

Tracing the origins of Stradivari's resonance wood

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ARTICLE INFO

Keywords:

Stradivari
Dendroprovenancing
Violin making
Resonance wood
Picea abies

ABSTRACT

Stradivari's violins represent the pinnacle of classical instrument making, yet the origins of the wood used to construct their soundboards have long remained unclear. By analysing 314 tree-ring series from 284 authenticated instruments, we show that the majority of soundboards were crafted from Norway spruce (*Picea abies*) that grew at very high elevations during the severe climatic conditions of the Maunder Minimum. Our data reveal that Stradivari frequently used wood from the same tree for multiple instruments and that its sources can be traced to the Eastern Alps. Comparison with 197 reference chronologies indicates that Stradivari's early work drew on diverse and less easily localised sources. During his "golden age" of production from the early eighteenth century onwards, he consistently selected spruce from high-altitude forests in Trentino, Italy, and most likely from the Val di Fiemme in particular. These findings provide the first large-scale dendrochronological evidence for the geographic and environmental origins of Stradivari's wood and offer new insights into both historical instrument making and the interplay between climate, materials, and musical heritage.

1. Introduction

The instruments made by Stradivari are renowned worldwide for their exceptional quality (Farga, 1942), and their sound and construction techniques have been studied extensively (Hill et al., 1909; Beare,

1987, 1993; Morris et al., 2024), with many investigations having explored the alleged "secrets" behind their excellence (Spinella et al., 2017; Harris, 2023). One of the many unresolved questions concerning Stradivari's work is the origin of the resonance wood used for his soundboards, despite the numerous legends surrounding this topic. One

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<https://doi.org/10.1016/j.dendro.2026.126480>

Received 4 November 2025; Received in revised form 29 December 2025; Accepted 26 January 2026

Available online 31 January 2026

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such legend, which is perhaps the most accredited (Zorzi, 1985), describes Stradivari's spruce as coming from the forests of Val di Fiemme in Trentino. However, similar legends also refer to other places both in Italy and elsewhere, including the Val Saisera forest in Friuli, Italy; the Pokljuka forest in Slovenia; and the Risoud forest in Switzerland. These legends are linked to a mythological and romantic vision of violin making, and although fascinating, they add to the confusion surrounding the origin of Stradivari's resonance wood.

Even from a strict dendrochronological perspective, the tree rings from Stradivari's instruments show peculiar properties (Cherubini, 2021). The tree-ring series obtained from the instruments generally show weak coherence when compared to reference chronologies from all over Europe (Bernabei, 2021). In contrast, correlations are very high when comparing the violins with each other, which is probably due to the frequent use of wood from the same tree trunk (Ratcliff, 2014). Consequently, the origin of Stradivari's resonance wood still remains largely unknown.

Dendroprovenancing analysis is based on the comparison of an already dated tree-ring series with a sufficiently large and spatially well-distributed number of reference chronologies (Ważny, 2005). Higher correlation values indicate that the environmental factors that influenced the tree growth were similar. Therefore, in theory, with all other factors being equal, a higher correlation value between the tree-ring series can be assumed to reflect the smaller distance between the sites at which the trees grew (Bonde et al., 1997; Bernabei and Franceschi, 2024). Environmental conditions, however, can vary considerably, even between sites that are very close to each other. Altitude, for example, is a parameter that greatly influences the correlation values between series and strongly affects dendroprovenancing results (Wilson and Hopfmueller, 2001; Wilson and Topham, 2004).

Many other factors can also influence the correlations between the tree-ring series, including site ecology, woodland population dynamics (such as competition between trees), slope exposure, substrate, anthropogenic disturbance, and the replication and reliability of the reference chronologies themselves. Notably, dendroprovenancing analysis becomes increasingly difficult as one looks further back in time because of the rapid decrease in the availability of long and well-replicated reference series. In spite of these uncertainties, establishing correlations between ring-width series remains the most effective method for dating and provenancing when the nature of the object requires absolutely non-invasive treatment (Bridge, 2012; Bernabei and Franceschi, 2025).

The aims of this study are to investigate the resonance wood that Stradivari used, to estimate the altitude and geographic origin of the source trees, and to assess how his material choices evolved over time. To address these objectives, we examine the most extensive dendrochronological dataset ever compiled for Stradivari's violins, which comprises 314 growth-ring series from 284 authenticated instruments. These data were compared with an extensive network of European reference chronologies spanning a broad latitudinal and longitudinal range—from Slovakia eastward to southern France, and from southern Germany southward to central Italy—encompassing five conifer species.

2. Material and methods

2.1. Stradivari's violins

A total of 284 Stradivari violins were considered in this study (Table 1S, Supplementary Material). Their tree-ring series were dated over recent decades by John Carass Topham (Topham and McCormick, 2000; Topham, 2002, 2003). Among these instruments, 230 soundboards are made up of two parts that are so similar that they are believed to have been made from mirrored sections obtained by splitting the same piece of wood (Bernabei, 2022). In these cases, the tree-ring series of the two halves were averaged, and only the resulting mean curve was considered representative of the instrument. There are 24 soundboards

that were made from a single piece of wood, while 30 were made from two pieces, as is customary, but the correlation between the two parts of the same instrument indicated a Student's t value that was below 6, so they were treated as two separate series. Consequently, the total number of tree-ring series analysed was 314.

2.2. Reference chronologies

The tree-ring series of the violins were compared with 197 reference chronologies, which are commonly referred to as master chronologies (Table 2S, Supplementary Material). The master chronologies originate from a geographical area from Slovakia to Southern France and from Germany to Central Italy and includes several species: Norway spruce (*Picea abies* Karst.), European larch (*Larix decidua* Mill.), silver fir (*Abies alba* Mill.), stone pine (*Pinus cembra* L.), and Scots pine (*Pinus sylvestris* L.). Although it is likely that the soundboards of the violins are made of spruce, the other species were also considered to broaden the spatial extent of the comparison and to compensate for gaps in the availability of *Picea abies* master chronologies by including additional conifer species. The complete list of contributors of the master chronologies is provided in Table 3S in the Supplementary Material.

The career of Antonio Stradivari (1644–1737) spanned the second half of the 17th century to the early decades of the 18th century. The tree-ring sequences observed in his instruments often exceed 200 rings, which makes it essential to compare these sequences with reference chronologies covering a period from approximately 1400–1740. This requirement highlights the challenge of finding sufficiently ancient, well-replicated, and geographically distributed reference chronologies for spruce in such analyses. This limitation also eliminated the possibility of *ad hoc* sampling in areas that have been historically reputed to be a source of resonance wood as it is extremely unlikely to find such old living trees. Consequently, it was necessary to rely on reference chronologies constructed primarily from historical and archaeological materials and timber sourced from ancient buildings.

The master chronologies collected in this way may present some critical issues. For instance, the exact origin of the building material is rarely known as it may have been transported over long distances (e.g. Bernabei et al., 2019). Furthermore, the sample depth varies greatly both within and between the reference chronologies. It is also important to note that the selection criteria for construction timber differ significantly from the meticulous standards applied to the selection of violin-making materials, for which defect-free wood with regular rings is highly preferred (Bernabei and Čufar, 2018; Cherubini et al., 2022). These considerations can obviously affect correlations and obscure the results of a dendroprovenancing investigation. Nevertheless, the lack of alternatives prompted us to make our comparisons with all available master chronologies while cautiously evaluating the results and their implications.

2.3. Statistical analysis

The ring-width series of each violin was visually and statistically compared with those of the other instruments and with reference chronologies according to standard methodologies that are commonly applied in the dendrochronological analysis of musical instruments (Bernabei and Čufar, 2019; Čufar et al., 2017; 2022). A substantial portion of the statistical analyses was conducted using R (R Core Team, 2024). To assess the influence of factors such as altitude on the relationship between inter-series correlations and geographical distance, raw individual tree-ring series, that have been georeferenced, were downloaded from the International Tree-Ring Data Bank (ITRDB, Guiterman et al., 2024). Norway spruce was targeted for the reference network due to its traditional use in the construction of violin soundboards. Rather than using archived detrended site chronologies, which are also available on the ITRDB platform, individual tree-ring series were chosen to consistently construct site chronologies to allow for the

evaluation of a meaningful inter-series correlation thresholds for grouping violin soundboards.

Data manipulation and plotting were performed using the tidyverse ecosystem (Wickham et al., 2019). Detrending and construction of the site chronologies were performed for dendrochronological analysis in 'dplR' (Bunn et al., 2023), and spatial analyses were performed using the 'sf' package (Pebesma and Bivand, 2023). Uniform Manifold Approximation and Projection (UMAP) was used to visualize the distribution of the individual series in the multidimensional space of the dendrochronological parameters. The exploratory multivariate analysis was performed using the R packages 'tidymodels' and 'embed'. Further processing steps were performed with a set of in-house R scripts, which are available upon request.

The Pearson correlation coefficient was used to perform pairwise comparison between the tree-ring series. Prior to comparison, the individual series were always detrended by applying the 5-year-running-average approach proposed by Baillie and Pilcher (Baillie and Pilcher, 1973). The t statistic (t_{BP}) calculated from the Pearson coefficient was chosen as a direct measure of the similarity among two series (Bernabei and Franceschi, 2025). Descriptive statistics for the violin samples and on the individual ITRDB series were calculated by using the 'rwl.stat' function of the 'dplR' package (Pebesma and Bivand, 2023). Each series was characterized by the following parameters: the mean, median, standard deviation, skewness, excess kurtosis (calculated as Pearson's kurtosis minus 3), the Gini coefficient, and first-order autocorrelation. The coefficient of variation was also calculated.

2.4. Dendroprovenance analysis

The dendroprovenance analysis consisted of several sequential steps, which began with:

- comparing the descriptive tree-ring characteristics from the violins with reference series for *P. abies* available in the ITRDB. This step helped to contextualize the technical characteristics of the wood and provided an estimate of the likely altitude of the growth sites based on parameters extracted from the violin samples.
- The violin samples were then grouped based on high dendrochronological similarity. A hierarchical iterative algorithm was used to group the individual series into a set of high-similarity groups. The algorithm can be described as a repeated application of a workflow: (a) identification of the pair of series or groups with the largest t similarity and (b) calculation of the average chronology of the pair. The grouping was stopped when the largest similarity among the elements became lower than a pre-set threshold (t_{th}). An objective threshold value ($t_{th} = 7.3$) was determined by evaluating the 0.999 quantile of the distribution of t values obtained from comparisons between individual *P. abies* tree-ring series belonging to different reference chronologies (i.e., all possible pairs formed by selecting one series from one chronology and one from another) in the ITRDB (see Table 4S in the Supplementary Material). This choice reflects the rationale of identifying a conservative upper limit for t values that may occur between unrelated chronologies, thus ensuring that only genuinely similar series are grouped together.
- The resulting groups were dendrochronologically validated while considering factors such as series length and medium- to long-term growth trends (Bernabei and Ćufar, 2018). This step identified potential anomalies or inaccuracies in the violin series, including missing rings or double-counted rings.
- The group chronologies were compared against the full set of georeferenced reference chronologies following the approach described by Bernabei and Franceschi (2024); (2025).

