More than dating ? Further information obtained by dendrochronology

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This article shows possibilities the method of dendrochronology on musical instruments may provide beyond mere dating. By using examples of instruments made by famous Italian and German instrument makers, some statements shall be made regarding storage durations as well as ways of manufacturing in different workshops. Another focus will be laid on the method of regionalisation and its potential benefit for organology. Furthermore criteria for determining the origin of wood from the same stem will be presented and discussed. Finally a classification of tree ring widths of spruce resonance wood will be introduced, which could lead to a more precise description and in consequence to a higher comparability of instruments' front plates and resonance boards – e. g. in catalogues and documentations.

I The laboratory

Since 1999 Dr. Micha Beuting is concerned with dendrochronology. After completing his diploma focussing on dendrochronology in 2000, he accomplished a phd thesis on the subject in 2004 and founded his own laboratory in 2003.
By a cooperation between the lab and the Centre of Wood Science at Hamburg University it was possible to fall back on a dendrochronological data stock which goes back to the early 80s of the last century. At present 110 chronologies are used for dating purposes. About 3750 sequences derived from stringed, plucked and keyboard instruments are stored in the database and can be used for the method of cross matching.
Next to the usual dating of tree rings, regionalising and cross matching, research on wood anatomy - especially wood species determination - is offered to customers. The lab's service addresses museums, instrument makers, dealers and private collectors of musical instruments. Special research fields are Italian and German stringed instruments and keyboard instruments.

Since there has been a great progress in the development of computer techniques and software within the last years, these devices could also be made useful in the field of dendrochonology. Larger amounts of sequences can be stored in databases and are now available for a greater range of statistical analysis.
In the following some examples of results that derive thereof are shown.

II Storage duration and ways of manufacturing

Storage duration and particular ways of manufacturing have always been of interest and subject to respective literature.

By comparing the dendrochronological dating (determining the date of the youngest tree ring found on the instrument) and the organological temporal classification of a instruments a conclusion about wood use and storage times can be made. Prerequisite for a definite conclusion is a number of instruments by one maker and a close collaboration with organologists and instrument makers!

II.1 Storage duration

The statements given in the respective literature about storage time of the wood used for instruments differ considerably: Frequently a very long duration for storage and drying from 30 years onwards is quoted. But when examining the tree rings of a huge number of instruments it became obvious that this time span often is much shorter than expected.
E.g. 87 sequences of violins by the Guarneri family (Petrus, Andrea and Giuseppe) had been analyzed. By comparing the dendrochronological dating with the respective organological dating for 34 instruments[1] a precise difference between these two classifications could be stated.

The following violins by Guarneri del Gesù, all labelled as made in 1737, may exemplify the quite short spans between dendro-dating and manufacturing dates:

The dendrochronological dating gave the following results: The youngest ring on the bass side of the « Joachim » was formed in 1721, for the « King Joseph » the treble side was dated 1734 and the bass side 1731. The bass side of the « Isaac Stern » was dated 1726. (Klein/Pollens 1998)

Furthermore a closer look on the instruments' datings showed with utmost probability, that the mentioned parts were manufactured out of the same tree (See Chapter IV). Taking this into account, it must be stated, that none of the three instruments could have been made before 1734.[2]
Given that no ring was cut off on the joining of parts a maximum period of three years for drying the wood can be inferred.

Applying the same method on the treble side of the « Devil » (label: 1734, youngest tree ring: 1720), the « Baltic » (label: 1731, treble: 1714, bass: 1712) and the « George Haddock » (label: 1734, bass: 1719, treble: 1722) a minimum storage time of nine years results (label of the « Baltic » 1731 and youngest tree ring of « George Haddock » 1722).

[1] Only instruments, that had a definite organological dating, were used for the comparison.
[2] This leads to the conclusion that del Gesù cut off at least 13 tree rings of the bass side of « Joachim », three rings from the bass side of « King Joseph » and eight tree rings from « Isaac Stern »'s bass side.

II.2 Ways of manufacturing

Next to a short storage time the examples given show that *luthiers* seem to have dealt with their material with reasonable care. It seems, that they just removed the bark before gluing both belly parts together as it is shown in the following picture.

Figure 1: The glued joint of a two part violin belly, photo M. Beuting.

