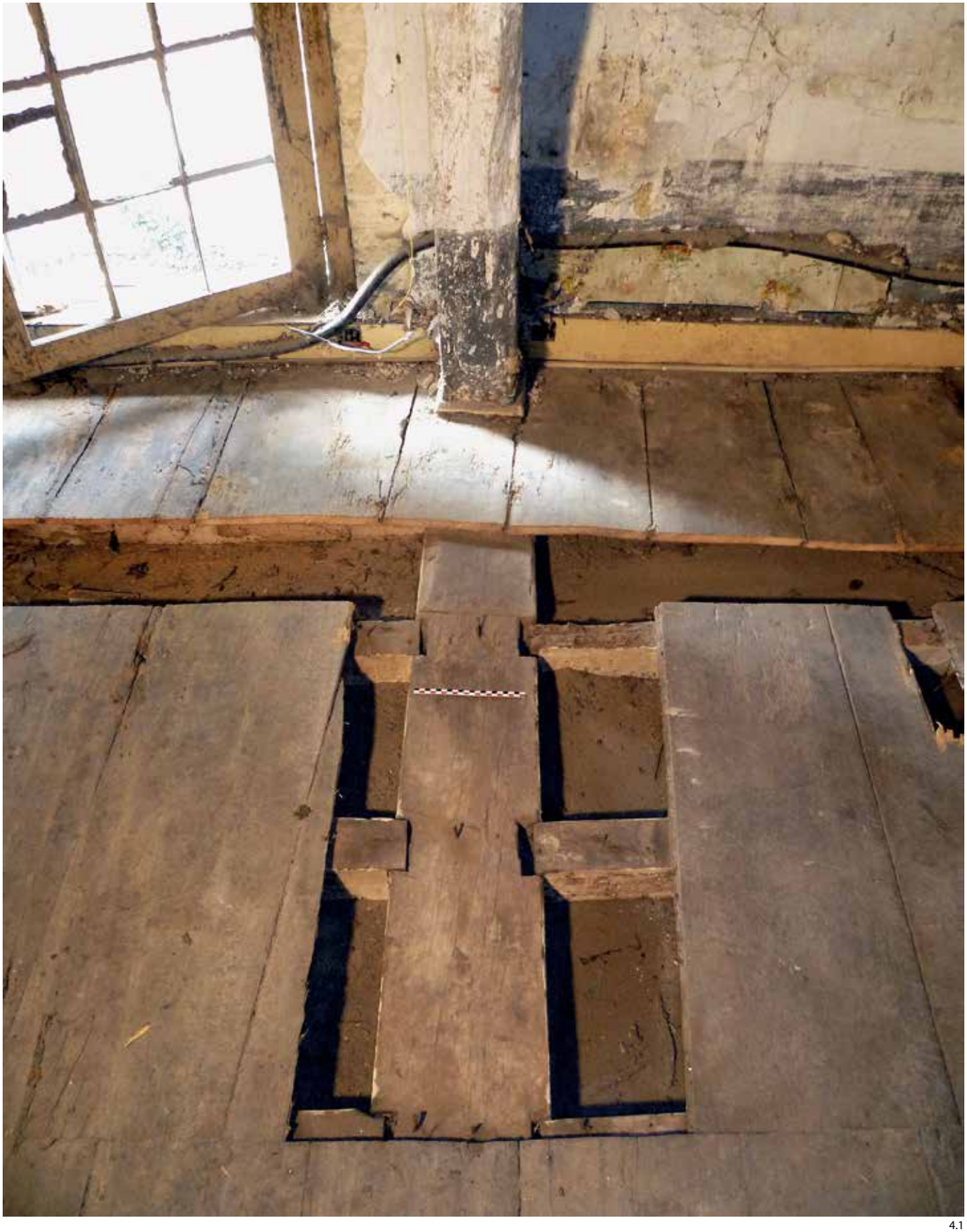

4.1

4

Contribution to the history of Brussels floorings, Belgium (16th-19th centuries): Initial results of an archaeological and dendrochronological investigation

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Introduction

The aim of this contribution is to present the main results of a study conducted on the use of wood planks as floorings in Brussels between the late 16th and 19th centuries. The work is part of doctoral research on construction materials, principally wood and brick, conducted at the Research Centre for Archaeology and Heritage at the Université libre de Bruxelles (Sosnowska, 2013). It benefits from a collaboration with the department of Archaeological Heritage of the Regional Public Service of Brussels (SPRB) and, for some cases, with the Royal Museums of Art and History (RMAH), including in particular the execution of detailed study of several archaeological sites in the territory of the Brussels Capital Region. These operations allow recording of abundant technical data

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Fig. 4.1. Site of the Hôtel de Merode, Brussels: flooring on the 1st storey. Photo: P. Sosnowska © DMS/RMAH

on these wooden structures via an *in situ* archaeological study, but also by the sampling of planks in order to complement the archaeological data with dendrological and dendrochronological analyses.[1] These were conducted for the most part by the Royal Institute for Cultural Heritage (KIK-IRPA; Fraiture *et al.*, 2013), but also by the European Centre for Archaeometry at the University of Liège (Gerrienne, 2009; Weitz and Gerrienne, 2011).

It should be noted at the outset that this research is not exhaustive and covers a fairly limited dataset of floorings, with ten sites studied (Sosnowska, 2013: 130-131). These sites are, however, sufficiently well-documented and dated to set the foundation of a synthetic approach for a detailed study of such structures and to demonstrate the interest in a better comprehension of craftsmen's skills during the *Ancien Régime* (fig. 4.1).[2] We thus examine in turn different approaches and questions. After description of the study subject, the dataset and the methodological aspects of the archaeological and dendrochronological analyses, we discuss the wood species exploited (Scots pine, poplar, spruce and elm), the qualities of each and their means of supply. This is followed by the description of the modes of cutting and shaping planks, assemblage techniques and changes in these through time. Finally, we examine some aspects of the installation and finishing of the planks, as well as means of attachment to the supporting structure. Throughout this article, the archaeological documentation is put into perspective with written sources, which include treatises and archival documents.

Apart from a few case studies, the scientific literature on the production of floorings and shaping of planks for floorings is poorly developed for Brussels cultural heritage and nearly non-existent for the Southern Netherlands. Archaeological research published on wood is in majority from the study of roof frames and timber-frame housing and concerns the study of structural work in oak (e.g., Hoffsummer, 1999; Hoffsummer, 2002; Houbrechts, 2008). For finishing work, parquet floors have most attracted the attention of historians of construction and art historians given the sumptuousness of their workmanship.[3] Our analysis does not directly involve this kind of flooring. This choice results in part from the low number of parquet floors in the dataset since, to date, only a single 18th-century parquet has been comprehensively studied (Taeymans, 2006a; Taeymans, 2006b), and in part from significant differences in implementation between a parquet and a plank flooring. These differences are observed both in the more complex execution of a parquet (which sometimes includes the installation of a subfloor, sleepers, plaster, etc.) and in the choice of materials utilised, and particularly in the much greater variety – and the precious value – of wood species used for their creation. Heritage and dendroarchaeological studies of finishing work in these regions are extremely rare. These include a few case studies (Buijs and Bergmans, 2010; Sosnowska, 2011: 177-193; Fraiture and Crémer, 2014; How *et al.*, 2016), with rare exceptions of attempts to produce a synthesis (Fraiture, 2015). We note in addition that studies undertaken on species other than oak in the Southern Netherlands have slowed to a trickle, whether with respect to dendrochronology, archaeology or history. Further, the lack of interest in wood finishing work in general is surprising considering that it is crucial for

the spatial organisation of a building (staircases, doors, walls, etc.), the creation of elements of comfort (window frames, built-in cabinets, etc.) and decoration (panelling, ceilings, etc.).

Definitions of plank and parquet floorings

The term *plancher* in French is applied to two different but complementary structures. On one hand, it refers to a horizontal component of the frame separating the stories of a building (i.e., subfloor) and supporting a floor covering (i.e., flooring) (Chabat, 1881, vol. IV: 12; Pérouse de Montclos, 2011: 142). When it is exposed and horizontal, the lower surface of the *plancher* is called the *plafond* (ceiling) (Pérouse de Montclos, 2011: 142). It can also refer to a particular type of more rudimentary parquet, characterised by the successive juxtaposition of planks via tongue-and-groove assemblage, 'squared across their entire width or recut with a width of three or four inches'[4] (Roubo, 1769: 154).[5] A parquet flooring *sensu stricto* is an assemblage of wooden elements joined by the tenon-and-mortise technique to form different blocks or compartments (Roubo, 1769: 154). This distinction is accepted by Pierre Chabat, but with a few qualifications with respect to the kinds of assemblages and a clear differentiation in the thicknesses of each kind of flooring. For Chabat, a plank flooring is an assemblage of 22 cm wide planks with butt joints while parquet floorings are composed of thin wood pieces 7-12 cm wide with tongue-and-groove joints (Chabat, 1881, vol.3: 543).[6] The floor as a supporting structure is part of structural work components since it contributes to the stability of a building, while floor coverings are part of finishing work.[7]

According to Roubo, the installation of wooden floorings is part of the joinery arts, and more specifically the fixed joinery of assemblage (Roubo, 1769: 1). The definition proposed by the author raises the difficult problems of the division of the execution of floorings between carpentry and joinery. Such precepts in Brussels should be qualified as multiple conflicts in the 15th century between the corporations of joiners and carpenters have been documented (Janssens, 1988: 22-24). Indeed, the professions regularly departed from their respective spheres of activity, carpenters acting as joiners, joiners becoming carpenters (Paquay, 2002: 385). To resolve these disputes, the Magistrate of the city promulgated a series of ordinances with a list of works proper to each corporation.[8] For example, it was forbidden for joiners to build staircases, doors, windows, ceilings, etc.[9] In this specific case, the term ceiling (*plafond* in French, *solre*/*solringe* in Middle Dutch; Verdam, 1932: 556; gtb.inl.nl),[10] refers to both the area of circulation – the flooring – and the covering of a room – the ceiling. No semantic distinction was thus made between these two structures. This duality ultimately expresses a quite material reality, that of the non-existence of a structural difference between a floor covering and a ceiling, the latter being only the under-surface of the first (Pérouse de Montclos, 2011: 272). We note, in fact, that until the early 18th century, ceilings with 'exposed' joists were the most common in the ordinary Brussels houses (fig. 4.2) (Sosnowska, 2013: 163-165).