3. Results

Table 1 shows the main dendrochronological parameters of

Table 1

Descriptive characteristics of the tree-rings of Stradivari violins. q05: lower quantile, q95 upper quantile, med: median, stdev: standard deviation, skew: skewness, Gini: Gini coefficient, ar1: first-order autocorrelation, c var: coefficient of variation.

Parameter	q05	q95	med	mean
n (tree rings)	68.00	206.00	111.00	122.09
mean	0.52	1.43	0.95	0.95
median	0.48	1.39	0.90	0.89
stdev	0.17	0.51	0.30	0.31
skew	-0.08	1.48	0.49	0.55
Gini	0.11	0.27	0.18	0.18
ar1	0.61	0.94	0.85	0.83
c var	0.19	0.53	0.33	0.34

Stradivari violins, including the distribution of the various parameters in terms of the 5th and 95th quantiles, the median, and the mean. The table shows that the average number of growth rings in a Stradivari violin is 122, which corresponds to an average ring width of 0.95 mm.

The UMAP multivariate embedding proved useful for comparing the violin growth ring series with the complete set of series available for *P. abies* from the ITRDB, where the altitude of the series is known. This analysis took into account the six relevant dendrochronological parameters, as shown in Table 1. The results are summarized in Fig. 1, which provides insights into the likely elevation of the spruce trees used by Stradivari for the construction of violin soundboards.

The UMAP representation was used to preserve the local and global structure of the dataset. Each dot in the plot represents one tree series, with circles showing the position of the 6117 individual *P. abies* samples available in the ITRDB, which were part of studies where elevation information was available. The blue crosses highlight the positions of the set from Stradivari. ITRDB series are colour coded to indicate one of five elevation classes. The plot does not show a clear partitioning of the series in groups, while a general trend in elevation along UMAP2 is clearly visible.

Our results indicate that elevation has a more significant effect on the analyzed dendrochronological parameters than the absolute geographical location. The UMAP embedding places the violin series closer to high-altitude samples, which are well represented at the top part of the sample cloud.

Fig. 1B highlights the trend of the series mean ring-width value and coefficient of variation across the five elevation classes, which were compared with the same parameters calculated for the violins. There is a clear trend in the ITRDB dataset for both parameters, which decrease with altitude. The mean shows a straightforward decrease in growth rate with elevation, and the coefficient of variation shows a decrease that suggests a more consistent growth variability at high altitudes.

Interestingly, for both parameters, the distribution of the violin samples was comparable with or even more extreme than the one observed for ITRDB samples collected at very high altitudes. According to the internal correlation between samples in the same series, the violin samples showed a distribution in line with that of the ITRDB data (Fig. 1S in the Supplementary Material). The presence of groups with mean inter-series t_{BP} larger than 10 suggests the recurrent use of wood from the same tree (Table 2).

For reliable dendroprovenancing, it is greatly beneficial to average several individual series into coherent groups, which helps to remove sample-to-sample variability and to make the results more consistent. In the case of the violin samples, however, this step is challenging due to the absence of prior information regarding sample grouping. To address this, we adopted an untargeted strategy (see Materials and Methods) based on recursive merging of sample pairs or groups of samples that exhibit t_{BP} values that exceed a threshold. The threshold was determined empirically through analysis of the ITRDB dataset (Fig. 2S in the Supplementary Material). The results of this automatic algorithm were then visually inspected and dendrochronologically validated. At the end of

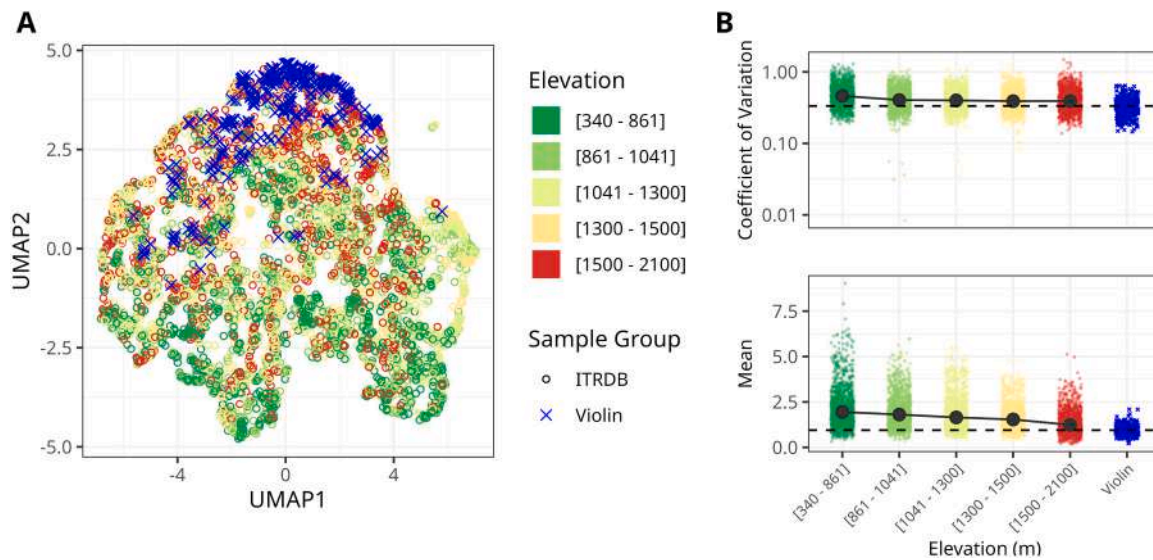


Fig. 1. Comparison of the dendrochronological parameters of the violins with the full set of *P. abies* series available at the ITRDB where the altitude of the series is known. **(A)** Bidimensional UMAP projection of the series in the multivariate space of the parameters. **(B)** Coefficient of variation and mean value of the tree-ring series. The black dots in the altitude classes highlights the median values, and the horizontal dashed line marks the median value of the violins.

Table 2
Characteristics of the 11 violin groups.

Group id	Number of tree-ring series	Median inter-series t_{BP}	First year	Last year
G4	134	5.4	1527	1723
G3	116	4.0	1431	1695
G2	24	13.1	1554	1715
G1	14	11.6	1609	1717
G10	5	7.8	1581	1697
G11	4	5.7	1624	1713
G5	4	8.1	1579	1656
G6	4	10.7	1571	1674
G7	4	8.8	1471	1651
G8	3	10.1	1634	1709
G9	2	14.4	1631	1710

the process, the 314 series were grouped into 11 distinct groups, which are shown in Fig. 2, and their individual characteristics are summarised in Table 2.

Untargeted clustering resulted in highly heterogeneous groups in terms of the number of samples. Groups G3 and G4 account for most of the violin samples (~80 %), and only four groups are composed of more than 10 samples. As can be expected, the median intragroup similarity is lower for large groups, which are expected to account for a large amount of diversity in the individual samples.

The date marked on the violin label was considered as an independent validation of the proposed approach. The label is not always

original, or the year indicated on the label cannot always be considered reliable as the actual year of manufacture of individual violins (Bernabei and Cufar, 2018), but it can be used as an approximate indication of the manufacturing period. The association between the four most represented sample groups and the date marked on the violin labels is shown as a dotplot in Fig. 3. Each dot in the figure represents a violin sample, and the pattern of the dots highlights the distribution in time of the samples belonging to each group. The most striking aspect of the figure is the clear partitioning between the samples belonging to G3 and the ones associated with G4/G1/G2. The large majority of G3 samples is indeed coming from violins which were potentially crafted before 1706, while the other three groups were almost exclusively belonging to violins of later production.

A plot showing the group level similarity is included in the Supplementary Information (Fig. 3S). Among the larger groups, G4, G1, and G2 (G4 - G1 (t_{BP} = 5.9), G4 - G2 (t_{BP} = 6.9)) appear more closely related to each other than G4 and G3 (t_{BP} = 4.1). This further suggests a partitioning between early and late violins. Importantly, no label information was used to perform the unsupervised grouping, so these results can be considered an independent validation of the proposed grouping approach.

3.1. The origin of Stradivari's wood

The average series of the 11 groups were matched with the full set of 197 reference chronologies. The top three matches for the violin groups with reference chronologies are summarized in Table 4S in the

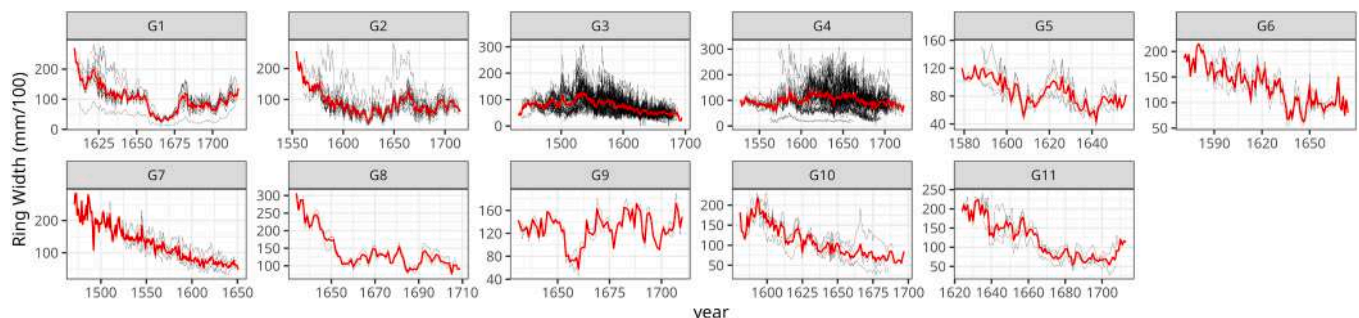


Fig. 2. Average chronologies of the 11 violin groups (Y-axis: ring width in mm/100).

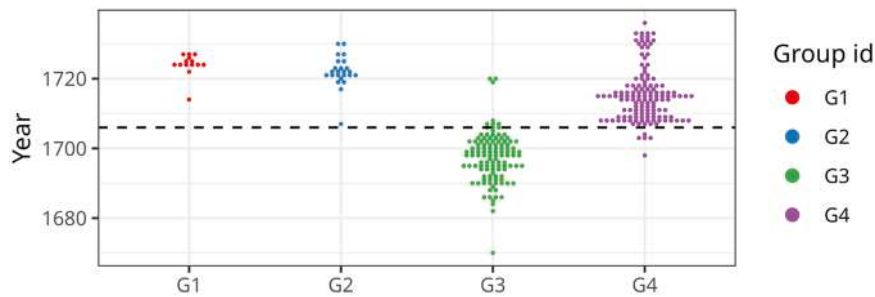


Fig. 3. Association between the year marked on the violin label and the results of the series grouping. The horizontal line highlights the year 1706. Only groups with more than 10 samples are represented.

Supplementary Material. For the four largest clusters (G1, G2, G3 and G4), matches with a t_{BP} greater than 6 were identified with reference chronologies of *Picea abies* and *Abies alba*. The two larger groups G3 and G4 showed positive matching only with *P. abies*, which is consistent with established practice in violin making. The *A. alba* masters show stronger correlations for the two smaller clusters G2 and G1. In the particular case of G1, three out of four matches were with *A. alba* (Table 4S).