III Regionalisation

By the statistical method of clustering the sequences of musical instruments and allocating the dendrochronological results to the biographies of the luthiers and their places of residence it was possible to install a regionalisation of reference chronologies (Beuting 2004).
At present five major regions of wood origin are distinguishable: Northern Alps, which means the region around Innsbruck and Mittenwald, Southern Alps with the Italian part of the Alps, Southern Germany, Bavarian / Bohemian Forest and the region around the Erzgebirge / Vogtland.
In recent years this regional classification has been numerously confirmed when dendrochronological and organological results were compared to each other.
So regionalisation can be a tool to provide an indication to an instrument's origin where no clear assignment through organological attributes exists.

IV Same tree origin

As touched on before, it is most interesting for research to determine instruments that were manufactured from the same stem.
In order to determine the origin of different pieces of wood from one and the same stem different criteria were established (Beuting 2004). These are based upon empirical experience, the examination of numerous radiuses from recent trees, the comparison of treble and bass sides from instrument bellies and the analysis of the sequences from wood used for resonance boards.

The following criteria have to be fulfilled as a whole to state that two pieces of wood are taken from one and the same stem:

- t-value > 8.0
- Gleichläufigkeit (Synchronousity) > 70%
- Statistical Significance 99,9 %
- Graphical similarity of the compared curves
- Same pointer years
- Nearly the same year of the beginning or the end of the curve
- Similar tree-ring-widths of the compared curves
- A minimum of 70 years of overlap

For research on musical instruments three categories of "same tree origin" can be formed:

IV. 1 Different instruments made by the same luthier

On first sight the fact that a violin maker should build several instruments out of a given stem may not surprise. Still some interesting deductions can be made. Three instruments of Jacob Stainer (1618 – 1683) may serve as example[3].

A violin of private ownership, which is dendrochronologically dated with the youngest tree ring from 1659.

A *viola da gamba* « ex Wenzinger collection» owned by the Art-historical Museum in Vienna, Inv. Nr SAM 1036, the treble side's youngest tree ring is from 1655, the last measured ring on the bass side was formed in 1645.

[3] See SEIPEL, W. (Ed.), Jacob Stainer: «...kayserlicher diener und geigenmacher zu Absom ». Exhibition catalogue of the Art-historical museum Vienna, Mailand: Skira, 2003.

And finally a *violoncello*[4] owned by the Musikkollegium Winterthur in Switzerland, with a dating of the youngest rings from 1645 for the treble and 1658 for the bass side. The sequences have a length between 152 and 179 tree rings.

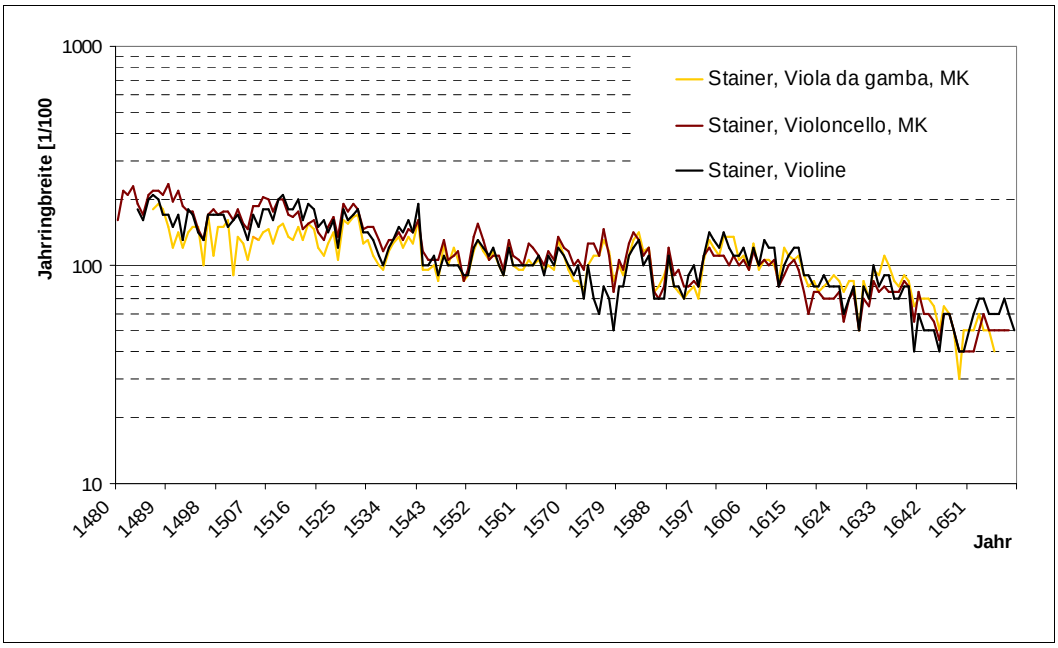

Figure 2: The sequences of the three instruments by Jacob Stainer set against each other. For the *violoncello* and the *viola da gamba* mean curves of the sequences of the bass and treble sides have been built in order to keep the diagram clearly arranged.