4.2

Fig. 4.2. Site of the Hôtel de Merode, Brussels: view of a ceiling with visible joists covering the 1st storey. Photo: P. Sosnowska © DMS/RMAH

Archaeological dataset

The study of these structures was conducted using archaeological methodology. The zone to be studied was cleaned, a plan drawing was made of the flooring at a 1:20 scale, allowing relatively rapid and simple execution while providing the necessary precision for the recording of the smallest details (e.g., nails, nail holes, plugs and wooden grafts) and finally, data recording by stratigraphic unit was done using the methodology we have developed (Sosnowska, 2013) (fig. 4.3). When a flooring was to be demolished, dismantling according to the structure was done to draw and study the supporting structure. Particular attention was given to the position of nail holes, bent nails, laths serving as wedges to heighten the flooring, etc. These details are crucial to determine the original state of the floor covering, and even more so in the construction of a typo-chronology for this kind of covering. Planks were sampled by taking slices to identify the wood species used, the types of cutting and shaping of the assemblages and, when necessary, for dendrochronological analysis.

4.3

The dataset of floorings studied is composed of structures from ten sites, including, in some cases, several different phases. Samples of the planks were collected for eight of these sites (table 4.1). However, sampling could not be done entirely systematically or logically as it was dependent on the administrative form of the intervention (preventive archaeology, programmed archaeology in a classified building, etc.) and on accessibility to the structures. In total, 103 wood samples were collected. These cover four centuries, from the late 16th to the 19th century. Most are from modest, ordinary or privileged houses; one sample, however, is from a religious institution and another from a farm.

Dendrochronological study of the planks

The dendrochronological study of the floorings in Brussels is new in the sense that no date on Scots pine (*Pinus sylvestris* L.) had ever been made previously in Belgium. This is primarily due to the predominant use of oak in architecture in these regions (see below), which has thus been the focus of dendrochronological research here, unlike other regions where coniferous woods were more commonly exploited.[11] We clarify, however, that some countries in Western Europe similar to Belgium with respect to choice of wood species (England, Scotland, the Netherlands) had previously addressed the question of the use of coniferous woods in architecture using dendrochronology. Some studies were specific, dependent on opportunity (Groves, 1997; Crone and Sproat, 2011; Domínguez Delmás *et al.*, 2011), while others were programmed in view of the potential of the information obtained.[12] We hope that this initial research on Belgian architectural material of Scots pine will lead to systematisation of the dendrochronological study of coniferous woods.

Fig. 4.3. Site at Rue Notre-Dame du Sommeil 17, Brussels: detail showing the stratigraphy of the different floorings on the 1st storey (17th-20th century). Photo: P. Sosnowska © DMS/ULB

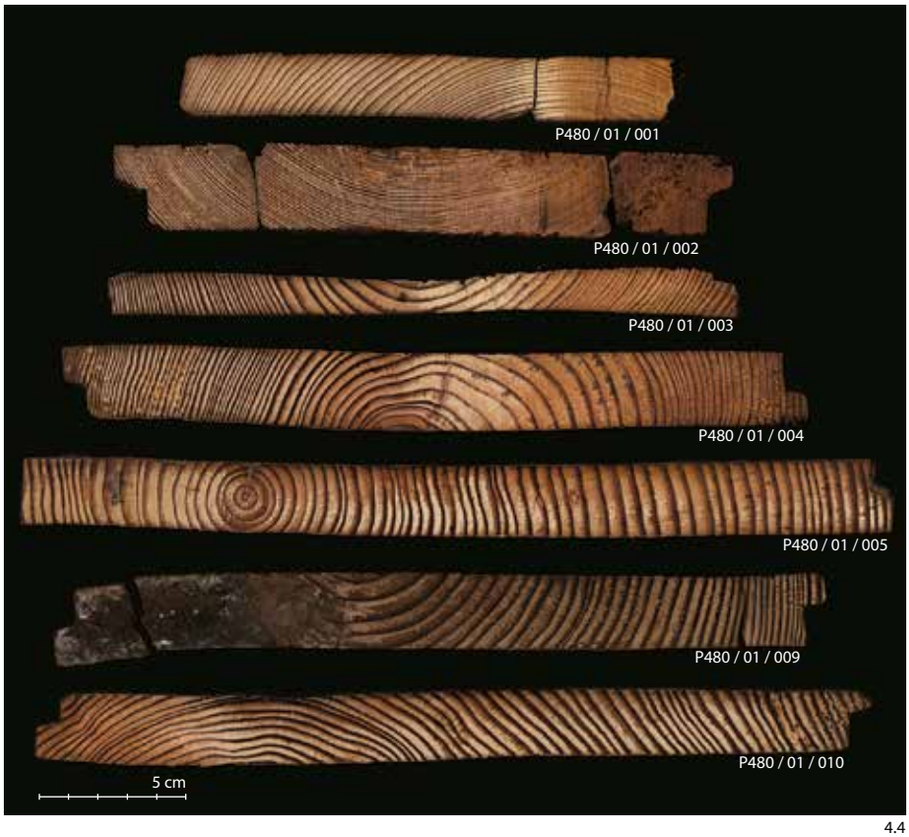
Sites	Plank width (cm)	Plank thickness (cm)	Assemblage type	Sawing type	Distance between striations (mm)	Plank type			Wood species	Date
Musée du Béguinage, Rue du Chapitre 31, Anderlecht	21.7 to 25.3	2.1 to 2.9	slip tongue-and-groove	mechanical	1 to 2	7 Slab	2 semi-radial	1 radial	Scots pine	1792-1814d
Maison (of Hôtel) Dewez, Rue de Laeken 73 and 75, Brussels	25.5	2.4	slip tongue-and-groove	mechanical	?	1 Slab			spruce	Late 18th century
Hôtel La Traviata, Rue des Pierres 34, Brussels	21.4 to 29.6	2.2 to 2.6	half-lap joint in S-profile	manual	1 to 6	4 Slab	1 semi-radial	1 radial	Scots pine	1st third of 18th century
House, Quai aux Bois-de-Construction 3, Brussels Phase 1	26.7 to 31	2 to 2.3	half-lap joint in S-profile	manual	2 to 7			8 radial	poplar	18th century
House, Quai aux Bois-de-Construction 3, Brussels Phase 2	20.8 to 26.2	2.3 to 3	slip tongue-and-groove	mechanical	2 to 3	5 Slab			Scots pine	19th century
Hôtel de Merode, Rue aux Laines 35, Brussels Phase 1	25.9 to 38.2	2.5 to 3.2	half-lap joint in T-profile	manual	1 to 4	2 Slab	1 semi-radial	6 radial	Scots pine	1570-1610d
Hôtel de Merode, Rue aux Laines 35, Brussels Phase 2	28.5 to 37.3	2.2 to 2.9	half-lap joint in T-profile	manual	3 to 8	?	?	?	poplar	1674d
Hôtel de Merode, Rue aux Laines 35, Brussels Phase 3	25.9	2.9	slip tongue-and-groove	mechanical	2			1 radial	Scots pine	19th century
House, Rue du Chevreuil 21, Brussels	19.2 to 32.1	2.2 to 2.6	half-lap joint in S-profile	mechanical	2 to 3	?	?	?	poplar	1774d
House, Rue Notre-Dame du Sommeil 17, Brussels	36.5 to 42	2.2 to 2.4	half-lap joint in T-profile	manual	1 to 5	?	?	?	poplar	17th century
Ferme Rose, Avenue De Fré 44, Uccle	15.1 to 45.4	1.9 to 2.4	half-lap joint in S-profile	manual	1 to 8	2 Slab			poplar	18th century

Tab. 4.1

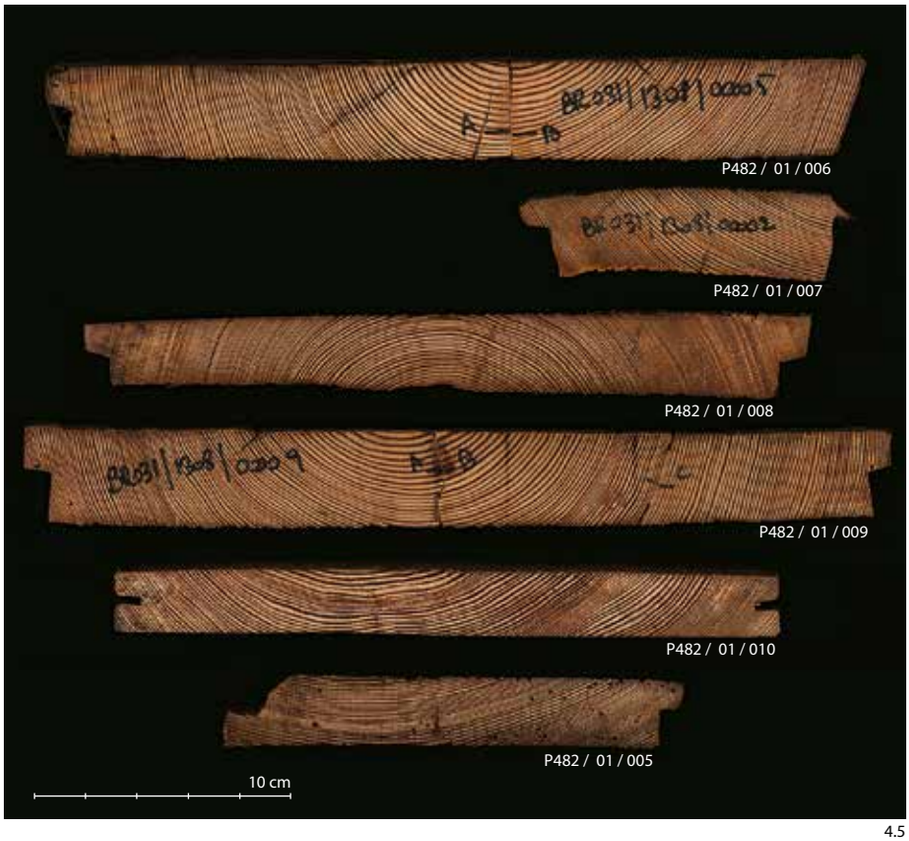
Table 4.1. Dataset of the floorings studied.

