary replication is given by the individual series relevancies that will form a chronology of the site. The secondary replication is achieved by comparison to the mean series of the site relative to other chronologies on different sites, which aim on being as long as possible, and due to the internal replication, they will have a more robust pattern of the yearly ring. The third replication represents a test, which assumes the analysis of correlation between the chronologies formed by different operators, reducing thus the error induced by the human factor.

Concerning the dendrochronology, there are two main concepts, which express the quality of matching the time series: Gleichlaeufigkeit and/or the value *t*, this representing the dating process specific to the dendroarchaeology. The statistical *t* test is very well known in testing the correlation significance, and Gleichlaeufigkeit has been especially conceived as dating instrument of the radial growth series [11, p. 38]. This concept is based on a different sensitiveness over the yearly ring pattern. The Gleichlaeufigkeit parameter signifies the general relevance of two series, where the *t* value is very sensitive to extreme values, as well as the event years or the characteristic years. The two parameters have been combined, producing the cross-dating index known as 'Cross – Date Index (CDI)'. Since such index signifies a significant parameter, the potential relevancies are decreasingly ordered.

Statistical software as TSAPwin offers for the Gleichlaeufigkeit the so-called 'signature', which shows the increasing or decreasing number of positions derived from the series source. This is denoted by SGlk - Signature Gleichlaeufigkeit, and is a parameter much stronger than the previous parameters, when the dependency between individual series and a chronology, or between two chronologies is calculated. The *Gleichlaeufigkeit signature* (SGlk.) represents the sum of gradient equal intervals expressed in percentages and calculated relative to the chronology years' signature. *The standard*

Gleichlaeufigkeit signature (_SGlk) is different from the previous, since the proofs are represented here by the chronology and the reference is represented by the individual series. The third parameter is represented by *the signature – the Gleichlaeufigkeit* (SSGlk) signature – where both the proofs and the reference signify chronologies.

The value of *the t standard test*, meaning *the t Baillie – Pilcher value* (TV BP), signifies the *t* value after standardization with a floating mean value of 5, and *e* basis logarithm [12], or the *t Hollstein value* (TV H), which represents the *t* value after standardization with the Wuchswert, w_i function [22]. *The cross-dating index* (CDI) illustrates the index combined from the *t* values and the Gleichlaeufigkeit value.

Since all these indicators are statistical and underlie on a basis of strictly mathematical rationality, it is favourable that the trust should not be given to only one indicator, but in association with at least two indicators, relative to the dating procedure. Using one single indicator might lead to errors of level 1 or 2, and in this way, by the existence of fewer relevancies, an accurate position might be seen as wrong. In other cases, an accurate relevance might not be recognized. Besides the statistical component assigned to dating, this also assumes the establishment of a parameter, this time a biological parameter that is quite significant in dating, meaning the alburnum wood (Figure 2). In order to understand better, one might start from the hypothesis according to which the operator has precisely drawn, measured and cross-dated all gathered proofs. By using the dating, one might not be able to conclude if a building was constructed in the same year with cutting the tree, but only in special conditions, when the joints were formed of green wood that 'were condensed' by drying. One should understand that dendro-chronology offers us most often the calendar date of cutting the tree, and sometimes an interval within which the calendar date of gathering the tree is included. These aspects have been priority accepted in studying the archaeological sites, where the dendroarchaeology provides the calendar date of the youngest construction, known under the name of 'terminus post quem'. This calendar date is not identical to the date of structures forming, which is mostly often found to be after the formation time, or after one or two years. Using the wood in different aims was connected in past to various practices. The wood was cut in the winter months or very early in the spring, relative to the difficulty of wood transportation in conditions of difficult winter, and afterwards the wood with crust was dried for one or two years.

Many times the wood was submitted to some processing operation, by which some parts were extracted from the initial configuration, thus remaining prisms, cases and boards, in the situation of the furniture processing (Figure 3). By eliminating the external part that might offer information regarding the year of cutting, the dating is partial or can be interpretable. For these reasons, the presence of the alburnum, known as having a relatively reduced number of yearly rings and as being someway specific to each area, it is essential for the accurate dating. Sometimes, an analysis over it will be able to tell us the season of cutting the tree, by a cross-yearly precision.