By knowing that all parts originate from one tree, dendrochronological results allow next to mere dating the following statements:

As the youngest tree ring of the violin was formed in 1659, the earliest date of origin of all three instruments is 1659.

As all three instruments bear labels giving the date of 1673, the maximum storage time of the utilised resonance wood is 15 years.

Furthermore it shows that Jacob Stainer did not make any difference in choosing his wood for different types of instruments whereas literature often mentions that luthiers had the habit of doing so. Rather were they quite pragmatical. The more so as the

4 See Cello Absam, 1673, Musikkollegium Wintherhur, Suisse: www.stainerquartett.ch

violin`s belly is made out of one piece being about as wide as half a cello's or viola da gamba's belly.

Eventually, by comparing the respective sequences with the regionalised chronologies it can be said that Jacob Stainer obtained his material from the surrounding woods, as it can be allocated to the region Northern Alps.

IV. 2 Instruments of different luthiers

To illustrate this group the following two instruments were chosen:

Violin, Antonio Stradivari « Sunrise », Cremona 1677, private ownership, on loan to the Kunsthistorisches Museum Vienna [4409909]

Violin, Nicolò Amati[5], Cremona 1673, Metropolitan Museum New York, Inv.-No.: 1974.229 [3027602]

The bellies of the instruments were respectively made from one piece. On the Stradivari's belly 151 tree rings were measured and could be dated between 1502 and 1652. At the Amati 163 rings could be measured and the dendrochronological result is 1494 – 1656.

Both sequences match each other significantly and fulfill the requested criteria, both, the statistical and the optical ones, completely, which may indicate that the pieces come from one and the same tree (See table 1 and figure 3).

Sample	Ref.	OVL[6]	Glk[7]	GSL[8]	TVH	CDI	DateL	DateR
3027602A	4409909a	151	75	***	9,1	70	1494	1656

Table 1: Statistical values of the cross-matching between the sequences of the Stradivari (4409909a) and the Amati (3027602a).

5 http://www.metmuseum.org/Works_of_Art/collection_database/musical_instruments/violin_nicolo-amati/obj
6 OVL = Overlap
7 Glk = Gleichläufigkeit (Synchrounosity) in %
8 GSL = Significance of synchrounosity according to Eckstein and Bauch 1969 in %

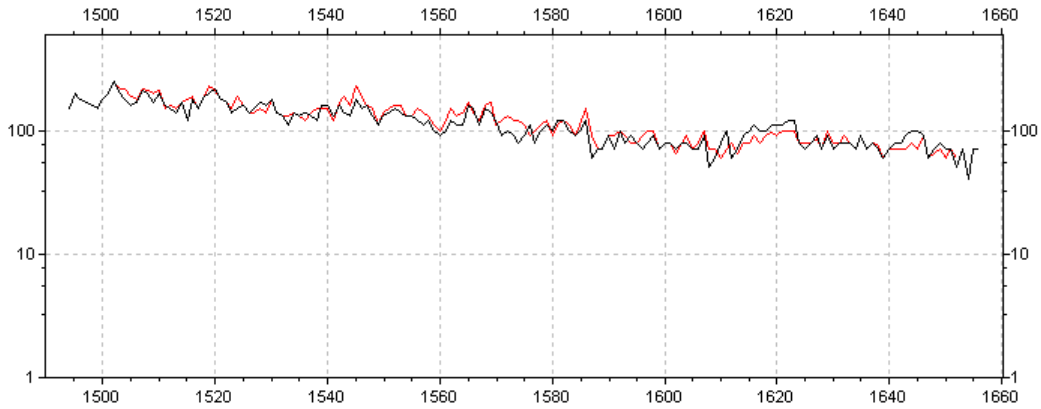

Figure 3: The sequences of the Stradivari violin (4409909a - red) and the Amati violin (3027602a – black) set against each other.