Methodology

Dendrochronological sampling consisted in removals of slices cut with a ribbon saw along the width of the planks to obtain the transversal section of the trunk. Preparation of the surface to be measured was done by sanding with increasingly fine-grained discs (from P40 to P1200) to make the limits between tree rings completely clear. The prepared samples were scanned at high resolution (800 or 1000 dpi; fig. 4.4 to 4.6), with calibration at a millimetre scale. Tree-ring widths were then measured on the computer screen via these digital files.[13] For samples showing very slow growth (very narrow tree rings), a second series of measurements was made using a binocular microscope to provide a set of observations of the tree rings independent of those made on the scans.[14] The measurement series, both onscreen and by microscope, have a precision of 1:100 mm.



4.4



4.5

Fig. 4.4. Scan of the samples of planks from the Hôtel La Traviata, Brussels: rapid growth rhythm; planks cut by through-and-through sawing (the orientation of the tree rings indicates the original position of the planks which come from the entire log, at different distances from the tree's centre); assemblage with S-profile. Scans: S. Crémer and P. Fraiture

Fig. 4.5. Scan of the samples of planks from the site of the Hôtel de Merode, Brussels: extremely slow growth rhythm; most planks produced by through-and-through sawing, originating from the part near the centre of the log (except for sample no. P482-01-005, slab plank from near the periphery of the trunk); assemblage with T-profile. Scans: S. Crémer and P. Fraiture

4.6

Synchronisation calculations for relative and absolute dating were done using the *Dendron* system (version IV), after having calibrated the dendrochronological series by the adjusted corridor transformation developed by Lambert (Lambert, 2006).[15] The correlations are based on a statistical test derived from the Student test, calculated using two correlation coefficients (Lambert, 2006); visual verification and replication provide further support to guarantee a date.

Sample set

The dendrochronological sample set is composed of 95 planks from six sites (table 4.2). Variability in preservation of the floorings played a considerable role in the quality of the samples. The Hôtel La Traviata provided 15 planks for the dendrochronological study, the Hôtel de Merode 17, the Musée du Béguinage in Anderlecht 23 and the house at Quai au Bois-de-Construction only three, while the sites of Rue Notre-Dame du Sommeil and Rue du Chevreuil provided five in total and the Maison Dewez a single sample. However, a date is more reliable when several individual series can be grouped in a dendrochronological mean, i.e., a 'chronology'.

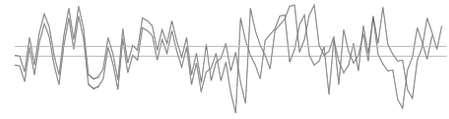
Fig. 4.6. Scan of the samples of planks from the site of the Musée du Béguinage, Anderlecht: extremely slow growth rhythm; planks produced by through-and-through sawing, originating from the entire log, at different distances from the tree's centre; slip tongue-and-groove assemblage profile. Scans: S. Crémer and P. Fraiture

The diversity in wood species used also affected the analysis (table 4.1), in particular the use of poplar which is not compatible with dating by dendrochronology (see below). As such, a third of the planks could not be analysed, again limiting the number of samples for certain sites (e.g., 18 planks from the house at Quai au Bois-de-Construction are of poplar, six for the Hôtel de Merode), but especially eliminating any possibility for dating the sites of Rue Notre-Dame du Sommeil and Rue du Chevreuil since all of the planks were of poplar.

An additional constraint results from the number of tree rings present on the planks. This depends in part on the growth rhythm of the tree since, with equal dimensions, a plank with rapid growth will have fewer rings than one with slow growth (fig. 4.4 versus 4.5), and in part on the original position of the plank in the trunk, since a plank from near the centre of the tree will include more rings than one cut along the outer edge of the tree (slab boards) (fig. 4.5, sample no. P482/01/005). The only sample available for the Maison Dewez contains only 40 rings, due to rapid growth. Since a reliable date for a single sample requires a minimum of 80 or 100 rings, the chance of obtaining a valid result for this site is practically impossible. More generally, of the 46 Scots pine planks retained for the analysis, only eight had more than 80 rings (table 4.2).

Next, the capacity of Scots pine to form 'false' tree rings or to not form a ring in a given year ('missing' tree rings) complicated the analysis.[16] As these growth irregularities can be identified by crossdating, two samples were collected on the planks when possible, and up to four different radii were measured. When the correlations between these different measurements account for shifts that reflect the presence of such irregularities, the difficulty lies in the identification of the correct series and those that are not strictly annual (fig. 4.7). As a result, inevitable complications occur when constructing chronologies within a site. At the Hôtel de Merode, only four planks could be grouped in a mean from the ten retained for study and the case of Anderlecht is even worse since, of the 16 individuals inventoried, no synchronisation was successful! Finally, for the house at Quai au Bois-de-Construction 3 (two planks of eight were assembled in a chronology) and the Hôtel La Traviata (five planks of ten were grouped), the short lengths of the individual series limited the construction of chronologies with a significant number of individuals (table 4.2).

All of these factors affecting measurement and synchronisation in the sample set had repercussions on dating. First, the limited number of samples and problems of crossdating meant that most of the tree-ring series had to be dated individually. This procedure is generally difficult, in particular when the climatic signal of the series is not strong – grouping individual series in a chronology allows this signal to be reinforced – and for short series, which is primarily the case here. Indeed, none of the planks from the Hôtel La Traviata have more than 67 tree rings and only one of the pine planks from Quai Bois-de-Construction 3 numbered 80 tree rings. In contrast, eight planks from Anderlecht and nine from the Hôtel de Merode go significantly beyond this threshold and have up to 150 tree rings for the first and 280 for the second site (table 4.2). These two sites were also the only ones to have been dated with certainty (see below).



4.7

Fig. 4.7. Drawing of two dendrochronological series showing a shift due to a 'false' tree ring on one series or a 'missing' tree ring on the other. Drawings: S. Crémer and P. Fraiture

Hôtel La Traviata, Rue des Pierres 34, Brussels					
ID dendro KIK-IRPA	**No. of measured rings**	**Mean ring width (in mm)**	**No. of visible sapwood rings**	**Cambium**	**Dating result**
P480/01/003	41	2.09	/	/	P480-M3, dendrochronological mean of 5 planks, undated
P480/01/004	59	1.93	/	/	
P480/01/005	54	4.02	/	/	
P480/01/007	33	3.60	/	/	
P480/01/010	74	3.45	/	/	
P480/01/001	44	1.95	/	/	undated
P480/01/002	67	0.93	/	/	undated
P480/01/006	41	3.65	/	/	undated
P480/01/008	37	3.25	/	/	undated
P480/01/009	38	3.64	/	/	undated

House, Quai aux Bois-de-Construction 3, Brussels					
ID dendro KIK-IRPA	**No. of measured rings**	**Mean ring width (in mm)**	**No. of visible sapwood rings**	**Cambium**	**Dating result**
P481/01/009	80	1.26	/	/	P481-M1, chronology grouping 2 planks, undated
P481/01/012	76	1.23	21	/	
P481/01/010	55	2.03	/	/	undated
P481/01/011	50	1.81	/	/	undated
P481/01/013	54	2.20	/	/	undated
P481/01/018	45	2.16	/	/	undated
P481/01/019	44	1.97	/	/	undated

Hôtel de Merode, Rue aux Laines 35, Brussels					
ID dendro KIK-IRPA	**No. of measured rings**	**Mean ring width (in mm)**	**No. of visible sapwood rings**	**Cambium**	**Dating result**
P482/01/001	224	0.73	58	/	P482-M2, chronology grouping 4 planks, dated: felling between 1570 and 1620
P482/01/002	181	0.98	28	/	
P482/01/004	277	0.58	43	/	
P482/01/008	204	0.59	33	/	
P482/01/003	158	1.03	/	/	undated
P482/01/005	64	0.93	/	/	undated
P482/01/006	102	1.58	/	/	undated
P482/01/007	87	0.99	/	/	undated
P482/01/009	106	1.52	/	/	undated
P482/01/010	87	1.18	/	/	undated

Tab. 4.2

Table 4.2. Dendrochronological sampling.

Maison (of Hôtel) Dewez, Rue de Laeken 73 and 75, Brussels					
ID dendro KIK-IRPA	**No. of measured rings**	**Mean ring width (in mm)**	**No. of visible sapwood rings**	**Cambium**	**Dating result**
P497/01/001	40	3.47	/	/	undated

Musée du Béguinage, Rue du Chapitre 31, Anderlecht					
ID dendro KIK-IRPA	**No. of measured rings**	**Mean ring width (in mm)**	**No. of visible sapwood rings**	**Cambium**	**Dating result**
P498/01/002	91	0.76	41	/	P498/01/008-002-ech (2 planks from the same tree), dated:felling between 1792 and 1814
P498/01/008	103	0.72	38	/	
P498/01/012	78	1.12	/	/	P498/01/015-012-ech (2 planks from the same tree), undated
P498/01/015	74	1.11	24	/	
P498/01/001	150	0.59	74	close ?	undated
P498/01/003	59	1.35	/	/	undated
P498/01/004	146	0.60	49	/	undated
P498/01/005	77	1.07	/	/	undated
P498/01/006	118	0.83	/	/	undated
P498/01/007	86	0.92	/	/	undated
P498/01/009	59	1.26	/	/	undated
P498/01/010	51	1.41	/	/	undated
P498/01/011	110	1.17	/	/	undated
P498/01/013	58	1.36	/	/	undated
P498/01/014	86	1	/	/	undated
P498/01/016	52	1.45	/	/	undated
P498/01/017	56	1.65	/	/	undated
P498/01/018	54	1.21	/	/	undated

Tab. 4.2

Reference chronologies

The database of absolute chronologies for coniferous woods (Scots pine and spruce), constructed through the collaboration with many European laboratories, covers several centuries and two broad geographic zones.[17] One roughly covers Switzerland, eastern France, southern Germany, Slovenia and Spain. The others includes chronologies representative of the Scandinavian and Baltic countries, Poland and Russia. These chronologies were produced from living or standing dead trees, and wood from archaeological material potentially transported over more or less long distances.[18]

It should be noted that our database of coniferous chronologies does not include all of the possible provenance areas for the trees used in the Brussels floorings. Supply sources such as North America (Groves, 2000: 60)[19] and Central Europe can however be explored in other laboratories by comparing our chronologies with their own datasets.[20] Nevertheless, the hypothesis of exploitation of native pine around Brussels cannot be verified before the creation of absolute chronologies specific to this region.