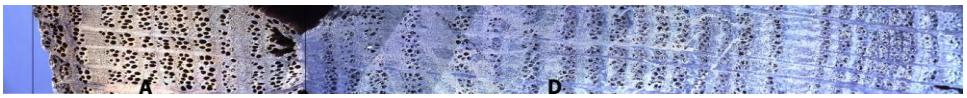

Figure 2. Archaeological wood core gathered from counter-escarp of Suceava Fortress: A – laburnum, D - heartwood.

Figure 3. Wood part derived from the internal structure of Reuseni Monastery from Suceava.

Figure 4. Position out of the wood samples extraction and wood part drawn from the internal wall at Saint Ioan cel Nou Monastery of Suceava.

The yearly ring of oak species can be separated into early wood and late wood. Early wood is normally formed in April – May, whereas late wood is normally formed from May till July. In this way, the tree cut in the early spring will not contain late wood. On the other hand, the tree cut during the summer will contain both early wood and late wood, which means that it may have been cut any time after August of the last year and March of the current year.

Unfortunately, the friable type of the alburnum wood will determine that most of the archaeological proofs will not be placed with accuracy in time, by a certain specification of the year. The alburnum wood can be partially illustrated or can be totally absent, as follows: (1) a small part of is absent or is deteriorated; (2) most of it will be absent, but one or two rings well differentiated will remain; (3) all the soft wood is absent, but other issues shows that only a part of it is absent; (4) all the alburnum and an unknown part of the heartwood are absent.

Figure 5. Wood plate derived from a bridge built during the Austro-Hungarian domination in Romania (1774–1918).

For all these situations, an establishment of the lacking rings, especially at the oak, has to be carried out by estimation, based on personal databases, resulted in accordance to many measurements, from where the average number of the alburnum wood rings is known. As mentioned, the variability of the alburnum rings number is high, so that within the same site, as well as in areas coming from different locations. Studies in this way have been carried out in Ireland [5, 12], and specialists have found that within the trust interval of 68%, alburnum is between 23 and 41 years old, while within the trust interval of 95%, the age limit is between 14 and 50 years old. In England, Hillam [23, 24] offered for a 95% trust interval a number within the interval of 15 to 50 years old. In

Germany, the rings alburnum average is of 20 years old [22, p. 173], and less of 14±3 in Finland [25].

In order to consent a full success, one should take into account the quality of wood, which should not be, under any circumstances, deteriorated, as can be seen in Figure 4. One should also take into account the number of growth measured rings, which has to be higher than 50 (see Figure 5). As result, it is quite essential to understand that the number of yearly rings matters, and not the proof dimension.

7. Conclusions

Although the dendroarchaeology of Romania is at its beginnings, the potential offered by multiple wooden buildings, the oldest ones being the halidoms, is quite high. Even if very precise dating processes were done abroad, for relatively small wood pieces, as the musical instruments, the wood statues or paintings, this does not mean that any object might be dated by means of the dendrochronological procedure. Generally, it is possible to date any wood piece, which illustrates at least 50 rings, though it is preferable that their number to exceed 100, with the condition of having a basic chronology for that time.

Another high importance issue is represented by the number of extracted proofs, which should be high enough in order to statistically ensure the chronology that follows to be dated. The high replication ensures values of new formed chronologies, middlemost values, fact that determines a higher dating accuracy. Knowing the historical conditions is essential, since the mathematical – statistical methods applied more often offer two or more positions for the series that should be dated. The historical sources might represent the dating key. The fact that twenty-five churches from Maramures were dated by Alexandru D. Babos and Ólafur Eggertsson prove us that dating the churches in Bucovina can be truly carried out. The researchers' interest is quite high, since in this way, such results will offer accurate information regarding the edification period of time, but also issues of the local culture. Future research studies will allow practical exemplification about dating such monuments.

Not all the wood pieces gathered in the view of dating can be placed on the temporal scale, by means of the dendrochronological method. The reasons that lead to such results are multiple. Some of them can be subjective and in direct connection with the experience of the operators, or directly correlated to the objects, relative to the quality of the wood submitted to the dating process. High significance is represented by a good knowledge over the methodologies applied to objects that can be dated, since the specialist might appreciate the limits of the instrument named dendroarchaeology.

The science and technique applied in connection with a spiritual field, as Theology, become significant in a world being in continuous movement. The difference between the nowadays people and our grandparents is represented by information, which is everywhere in our times. More information attracts more

questions. A non-consentaneous answer or an uncertainty can transform a faithful individual of into an unreligious individual on the long run.