To obtain an estimated dendroprovenance, the quantile regression approach introduced by Bernabei and Franceschi (2024) was applied to the Pearson correlation coefficients of the four violin groups with the master chronologies of *P. abies*. The maximum radius resulting from the correlations expressed in kilometres is included in Table 4S and illustrated in Fig. 4 for the four largest clusters.

The larger violin group G4 showed the highest confidence in dendroprovenance. High correlation was indeed found with the ITPA01 and ITPA02 master chronologies with estimated distances of 37 and 30 km, respectively. The second one is relative to the Trentino region, while the first, which shows the largest correlation value, was reconstructed from specimens collected in the Val di Fiemme forests (ITPA01, Tables 2S and 3S). The results obtained for group G3 were less definitive. The average series indeed shows a larger correlation coefficient with the Austrian master ATPA115 from the Lech region. The correlation coefficient was low, however ($corr = 0.4$, estimated $d < 306$ km), allowing only a vague estimation of the dendroprovenance.

For the smaller G2 and G1, the results were not conclusive. The matching with the master of *P. abies* produced correlation coefficients that are compatible with reasonably small distances (G2: $corr = 0.5$, estimated $d < 101$ with ATPA113, G1 $corr = 0.54$, estimated $d < 57$ with

ATPA01), but the larger matching of the two groups occurred with masters for *A. alba*. It is also important to highlight that the replication of G1 and G2 is rather small and could lead to less reliable results.

4. Discussion

Stradivari violins are distinguished by their narrow growth rings (mean value = 0.95 mm, standard deviation = 0.31 mm), which are significantly smaller than those observed in many other instruments from the classical period (Bernabei et al., 2022). Such reduced ring widths are generally indicative of trees growing under high-altitude temperature-limited conditions. This inference is supported by Fig. 1, which compares the dendrochronological parameters of Stradivari’s violins with the complete spruce dataset from the ITRDB. Even when accounting for potential environmental variables, the characteristics of the wood that Stradivari used seem to indicate that it came from altitudes even higher than those currently occupied by spruce in the Alps (Fig. 1B). We hypothesize that the formation of growth rings was influenced by the enhanced limiting factor of lower temperatures and/or low insolation, possibly associated with the Maunder Minimum (Burckle and Grissino-Mayer, 2003). This period lasted from 1645 to 1715 and was characterized by reduced solar activity, which led to a drop in global average temperatures by between 1 and 2°C, with temperatures treelines lower on a regional scale (Büntgen et al., 2006), resulting in slower tree growth rates and lower relative upper tree-line compared to the present day.

In general, all 314 series show high mutual correlation (Fig. 1S), and more than 90 show $t_{BP} > 10$ when compared with the average series of

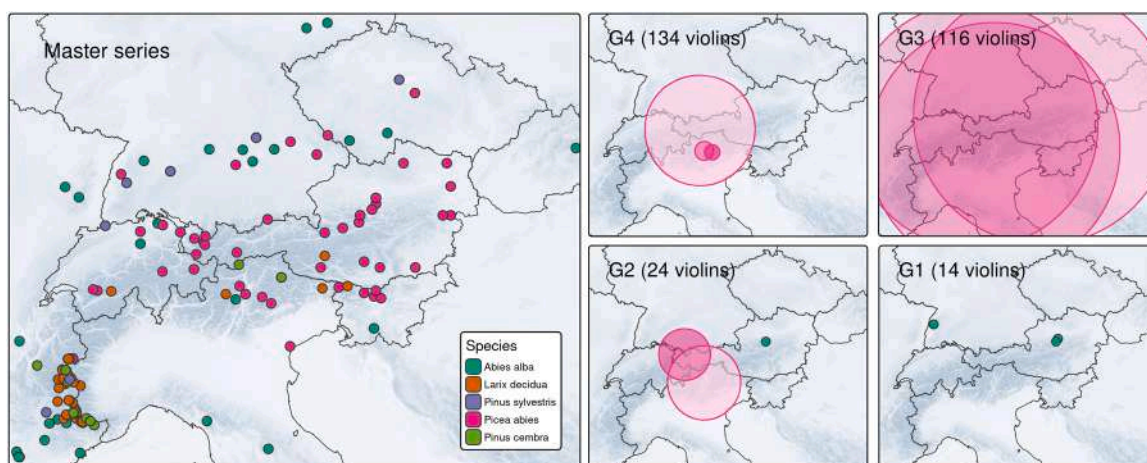


Fig. 4. The left map shows the spatial distribution of the set of the 197 reference chronologies used for cross dating. Different colours highlight the tree species. Regional references were assigned to the centroid of the area. The four maps on the right highlight the position of the three highest matches resulting from the dendroprovenancing of the larger violin groups (G1, G2, G3, and G4). The radii of the circles are proportional to the estimated distance. Additional details about the matching are presented in Table 4S. For the green dots of the silver fir masters, the distance estimate based on correlation is less consistent (Bernabei and Franceschi, 2024) and therefore the distance circle has not been represented.

all the other series. This generalised similarity has caused many difficulties in recognising wood from the same tree and in creating groups with high internal correlation. The repeated use of the same tree can be partly attributed to economic reasons, but it likely reflects a deliberate choice by the maker when he encountered wood with optimal acoustic, workability, and aesthetic properties. This hypothesis is supported by the observation of contrasting cases in which a piece of wood was used only once and then discarded, probably due to unsatisfactory performance. From a statistical perspective, there are several cases in which high Pearson correlation coefficients ($\rho > 0.9$) were found between tree-ring series associated with violins bearing label dates up to 20 years apart (see [Supplementary Fig. 4S](#)).

The two-step approach combining an automatic algorithm with dendrochronological validation led to the identification of 11 high-similarity groups. However, the vast majority of samples were concentrated in just two clusters: G3, comprising 116 samples, and G4, comprising 134 samples. Notably, the samples assigned to these two clusters also exhibit a clear chronological division based on the dates reported on the violin labels ([Fig. 3](#)). Cluster G3 comprises almost exclusively violins made before 1706, whereas G4 (along with G1 and G2) includes instruments crafted in later years. This division not only supports the validity of the clustering, which is corroborated by its alignment with the labelled production dates, but also suggests a shift in the selection of wood sources over time.

Among the 11 identified violin groups, matches with t_{BP} greater than 6 were found only for the four largest clusters (G1, G2, G3, and G4; [Table 4S](#)), and exclusively with master chronologies related to *P. abies* and *A. alba*. A relatively low t_{BP} threshold of 6 was adopted to allow for the detection of potential matches with other species, particularly in regions where reference series for spruce might be lacking. For G3 and G4, which together account for ~80 % of the samples, high correlation values were found exclusively with *P. abies* chronologies.

The situation for G1 and G2 is less clear: while *P. abies* remains a consistent match, in many cases, master chronologies for *A. alba* yielded stronger correlations. This suggests that the possible use of silver fir for soundboards in these groups cannot be entirely excluded, although G1 and G2 exhibit lower replication. Notably, the presence of silver fir in Stradivari violins has not been previously documented, although its use has been reported in other prominent violin-making traditions, such as the Tuscan school ([Bernabei et al., 2010](#); [Bernabei and Bontadi, 2011](#)). While the observed similarity between spruce and silver fir chronologies may be attributed to ecological proximity, the high correlation values between the average series of G1 and G2 and several *A. alba* chronologies, particularly Austrian ones, remain noteworthy.

For all groups, the results are consistent with a provenance of wood from the Alpine region, specifically within an area encompassing parts of Italy, Switzerland, and Austria. The accuracy of the origin determination varies considerably among groups, primarily due to differing levels of correlation with the master chronologies. As a general rule, a correlation coefficient greater than 0.5 is considered informative and corresponds to an estimated spatial precision of approximately 100 km ([Bernabei and Franceschi, 2024](#)). Because the typical overlaps observed in this study range between 150 and 200 years, this level of correlation is associated with a t_{BP} value exceeding 7.

Among all the groups, G4 exhibited the highest similarity, reaching t_{BP} values of 9.81 and 8.57 with the ITPA02 and ITPA01 master chronologies, respectively. The strongest match was with the Trentino spruce chronology (ITPA02), while the second-best match corresponded to the Val di Fiemme chronology (ITPA01), which is shorter, thus resulting in a reduced overlap with the group chronology. Although dendroprovenancing is based primarily on t_{BP} values (which account for overlap length), we note that the correlation coefficients slightly modify the relative ranking of the two Trentino chronologies, with the Val di Fiemme showing the highest r value. This secondary evidence is consistent with a dendroprovenancing radius of approximately 30 km and further supports the attribution to the eastern Trentino region,

particularly the area surrounding the Val di Fiemme forest.

Unlike the observations for G4, the dendrochronological match for G3 is less informative. The correlation is below 0.5 for ATPA115, an Austrian master chronology from the Lech region, and as such, this result cannot support more than a vague provenance determination. As discussed by [Bernabei and Franceschi \(2014\)](#), low correlation values can also occur at short geographic distances, making the results for this group largely inconclusive. Additional evidence, however, highlights the peculiar nature of G3. First, it shows limited overlap with the entire set of master chronologies, with only one match with a t_{BP} value greater than 6, as shown in [Fig. 3S](#). Furthermore, it exhibits the lowest median internal similarity ($t_{BP} = 4.0$), as well as weak similarity with G4 ($t_{BP} = 2.2$). Notably, group G3 encompasses the overwhelming majority of samples associated with violins manufactured prior to 1706. As discussed above, this observation suggests a significant change in Stradivari's wood-procurement strategy after 1706, with a transition towards sourcing timber from the Val di Fiemme forests.

Three principal phases are usually recognized in the production of Antonio Stradivari's instruments, and each one is distinguished by specific constructional and artistic characteristics ([Beare, 1987](#); [Morris and Smith, 2024](#)). The "early period" (c. 1666–1680) is marked by instruments modelled after those of Nicola Amati, featuring smaller dimensions, refined craftsmanship, and an emerging acoustic quality that has not yet fully matured. The "transition period" (c. 1680–1700) is characterized by increased experimentation, with larger instrument dimensions and a noticeable enhancement in tonal quality. The "golden age" (around 1700–1725) represents the peak of Stradivari's production, when he crafted instruments of remarkable formal and acoustic excellence with luminous varnishes.

This was followed by a late period (1725–1737), during which there was a gradual decline in production and a potential decrease in overall quality, although several instruments from this phase still display exceptional characteristics. The transition from group G3 to group G4 ([Fig. 3](#)) coincides with Stradivari's transition from his experimental phase to his period of maturity. Around 1700, Stradivari seems to have stopped using wood from mixed or variable sources and instead identified an optimal source in the high-altitude forests of eastern Trentino, most likely in the Val di Fiemme area, with only a few sporadic exceptions later occurring northward, as suggested by the correlations of groups G1 and G2 with Austrian reference chronologies ([Table 4S](#), [Supplementary Material](#)).

5. Conclusions

Numerous legends surround Stradivari's violins, which are often rooted in a mythologized perception of the luthier. This study represents the most comprehensive dendrochronological investigation ever conducted on Stradivari's violin production. The results revealed frequent use of wood that was from the same trunk, from high-altitude sites, and subject to an enhanced growth-limiting factor, which was probably related to low temperatures as a consequence of the Maunder Minimum. The vast majority of the material was traced back to the Eastern Alps and adjacent Central European regions. The identification of groups with high internal similarity suggests that around the early 1700 s, Stradivari ceased using materials of mixed provenance and began to favour wood sourced from high-altitude forests in the Val di Fiemme area. This result supports the well-documented qualitative evolution of Stradivari's craftsmanship, which reached its peak known as the "golden period" in the early 18th century.