4.8

Fig. 4.8. Detail of the end of growth for a Scots pine sample with very slow growth: 2-3 mm of wood containing more than 30 rings (Hôtel de Merode, sample no. P482-01-001). Photo: S. Crémer and P. Fraiture

Interpretation of a dendrochronological date

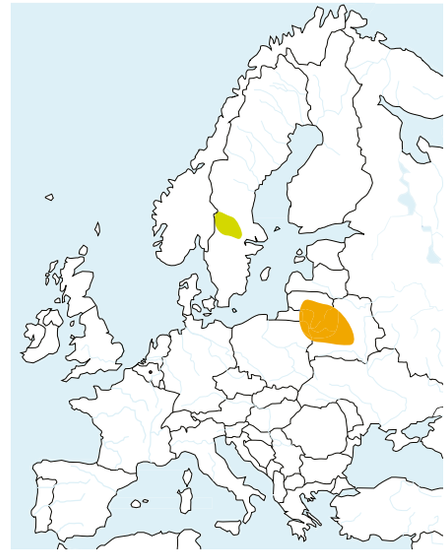
The date obtained for the last tree ring measured on a sample indicates the felling time for the tree, which will be determined with varying precision depending on the state of preservation of sapwood on the samples dated (absent, partial, complete). However, no cambium was identified on the sampled planks; sapwood is thus considered to be incomplete. It should be clarified that unlike oak sapwood, Scots pine sapwood does not decay. Wood craftsmen therefore did not need to remove it for the use the wood in floorings.[21] It should be noted, however, that squaring of long planks like those analysed may have caused the loss of the final tree rings, depriving us of some or all of the sapwood on the samples collected. For cases of extremely slow growth, the loss of 2-3 mm of wood can result in the loss of 25 rings (fig. 4.8). At this stage, the obstacle thus lies in determination of the proportion of missing rings. This estimation is difficult since the number of sapwood rings can vary from one tree to another and even within a single trunk. In addition, unlike oak, very little statistical data is available concerning the number of sapwood rings for Scots pine, according to age, growth rhythm and provenance.[22]

Finally, it must be emphasised that the dates provided by dendrochronology correspond to the felling of the trees and not their utilisation. The time elapsed between the felling period and use of the wood must therefore be estimated. This interval is generally short for carpentry, from six months to a year after felling, in the majority of cases (Hoffsummer, 1995; Hoffsummer, 2002; Hunot, 2001; Épaud, 2011 Houbrechts, 2008). In contrast, it is inevitably longer for joinery products because, in addition to squaring and transport, one must add the time needed to cut and dry the planks and make the woodwork.[23] For oak, historical and archaeological research suggests that for the period from the 15th to 17th century, the time elapsed between felling and use could be only a few months (Fraiture and Haneca, in press). However, some dendrochronological studies have shown a longer interval between the dendrochronological date and the known or estimated use date (Fraiture, 2012).[24] For pine, no large-scale study on this subject is known to the authors. This interval is therefore considered to be highly variable and cannot be generalised. The dendrochronological result proposed for felling is thus also provided as a *terminus post quem* for the installation of the structure.

Dating of the Brussels floorings

At the Hôtel de Merode, ten of 11 Scots pine planks from one of the floorings were retained for dendrochronological analysis; these have between 60 and 280 rings. Four ring series were crossdated and the resulting chronology (277 rings) was dated with a final tree ring in 1563 (table 4.2).[25] The trees from which these planks were cut come from Scandinavia, most likely in central Sweden (table 4.3a and fig. 4.9).[26] It is of interest that central/west Sweden-Norway was an area known for the export of deals (boards) more than of baulks (Groves, 2000: 63). Since sapwood was visible on four samples, a chronological range for felling is estimated between 1570 and 1610.[27] The dendrochronological result could associate part of the dated flooring to a work campaign conducted from 1616-1618 (Sosnowska, 2008: 15, 27) if we consider the time that could have elapsed between felling and use of the wood.

Hôtel de Merode, Rue aux Laines 35, Brussels						
P482-M2 : 1287 – 1563 AD						
Student's *t*	**Corr. coeff. 1**	**Corr. coeff. 2**	**Probability/ security**	**Overlap**	**Repository chronology**	**© reference**
8.23	0.4	0.56	0.999995	174	GvleC-PISY-1383-2011-Ga-vle-Suede	Larsson (www.cybis.se/ forfun/dendro)
6.09	0.25	0.42	0.99999	266	Alvdalen-PISY-1168-1768-Dalarna-Suede	Larsson (data by Bertil Israels and Torbjörn Axelson)
5.76	0.29	0.42	0.999982	203	London-Westminster107JermynStreetJemGrp02	Groves and Locatelli, 2005
4.33	0.28	0.31	0.999921	182	NLPISYv1.7-SvD	van Daalen Dendrochronology, unpublished (former BAAC bv, NL)
4.23	0.25	0.24	0.999918	267	RangersHouseGreenwichParkLondonRANGR-P1	Tyers, forthcoming
4.07	0.31	0.35	0.9999	121	Kungsberg-PISY-1441-2005-Dalarna	Larsson (www.cybis.se/ forfun/dendro)



4.9

Musée du Béguinage, Rue du Chapitre 31, Anderlecht						
P498/01/008-002-ech : 1685-1791 AD						
Student's *t*	**Corr. coeff. 1**	**Corr. coeff. 2**	**Probability/ security**	**Overlap**	**Repository chronology**	**© reference**
7.13	0.45	0.59	0.999992	102	NYorkshireBishopthorpePalaceBishopthorpebsta-T5a	Arnold *et al.*, 2008 (English Heritage, UK)
5.15	0.27	0.57	0.999958	104	ZP06PSC425_Vilnius_RP	Pukienė R., unpublished (National Museum, Palace of the Grand Dukes of Lithuania, LT)
4.77	0.24	0.55	0.999945	104	zpMLpsc7323_Vilius_refRP	Pukienė R., unpublished (National Museum, Palace of the Grand Dukes of Lithuania, LT)
4.25	0.27	0.46	0.999911	104	DevonWarleighHouseTamertonFoliottmfasq05	Howard *et al.*, 2006
4.12	0.34	0.37	0.999903	104	SWED022	Schweingruber, ITRDB

Tab. 4.3

At the Musée du Béguinage in Anderlecht, 23 planks were recovered. All are of Scots pine and 18 of these were studied, those with 50-150 tree rings (table 4.2). Crossdating revealed twice that two planks originated from the same tree. Apart from this, no other synchronisation could be found between the planks. All of the individual series were thus compared to the reference database and only one could be reliably dated, using the Baltic chronologies.[28] Since sapwood was present, the range of 1792-1814 is proposed for felling (last tree ring measured dating to 1791; table 4.3b and fig. 4.9).[29] The lack of correlation between the individual series from the site and the dating of a single sample prevents confirmation of the homogeneity of the flooring proposed on the basis of the typology of the assemblages.

Table 4.3. Dating results for the planks from the Hôtel de Merode, Brussels (4.3a) and the Musée du Béguinage, Anderlecht (4.3b) compared to the KIK-IRPA reference database for conifers.

Fig. 4.9. Geographic provenances identified by dendrochronology for the dated planks of floorings from the Hôtel de Merode (in green) and the Béguinage of Anderlecht (in orange). Map: S. Crémer and P. Fraiture

From the tree to the plank…

Selection of wood species to create the flooring planks

Both treatises on architecture and joinery and carpentry studies describe the attention paid by the construction sector to the choice of wood species and the different qualities of the wood used in buildings (Houbrechts, 2008: 17; Épaud, 2011: 30-32; Touzé, 2011: 23-24, Hunot, 2001: 41). While, based on Hoffsummer (2002), oak was the most common used for structural work in the Southern Netherlands, archaeological and dendrological studies in the Brussels region have also revealed the use of cherry wood, ash, poplar and elm in carpentry (Charruadas and Sosnowska, 2013: 34-36; Sosnowska, 2013: 15-16; Weitz *et al.*, 2015: 200-201; Weitz *et al.*, 2016).

With respect to floorings, only spruce (*Picea* sp.), elm (*Ulmus*), poplar (*Populus*) and Scots pine (Pinus sylvestris) have been identified in Brussels; no evidence of oak or other species is found in our dataset (Gerrienne, 2009; Weitz and Gerrienne, 2011: 3; Fraiture *et al.*, 2013) (table 4.1). Poplar and Scots pine are representative of the 16th-18th centuries while elm has been identified in a building from the first third of the 18th century, alongside Scots pine, and spruce appears only in a context built in the late 18th century (Sosnowska, 2011: 190; Gerrienne, 2009). We stress that the very low representation of elm and spruce in the dataset at present prevent establishment of a broader consideration of the use of these two species. As a result, they will no longer be discussed in this article.

From the published contracts awarded in Brussels, coniferous woods were the only choice indicated for floor coverings. The specification for the construction of the refuge at the Dieleghem abbey, for example, mentions a series of works that were to made of pine (*denen*): the doors of the rooms on the first storey were to made of *widt denen* ('white fir') and the floorings of *goedt denen*, without further clarification of the exact nature of the wood (Van den Haute, 1968-1969: 42). In addition, some construction accounts indicate the use of red fir (*roode denen*) (Hennaut, 2011: 84; Culot, 1992: 175, 264-265). Caution is needed in the interpretation of the descriptions of colour. However, if we compare these terms to modern references, red fir may correspond to Scots pine (*Pinus sylvestris* L.), also called northern red fir (Rameau *et al.*, 2008: 347) given its more or less dark salmon pink colouration (Barry-Lenger *et al.*, 1999: 94-95). In contrast, white fir may be identified as silver fir (*Abies alba* Mill.) whose wood is a creamy pinkish white (Barry-Lenger *et al.*, 1999: 94-95).

This use of white wood and conifers differs from the practices observed at sites in Liège[31] and the southern Brabant (Fraiture and Crémer, 2014) where oak dominates. Brussels is also at odds with some French treatises of the *Ancien Régime*, although far from the geographic context of this article, which also consider oak as the ideal species. Roubo (1769: 162) thus prescribes oak and even insists that, for floorings, one should never use 'pine, because this wood is too soft and shrinks too much'.[32] However, other treaties of the *Ancien Régime*, but especially those from the 19th century, qualify these writings.[33] Philibert Delorme (1561: f°3) points out that if oak is unavailable, beech, poplar, ash, elm, pine, fir, chestnut, etc. can also be used.[34] Similarly, pine is described as being

very good for frames and poplar suitable for joinery or carpentry depending on the species (Nosban, 1827: 47-48; Garraud, 1869: 171).