What answers can the dendroarchaeology offer? One might consist in the longest series, formed by growth rings, represented by 'The South German Hohenheim oak chronology', which reaches up the year 8480 B.C. This chronology includes growth sequences of the first oak trees [26, 27]. In accordance with the Biblical data, starting with the first human being that existed on Earth, meaning Adam, and following its descendants up to Jesus Christ, the number of years is approximately the same [28]. Such affirmations come in order to support the Theology, when the essence of the Biblical text is called in question, as regards the creation of human beings and the age of Terra.

If one makes a more underlying analysis, one might observe that some trees used in order to construct this chronology have been gathered from the North parts of Europe, where the oak doesn't exist anymore nowadays. Moreover, within the Neolithic age, such series allowed the dating of various objects to a large scale. Afterwards, the series had to be extended to a more regional level. What can people understand by this issue? The research developed by many archaeologists, and even geologists, amongst the most well-known being William Ryan and Walter Pitman, has told us that during the Biblical flooding, the cataclysm had huge proportions [29]. Such a theory is also confirmed by the fact that flooding has been found in all cultures and great civilizations of the world. The scripts of Saint Basil the Great and more recent of Seraphim Rose, as regards the Biblical Genesis, gave an interpretation of text, by speaking about "the force that separated the water from above from the water underneath" (Genesis 1.7). Such strength protected the ground in a special way, offering great conditions to luxurious vegetation, where the climate had been the same at the poles and tropics, thus explaining the oak existence near the poles. In the postdiluvian period, when 'the strength' was cut down, the climate has been modified by different universal, regional or even local level variations.

Another contradictory issue between the evolutionist theory and Biblical theology was given by observations where the trees were included. In this way, the National Park of Yellowstone, which signifies the oldest park within the United States of America, is well-known for its geothermal activities. This park includes over ten thousands hot headwaters and two hundreds geysers, amongst which the most well-known is 'the Old Faithful', the black obsidian mountain (volcanic glass) or the canyons and wood stone forests that signify the result of the volcanic processes. The lateral erosion of a hill brought the stone trees on sight.

There is an evolutionist explanation, able to find a justification that during millions of years, forming such curiosities occurred, but this theory is full of non-correspondences. One of the easiest consists in the stone naturally forest of millions years ago, where stone branches or leaves should have been existed, but it is not the case here. The trunks have three or four meters in height, and many times wounds traces, are lacked of branches and sometimes without crust. If usually after they die, the trees fall down naturally in the horizontal plane, and

fewer times disposed in the same direction, in the above mentioned case, there is a symmetric disposal in the longitudinal axis. This signifies the existence of a cataclysm, such as the very strong wind or high floating stream. Considering that after a wind felling, one might not be able to explain the transport of trees, the second variable is the most plausible. Trying to explain this phenomenon, by successive volcanic activities on long time periods, is not realistic, since each level provided in this way should include different minerals, but is the same on a height of 1200 meters. The studies carried out on pollen have indicated that there are more plants as comparing to those found in a normal forest.

Considering the normal conditions, each tree grows yearly in diameter, simultaneously with the formation of the radial growth ring. The variation of the growth rings was explained above, and the conclusion is that it varies in report to a multitude of factors, which are relative to the microclimate and the site. The trees that grow in similar conditions presented similar sequences of thin and thick rings. Dr. John Morris noticed that in 1975, the trees had a similar pattern [30]. Michael Art analyzed in a dendrochronological way 14 trees on different levels, on a height of 7 meters. Dating has proven that from those 14 trees, four trees died by 7, 4, 3 and 2 years before the other ten trees. By exposing such periods, the theory according to which these trees died in a recent cataclysm (probably in 1980, when the St. Elena volcano erupted) is dendrochronologically proven [31]. In Hunedoara, Romania, there is also a stoned forest.

Such answers given by the vegetation study by means of radial growth rings of the trees can support Theology against ideas having a strong influence on human thinking, such as: Darwin's theory (the evolutionism), Anaxagoras' theory (the panspermia), and the theories of Erich Von Danieken or the exogenesis. Faced with issues regarding the Biblical vision over the world, one should admit that we cannot have all the answers, but God has, and at the right time, it offers to His creation the necessary tools on discovering it.

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