CRediT authorship contribution statement

Nicola La Porta: Writing – review & editing, Data curation. **Frédéric Guibal:** Writing – review & editing, Data curation. **Michael Grabner:** Writing – review & editing, Data curation. **Katarina Čufar:** Writing – review & editing, Data curation. **Pietro Franceschi:** Writing – review &

editing, Writing – original draft, Validation, Supervision, Software, Methodology, Investigation, Formal analysis, Data curation. **Bernabei Mauro:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Klaus Pfeifer:** Writing – review & editing, Validation, Data curation. **Olivia Pignatelli:** Writing – review & editing, Data curation. **Nicoletta Martinelli:** Writing – review & editing, Data curation. **Paolo Cherubini:** Writing – review & editing, Data curation. **Rob Wilson:** Writing – review & editing, Data curation, Conceptualization. **Marco Carrer:** Writing – review & editing, Data curation. **John Carass Topham:** Writing – review & editing, Data curation, Conceptualization. **Ulf Büntgen:** Writing – review & editing, Data curation. **Willy Tegel:** Writing – review & editing, Data curation. **Ilaria Stefani:** Writing – review & editing, Investigation, Data curation. **Andrea Seim:** Writing – review & editing, Data curation.

Declaration of Competing Interest

The authors declare that they have no competing financial interests or personal relationships that could influence the work reported in this paper.

Acknowledgement

The authors thank Jean Louis Édouard, Vincent Labbas, Mélanie Saulnier, Lisa Shindo, and Chiara Torresan for providing reference series and continuous insights. Co-author John Carass Topham (8 April 1951 – 9 January 2025) passed away prior to the publication of this manuscript, and this work is dedicated to his memory. He was a pioneer in the dendrochronological study of musical instruments and provided all the data on Stradivari violins that he had collected during his lifetime for this study.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.dendro.2026.126480](https://doi.org/10.1016/j.dendro.2026.126480).

Data availability

Data will be made available on request.

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Table 1S. 314 mean and individual sequences representing 284 Stradivari violins. **No.** is the progressive number of the instruments; **Designation** the code of the tree-ring sequences; **Instr. date** the date on the label; **Series** indicates mean or individual sequences; **Dendro Dates** are the first and last years of the tree-ring sequence as identified through dendrochronology.

No.	Designation	Name	Instr. date	Series	Dendro Dates
1	Vn1666_01	Sachs *	1666	Mean	1638 - 1710
2	Vn1666_02	Serdet	1666	Mean	1572 - 1657
3	Vn1666_03	- *	1666	Mean	1637 - 1708
4	Vn1666_04	Ashby	1666	Mean	1572 - 1653
5	Vn1666_05	-	1666	Mean	1524 - 1640
6	Vn1667_01	Debois	1667	Mean	1545 - 1654
7	Vn1667_02	Aranyi	1667	One piece front	1465 - 1650
8	Vn1670_01	-	1670	Mean	1476 - 1658
9	Vn1670_02	Amatise	1670	Mean	1581 - 1667
10	Vn1677_01	Sunrise	1677	One piece front	1502 - 1651
11	Vn1679_01	-	1679	Mean	1544 - 1654
12	Vn1680_01	- *	1680	Mean	1632 - 1709
13	Vn1680_02	Reichardt *	1680	Mean	1634 - 1704
14	Vn1682_01	-	1682	Mean	1452 - 1669
15	Vn1683_01	Amatise, De Ahna	1683	Mean	1588 - 1667
16	Vn1683_02	Arma Senkrah	1683	Mean	1571 - 1658
17	Vn1684_01	Florentiner, Becker	1684	One piece front	1467 - 1661
18	Vn1685_01	-	1685	Mean	1510 - 1659
19	Vn1686_01	Nachez	1686	One piece front	1459 - 1665
20	Vn1686_02	Golden Bell	1686	One piece front	1471 - 1649
21	Vn1686_03	Guyot	1686	Mean	1529 - 1682
22	Vn1686_04	Clark	1686	One piece front	1458 - 1674
23	Vn1686_05	Ex Rosenheim	1686	Mean	1585 - 1674
24	Vn1686_06	Becker-Florent	1686	One piece front	1467 - 1660
25	Vn1687_01	Bertier, Kubelick *	1687	Mean	1631 - 1710
26	Vn1688_01	Mercury, Avery	1688	Bass	1525 - 1675
	Vn1688_02			Treble	1553 - 1682
27	Vn1689_01	Arditi	1689	Mean	1529 - 1675
28	Vn1690_01	Lord Nelson	1690	Bass	1551 - 1684
	Vn1690_02			Treble	1557 - 1679
29	Vn1690_03	Theodor	1690	Bass	1546 - 1678
	Vn1690_04			Treble	1539 - 1680
30	Vn1690_05	-	1690	Mean	1511 - 1674
31	Vn1690_06	-	1690	Mean	1533 - 1666
32	Vn1690_07	Ex-Stephens	1690	One piece front	1464 - 1636
33	Vn1690_08	Bennett	1690	One piece front	1437 - 1669
34	Vn1691_01	Red Cross Knight	1691	Bass	1453 - 1672
	Vn1691_02			Treble	1478 - 1669
35	Vn1691_03	Auer	1691	Mean	1458 - 1668
36	Vn1691_04	Francesca-Ginn	1691	Mean	1528 - 1674
37	Vn1692_01	Falmouth	1692	One piece front	1440 - 1667
38	Vn1692_02	-	1692	One piece front	1444 - 1679
39	Vn1692_03	Oliveira	1692	Mean	1482 - 1686
40	Vn1692_04	Goetz	1692	Mean	1458 - 1671
41	Vn1693_01	Harrison	1693	Mean	1530 - 1677
42	Vn1694_01	Queux St Hilaire	1694	Mean	1554 - 1681
43	Vn1694_02	Rutson	1694	Mean	1564 - 1679
44	Vn1694_03	Muir-Mackenzie	1694	Mean	1523 - 1680
45	Vn1694_04	Lady Margaret Bonvalot	1694	One piece front	1453 - 1641
46	Vn1694_05	Benecke	1694	Mean	1531 - 1683
47	Vn1695_01	Scheck	1695	Bass	1486 - 1608
	Vn1695_02			Treble	1455 - 1575
48	Vn1695_03	-	1695	One piece front	1476 - 1667
49	Vn1695_04	-	1695	Mean	1458 - 1607
50	Vn1695_05	-	1695	One piece front	1476 - 1666
51	Vn1695_06	Goetz	1695	Mean	1458 - 1674
52	Vn1695_07	Salomon	1695	Mean	1470 - 1676
53	Vn1695_08	Sandars	1695	Mean	1525 - 1684
54	Vn1695_09	-	1695	Mean	1455 - 1608
55	Vn1695_10	Montbel	1695	Bass	1541 - 1643
	Vn1695_11			Treble	1442 - 1534

56	Vn1696_01	Amici Bernardi, ex Kim	1696	Mean	1522	-	1586
57	Vn1696_02	Muirhead	1696	One piece front	1473	-	1654
58	Vn1696_03	Steinthal	1696	One piece front	1498	-	1675
59	Vn1696_04	Cabriac	1696	Mean	1542	-	1679
60	Vn1696_05	-	1696	Mean	1479	-	1670
61	Vn1697_01	Molitor	1697	Bass	1533	-	1680
	Vn1697_02			Treble	1523	-	1640
62	Vn1698_01	Lark	1698	Mean	1555	-	1684
63	Vn1698_02	Thulow *	1698	Mean	1629	-	1712
64	Vn1698_03	Ida Haendel	1698	Mean	1529	-	1686
65	Vn1698_04	Joachim	1698	Bass	1474	-	1562
	Vn1698_05			Treble	1567	-	1662
66	Vn1698_06	Ries	1698	Mean	1530	-	1682
67	Vn1698_07	Ex Rouse-Broughton	1698	Mean	1480	-	1684
68	Vn1698_08	Baron Knoop	1698	Mean	1498	-	1667
69	Vn1698_09	Theonville	1698	Mean	1562	-	1681
70	Vn1698_10	Lafont	1698	Bass	1500	-	1668
	Vn1698_11			Treble	1476	-	1681
71	Vn1699_01	-	1699	Mean	1542	-	1682
72	Vn1699_02	Ex-Crespi	1699	Mean	1527	-	1679
73	Vn1699_03	-	1699	Mean	1538	-	1674
74	Vn1699_04	-	1699	Mean	1479	-	1650
75	Vn1699_05	Kustendyke	1699	Mean	1484	-	1670
76	Vn1699_06	Lady Tennant	1699	Mean	1529	-	1684
77	Vn1699_07	Castelbarco	1699	Mean	1519	-	1681
78	Vn1699_08	Penny	1699	Mean	1506	-	1649
79	Vn1699_09	St. Vallier	1699	One piece front	1431	-	1669
80	Vn1699_10	Heberlein	1699	Mean	1573	-	1682
81	Vn1700_01	-	1700	Mean	1553	-	1684
82	Vn1700_02	-	1700	Mean	1498	-	1681
83	Vn1700_03	Jupiter	1700	Mean	1522	-	1683
84	Vn1700_04	Ward	1700	Mean	1568	-	1679
85	Vn1700_05	Dushkin	1700	Bass	1545	-	1670
	Vn1700_06			Treble	1518	-	1676
86	Vn1700_07	Petri	1700	Bass	1553	-	1683
	Vn1700_08			Treble	1498	-	1680
87	Vn1701_01	Van Houten	1701	Bass	1538	-	1679
	Vn1701_02			Treble	1547	-	1676
88	Vn1701_03	Marquise	1701	Mean	1521	-	1680
89	Vn1701_04	Markees	1701	Mean	1521	-	1681
90	Vn1701_05	Circle	1701	Mean	1525	-	1678
91	Vn1701_06	Ex-Brodsky	1701	One piece front	1474	-	1685
92	Vn1702_01	De la Taille	1702	Bass	1563	-	1687
	Vn1702_02			Treble	1584	-	1685
93	Vn1702_03	Irish	1702	One piece front	1476	-	1685
94	Vn1702_04	Lady Harmsworth	1702	One piece front	1447	-	1622
95	Vn1702_05	Conte de Fontana	1702	One piece front	1475	-	1685
96	Vn1702_06	Lukens	1702	Mean	1524	-	1689
97	Vn1702_07	Maximilian	1702	One piece front	1481	-	1668
98	Vn1702_08	Phillips	1702	Mean	1459	-	1674
99	Vn1702_09	Ex-Thunis	1702	Mean	1526	-	1686
100	Vn1703_01	Dancla	1703	Mean	1504	-	1678
101	Vn1703_02	Ford	1703	Mean	1548	-	1679
102	Vn1703_03	Foulis Cohen	1703	Mean	1531	-	1691
103	Vn1703_04	Gibson Cobbett Kontra	1703	One piece front	1432	-	1678
104	Vn1703_05	-	1703	One piece front	1467	-	1672
105	Vn1703_06	Prince Frederick	1703	Mean	1534	-	1675
106	Vn1703_07	-	1703	Mean	1531	-	1684
107	Vn1703_08	-	1703	Mean	1598	-	1699
108	Vn1703_09	Betts	1703	Mean	1565	-	1681
109	Vn1704_01	Sleeping Beauty 1	1704	Bass	1571	-	1688
	Vn1704_02			Treble	1571	-	1676
110	Vn1704_03	Liebig	1704	Mean	1516	-	1668
111	Vn1704_04	Sammons	1704	Mean	1484	-	1681

