Journal of Cultural Heritage xxx (2016) xxx–xxx

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Wooden Musical Instruments

Dating of violins – The interpretation of dendrochronological reports

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ARTICLE INFO

Article history:
Received 30 November 2015
Accepted 28 July 2016
Available online xxx

Keywords:
Musical instruments
Age determination
Tree rings
Dendrochronology
Terminus post quem
Norway spruce = *Picea abies*

ABSTRACT

We dendrochronologically analyzed the bellies of 10 violins differing in age, origin, number and width of tree rings, state of preservation as well as fabrication. All the bellies were made of Norway spruce (*Picea abies*). The dating of each violin was given as a calendar year (end date), as is usual in dendrochronological reports. We demonstrate how to interpret such reports in terms of age, origin, producer and authenticity of the instrument. Six violins were made by a known violin maker in Slovenia, who provided reliable information on the source of wood as well as on details on the wood processing. The dendrochronologically determined end dates varied from 1988 to 2005 and hence deviated by 5–22 years from the documented date of tree felling in 2010 and by 10–27 years from the years of the instrument fabrication (2014–2015). This explains why the end year (i.e., the dating of a violin) should always be considered as *terminus post quem*. The violins had relatively few tree rings (51–72) but it was possible to date them with local tree-ring chronologies, showing that adequate reference chronologies are essential for successful dating. An end date of 1929 was determined for violin of unknown provenance (violin 7). This date was repeatedly confirmed by numerous local chronologies and by various tree-ring sequences of instruments. The most significant statistical parameters of dating, obtained with German local chronologies and instruments, supported the opinion of experts that this instrument was probably made in a German workshop. Another violin (violin 14), privately owned in Slovenia, was dated with very high statistical values using several chronologies from the wider region of the Bohemian Forest. Its possible origin and end date 1893 confirmed the opinion of organologists that the instrument may have been made by a German workshop in the 19th century, thus proving the label "Joseph Guarnerius fecit Cremonae anno 1721" being false. Violin 15, from a private owner in Paris, dated 1748 with chronologies from the northern Alps, is in agreement with the opinion of experts that it may have been made in Paris around 1750, while the label "STRADEVARIUS [sic] Filius Cremona" proved to be a fake. Violin 13, of unknown age and origin, remained undated, although the treble side of the belly contained a very high number of tree rings (193), which usually increases the likelihood for dendrochronological dating. Its undatability is ascribed to possible measuring errors due to extremely narrow rings and a dark opaque varnish. Even the application of various equipment and methods (lenses, stereo microscope, high-quality digital image analysis) did not help to exactly identify the tree rings. This case demonstrates one of the limitations of dendrochronology.

1. Research aims

Dendrochronology is often applied to date stringed musical instruments to support the determination of authenticity and give hints to their maker. The success of such an analysis greatly depends on the wood characteristics, number of tree rings, accurate tree-ring width measurements and reliable cross-dating with adequate reference tree-ring chronologies and tree-ring sequences of dated instruments.

A dating report usually presents an end date, which means the year when the most recent visible tree ring was formed. This date has to be considered as a *terminus post quem*, i.e., time after which the instrument was made.

Our study presents an analysis of six violins for which we know all the crucial parameters (time of tree felling, details of wood

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http://dx.doi.org/10.1016/j.culher.2016.07.010
1296-2074/

