

Dendrochronological analyses on Flemish paintings of the National Gallery of Prague

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Dendrochronology is a discipline of biological sciences which determines the age of wooden objects. This method is used primarily for dating archaeological and architectural objects, but may also aid in investigating art-historical problems. The main goal is to offer at least a terminus post-quem for the creation of a painting by determining the felling date of the tree which provided the wood for the panel. Dendrochronology focuses on the annual periodicity of growth which is controlled by the climate, *e.g.* temperature and rainfall. In cool and temperate climates, there is a dormant season from autumn to spring and a growth season during the summer. When the vegetative period begins, new cells for the transport of water from the roots to the top of the tree are formed. During the summer, the so called latewood formation starts, and around the middle of September the radial growth of the tree stops and rests up to the next spring. The result is an annual ring or tree ring. Besides the differences in structure, two species of wood differ physiologically: in ring-porous wood the latest growth ring fulfils the major task of water transport and, consequently, a new ring must be formed every year. In diffuse-porous woods and in conifer wood, some growth rings participate in the water conduction. Hence, under adverse climatic conditions, the trees do not need to form a growth ring every year and may be characterized by totally or partially missing rings. On the other hand some growth increments may be formed in one year. These occurrences make the determination of growth rings and dendrochronological work with diffuse-porous species more difficult than with ring-porous species such as oak.

The biological regularity of the ring series in trees from temperate zones permits dating of wood by comparing the ring sequences of undated wood with those of wood of known age and position in time. In order to establish comprehensive continuous growth ring curves for periods longer than a tree's lifetime it is necessary to use an overlapping system of individual curves for the establishment of master chronologies; in Europe trees normally live only 200 to 300 years. Standard curves exist for South and West Germany, for several regions of North Germany and, in part, for several areas in the Netherlands and France, and also for the Baltic area from which the wood for most Flemish and Dutch paintings was obtained.

In order to determine the ring widths one can use a magnifying glass with an integrated scale. This method is used if measurements have to be taken on site without laboratory equipment. It is more convenient to take measurements in the laboratory using a machine. The laboratory equipment can be connected to a computer to record the data immediately after measurements are taken for use in the next steps of the analysis. In some cases the measurements may be taken from x-rays. Digital cameras may also be used to take photographs and to measure the rings from the photographs. However, in all cases it is necessary to clean the edges of the panel for a full recognition of the rings.

The purpose of cross dating is to find out if and to what degree the two sequences match. In general terms this would mean the placement in time of one ring series relative to the other. If one of the curves is attributed to a definite stretch of time, the positioning of the second curve by maximum coincidence leads to absolute dating. For each kind of wood, a master chronology must be established for different regions.

Problems

Problems encountered in the course of dendrochronological work involving the biological material as well as the methodology include:

- Conifers such as spruce or diffuse-porous broad-leaved trees such as lime may not produce a tree ring every year; the missing data may prevent precise dating.
- Sometimes the condition of a sample does not permit the determination of ring widths, as in the case of sapwood which may have suffered attack by insects, bacteria, or fungi or may have collapsed due to excess drying. In these cases the number of rings cannot be accurately determined and no precise dating can occur.

- For the cross dating of curves, a minimum number of rings must be present in order to obtain reliable results. Unfortunately, it is not possible to list a precise number as the required minimum. Even curves considered quite 'long' sometimes do not provide the necessary characteristic patterns which would help to date the curve. There are many variables involved; sometimes dating is possible with as few as fifty tree rings, but sometimes even one hundred rings may not be enough. It all depends on the quality of the sample.

Sapwood estimation and seasoning

Identification of the year the tree was felled is the most important information the art historian can learn from the dendrochronologist. If the last ring under the bark has been preserved, it provides the exact date—even the season—when the tree was cut. In preparing oak panels for paintings, panel makers usually cut normally the planks radially. The bark and the light, perishable sapwood were mostly cut away, thereby eliminating evidence of the latest growth rings and making a determination of the exact felling year impossible. Only the latest measured growth ring of the panel can be determined to the exact year. In the fifteenth and sixteenth centuries, the presence of sapwood rings is rare, but in the seventeenth century, a lot of sapwood rings may be present.

On the other hand, the records regarding the number of sapwood rings to be added are derived from statistical evaluation and must be considered in each particular case. In addition to the dependence of the number of sapwood rings on the age of the tree, the provenance of the oak is significant. In Europe the number of sapwood rings varies from western regions with numbers between 7 to 50, to eastern regions with 9 to 36. The number of sapwood rings found in trees from the Baltic regions was analysed with the result of a median value of 15. 90 % of all trees had 11 to 22 sapwood rings; the minimum was 9; the maximum was 36 (**fig. 1**). For wood originating from Germany or the Netherlands, a median value of 17 with 90 % of all values lying between 12 and 26 was determined with a minimum of 7.

In order to determine the earliest possible felling date at least 9 or 7 sapwood rings (eastern or western origin) must be added to the latest growth ring found on the panel. The determination of the felling date also provides information regarding the length of time the wood was seasoned before use. For oak panels of the sixteenth and seventeenth centuries, in most cases the interval between the felling of the tree and the creation of the painting was approximately 2-8 years.