112	Vn1704_05	Corbett	1704	Mean	1539	-	1694
113	Vn1704_06	Viotti	1704	Mean	1505	-	1630
114	Vn1705_01	-	1705	Mean	1523	-	1680
115	Vn1706_01	Claveness	1706	Bass	1523	-	1683
	Vn1706_02			Treble	1565	-	1681
116	Vn1706_03	Russian Tretyakov	1706	Mean	1507	-	1625
117	Vn1707_01	Cathedral	1707	Mean	1590	-	1692
118	Vn1707_02	Dushkin Bellarosa	1707	Mean	1597	-	1694
119	Vn1707_03	Rivaz Baron Gutman	1707	Mean	1590	-	1696
120	Vn1707_04	Stella Omobono	1707	Bass	1559	-	1675
	Vn1707_05			Treble	1572	-	1685
121	Vn1707_06	Zubov	1707	Mean	1597	-	1700
122	Vn1707_07	-	1707	Mean	1541	-	1694
123	Vn1707_08	Hammer	1707	Mean	1584	-	1701
124	Vn1707_09	Brüstlein	1707	Mean	1503	-	1622
125	Vn1708_01	Dancla 2	1708	Mean	1537	-	1690
126	Vn1708_02	Ruby	1708	Bass	1530	-	1677
	Vn1708_03			Treble	1542	-	1697
127	Vn1708_04	Straus Soil	1708	Bass	1597	-	1697
	Vn1708_05			Treble	1543	-	1695
128	Vn1708_06	Txinca	1708	Mean	1540	-	1676
129	Vn1708_07	Davidoff	1708	Mean	1569	-	1687
130	Vn1708_08	Tua	1708	Mean	1571	-	1698
131	Vn1708_09	Ex-Regent	1708	Mean	1591	-	1697
132	Vn1708_10	-	1708	Mean	1593	-	1700
133	Vn1708_11	-	1708	Mean	1533	-	1686
134	Vn1708_12	Havemeyer	1708	Mean	1554	-	1699
135	Vn1708_13	Andrejeus	1708	Mean	1595	-	1698
136	Vn1708_14	Empress Caterina	1708	Bass	1612	-	1703
	Vn1708_15			Treble	1599	-	1702
137	Vn1708_16	Marchesa	1708	Mean	1593	-	1701
138	Vn1708_17	Greffuhle	1708	Mean	1534	-	1686
139	Vn1709_01	Artot	1709	Mean	1592	-	1699
140	Vn1709_02	Craford Composite *	1709	Bass	1624	-	1703
	Vn1709_03			Treble	1624	-	1708
141	Vn1709_04	Mond Tua	1709	Mean	1597	-	1703
142	Vn1709_05	Ernst	1709	Mean	1563	-	1659
143	Vn1709_06	Maiden	1709	Mean	1561	-	1663
144	Vn1709_07	La Pucelle	1709	Mean	1547	-	1693
145	Vn1709_08	-	1709	Mean	1592	-	1699
146	Vn1709_09	Viotti	1709	Mean	1534	-	1695
147	Vn1709_10	Ex Hammerle, Ex Adler	1709	Mean	1591	-	1700
148	Vn1709_11	Kempner	1709	Mean	1527	-	1686
149	Vn1709_12	Tate	1709	Mean	1570	-	1688
150	Vn1710_01	Campo Selice	1710	Bass	1601	-	1688
	Vn1710_02			Treble	1605	-	1684
151	Vn1710_03	Leslie Tate	1710	Mean	1573	-	1672
152	Vn1710_04	Kreisler	1710	Mean	1609	-	1703
153	Vn1711_01	Parke	1711	Mean	1610	-	1704
154	Vn1711_02	-	1711	Mean	1609	-	1703
155	Vn1711_03	-	1711	Mean	1550	-	1683
156	Vn1711_04	Lady Ichijun	1711	Bass	1537	-	1678
	Vn1711_05			Treble	1594	-	1698
157	Vn1711_06	Schreiber	1711	Mean	1608	-	1704
158	Vn1711_07	Vogelweith	1711	Mean	1609	-	1704
159	Vn1711_08	-	1711	Mean	1640	-	1706
160	Vn1712_01	Fontaine	1712	Mean	1642	-	1702
161	Vn1712_02	Le Brun	1712	Mean	1606	-	1705
162	Vn1712_03	Da Vinci	1712	Mean	1610	-	1693
163	Vn1712_04	Gibson-Huberman	1712	Mean	1600	-	1706
164	Vn1713_01	Baron d'Assignies	1713	Mean	1604	-	1702
165	Vn1713_02	Wirth	1713	Mean	1598	-	1704
166	Vn1713_03	Pingrille	1713	Mean	1605	-	1703
167	Vn1713_04	Boissier-Sarasate	1713	Mean	1597	-	1705

168	Vn1714_01	Dolphin	1714	Mean	1610	-	1704
169	Vn1714_02	General Kyd	1714	Mean	1606	-	1700
170	Vn1714_03	Langbein	1714	Mean	1611	-	1704
171	Vn1714_04	- *	1714	Mean	1615	-	1714
172	Vn1714_05	Leonora Jackson	1714	Mean	1613	-	1689
173	Vn1714_06	Joachim Ma	1714	Mean	1608	-	1687
174	Vn1714_07	Joachim	1714	Mean	1607	-	1699
175	Vn1714_08	Cremonese	1714	Mean	1609	-	1703
176	Vn1714_09	Da Vinci	1714	Mean	1610	-	1693
177	Vn1714_10	-	1714	Mean	1607	-	1695
178	Vn1715_01	Earl Spencer	1715	Mean	1625	-	1704
179	Vn1715_02	Camilloni	1715	Mean	1600	-	1699
180	Vn1715_03	Marsik	1715	Mean	1612	-	1703
181	Vn1715_04	Ex Prové	1715	Mean	1632	-	1683
182	Vn1715_05	-	1715	Mean	1610	-	1702
183	Vn1715_06	Baron Knoop	1715	Mean	1623	-	1701
184	Vn1715_07	-	1715	Mean	1627	-	1705
185	Vn1715_08	Ex De Barrou	1715	Mean	1599	-	1699
186	Vn1715_09	-	1715	Mean	1635	-	1705
187	Vn1715_10	Tartini *	1715	Mean	1640	-	1719
188	Vn1715_11	Alard	1715	Bass	1615	-	1703
	Vn1715_12			Treble	1629	-	1699
189	Vn1715_13	Aurea	1715	Mean	1630	-	1706
190	Vn1715_14	Schneiderhan	1715	Mean	1633	-	1705
191	Vn1715_15	Wittgenstein	1715	Bass	1623	-	1704
	Vn1715_16			Treble	1607	-	1704
192	Vn1715_17	Rode	1715	Mean	1623	-	1696
193	Vn1716_01	Messiah	1716	Mean	1581	-	1682
194	Vn1716_02	Milstein	1716	Mean	1639	-	1706
195	Vn1716_03	Provigny	1716	Mean	1610	-	1699
196	Vn1716_04	Booth	1716	Mean	1630	-	1704
197	Vn1716_05	-	1716	Mean	1625	-	1703
198	Vn1716_06	de Duranty	1716	Mean	1618	-	1703
199	Vn1716_07	Medici	1716	Bass	1607	-	1674
	Vn1716_08			Treble	1606	-	1673
200	Vn1716_09	Cessol	1716	Mean	1575	-	1694
201	Vn1716_10	Ex Baron Oppenheim	1716	Bass	1632	-	1707
	Vn1716_11			Treble	1642	-	1706
202	Vn1716_12	Baumgartner	1716	Mean	1626	-	1712
203	Vn1717_01	Sasserno	1717	Bass	1585	-	1665
	Vn1717_02			Treble	1597	-	1686
204	Vn1717_03	Park	1717	Mean	1591	-	1689
205	Vn1717_04	Kochanski	1717	Mean	1574	-	1714
206	Vn1717_05	Tyrrell	1717	Mean	1627	-	1705
207	Vn1717_06	-	1717	Mean	1586	-	1697
208	Vn1717_07	Reiffenberg	1717	Mean	1627	-	1701
209	Vn1717_08	Bower	1717	Mean	1534	-	1686
210	Vn1717_09	Ex Piatti	1717	Mean	1623	-	1704
211	Vn1718_01	Hamma	1718	Mean	1613	-	1702
212	Vn1718_02	Szekely	1718	Mean	1608	-	1704
213	Vn1718_03	Salvatori Accardo	1718	Mean	1625	-	1707
214	Vn1718_04	Ex Viotti, Ex Arnol Rose	1718	Mean	1609	-	1695
215	Vn1718_05	Prové	1718	Bass	1627	-	1687
	Vn1718_06			Treble	1642	-	1695
216	Vn1718_07	Malboro	1718	Mean	1629	-	1682
217	Vn1719_01	Alba Herzog	1719	Mean	1586	-	1706
218	Vn1719_02	-	1719	Mean	1632	-	1709
219	Vn1719_03	Bavarian	1719	Mean	1535	-	1684
220	Vn1719_04	-	1719	Mean	1569	-	1713
221	Vn1720_01	Ex Beckerath	1720	Bass	1624	-	1682
	Vn1720_02			Treble	1630	-	1692
222	Vn1720_03	Rochester	1720	Mean	1531	-	1678
223	Vn1720_04	-	1720	Mean	1632	-	1711
224	Vn1720_05	L'Eveque	1720	Mean	1534	-	1682
225	Vn1720_06	Mendelssohn	1720	Mean	1628	-	1704