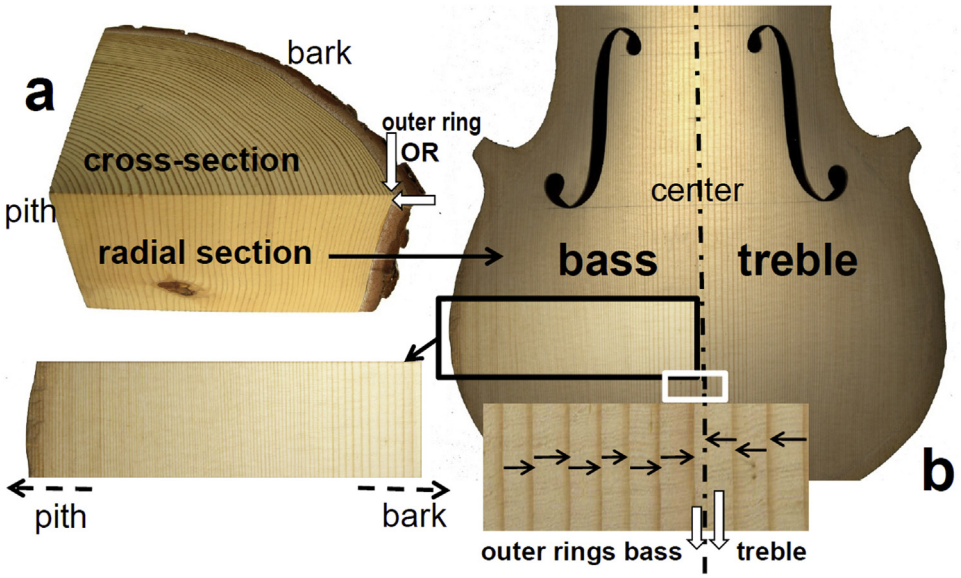

Fig. 1. Wood structure and tree-rings in Norway spruce: (a) piece of wood with cross- and radial sections, (b) raw violin with belly made of two radial boards and section selected for tree-ring measurement on bass side (black frame), with detailed view showing the direction of bark and pith; white frame shows the portion of the central part of the violin, where two boards are glued together, arrows show the principle of tree ring measurement (from early to late wood). White arrows show the outer rings (originating from the outer part of the tree) on both sides of the violin belly; the dating of these rings is crucial to determine the age of the instrument.

origin, the maker, and the time of fabrication of the instrument) and possible deviations between the dendrochronologically established end date for the instrument and the real year of fabrication. Moreover we present an analysis of four instruments for which the origin, producer and age were not known.

In conclusion, we want to contribute to a better understanding of the strengths and limitations of dendrochronological dating, and helping those who have ordered an analysis to know how to interpret dendrochronological reports.

2. Introduction

Dendrochronology is a widely accepted method for determining the age of historical wood. In the literature numerous articles are listed reporting the application of dendrochronology for the study of musical instruments, with a prevalence of string instruments [1–12]. These and numerous other works show that dendrochronology can be helpful in determining the authenticity of instruments and identifying the origin of the wood and of the maker of the instrument [11–16].

Dendrochronology is based on the tree-ring width measurements, which is done on cross-sections in most cases (Fig. 1). However, in string instruments, such measurements are taken on the upper part of the instrument termed belly, which is usually made of two or, rarely, one or up to five radial boards. Bellies are mainly made of Norway spruce (*Picea abies* Karst.), or occasionally of silver fir (*Abies alba* Mill.) or of other softwood species. For the bottoms of the instruments, which are normally made of maple (*Acer* ssp.), particularly fiddle-back maple [17], tree-ring analysis cannot be applied for dating since the wood in these parts is usually not oriented radially; such wood does not contain enough tree rings for an analysis, and reliable reference chronologies for dating cannot be constructed.

Dendrochronology has developed a variety of measuring techniques. The most basic equipment consists of a lens with 10× magnification and a build-in metric scale as well as various methods of recording the measurements (Fig. 2a and b). However, the classical equipment of dendrochonological laboratories usually consists of a movable measuring table on which the investigated object is placed, a stereo microscope, computer and program for tree-ring width measurement, cross-dating and statistical analyses (Fig. 3). Since the musical instrument cannot always be brought to a laboratory, images are often captured (with cameras or scanners) (Fig. 2c) and the tree-ring width measured using image analysis systems (Fig. 4). In ideal cases, system for automatic recognition of tree rings and measurement of their widths can be used, such as the Coo-Recorder of Lars-Åke Larsson of Cybis Elektronik & Data AB in Saltsjöbaden, Sweden (http://www.cybis.se) (Fig. 4). This technique can be used in particular on raw wood surfaces or where the varnish is transparent.

After the measurement is completed and verified, the cross-dating procedure is performed, which matches patterns of conspicuously wide and narrow rings caused by climatic variation [18,19]. If the tree-ring series is long enough, its pattern caused by random climatic variation will be unique, so that there can only be one correct placement in time of each tree-ring series. Cross-dating is performed graphically (by comparing graphs of tree-ring series) and by calculating statistical parameters. The reliability of graphical/optical cross-dating depends on the experience of the dendrochronologist. Dating based on statistical parameters in the final stage also requires the decision of a skilled person.

Adequate tree-ring chronologies are needed for dating. Norway spruce, as the most widely used wood species for resonance boards of string instruments, grows over a wide geographical area [20] and on a great variety of sites, altitudes and climatic regimes, which affects tree-ring patterns [21]. It is therefore necessary to use a number of reference chronologies, and any results must be carefully verified to avoid “dating” at an erroneous temporal position [7].

Some laboratories in Europe, such as those at the Institute of Wood Biology of the University of Hamburg and the laboratory of Micha Beuting [2,9,11], have dated thousands of instruments and built large databases of reference chronologies of trees from known localities. Based on this, they can build reference chronologies for different geographical areas and makers of musical instruments [2,3]. Such chronologies provide an important source of information for determining the origin of the wood – dendroprovenancing [2,22], which is based on the premise that tree-ring patterns of trees from the same or nearby sites show higher similarity than those from remote ones. Areas in countries like Italy, Germany, Austria

Please cite this article in press as: K. Čufar, et al., Dating of violins – The interpretation of dendrochronological reports, Journal of Cultural Heritage (2016), http://dx.doi.org/10.1016/j.culher.2016.07.010