We note from the outset that poplar is the dominant white wood species in the region studied. Two species were used: European aspen and white poplar.[35] While both were used in joinery, white poplar appears to be better adapted for construction (Garraud, 1869: 171-172, 174-175): cut into small planks, in Flanders it was used to 'make beautiful parquets' and lends itself well to the assemblage (Nosban, 1827: 47). Based on Bosc and Baudrillart (1821: 645), this species was used in rural buildings and all kinds of planks of different thicknesses were cut from the trunks 'for use in the interior'. The rapid growth of this species allows the trunk to obtain its optimum between 20 and 30 years, which is not the case of oak and beech for example, which are slower growing trees (Nosban *et al.*, 1929: 4).[36] Its use, as well as birch, ash and beech, is very often observed in construction, particularly in the ancient palace of Dukes of Brabant (currently Palace of Coudenberg), in secondary buildings or constructions of lesser importance: stables, mills, scaffolding, roofing material and other parts of building made of whit wood, etc. (Rochette, 1960: 73). Poplar is also abundantly used in vernacular architecture, according to written sources (Pierron, 1905 142-143, 243). Its use is attested since at least the 15th century and thus evidences a long tradition in construction.

Pine is an imported species that seems to have been exploited in the Southern Netherlands, and more specifically in the northern Campine region, from the early 17th century, if we accept Gobelet d'Alvillea (1927: 409). It was not, however, used in Brussels or its immediate periphery before the turn of the 20th century (Charruadas, 2012: 103). The dendrochronological study of the flooring of the Hôtel de Merode, dated to the late 16th or early 17th century, shows the use of Scots pine from Scandinavian countries, while the flooring in the Béguinage of Anderlecht, dated to the late 18th or early 19th century, is of Scots pine from Baltic provenance (see above; fig. 4.9 and table 4.3). The simultaneous use of pines from these two large provenance zones has also been demonstrated in England in a single building (Groves, 2000), and in Scotland in different buildings (Crone and Mills, 2012).

It should be noted that these dated planks come from trees of more than a hundred years old, with slow growth (table 4.2; fig. 4.5 and 4.6). At present, no pine plank originating from the Southern Netherlands has been identified at Brussels sites after the 18th century, which is due to the fact that there is currently no dated pine chronology for our regions. Yet it is plausible that planks in the dataset, in particular those with rapid growth very different from the imported ones, come from regional exploitation (fig. 4.4). This was demonstrated in the Netherlands for constructions in the late 19th century at the earliest (Sass-Klaassen *et al.*, 2008), and in Scotland where the 'commercial exploitation of native Scottish pinewood began in earnest in the early 17th century' (Smout *et al.*, 2007: 193 cited in Crone and Mils 2012: 334). This issue could be explored through historical research, coupled with targeted dendrochronological sampling campaigns.

Several arguments shed light on the reasoning behind wood species selection, first from a structural viewpoint. We point out their relative lightness in

comparison to oak, reducing the weight exerted on the exposed beams and thus an ideal material to create floor coverings. Dendrological studies show that oak is one of the heaviest species and the Scots pine and poplar among the lightest (Barry-Lenger *et al.*, 1999: 94-95).[37] These same studies also demonstrate that pine is highly resistant, easy to nail and holds nails well. It is also less susceptible than oak to shrinkage and swelling (Barry-Lenger *et al.*, 1999: 128-131), making it a material particularly well-adapted for cutting into planks.[38] Poplar does not have all of these qualities since it is softer, more fragile and has little tendency to split, but is excellent for nailing, resists splintering (Barry-Lenger *et al.*, 1999: 94-95) and also undergoes less movement than oak.[39] Poplar also allows the cutting of wider planks than other species (see above).

It remains to consider the difficult question of the cost of the product by species – poplar, pine or oak – in the context of Brussels in the 16th-19th centuries. Pertinent data is relatively rare. For example, written sources indicate that poplar had little value and was frequently the object of gracious donations to village communities or some congregations for rural timber-frame construction (Charruadas and Sosnowska, 2013: 35-36). The same observation appears for the Duchy of Brabant (De Jonge *et al.*, 2009: 176). One can also envisage efficient management of resources for construction timber in Brussels, dependent on the availability of different species on the market. In a forested context less abundant than the rich regions situated south of the Sambre and Meuse band, it is plausible than oak was reserved for structural work and poplar for floorings. With respect to Scots pine, one should distinguish that produced locally, or at least regionally, from that imported from northern countries, the transport cost representing the majority of the price of timber (Tossavainen, 1994: 1.2; Sosson, 1996: 752). Regardless, a systematic survey of the Brussels archives would certainly provide a clearer picture of the cost and modes of wood supply for the production of floor coverings.

Finally, we note that oak is not entirely excluded from the creation of floor covering since it is cut into thin strips to be used in the installation of slip tongue-and-groove floorings. This specific use may be linked to the high resistance and density of oak wood.

Cutting of the planks

In Brussels, it appears that wood cutting was done primarily, if not uniquely, by through-and-through sawing, at least until the 18th century. This allows the archaeological analysis of the planks using the following indices: variability in the widths of the planks within a single flooring, differences in dimensions at the ends of a single plank and the nearly trapezoidal section of some planks that follows the initial conical form of the trunk.[40] These data are corroborated by ancient joinery treatises (Roubo, 1769: 32-33).

This cutting technique is time-efficient and easy to implement. The work is executed in three stages: bark removal, placement of lines for cutting the planks and sawing itself. This results in all of the planks being utilised, even the slab planks coming from the edges of the log, which are the most likely to become deformed. Indeed, the latter are present when making floorings, alongside radial- and semi-radial-cut planks. A high disproportion between the planks of

each type can be seen in some cases, perhaps related to the species utilised. For pine floorings, the number of slab planks is relatively high, with the exception of the Hôtel de Merode which is composed of planks coming in majority from near the centre of the log (fig. 4.5). The site of Quai aux-Bois-de-Construction 3 contains six slab planks from a set of 13 planks in total. At the same site, another flooring in poplar has no slab planks in 12 samples. A similar observation can be made for the Scots pine flooring at the Hôtel La Traviata which has a higher number of slab planks (fig. 4.4). Two reasons, perhaps connected, can be proposed to explain such use: the low shrinkage of pine that makes slab planks less subject to buckling and the selection of planks of the best quality (radial and semi-radial planks) for more refined works, such as parquet floorings. These are, however, preliminary observations that should be tested by future studies.

At the Hôtel de Merode, the planks are of trapezoidal and non-parallelepiped format, due to the longitudinal conical section of the tree trunk. The ends of the planks have differences in width between 6 to 11 cm from one side to the other, with respective lengths of 3.24 m and 3.80 m. They thus were not squared, probably to economise labour and materials. However, in contrast, their installation would have been more complicated given the irregularity in the planks to be assembled. This implementation is even more surprising since this is an aristocratic house and the rooms with this kind of flooring are found on the main storey and decorated with wall paintings (Sosnowska, 2008: 22, 27-28). From this viewpoint, the Hôtel de Merode is an exception since it varies so highly, most of the sites studied having only slightly trapezoidal planks. We note that no evidence has been found to indicate that this was a subfloor that would have been overlain by another floor covering, whether in wood or architectural *terra cotta*, for example. This installation may be explained by the dimensions of the rooms in which the width is not greater than the length of single planks. The irregularities in the planks are therefore not directly visible (fig. 4.10).

We assume that flat sawing was also employed. This is identical to the preceding technique (through-and-through sawing) except for the preparation of the log, which was first squared to remove the four slab planks. All of the planks obtained thus have an identical width, unlike the first method that produces narrower slab planks (at the edges) than those from the centre of the log.

Cutting was done manually or mechanically by hydraulic force. The first assumes attaching the log onto a tripod, followed by sawing along its length with a saw held by two men, one above the log and the other below. Attached by a chain, the log is positioned by cantilevering it on the tripod, horizontally or slightly angled and held in place by the counterweight of the log. The sawing angle is 70-80°. It is done at the end of the cantilevering near the centre, then the log is pivoted 180° and sawn from the other end to the centre. Part of the log thus remains unsawn and is split once the log is on the ground, leaving a typical V-shaped mark (Bláha *et al.*, 2008: 126; Fraiture, 2007: 34) (fig. 4.11). In some cases up to three different sawing planes can be observed on the planks, making it possible to follow the movement of the saw from the edges of the log to the centre. On the samples studied, the distance between the striations most commonly ranges between 2 and 7 mm but can be up to 1 cm.