226	Vn1720_07	Joseph Suk	1720	Mean	1575	-	1714
227	Vn1721_01	-	1721	Mean	1578	-	1710
228	Vn1721_02	-	1721	Mean	1578	-	1708
229	Vn1721_03	-	1721	Mean	1597	-	1709
230	Vn1721_04	Prof Lutz 1	1721	Mean	1598	-	1702
231	Vn1721_05	Archinto	1721	Mean	1625	-	1711
232	Vn1721_06	Lady Blunt	1721	Mean	1569	-	1707
233	Vn1721_07	Violin 298	1721	Mean	1615	-	1705
234	Vn1721_08	Rode	1721	Mean	1581	-	1715
235	Vn1722_01	-	1722	Mean	1563	-	1694
236	Vn1722_02	Conte de Chaponay	1722	Mean	1572	-	1713
237	Vn1722_03	Duke of Edinburgh	1722	Mean	1612	-	1715
238	Vn1722_04	Vollrath	1722	Mean	1569	-	1710
239	Vn1722_05	Cassavetti	1722	Mean	1634	-	1713
240	Vn1722_06	Wilmotte	1722	Mean	1625	-	1708
241	Vn1722_07	Wilhelmj-Barlett	1722	Mean	1575	-	1714
242	Vn1723_01	-	1723	Mean	1554	-	1693
243	Vn1723_02	-	1723	Mean	1560	-	1712
244	Vn1723_03	Emiliani	1723	Mean	1577	-	1713
245	Vn1723_04	Ludwig	1723	Mean	1638	-	1711
246	Vn1724_01	Sarasate	1724	Mean	1610	-	1713
247	Vn1724_02	-	1724	Mean	1615	-	1714
248	Vn1724_03	-	1724	Mean	1612	-	1716
249	Vn1724_04	Abergavenny	1724	Mean	1615	-	1715
250	Vn1724_05	Ex Rawark	1724	Mean	1579	-	1688
251	Vn1724_06	Paganini	1724	Mean	1630	-	1713
252	Vn1724_07	Bott	1724	Bass	1619	-	1713
	Vn1724_08			Treble	1625	-	1715
253	Vn1725_01	Da Vinci 2	1725	Mean	1571	-	1714
254	Vn1725_02	Chacone	1725	Mean	1609	-	1715
255	Vn1725_03	Koeber	1725	Mean	1613	-	1717
256	Vn1725_04	Barrere	1725	Mean	1575	-	1713
257	Vn1726_01	-	1726	Mean	1621	-	1717
258	Vn1726_02	Sleeping Beauty	1726	Mean	1626	-	1721
259	Vn1727_01	Plotenyi	1727	Mean	1621	-	1716
260	Vn1727_02	Cassavetti	1727	Mean	1635	-	1702
261	Vn1727_03	Vesuvius	1727	Mean	1561	-	1710
262	Vn1727_04	di Barbaro	1727	Mean	1573	-	1706
263	Vn1727_05	Deurbroucq	1727	Mean	1638	-	1713
264	Vn1727_06	Benvenuti	1727	Mean	1622	-	1718
265	Vn1727_07	Holroyd	1727	Mean	1610	-	1714
266	Vn1727_08	-	1727	Mean	1616	-	1717
267	Vn1729_01	Loder	1729	Mean	1629	-	1722
268	Vn1729_02	Lady Jeanne	1729	Mean	1610	-	1723
269	Vn1730_01	-	1730	Mean	1615	-	1702
270	Vn1730_02	-	1730	Mean	1578	-	1695
271	Vn1730_03	Prof. Lutz 2	1730	Mean	1578	-	1694
272	Vn1730_04	-	1730	Mean	1634	-	1700
273	Vn1730_05	-	1730	Mean	1634	-	1697
274	Vn1731_01	Tartini	1731	Mean	1640	-	1720
275	Vn1731_02	Kreutzer	1731	Mean	1632	-	1719
276	Vn1731_03	Briselli	1731	Mean	1624	-	1704
277	Vn1731_04	-	1731	Mean	1617	-	1716
278	Vn1732_01	Baillot	1732	Mean	1624	-	1704
279	Vn1732_02	Segelman	1732	Mean	1637	-	1722
280	Vn1733_01	Hamma	1733	Mean	1641	-	1722
281	Vn1733_02	Menuhin	1733	Mean	1637	-	1705
282	Vn1733_03	Sassoon	1733	Mean	1637	-	1721
283	Vn1733_04	Fritz-Kreisler	1733	Mean	1640	-	1719
284	Vn1736_01	Muntz	1736	Mean	1636	-	1716

* indicates late dates compared to label date or attributed date of instrument's manufacture.

Table 2S. The reference chronologies used in this study. **Start:** starting year, **End:** ending year, **Length:** number of rings. For data contributors see Table 3S.

No.	Code	Country	Species	Region	Data contributor	Start	End	Length
1	ATAA01	Austria	Abies alba	Alps	s	1400	1700	301
2	ATAA02	Austria	Abies alba	Alpine Northern Rim	s	1400	1700	301
3	ATAA03	Austria	Abies alba	Austria	s	1400	1700	301
4	ATAA04	Austria	Abies alba	Northern foothills of the Alps	s	1400	1700	301
5	ATAA06	Austria	Abies alba	Burgenland	s	1507	1700	301
6	ATAA07	Austria	Abies alba	Limestone Alps	s	1421	1700	272
7	ATAA11	Austria	Abies alba	Southeastern Austria	s	1549	1700	245
8	ATAA12	Austria	Abies alba	Eastern Austria	s	1400	1700	301
9	ATAA13	Austria	Abies alba	Salzburg	s	1400	1700	301
10	ATAA16	Austria	Abies alba	Waldviertel	s	1400	1700	301
11	ATAA19	Austria	Abies alba	Weinviertel	s	1666	1700	301
12	ATLD01	Austria	Larix decidua	Alps	s	1400	1700	301
13	ATLD02	Austria	Larix decidua	Alpine Northern Rim	s	1400	1700	301
14	ATLD07	Austria	Larix decidua	Limestone Alps	s	1421	1700	60
15	ATLD08	Austria	Larix decidua	Carinthia	s	1617	1700	84
16	ATLD09	Austria	Larix decidua	Nockberge	s	1400	1700	301
17	ATLD15	Austria	Larix decidua	Dachstein	s	1400	1700	301
18	ATPA01	Austria	Picea abies	Alps	s	1400	1700	301
19	ATPA02	Austria	Picea abies	Alpine Northern rim	s	1400	1700	301
20	ATPA03	Austria	Picea abies	Austria	s	1400	1700	301
21	ATPA04	Austria	Picea abies	Northern foothills of the Alps	s	1400	1700	301
22	ATPA05	Austria	Picea abies	Southern foothills of the Alps	s	1400	1700	301
23	ATPA06	Austria	Picea abies	Burgenland	s	1507	1700	194
24	ATPA07	Austria	Picea abies	Limestone Alps	s	1421	1700	280
25	ATPA09	Austria	Picea abies	Nockberge	s	1400	1700	301
26	ATPA10	Austria	Picea abies	Western Carinthia	s	1583	1700	118
27	ATPA11	Austria	Picea abies	Southeastern Austria	s	1549	1700	152
28	ATPA12	Austria	Picea abies	Eastern Austria	s	1400	1700	301
29	ATPA13	Austria	Picea abies	Salzburg	s	1400	1700	301
30	ATPA14	Austria	Picea abies	Southeastern Austria	s	1400	1700	301
31	ATPA15	Austria	Picea abies	Dachstein	s	1400	1700	301
32	ATPA16	Austria	Picea abies	Waldviertel	s	1400	1700	301
33	ATPA17	Austria	Picea abies	Vienna Alps	s	1400	1700	290
34	ATPA18	Austria	Picea abies	Vienna Northern Foothills	s	1400	1700	301
35	ATPA19	Austria	Picea abies	Weinviertel	s	1666	1700	35
36	ATPA20	Austria	Picea abies	Vienna Eastern Austria	s	1549	1700	263
37	ATPA21	Austria	Picea abies	Vienna Salzburg	s	1400	1700	256
38	ATPA22	Austria	Picea abies	Vienna Southeastern Austria	s	1400	1700	198
39	BECK-GS	Germany	Abies alba	Bavarian Forest	c,z	1541	1920	1142
40	CHLD01	Switzerland	Larix decidua	Graubunden	a	1437	1711	275
41	CHPA01	Switzerland	Picea abies	Graubunden	a	1407	2020	614
42	DEAA01	Germany	Abies alba	Bavarian Forest	w	1233	2001	769
43	DEAA100	Germany	Abies alba	Germany South	z,c	820	1985	1166
44	FRAA101	France	Abies alba	Vosges Lorraine	ae	1059	1983	925
45	DEAA102	Germany	Abies alba	Wuerttemberg	z,c	1003	1984	982
46	CHAA103	Switzerland	Abies alba	Northwestern	v	1209	1983	775
47	CHAA104	Switzerland	Abies alba	Northern	ad	1440	1823	384
48	DEAA107	Germany	Abies alba	Black Forest	ae	1029	1952	924
49	DEAA108	Germany	Abies alba	Saxony	ae	942	1906	965
50	DEAA109	Germany	Abies alba	Western	ae	962	1952	991
51	DEAA110	Germany	Abies alba	Central	ae	1010	1996	987
52	DEAA111	Germany	Abies alba	Eastern	ae	994	2007	1014
53	FRAA112	France	Abies alba	Vosges Alsace	ae	869	2019	1151
54	CHAA113	Switzerland	Abies alba	Thurgau	af	1464	1863	400
55	DEAA114	Germany	Abies alba	Bavaria	g	560	1885	1326
56	CZAA115	Czechia	Abies alba	Northwestern Bohemia	x	985	1952	968
57	CZAA116	Czechia	Abies alba	Northeastern Bohemia	x	942	1906	965
58	SKAA117	Slovakia	Abies alba	Slovakia	x	1109	2006	898