Regarding these problems and limitations the following table have to be used.

Painter, Painting Inv.-No.	wood species	Number of growth rings/ sapwood/ youngest heartwood ring	Earliest possible felling date: 9/7 sapwood rings	Estimated felling date: 15/17 sapwood rings	Presumed date: 15/17 sapwood rings + 2 (years for seasoning)	Remarks
Poelenburch Cornelis van Rocky Landscape with a Trumpet Player O2558	oak	I – 214 - 1637	1644	1654	1656	Western German/ Netherlandish
Poelenburch Cornelis van Studio Mary Magdalene in Penitence O13401	oak	I -136-1603	1610	1620	1622	Western German/ Netherlandish

Rembrandt van Rijn- manner of Head of an Old Man DO4604	oak	I- 109-1690	1697	1707	1709	Western German/ Netherlandish
Rembrandt van Rijn Follower of Bust of a Man with Wavy Hair and a Jewish Hat DO7149	oak	I – 86-1588 II- 165-1616	1623	1629	1631	Baltic/Polish
Delen Dirck van The Interior of a Palace O15689	oak	I – 180/8 – 1641 II – 41- III - 136 – 1614 IV – 178 - 1614	1642	1648	1650	Baltic/Polish
Dou Gerrard Lady on Balcony O650	oak	I – 183/14 - 1649	1649	1652	1654	Western German/ Netherlandish
Haarlem Painter Archer and Woman O9317	oak	I – 45 – II – 96 - III – 223/6– 1603 IV – 77 -	1606	1612	1614	Baltic/Polish
Flemish Painter Cave with a Hermit O283	oak	I – 318 - 1618	1627	1633	1635	Baltic/Polish
German Painter Adoration of the Shepherds O10625	oak	I – 212 - 1608	1617	1623	1625	Baltic/Polish
Bloemaert Abraham Follower of St. Elijah of Egypt O12667	oak	I – 146 -1491	1500	1506	1508	Baltic/Polish
Bloemaert Abraham Circle of Head of St.Paul O16389	oak	I – 235/3 - 1619	1625	1631	1633	Baltic/Polish
Wouwerman Philips Follower Three Horses out to Pasture O168	oak	I – 222 - 1610	1619	1625	1627	Baltic/Polish
Cuyp Albert Imitation of Shepherd and Herd O169	oak	I – 176/9 – 1640 II – 174 - 1630	1640	1646	1648	Baltic/Polish
Molenaer Jan II Peasants Carousing in a Tavern O1646	oak	I – 161 - 1637	1644	1654	1656	Western German/ Netherlandish
Metsu Gabriel Copy after Girl with Grapes O2655	oak	I - 85 - 1627	1634	1644	1646	Western German/ Netherlandish
Molenaer Jan Miense Peasant's Repast O5532	oak	I – 257/4 - 1618	1623	1629	1631	Baltic/Polish
Neer van der Eglon Copy after Woman Selling Fish O9081	oak	I – 164 - 1630	1639	1645	1647	Baltic/Polish
Ostade Adriaen van Brawling Cardplayers O10140	oak	I – 273/10 -1623	1623	1628	1630	Baltic/Polish
Dutch (?) Moses and Aaron before the Pharaoh O10641	oak	I – 188 -1679	1686	1696	1698	Western German/ Netherlandish

Lingelbach Johannes The Dice Players O10685	oak	I – 119 - 1576	1585	1591	1593	Baltic/Polish
Mieris I Frans van Wokshop Copy (?) Wooring DO4301	oak	I - 109				No dating
Steen Jan The Doctor at a Sick Woman DO4598	oak	Original: 98 – 1641 Addition Top – 101 -1640 Back: 191 - 1641	1650	1660	1662	Western German/ Netherlandish Top and Back = same tree
Mieris I Frans van Copy after DO4608	oak	I – 157 - 1651	1658	1668	1670	Western German/ Netherlandish
Kessel Jan van Waterfall in a Mountain Landscape DO4620	oak	I – 86 - 1582 II -139 - 1625 III -157- 1583	1634	1640	1642	Baltic/Polish
Ostade Adrien van Copy after Peasants Making Music DO6322	oak	I - 156				No dating
Saftleven Cornelis Circle of Barn Interior with Peasants Company O51	oak	I – 107/3 -1621 II – 192 -1618 III – 72/8 – 1626 IV - 115 - 1551	1627	1633	1635	Baltic/Polish II and IV = same tree
Mierevelt van Michiel Jansz. Portrait of a 69-year-old- man O10452	oak	I – 53 – II – 204 – 1607 III – 70 - 1537	1616	1622	1624	Baltic/Polish
Lesire Paulus 17 th century copy O10637	oak	I – 98 – 1603 II – 188 -1630 III – 136 -	1639	1645	1647	Baltic/Polish
Dutch After 1650 Ships before an Oriental Coast DO4231	oak	I – 2194 -1646	1653	1663	1665	Western German/ Netherlandish
Amsterdam Painter First Half of the 1630s Portrait of an Older Man with Book O11979	oak	I - 142-1633 II - 188- 1633 III – 130 - 1633	1642	1648	1650	Baltic/Polish
Verschuier Lieve Pietersz. Follower South Bay at Sunset O12947	oak	I – 140 - 1808	1815	1825	1827	Western German/ Netherlandish
Key Adriaen Thomasz. Manner/Copy after 1628 Portrait of an Older Man with a Short Ruff O10032	oak	I – 217 - 1611	1620	1626	1628	Baltic/Polish
Hals Dirck A Merry Musical Company O10162	oak	I – 123/10 - 1611	1611	1616	1618	Baltic/Polish
Duyster Willem Cornelisz. 17 th Century Copy Guardroom with Military Paraphernalia O8004	oak	I – 184 -1593 II – 136 - 1614	1623	1629	1631	Baltic/Polish