To find the same stem on instruments of two important violin makers gives the possibility to confirm or to speculate on historical facts such as A. Stradivari being an apprentice of N. Amati or having other access to Amati's material, maybe buying from him, or both working independently from each other but buying from the same salesperson.

IV. 3 Instruments of unknown origin that may be attributed to an instrument maker or at least a region

Example for this group shall be the following instruments:

Trumpet marine, Matthias Hornsteiner, Musical Instrument Museum Berlin, Stiftung Preussischer Kulturbesitz, Inv.-No. 158, 1575 – 1780 (206) [1260102] ;

Trumpet marine, attributed to Matthias Hornsteiner Musical Instrument Museum Berlin, Stiftung Preussischer Kulturbesitz, Inv.-No. 534, 1573 – 1774 (202) [1260101].

Whereas the trumpet marine with the Inv.-No. 158 bears a handwritten label « mathies hornsteiner / in midten waldt an der / ißer grätz geigen / macher / 1790 », the instrument with the Inv.-No. 534 was attributed to Matthias Hornsteiner based on its form and other construction characteristics.

Close analysis showed that the statistical accordances as well as the optical comparison of the dendrochronological sequences were highly significant.

Considering both, the organological and the dendrochronological results, this former attribution could absolutely be ensured.

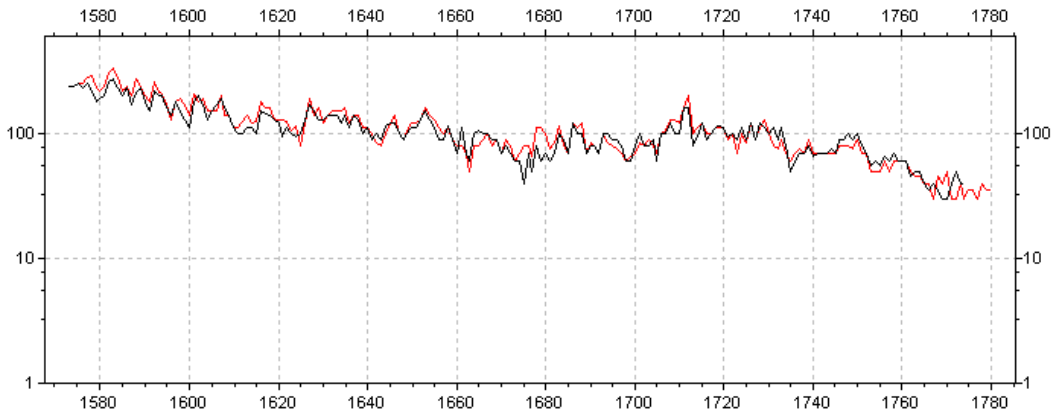

Figure 4: The sequences of two trumpet marines by M. Hornsteiner set against each other 1260101a – black, 1260102a - red).

Sample	Ref.	OVL	Glk	GSL	TVH	CDI	DateL	DateR
1260101a	1260102a	200	76	***	12,7	92	1573	1774
1260102a	1260101a	200	76	***	12,7	92	1575	1780

Table 2: Statistical values of the cross-matching between the sequences of two trumpet marines by Matthias Hornsteiner.

Regarding the dating of the youngest tree rings both instruments could have been built at the earliest in 1780. The best matches were achieved with reference chronologies for the region Nordalpen/Mittenwald.

V Classification of tree ring width

In contrast to large parts of the wood industry, at present neither dendrochronology nor organology provide exact criteria to describe the tree ring structure of resonance wood, though rudiments of such exist and are used in literature and catalogues. In order to enable all those who deal with wooden instruments to render their descriptions more precisely, which will result in higher comparability of information and better differentiation of instruments, such a classification should be established.

At present the common description of « narrow » tree ring structure is often found, applied to rings of a width from 0,1 mm to 3 mm. The notion of wider rings for bigger

instruments (like violoncelli) is often referred to, as well, not taking into account that the wider belly inevitably comprises tree rings from the inner parts of the stem.
A distinct classification of tree ring widths will help to conform subjective estimations. Still this classification should be kept simple and applicable to a daily use for the description of musical instruments in catalogues and documentations.
To establish those precise criteria the mean tree ring widths of all disposable sequences of the database were determined according to different types of instruments such as violins, violas, cellos, viole da gamba, basses, plucked instruments and the resonance boards of keyboard instruments. Of all this data a normal curve of distribution was set up and classified in different scopes, that were based on different classifications derived from literature, from resonance wood traders and descriptions already used in catalogues.