59	CZAA118	Czechia	Abies alba	Bohemia	x	942	1952	1011
60	DEAA119	Germany	Abies alba	Kinzigtal	ae	1481	2019	539
61	CHLD107	Switzerland	Larix decidua	Loetschental	y	1085	2002	918
62	AULD108	Austria	Larix decidua	Oetztal	z	1333	1974	642
63	DEPA100	Germany	Picea abies	Wuerttemberg	c	1252	1984	733
64	DEPA101	Germany	Picea abies	Southern	c	1032	1985	954
65	CHPA102	Switzerland	Picea abies	Northern	ad	1333	1823	491
66	CHPA104	Switzerland	Picea abies	Laenen	u	1269	1976	708
67	AUPA105	Austria	Picea abies	Oetztal	z	1276	1974	699
68	CHPA106	Switzerland	Picea abies	Northern	v	1468	1822	355
69	CHPA107	Switzerland	Picea abies	Alpine Rhine	v	1633	1983	351
70	CZPA108	Czechia	Picea abies	Czechia	x	1150	1937	788
71	AUPA109	Austria	Picea abies	Montafon	m	1459	1987	557
72	AUPA110	Austria	Picea abies	Tannberg, Schroecken	m	1247	2003	757
73	CHPA111	Switzerland	Picea abies	Northern	ad	1340	1853	514
74	CHPA112	Switzerland	Picea abies	Thurgau	af	1343	2018	676
75	AUPA113	Austria	Picea abies	Kleines Walsertal	m	1197	1999	803
76	AUPA114	Austria	Picea abies	Damuels	m	1235	1925	691
77	AUPA115	Austria	Picea abies	Lech	m	1218	1986	769
78	DEPA116	Germany	Picea abies	Bavarian Forest	w	1456	2001	546
79	DEPC100	Germany	Picea abies	Black Forest	ae	1570	2019	450
80	DEPS101	Germany	Pinus sylvestris	Wuerttemberg	c	1229	1985	757
81	CZPS102	Czechia	Pinus sylvestris	Czechia	x	1183	1888	706
82	DEPS103	Germany	Pinus sylvestris	Bavaria	g	1297	1822	526
83	CHPS104	Switzerland	Pinus sylvestris	Northwestern	v	1144	1990	847
84	DEPS105	Germany	Pinus sylvestris	Black Forest	ae	1566	2011	446
85	FRAA01	France	Abies alba	Provence	n	1214	1533	320
86	FRAA02	France	Abies alba	Provence	n	1273	1846	574
87	FRAA03	France	Abies alba	Provence	j	1303	1845	543
88	FRAA04	France	Abies alba	Provence	j	1388	1891	504
89	FRAA05	France	Abies alba	Provence	n	1394	1592	199
90	FRAA06	France	Abies alba	Provence	n	1404	1851	448
91	FRAA07	France	Abies alba	Ubaye	n	1409	1496	88
92	FRAA08	France	Abies alba	Briançonnais	n	1422	1646	225
93	FRAA09	France	Abies alba	Provence	n	1429	1542	114
94	FRAA10	France	Abies alba	Briançonnais	n	1454	1647	194
95	FRAA11	France	Abies alba	Provence	n	1511	1657	147
96	FRAA12	France	Abies alba	Briançonnais	n	1531	1647	117
97	FRAA13	France	Abies alba	Provence	j	1562	1676	115
98	FRAA14	France	Abies alba	Provence	j	1600	1717	118
99	FRAA15	France	Abies alba	Mercantour	e	1622	1994	373
100	FRAA16	France	Abies alba	Provence	n	1635	1715	81
101	FRAA17	France	Abies alba	Provence	r	1640	2006	367
102	FRAA18	France	Abies alba	Ubaye	n	1647	1798	152
103	FRAA19	France	Abies alba	Provence	n	1665	1852	188
104	FRAA20	France	Abies alba	Provence	n	1668	1762	95
105	FRLD01	France	Larix decidua	Mercantour	f	933	1975	1042
106	FRLD02	France	Larix decidua	Mercantour	ab	958	1902	945
107	FRLD03	France	Larix decidua	Mercantour	ab	991	1927	937
108	FRLD04	France	Larix decidua	Mercantour	ab	1012	1859	848
109	FRLD05	France	Larix decidua	Mercantour	ab	1027	1734	708
110	FRLD06	France	Larix decidua	Mercantour	e	1160	1994	835
111	FRLD07	France	Larix decidua	Mercantour	ab	1198	1852	655
112	FRLD08	France	Larix decidua	Briançonnais	j	1338	1995	658
113	FRLD09	France	Larix decidua	Vanoise	o	1353	1974	621
114	FRLD10	France	Larix decidua	Mercantour	j	1374	1547	174
115	FRLD11	France	Larix decidua	Briançonnais	n	1380	1905	526
116	FRLD12	France	Larix decidua	Briançonnais	j	1381	1989	609
117	FRLD13	France	Larix decidua	Mercantour	j	1383	1551	169
118	FRLD14	France	Larix decidua	Briançonnais	j	1384	1894	511
119	FRLD15	France	Larix decidua	Mercantour	j	1391	1708	318
120	FRLD16	France	Larix decidua	Mercantour	j	1414	1995	582

121	FRLD17	France	Larix decidua	Briançonnais	j	1416	1551	136
122	FRLD18	France	Larix decidua	Mercantour	j	1417	1995	579
123	FRLD19	France	Larix decidua	Briançonnais	j	1517	1797	281
124	FRLD20	France	Larix decidua	Briançonnais	n	1420	1776	357
125	FRLD21	France	Larix decidua	Briançonnais	n	1424	1811	388
126	FRLD22	France	Larix decidua	Mercantour	ab	1425	1871	447
127	FRLD23	France	Larix decidua	Mercantour	j	1452	1623	172
128	FRLD24	France	Larix decidua	Briançonnais	n	1463	1650	188
129	FRLD25	France	Larix decidua	Briançonnais	j	1465	1860	396
130	FRLD26	France	Larix decidua	Briançonnais	j	1474	1992	519
131	FRLD27	France	Larix decidua	Mercantour	ab	1476	1848	373
132	FRLD28	France	Larix decidua	Briançonnais	j	1477	1680	204
133	FRLD29	France	Larix decidua	Briançonnais	j	1479	1839	361
134	FRLD30	France	Larix decidua	Briançonnais	j	1485	1840	356
135	FRLD31	France	Larix decidua	Mercantour	ab	1488	1887	400
136	FRLD32	France	Larix decidua	Briançonnais	j	1492	1989	498
137	FRLD33	France	Larix decidua	Briançonnais	n	1504	1798	295
138	FRLD34	France	Larix decidua	Briançonnais	j	1505	1706	202
139	FRLD35	France	Larix decidua	Briançonnais	h	1557	1995	439
140	FRLD36	France	Larix decidua	Mercantour	ab	1566	1911	346
141	FRLD37	France	Larix decidua	Mercantour	j	1577	1908	332
142	FRLD38	France	Larix decidua	Ubaye	h	1617	1990	374
143	FRLD39	France	Larix decidua	Briançonnais	h	1640	1995	356
144	FRLD40	France	Larix decidua	Briançonnais	h	1651	1994	344
145	FRLD41	France	Larix decidua	Ubaye	h	1654	1986	333
146	FRLD42	France	Larix decidua	Mercantour	ab	1655	1914	260
147	FRLD43	France	Larix decidua	Ubaye	h	1664	1990	327
148	FRLD44	France	Larix decidua	Maurienne	aa	1665	1994	330
149	FRLD45	France	Larix decidua	Ubaye	h	1669	1981	313
150	FRLD46	France	Larix decidua	Briançonnais	h	1679	1989	311
151	FRPA01	France	Picea abies	Maurienne	aa	1546	1997	449
152	FRPC01	France	Pinus cembra	Belledonne	j	1312	1989	678
153	FRPC02	France	Pinus cembra	Mercantour	j	1313	1999	687
154	FRPC03	France	Pinus cembra	Briançonnais	j	1475	1998	524
155	FRPC04	France	Pinus cembra	Mercantour	j	1541	2000	460
156	FRPC05	France	Pinus cembra	Queyras	j	1575	1998	424
157	FRPC06	France	Pinus cembra	Queyras	j	1583	2003	421
158	FRPC07	France	Pinus cembra	Briançonnais	j	1594	2000	407
159	FRPC08	France	Pinus cembra	Mercantour	j	1637	2000	364
160	FRPC09	France	Pinus cembra	Mercantour	j	1663	2001	339
161	FRPC10	France	Pinus cembra	Mercantour	j	1679	2000	322
162	FRPC11	France	Pinus cembra	Mercantour	j	1689	2000	312
163	FRPS01	France	Pinus sylvestris	Briançonnais	n	1530	1731	202
164	FRPS02	France	Pinus sylvestris	Ubaye	n	1589	1992	404
165	ITAA01	Italy	Abies alba	Trentino	q	1089	1597	509
166	ITAA02	Italy	Abies alba	Toscana	q	1295	1890	596
167	ITLD01	Italy	Larix decidua	Friuli-Venezia Giulia	p	1594	1999	406
168	ITLD02	Italy	Larix decidua	Veneto, Trentino - Alto Adige	b	781	1988	1208
169	ITLD03	Italy	Larix decidua	Trentino	q	678	2019	1342
170	ITLD04	Italy	Larix decidua	Trentino (Val di Sole)	d	969	1995	1027
171	ITPA01	Italy	Picea abies	Trentino (Val di Fiemme)	q	1583	1780	509
172	ITPA02	Italy	Picea abies	Trentino	q	1380	1779	400
173	ITPA03	Italy	Picea abies	Primiero Valley	t	1526	1617	92
174	ITPA04	Italy	Picea abies	Alps	t	1555	1700	146
175	ITPA05	Italy	Picea abies	Venice	t	1393	1614	222
176	ITPA06	Italy	Picea abies	Friuli-Venezia Giulia	p	1689	1999	311
177	ital022	Italy	Abies alba	Toscana	c	1540	1973	434
178	germ4	Germany	Abies alba	Bavaria	c	1541	1951	423
179	germ5	Germany	Abies alba	Bavaria	c	1541	1951	423
180	germ12	Germany	Abies alba	Bavaria	c	1586	1961	376
181	ital024	Italy	Larix decidua	Veneto	ac	1520	1990	471
182	fran012	France	Larix decidua	Alvernia-Rodano-Alpi	o	1353	1958	621

183	germ040	Germany	Picea abies	Bavarian Forest	w	1540	1995	456
184	germ11	Germany	Picea abies	Bavaria	c	1573	1961	389
185	germ14	Germany	Picea abies	Bavaria	c	1622	1953	332
186	swit173	Switzerland	Picea abies	Grisons	i	1537	1995	459
187	swit169	Switzerland	Picea abies	Simmental	i	1532	1986	455
188	swit177	Switzerland	Picea abies	Oberland	i	982	1976	894
189	ital025	Italy	Picea abies	Veneto	ac	1598	1990	393
190	aust002	Austria	Pinus cembra	Tyrol	z	1566	1971	406
191	ital023	Italy	Pinus cembra	Veneto	ac	1474	1990	517
192	SLOAA01	Slovenia	Abies alba	Slovenia	k	1499	1760	262
193	SLOLD01	Slovenia	Larix decidua	Alps	k,l	1596	1795	200
194	SLOPA01	Slovenia	Picea abies	Julian Alps, Kamnik Alps	k	1512	1854	343
195	SLOPA02	Slovenia	Picea abies	Alps	k	1512	1750	239
196	SLOPA03	Slovenia	Picea abies	Kamnik Alps, Primož	k	1568	1760	193
197	SLOPA04	Slovenia	Picea abies	Alps	k,l	1611	1824	214

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Table 4S. The three best matches between violin groups and master chronologies. Strad_mv is the mean series of all soundboards. The distance estimate (**qr_preds (km)**) based on correlation is reported only for spruce (Bernabei & Franceschi, 2024).