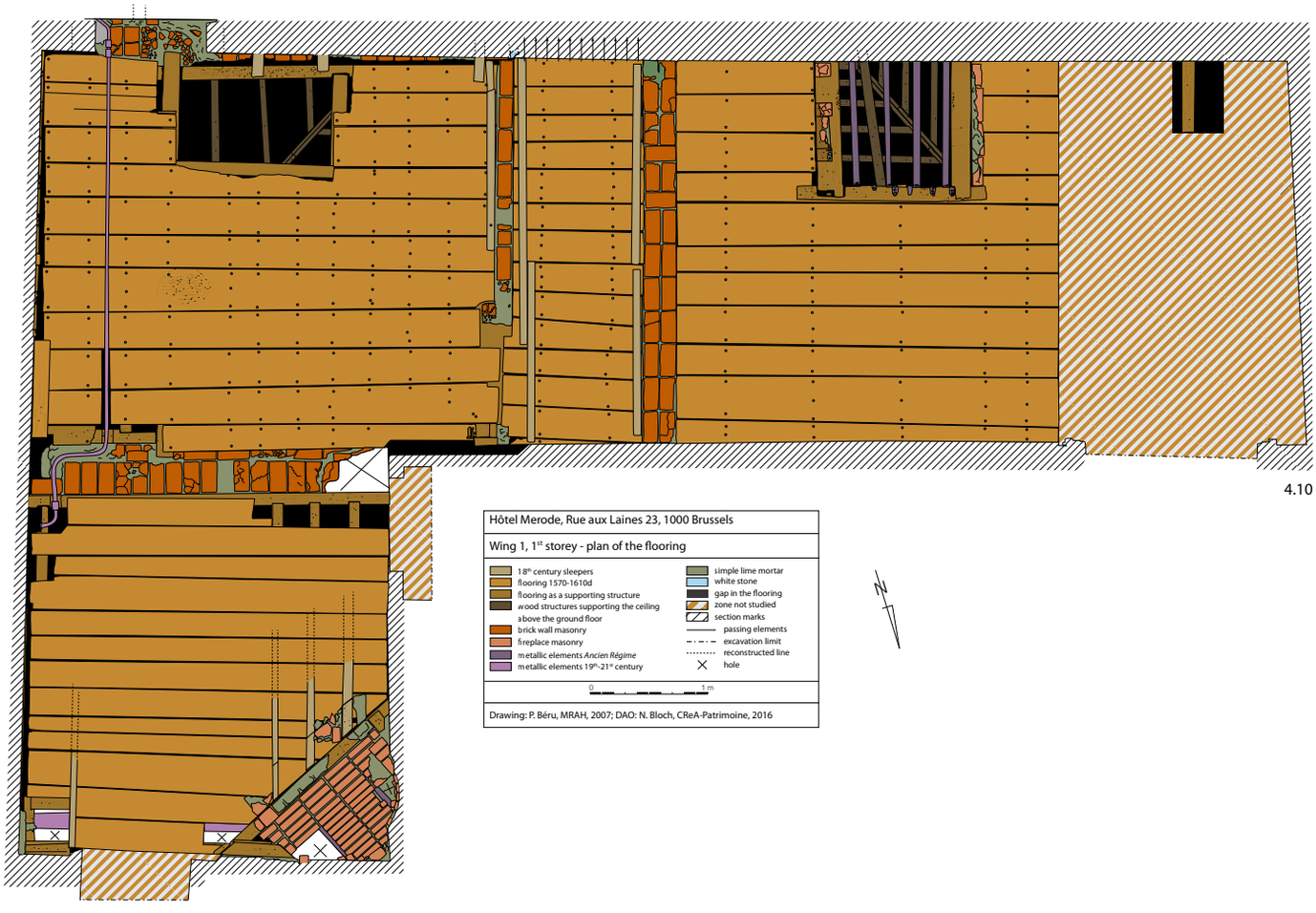


Fig. 4.10. Site of the Hôtel de Merode, Brussels, 1st storey, eastern wing: drawing of a flooring dated between 1616 and 1618. Drawing and CAD: P. Béru © DMS/RMAH

This irregular pattern is clearly differentiated from that created by a mechanical saw which leaves regular traces produced at a constant rhythm. At Quai au Bois-de-Construction 3, the distance between striations is nearly constant at 2-3 mm (fig. 4.12). In addition, at hydraulic sawmills, the plank does not have the sawing V-shaped mark since the saw passes entirely through in one pass without turning the log.

The width of the planks varies with the wood species used (table 4.1). For Scots pine, widths are generally 20-30 cm. Planks have fairly similar widths within a single lot. This is the case at the Béguinage of Anderlecht and Quai au Bois-de-Construction 3 for planks dated to the 19th century. For the first site, these range between 22 and 25 cm, for the second, between 23 and 26 cm. The single exception, once again, is the Hôtel de Merode, which has planks between 28 and 38 cm. For poplar, widths are more variable. The Ferme Rose in Uccle has planks between 15 and 45 cm, with most greater than 28 cm. The same observation is made at Quai au Bois-de-Construction 3 and the Hôtel de Merode[41]. It is also likely to be true for Notre-Dame du Sommeil 17, which provided samples in the same range, with planks up to 40-45 cm.

The thickness is generally between 2 and 3 cm,[42] which is more or less the value of the Brussels inch estimated at 25.068 mm (Ghiesbrecht, 1801-1802: 166). The Hôtel de Merode yet again differs from the other sites, the thickness of the planks reaching 3-4 cm for the oldest. Several hypotheses can be proposed

4.11

4.12

to explain this difference, such as a supply of more robust planks (but more costly) for a prestigious building, the availability of imported planks of larger dimensions in the late 16th-early 17th century compared to the more recent periods at the other sites studied or specific technical modalities of the period and/or the import region. The continuation of our investigations should provide evidence to support one or another of these possibilities.

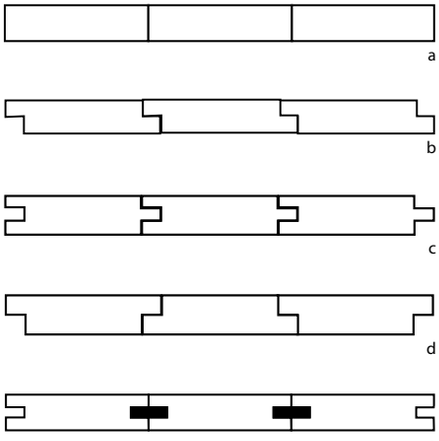
The lengths of the planks for the two species are systematically less than six metres (slightly less than 22 Brussels feet)[43]. In some cases, this constraint required the planks to be laid end to end to cover the surface area. For example, a street-side room on the second storey of the Quai au-Bois-de-Construction 3 building, 7.75 m long, was covered with a series of planks c. 5.30 m long and another series c. 2.40 m long.

Layout of the assemblages: Establishment of a preliminary Brussels typo-chronology

The installation of the plank assemblages of the floorings has been a specific focus in this study, considering its key role in the endurance of the floorings. The assemblages attenuate deformations of the planks subject to movement (shrinkage, swelling, splitting in the middle) by forcing their horizontal

Fig. 4.11. Site at Quai aux Bois-de-Construction 3, Brussels: detail of an 18th-century plank with the typical V-shaped mark from manual sawing. Photo: P. Sosnowska

Fig. 4.12. Site at Quai aux Bois-de-Construction 3, Brussels: detail of saw marks with regular oscillation indicating the use of machine to cut the planks. Photo: P. Sosnowska



4.13

Fig. 4.13. Schema of the different types of assemblages of planks documented in the Brussels floorings. Drawings: P. Sosnowska

position, either by overlapping assemblages – with half-lap joints – or by interlocking the elements. Whether shaped by carpenters or joiners, these assemblages changed over time to improve the system to support all of the elements by reducing the fragility of the assemblages themselves. Five types of assemblages have been identified at present in Brussels, in buildings made between the late 16th and the 19th century. Their presentation below demonstrates a trend towards growing complexity (fig. 4.13). It is to note that this part of the study includes seven additional floorings examined only *in situ*.

Butt joint assemblage

The first type is not a strictly speaking an assemblage since it is made with butt joints. The planks are thus not secured to one another; they are simply nailed to the joists. Few examples have been encountered, except in contexts of repairs or installation of staircase landings, for example at Notre-Dame de Bon-Secours, Rue du Marché-au-Charbon and Place du Grand Sablon 49. Its simplicity explains why it was used during the *Ancien Régime* and until the 19th century.

Half-lap joint in T-shaped rabbet assemblage

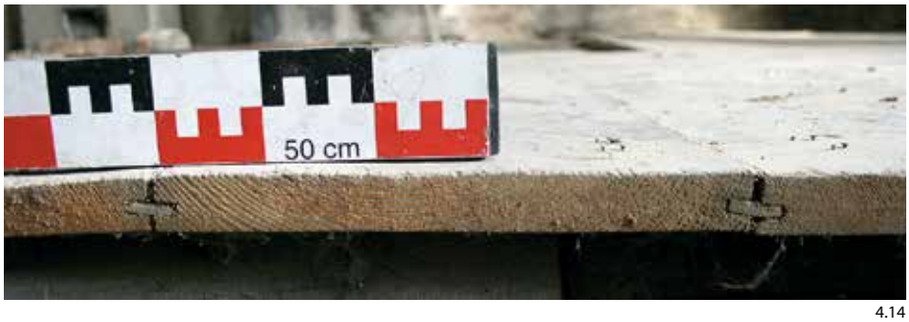
In half-lap joint in T-shaped rabbet assemblages, the disposition of the planks and the orientation of the assemblage faces are reversed each time. The height of the rabbets depends on the thickness of the plank but is never more than half the plank's thickness and is most commonly smaller. They generally have a depth of 10 mm. Some assemblages are bevelled and most are smooth.

The earliest example was seen at the Hôtel de Merode, dated to late 16th-early 17th century (1570-1610d). It is also found in the 17th century in more modest sites (Rue Notre-Dame du Sommeil 17) and up until the turn of the 18th century (Rue du Marché-aux-Herbes 50).

Half-lap joint in S-shaped rabbet assemblage

Half-lap joint in S-shaped rabbet assemblages allow interlocking of the elements and greater resistance to wood movement and crushing due to successive overlaps of the rabbets, each plank blocking by its assemblage the plank that it covers. This type appears in the late 17th century, as evidenced by recent research on houses dating to the reconstruction of the city centre after the 1695 bombardment (Rue du Marché-aux-Herbes 8-10; Rue du Marché-aux-Herbes 46). It was in common usage throughout the 18th century where it was seen in all of the architecture studied for this period: Musée du Béguinage in Anderlecht, Ferme Rose in Uccle (Sosnowska, 2013), Hôtel La Traviata (first third of the 18th century; Hoffsummer and Weitz, 2013), house Rue du Chevreuil 21 and Maison Dewez, dated by their roof frames to 1774d and 1774-1776d respectively (Hoffsummer and Weitz, 2012; Eeckhout, 2004; Perrault, 2008; Sosnowska, 2011).

It should be noted that for the S- and T-shaped rabbet joint assemblages, the planks placed at the end of the floor covering and touching the walls have a rabbet only on the lateral face, the other being a butt joint. This systematic observation indicates that the work to shape the planks was calibrated to the structural needs of the floor covering in preparation.



4.14

Slip tongue-and-groove assemblage

The fourth type of assemblage, using slip tongue-and-groove joints, requires a somewhat more complex preparation than the others. Each edge of the plank must be carved with a groove to receive an independent tongue that will reinforce two adjacent elements (fig. 4.14). The groove is not centred but slightly offset, always towards the bottom, leaving more thickness in the upper part. This arrangement is done to reinforce the operational face of the plank at its most vulnerable zone. While the groove has a variable thickness, its depth appears to be constant at 0.9-1.0 cm. The ridges of the opening may be bevelled. No tool marks were observed.

This type appears to have been in usage at the latest from the extreme end of the 18th century, evidenced by a flooring in the Maison Dewez (Perrault, 2008; Sosnowska, 2011); it was then commonly used at least during the first half of the 19th century, for example in an 1829 building at the Godin factory in Laeken (Quai-aux-Usines 158).