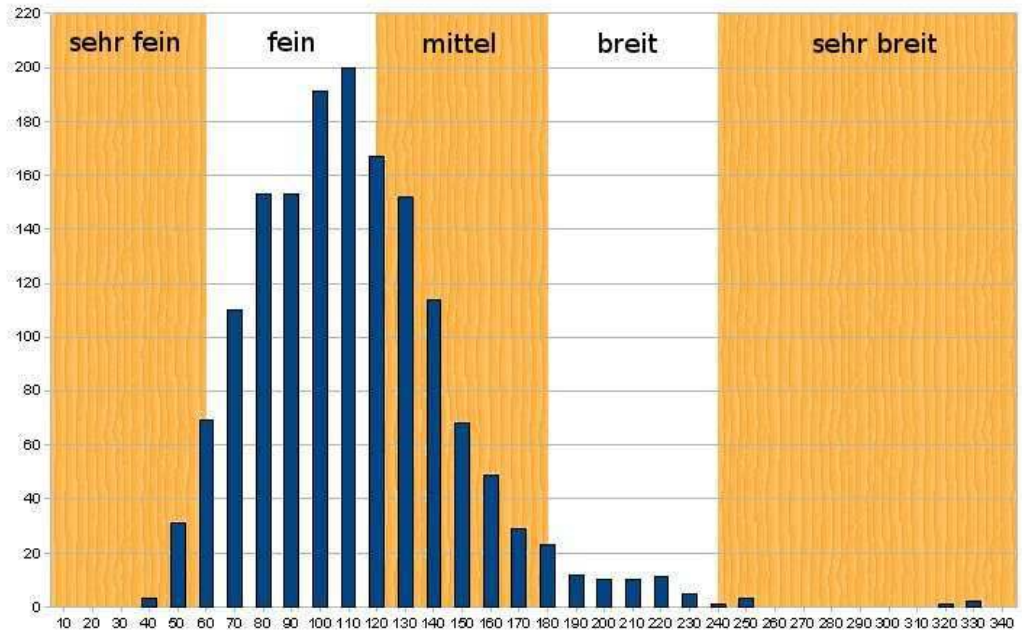

Figure 5: Normal curve distribution of tree ring widths with the different classes.

To make it easy to apply consistent intervals of 0,6 mm were chosen. The classes are named in German with an equivalent in English.

< 0,6 mm .	sehr fein	very narrow
0,6 – 1,2 mm:	fein	narrow
1,2 – 1,8 mm:	mittel	medium
1,8 – 2,4 mm	breit	wide
> 2,4 mm	sehr breit	very wide

Based on these parameters it is possible to describe the tree ring structure precisely. Possible descriptions could sound like the following:

« The one piece belly has got medium and very regular grain all over the belly » or « the bass side is narrow grained with a section of very fine grain near to the f-whole ».

More concrete on the following example of a Violoncello, S. Dallinger, Musical Instrument Museum Berlin, Stiftung Preussischer Kulturbesitz, Inv.-No. 5909 [2550104]:

For the treble and bass side of this instrument's belly a description could read as follows:

The two-part belly is made of spruce and treble and bass side match each other significantly, which may indicate that both were made from the same stem. Near to the glued joint they show a regular and narrow grained structure which stretches on for about 2/3 of each side. Over the adjacent range the ring width increases rapidly passing from medium to wide to very wide grain structure towards the outside (See Figures 6 and 7).