Group id	Master id	Overlap	Pearson	tBP	Species	qr_preds (km)
Strad_mv	ITPA02	288	0.55	11.00	<i>Picea abies</i>	56
	ITPA01	143	0.66	9.97	<i>Picea abies</i>	15
	ATPA115	288	0.49	9.44	<i>Picea abies</i>	111
G4	ITPA02	192	0.58	9.81	<i>Picea abies</i>	37
	ITPA01	134	0.60	8.57	<i>Picea abies</i>	30
	ATPA105	192	0.43	6.60	<i>Picea abies</i>	216
G3	ATPA115	198	0.40	6.29	<i>Picea abies</i>	306
	ATPA15	198	0.38	6.24	<i>Picea abies</i>	404
	ITPA02	198	0.34	5.89	<i>Picea abies</i>	500
G2	ATAA07	143	0.54	7.70	<i>Abies alba</i>	
	ATPA113	158	0.50	7.12	<i>Picea abies</i>	101
	ITPA02	158	0.46	6.56	<i>Picea abies</i>	145
G1	ATAA07	88	0.58	6.65	<i>Abies alba</i>	
	ATAA02	88	0.58	6.58	<i>Abies alba</i>	
	DEAA119	105	0.53	6.43	<i>Abies alba</i>	
G10	ATPA15	113	0.35	3.93	<i>Picea abies</i>	500
	ATPA105	113	0.34	3.81	<i>Picea abies</i>	500
	ATPA113	113	0.32	3.56	<i>Picea abies</i>	500
G7	ATPA115	176	0.39	5.52	<i>Picea abies</i>	373
	ATPA110	176	0.37	5.29	<i>Picea abies</i>	439
	ATPA109	176	0.37	5.24	<i>Picea abies</i>	456
G6	SLOPA03	100	0.48	5.37	<i>Picea abies</i>	126
	CHAA103	100	0.46	5.10	<i>Abies alba</i>	
	ATPA09	100	0.45	5.05	<i>Picea abies</i>	165
G11	ITPA02	86	0.41	4.14	<i>Picea abies</i>	275
	ITPA01	86	0.40	3.99	<i>Picea abies</i>	318
	ATPA113	86	0.37	3.71	<i>Picea abies</i>	425
G5	ITPA02	47	0.52	4.07	<i>Picea abies</i>	77
	ATPA115	47	0.49	3.80	<i>Picea abies</i>	104
	FRAA10	41	0.51	3.74	<i>Abies alba</i>	
G8	FRLD42	51	0.40	3.03	<i>Larix decidua</i>	
	FRPA01	72	0.33	2.90	<i>Picea abies</i>	500
	FRLD06	72	0.31	2.74	<i>Larix decidua</i>	
G9	ATAA07	66	0.43	3.84	<i>Abies alba</i>	
	ATPA07	66	0.43	3.83	<i>Picea abies</i>	217
	swit169	76	0.39	3.69	<i>Picea abies</i>	339

Supplementary figures

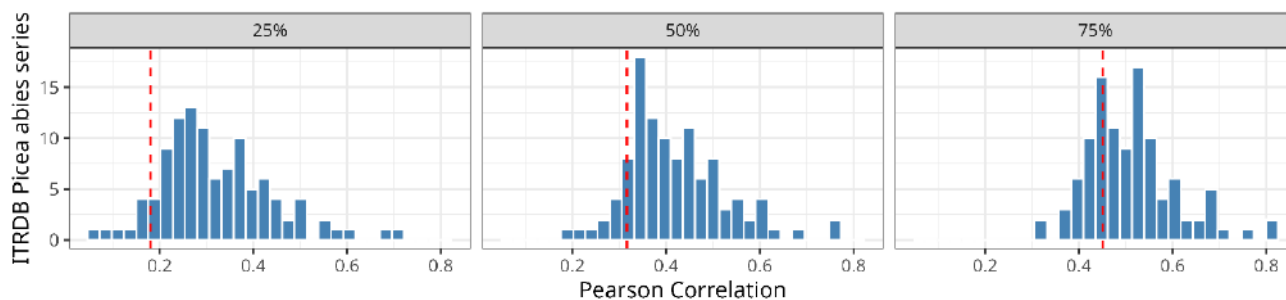


Figure 1S. Comparison between the distributions of Pearson correlation coefficients of the violin dataset and of the ITRDB *Picea abies* chronologies with ≥ 20 samples. The vertical red line indicates the 25%, 50%, and 75% percentile of the distribution of the Pearson correlation of the violin tree-ring series. The histograms show the distribution of the same statistics for the ITRDB *Picea abies* chronologies.

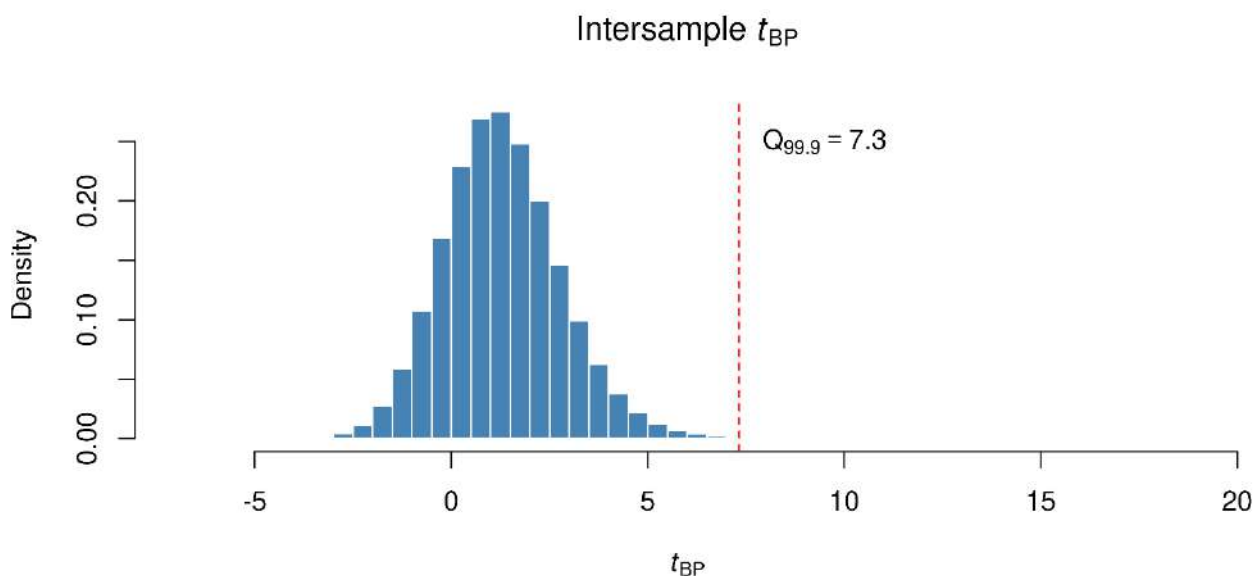


Figure 2S. Distribution of t_{BP} values obtained from all pairwise comparisons between individual *Picea abies* tree-ring series belonging to different ITRDB chronologies assigned to different geographic locations (~ 12 million comparisons). The red dashed line marks the 99.9th percentile (Q_{99.9} = 7.3).

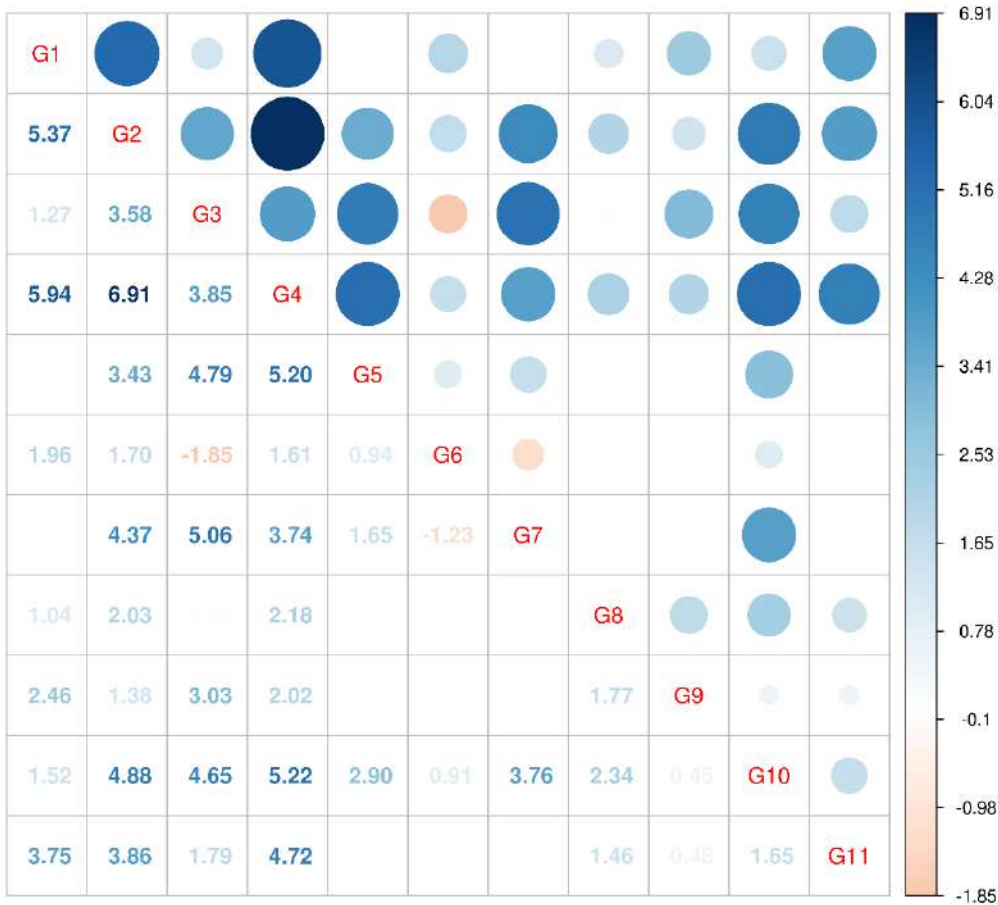


Figure 3S. t_{BP} similarity among the violin groups. A minimum overlap of 50 years was required for all pairwise comparisons.

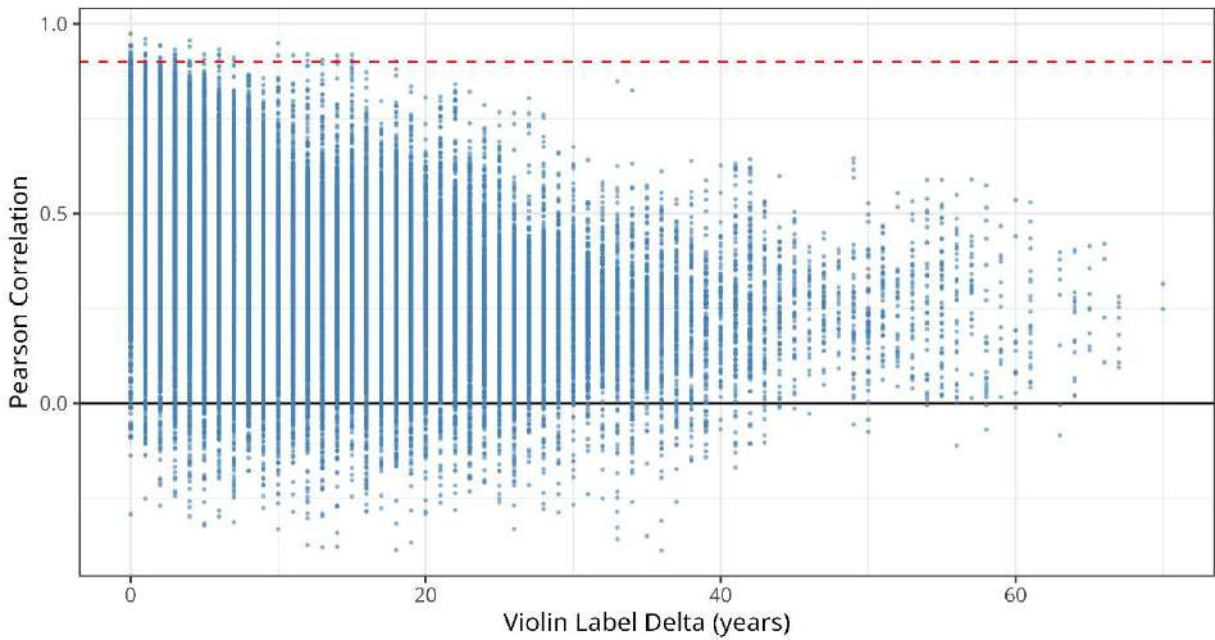


Figure 4S. Association between the correlation between the violin samples and the difference in age marked on the violin label. The horizontal line highlights a correlation of 0.9.