Tongue-and-groove assemblage

Finally, in tongue-and-groove joint assemblages, the two lateral sides of the plank are shaped differently. The groove is carved in one and the tongue in the other such that the tongue is centred and will interlock with the groove on the adjacent plank. This assemblage mode, observed in the second half of the 19th and the 20th century, is recent.

Assemblages in treatises

The brevity with which treatises address this subject contrasts with the diversity of assemblages demonstrated by our archaeological research. Rondelet reports that floorings *sensu stricto* are 'nothing more than a jointed assemblage of oak or pine planks [...]'[44] (Rondelet, 1834: 211) and indirectly specifies that parquets should be mounted on 'tongue-and-groove' floorings (Rondelet, 1834: 213). The *Encyclopedia* mentions the existence of rabbet assemblages that correspond to half-lap joints, but without indication of the arrangement of the assemblages. Slip tongue-and-groove joint assemblages are not mentioned either in the *Encyclopedia* or in Roubo's treatise (Roubo, 1769: 153-164).

Fig. 4.14. Site at Quai aux Bois-de-Construction 3, Brussels, 1st storey: slip tongue-and-groove joint assemblage. Photo: P. Sosnowska

The installation and attachment of the planks of floorings

The art of installing a flooring and its finish

The installation of floorings is done on the beams perpendicular to the joists when this is done in a single work campaign. New floorings, in contrast, may be installed directly onto the area of circulation or on the beams; these do not necessarily follow the orientation perpendicular to the joists.

We also point out that the lateral planks of the floor covering, along the walls, are not directly laid against the masonry but with a gap of 1 to nearly 2 cm that has often been documented (Rue des Pierres 34; Quai aux Bois-de-Construction 3; Maison Dewez; Ferme Rose in Uccle). This would allow a degree of movement of the structure, a margin for the movement of the wood to avoid removal of the planks. In the same spirit, the construction archives for a house situated on the *steenwegh* ('paved road') stipulates that after the floorings are laid, a delay of six months should occur before the final nailing of the planks so that the structure can take its definitive form (Hennaut, 2011: 84). Such a gap would then require the installation of a plinth or panelling to mask it.

The original finish of the circulation side of a flooring is difficult to determine. Wear and maintenance, even sanding, have most often effaced, or at least altered, the first layers of protection of the wood. Research by Bruno Togni provides an interesting look at this subject, particularly on the planing and oiling techniques (Togni, 2012: 31-32). In our dataset, it seems that some of the treatments identified by Togni were not systematically executed. For example, scraping to erase saw marks and smooth the circulation surface to the same level was visibly not done in the attics of ordinary houses (Place du Grand Sablon 49; fig. 4.15) or in a building destined for storage or industrial use (Rue du Chevreuil 21) (Claes and Gautier, 2012: 75, 80); the non-domestic or formal usage of these spaces is clearly the reason for this savings in labour and cost.

The use of nails

The assemblages between planks insufficient in themselves, for the endurance of the flooring, it was necessary to attach the planks to the structural frame. In general, they were nailed to all of the joists with two nails set c. 3-5 cm from the ridges and the widest planks could have a third nail for reinforcement. To date, no nail has been found in a joint assemblage, which appears to reflect a concern to not weaken or deteriorate the assemblages.

Our observations have not shown attachment of planks with wooden pegs. The practice, longer and more inconvenient than the use of nails, exists, however, in other regions, such as France (Togni, 2012: 30). Does this reflect a question of cost, supply, aesthetics or a technical or technological choice?

Two broad categories of forged iron nails have been identified: 'round-headed' nails and 'flat-headed' nails using Roubo's terminology (Roubo, 1769: 259), or 'flattened head' according to the *Encyclopedia* (Diderot and d'Alembert, 1765: 565).[45] The first category is characterised by a circular head and a slightly conical upper face. After nailing, the head remains visible; it is not always at the same level as the wood but somewhat protruding. None of the examples

4.15

examined show the preparation of a small mortise that would allow the entire nail to be inserted. This kind of nail and its use was observed at the Hôtel de Merode for the floorings dated to the first and last quarters of the 17th century, as well as at the two 17th-century houses (Rue Notre-Dame du Sommeil 17, Place du Grand Sablon 49). The nails have a head of 10 × c. 5 mm, a point with maximal section of 4 × 4 mm and a length – for the different elements that could be measured – of 70 to 80 mm.

The iconography confirms this archaeological evaluation, for example on the right lateral panel of the *Annunciation Triptych* (Merode Altarpiece) (Metropolitan Museum of Art, New-York, inv. 56.70a-c) painted by Robert Campin (c. 1378-1444), dated between 1427 and 1432 and representing saint Joseph in his workshop. In addition to the carpenter's tools, the painter represented the flooring and the ceiling in minute detail. The upper side of the flooring is dotted with round-headed nails, arranged linearly three by three and flush with the wood. Their spacing corresponds to the position of the joists, if we refer to the arrangement of the ceiling joists above the workshop. The *Polyptych of the Life of the Virgin* (c. 1541-1560) conserved in St Denis' Church in Forest shows an identical arrangement (fig. 4.16). Numerous 17th-century paintings with interior themes also evidence this practice: in paintings of this type by Jan Steen (c. 1626-1679)[46], Jan Siberechts (1627-1703)[47], in portraits by Cornelis de Vos (1584-1651; fig. 4.17)[48], Jan Cossiers (1600-1671)[49], etc.

Fig. 4.15. Site at Place du Grand Sablon 49, Brussels, storey under the rafters: detail of the upper side of the floor covering showing oblique saw marks. Photo: P. Sosnowska © DMS/ULB

4.16

Fig. 4.16. Reverse of the right wing of the *Polyptych of the Life of the Virgin*, anonymous, c. 1541-1560, St Denis' Church, Forest, oil on wood, 166 × 84 cm (closed) © KIK-IRPA (X003707)

4.17

The second category of nails, with flat heads, is characterised by a head with an oblong T-shaped form for which one of the width of the head is aligned with the point of the nail (fig. 4.18)[50]. It has been observed many times at the Hôtel de Merode in floorings dated to the 18th and 19th centuries, as well as in several more modest buildings, the earliest of which dates to the late 17th century (Rue des Éperonniers 47; Rue du Marché-aux-Herbes 46 and 50), and others of the 18th century (Rue des Pierres 34; Quai au Bois-de-Construction 3; Rue du Chevreuil 21; Maison Dewez). For the Hôtel La Traviata, the nails are c. 60-65 mm long with a nearly square section of 3.5-4 × 3.5-4 mm. The head has a section of 10 mm and a height of 5 mm. At the Maison Dewez, the nails have a length between 60 and 70 mm; their section is relatively square with a thickness varying between 4 and 6 mm; their heads measure between 10 and 12 mm long while their height is between 5 and 7 mm. For each of these sites, the entire nail was embedded in the wood, and the empty space between the head and the surface of the planks could be filled with a small wooden plug. This practice is mentioned in Roubo (1769: 259).

Conclusion

Despite a small dataset, dated between the late 16th and 19th centuries, this study lays the basis for new considerations on a rarely studied type of structure. It is to be hoped that ultimately the Brussels archaeological and dendrochronological studies will expose older examples of floor coverings to enrich the dataset and, as a result, expand our knowledge on the development of floorings. However, the generally poor state of preservation of these coverings, the high real estate pressure in the Brussels Capital Region and, it must be admitted, a certain disinterest or ignorance of this material by architects and other heritage

Fig. 4.17. Cornelis De Vos, *Portrait of a Family*, 1631, Royal Museum of Fine Arts Antwerp, oil on canvas, 165 × 235 cm, and detail of the flooring. Photo © KIK-IRPA, Brussels (B115280)

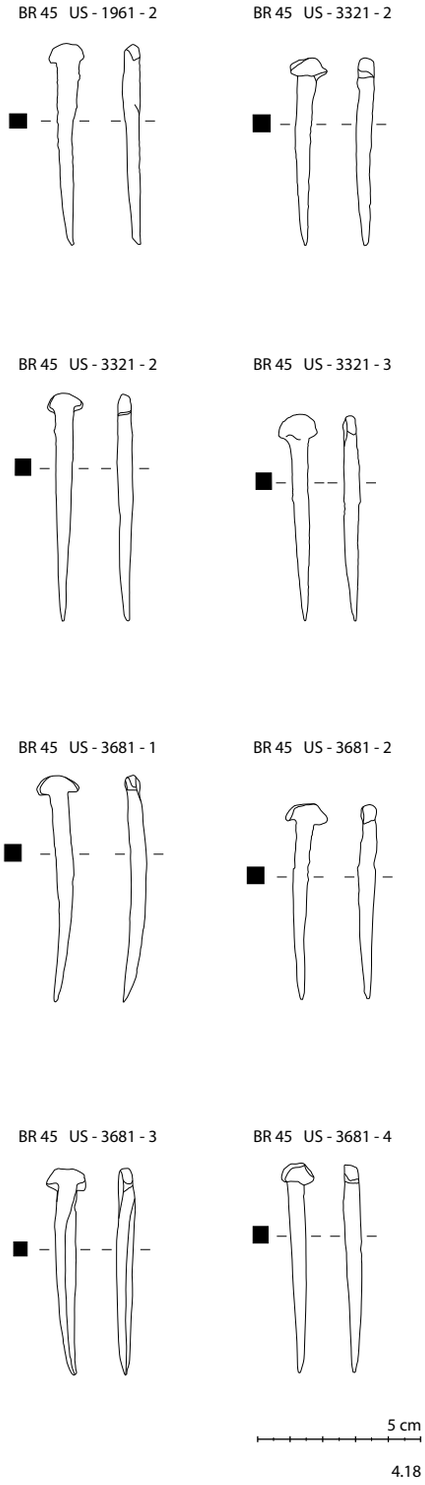


Fig. 4.18. Site of the Maison Dewez, Brussels: flat-headed nails dated to the last quarter of the 18th century. Drawing and CAD: A. Haouata © DMS/RMAH

actors lead most of the time to their disappearance, or to at least major alteration during renovation and restoration projects.