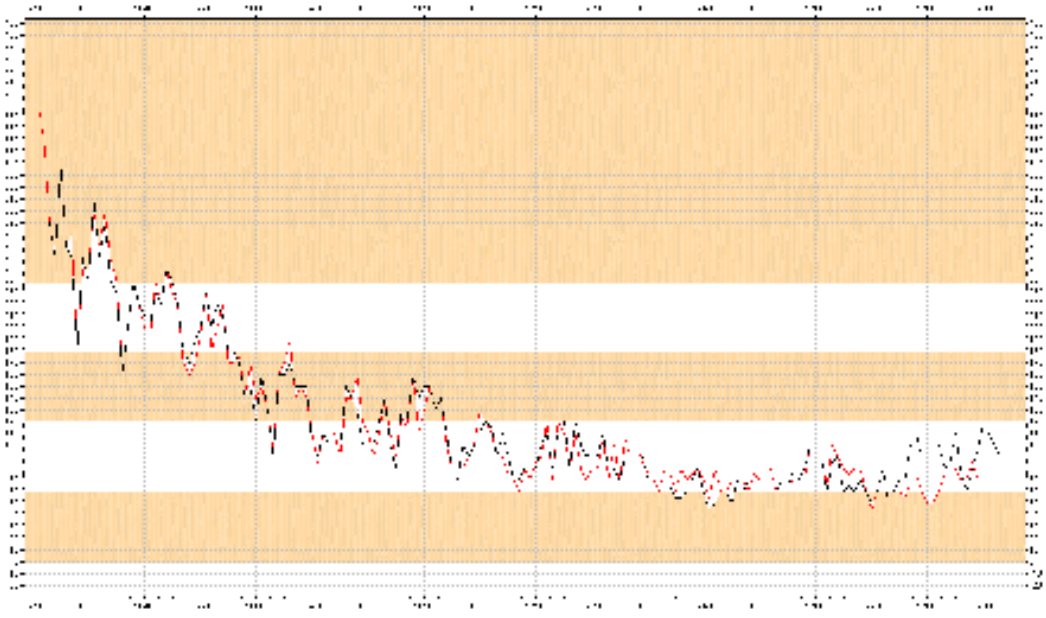

Figure 6: The sequences of the treble side (black) and the bass side of a violoncello by S. Dallinger set against each other. The different classes of tree ring widths are marked.

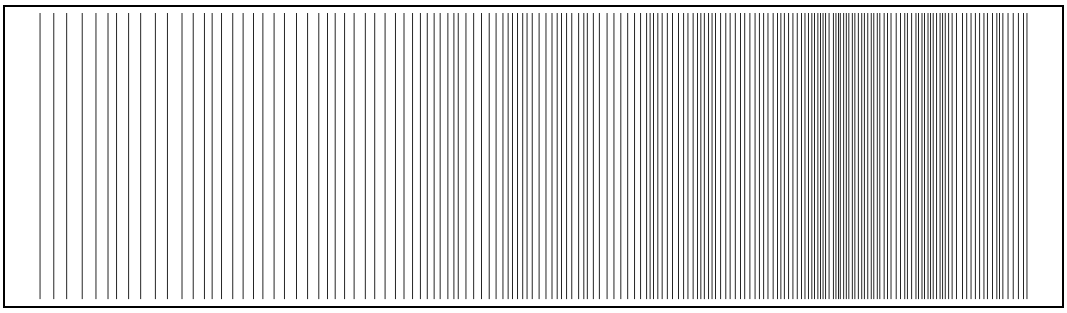

Figure 7: A grid beam showing the tree ring widths of the treble side of the violoncello by S. Dallinger.

Regarding all the aspects narrated above showing a range of additions dendrochronology may be able to provide to organology, it can be suggested that next to dendro-archeology or dendro-climatology another sub-discipline may be named as « dendro-organology ».

Bibliographic references

BEUTING, M, *Holzbiologische und dendrochronologische Untersuchungen an Tasteninstrumenten*, Diploma thesis, University of Hamburg, Fachbereich Biologie, unpublished, 2000, 138 p.

BEUTING, M., *Holzkundliche und dendrochronologische Untersuchungen an Resonanzholz als Beitrag zur Organologie*, Remagen-Oberwinter: Kessel-Verlag, 2004, 219 p.

ECKSTEIN, D.; BAUCH, J., *Beitrag zur Rationalisierung eines dendrochronologischen Verfahrens und zur Analyse seiner Aussagesicherheit*, Forstwissenschaftliches Centralblatt 88 (4), 1969, p. 230-250.

KLEIN, P.; POLLENS, S. *The Technique of Dendrochronology as Applied to Violins Made by Giuseppe Guarneri del Gesù*. In: Biddulph, P. (Hrsg.): *Giuseppe Guarneri del Gesù*, Vol. 2. London: Biddulph, 1998, p. 159-161.

SEIPEL, W. (Ed.), Jacob Stainer: «...kayserlicher diener und geigenmacher zu Absom ». Exhibition catalogue of the Art-historical museum Vienna, Mailand: Skira, 2003, 215 p.