Baburen Dirck Jaspersz. Van Copy after Flute Player DO4241	oak	I – 85 - 1612 II – 177 -1618 III – 98 -	1627	1633	1635	Baltic/Polish
Hals Dirck Circle Musical Company DO4621	oak	I – 85/1 - 1621 II – 156 - 1620	1629	1635	1637	Baltic/Polish
Bloemart Hendrick Circle of Couple Singing DO4224	oak	I – 185 - 1591 II – 279 - 1623 III – 173 - 1580	1632	1638	1640	Baltic/Polish
Ravesteyn Jan Anthonisz. Van and Workshop Portrait of an Officer in Armor O10623	oak	I – 59-1594 II – 177 – 1592 III – 107 - 1595	1604	1610	1612	Baltic/Polish
Duck Jacob Copy after Call to Arms O10547	oak	I – 150 - 1625 II – 161 - 1616	1634	1640	1642	Baltic/Polish
Ketel Cornelis Copy after Portrait of a 46-Year-Old- Man	oak	I – 115 -1615 II – 287 – 1619 III – 59 - 1615	1628	1634	1636	Baltic/Polish
Haarlem van Cornelis Cornelisz. Imitator from the 16/17th Century Bust of a Woman in Profile O12669	oak	I – 139 - 1557	1566	1572	1574	Baltic/Polish

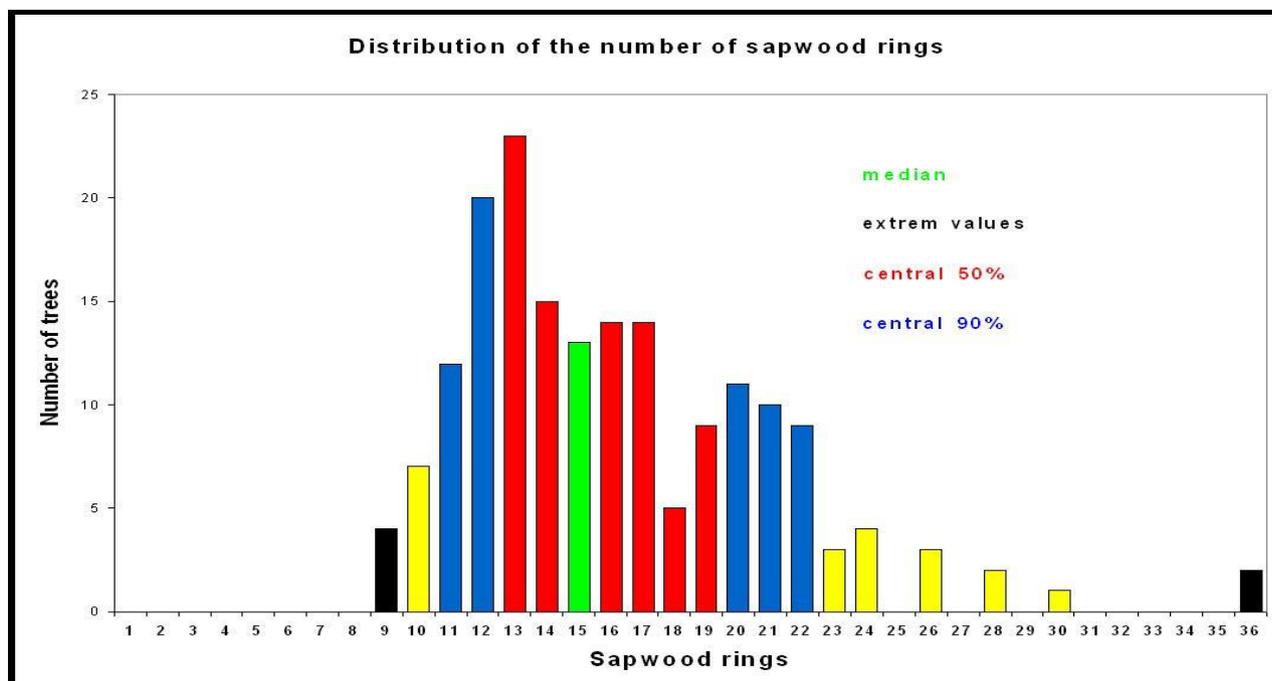


Fig. 1 Distribution of the number of sapwood rings for Eastern Europe