Both recent and older historiography stress the attention paid to the choice of wood species and their specific qualities, as well as the care given to the execution of the different wooden elements of a *plancher*, whether structural or finishing work. The creation of floor coverings did not, however, catch the attention of theoreticians, and even practitioners of the *Ancien Régime*, before the 18th century. We point out, nonetheless, strong disagreement between authors, particularly concerning the usage of recommended species: some, Roubo at the head, show a clear preference for oak, while others propose a wider range of solutions, including coniferous trees and other white woods such as poplar.

In Brussels, the choice of Scots pine and poplar rather than oak may be explained by different, closely linked, factors. The first concerns the anatomic characteristics and technological properties of the two species, suitable for use as planks because they are light and less susceptible to wood movement than oak. They therefore lessen the weight on the beams and provide a better support for the floor covering by limiting deformations in the wood. Scots pine offers more than good resistance to crushing, unlike poplar, which appears more fragile. For the latter, it would be rather the possibility of obtaining wide planks on the local market, at low cost that would explain its use. We note, however, that poplar was used as much in modest houses as in prestigious ones. The second factor explaining the choice of these two species may be connected with the Brussels forested environment in which oak resources were not sufficient to meet all needs. In contrast, poplar was an omnipresent white wood in the regional forest since the medieval period, and imported Scots pine, ideally suited for this usage, was available on the Brussels market from at least the late 16th-early 17th century.

In general, alongside a local supply source, at least for some species, wood was a major part of international commerce, especially from the Baltic countries and Scandinavia. The importation of oak is already largely attested both in written archives and by dendrochronology, particularly in Brussels. Our study has enabled identification of the use of Scots pine from Scandinavia in a case dated to the late 16th-early 17th century and from the Baltic countries in another case dated to the late 18th-early 19th century to make floor coverings. On the other hand, these results stimulate research concerning the organisation of a regional commerce for pine, given that its forest exploitation in the Southern Netherlands could date back to the 17th century based on written sources. The differences in growth typologies documented between sites, and even within a single site, in particular the use of pine of rapid and/or irregular growth alongside individuals of very slow growth, could correspond to 'local' conifers. The systematisation of the dendrochronological study of pine for structural and finishing components of buildings and, through this, the construction absolute regional chronologies would considerably enrich the state of our knowledge of forest resources in our regions during the periods concerned.

In addition to dating and determination of the geographic provenance of the wood utilised, the dendroarchaeological examination contributes to different questions addressed in the history of techniques, such as the selection of

materials, their preparation – for example by the systematic documentation of the preservation of bark/cambium/sapwood – and the time elapsed between felling in a forest and the use of a plank.

The development of the assemblages between the late 16th and the 19th century evidences, in our view, the desire of builders to increase the support and performance of the planks. The objectives of these changes were to increase their resistance at their weak points, in particular to crushing. We note that the diversity in the types of joints observed archaeologically does not appear in ancient treatises, which indicates that the skills of the joiners went further than the theoretical framework of these treatises – although regional preferences also probably played a role. Change also occurred in the types of nails used for floorings in the main rooms: round-headed nails until the turn of the 18th century and flat-headed nails from the late 17th century, the appearance of the second overlapping the end of the use of the first. This adaptation likely reflects an aesthetic development and a search for practicability since it allowed the complete insertion of the nails into the wood.

Finally, in the light of these observations, it is apparent that this kind of component is far from being a simple juxtaposition of planks. The modes of construction employed reveal even more clearly their complexity, from the choice of species to the installation of the planks and the finish on the circulation surfaces. Their examination has thus revealed some of the technical[117] research done by carpenters and joiners of the *Ancien Régime* and highlights the wealth of skills of these craftsmen.

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Notes

1 These analyses were funded by the ULB with the assistance of the Fonds d'Encouragement à la Recherche.

2 Since 2015, this research theme has been integrated within a project on construction materials at the ULB subsidised by the Direction des Monuments et Sites (DMS) of the SPRB. The results obtained will ultimately contribute to the considerations raised in the present article.

3 For Belgium, we cite the example of the exhaustive study conducted on the Notelaer pavilion in Hingene (Buijs and Bergmans, 2010). A preliminary historical and technical overview of the history of floorings in France has been published in the Albums collection of the Centre de Recherches sur les Monuments Historiques (Togni, 2012).

4 Authors' translation in the text of: '*corroyées de toute leur largeur, ou refendues à la largeur de trois ou quatre pouces*'.

5 The *Encyclopedia* differentiates the two types by also specifying that the execution of plank floorings is less expensive than parquet floorings (Diderot and d'Alembert, 1765, vol. 10: 353).

6 It should be noted that this definition of plank flooring as an area of circulation is not accepted by Jean-Marie Pérouse de Montclos. He distinguishes plank flooring as a supporting structure from parquet flooring that includes all areas of circulation made of wood (Pérouse de Montclos, 2011: 167). For him, Roubo's rudimentary plank flooring refers to the typology of parquet floorings without sleepers (Pérouse de Montclos, 2011: 167).

7 Consideration should be given to the structural role played by the planks of a flooring in a timber-framed building.

8 This involved two ordinances: Ordonnance du 13 octobre 1423, Archives de la Ville de Bruxelles, Fonds de l'Ancien Régime, no. 1447, fol. 16r-17r, and an undated ordinance, Archives de la Ville de Bruxelles, Fonds de l'Ancien Régime, no. 1447, fol. 17v-18v, cited in Janssens, 1988: 22.

9 Ordonnance du 13 octobre 1423 (Janssens, 1988: 22).

10 For *solre*, see: http://gtb.inl.nl/iWDB/search?actie=article&wdb=MNW&id=53274 ; for *solringe*, see: http://gtb.inl.nl/iWDB/search?actie=article&wdb=MNW&id=53279&lemma=solringe

11 For example, Siebenlist-Kerner, 1984 or Nicolussi and Patzelt, 2000 in the Alps; Thun, 2002 in Scandinavia; Zunde, 1998 or Läänelaid and Eckstein, 2003 in the Baltic countries.

12 For example, Groves, 2000 in England; Crone and Mills, 2012 in Scotland; Sass-Klaassen *et al.*, 2008 in the Netherlands.

13 The measurement was done onscreen by a specific procedure in *Adobe Photoshop*. The data were then reconstructed and converted to 'Besançon' format by a programming tool *TakeMeasuresFromAdobePhotoshop* (Lambert G.-N., version 20120113, KIK-IRPA).

14 The microscope is coupled with a tree-ring measuring station (*LINTAB 6*, RINNTECH e.K) hooked to a computer with the *TSAP-Win Professional* program that records the tree-ring widths and converts them to dendrochronological format.

15 See Lambert, 2006 (Centre National de la Recherche Scientifique – Laboratoire de Chrono-Écologie de l'Université de Franche-Comté – UMR 6249) for the first working version of *Dendron*. Version IV, used here, is a later upgrade, also by G.-N. Lambert (University of Liège, scientific collaborator).

16 A 'false' tree ring is one in excess, apparently complete with clearly marked limits, which is formed during the same vegetation period as the 'true' ring (as two rings were formed in a single year). 'False' tree rings are not morphologically different from true rings. A 'missing' ring is one absent in a sample due to a failure in cambial activity. Kaennel and Schweingruber, 1995: 135, 232-234.

17 The KIK-IRPA Dendrochronology Laboratory thanks the following laboratories for the chronologies they provided to create this database: Thomas Bartholin (Sveriges lantbruksuniversitet, SE), Marta Domínguez Delmás (formerly of *Stichting RING*, NL), Patrick Gassmann (formerly of the Laboratoire de dendrochronologie, Office du Patrimoine et de l'Archéologie, Neuchâtel, CH), Georges-Noël Lambert (formerly of the Centre National de la Recherche Scientifique – Laboratoire de Chrono-Écologie de l'Université de Franche-Comté – UMR 6249), Lars-Åke Larsson (www.cybis.se/forfun/dendro), Rūtilė Pukienė (National Museum – Palace of the Grand Dukes of Lithuania, LT), Cathy Tyers (University of Sheffield, GB), Sjoerd van Daalen (Van Daalen Dendrochronologie, Deventer, NL, formerly of BAAC bv) and Maris Zunde (University of Latvia, LV).

18 See for example Groves, 1997; Groves, 2000; Sass-Klaassen *et al.*, 2008; Domínguez Delmás *et al.*, 2011; Crone and Sproat, 2011.

19 Mention of the use of American pine, for example, from 1765 in England (Hubbard, 1981: 153).

20 The following laboratories have directly compared our data to be dated with their datasets: Thomas Bartholin (Sveriges lantbruksuniversitet, SE), Claudia Battinger and Niels Bonde (National Museum of Denmark, DK), Anne Crone (AOC Acrhaeology, Edinburgh, GB), Sebastian Luke (Pressler GmbH, DE), Ute Sass-Klaassen (Wageningen University, NL), Willy Tegel (*DendroNet*, DE) and Sigrid Wrobel (Hamburg Universität, DE).

21 References in treatises and rules of the guilds provide many examples, for common joinery and art. For example, a 1508 regulation for the corporation of painters and image sculptors of Abbeville specifies that 'the said sculptors will make images, altar tables... only in good oak wood or *wood from Ireland* without sapwood (Thorel, 1915: 53-79) (authors' translation of: '*les dits tailleurs ne feront images, tables d'autels… que de bons bois de quesne (chêne) ou* bois d'Irlande, *sans nul obel (aubier)*'). Roubo clarifies the importance of removing sapwood 'because if one leaves it, it will soon be riddled with woodworm and crumble into dust' (Roubo, 1769: 25-26) (authors' translation of: '*parce que si on en laissoit, il seroit bien-tôt vermoulu and tomberoit en poussiere*'). In practice, examination of oak floorings and ceilings reveals that the recommendation was generally well-followed, even if some small fragments of sapwood sometimes escaped the vigilance of the craftsmen (e.g., Fraiture, 2015).

22 Numerous statistical studies exist that allow estimation of oak sapwood (e.g., Hollstein, 1978; Hughes *et al.*, 1981; Hillam *et al.*, 1987; Durost and Lambert, 2007; Sohar *et al.*, 2014), while for pine, the only information comes from experimental observations of colleagues working on Scandinavian (Bartholin T., Sveriges lantbruksuniversitet, and Wrobel S., Hamburg Universität, pers. comm., 06/09/2012) and Baltic pines (Pukienė R., National Museum – Palace of the Grand Dukes of Lithuania, pers. comm., 02/10/2012).

23 Treatises are common on the importance of using well-dried wood for joinery (e.g., Roubo, 1769: 1; Diderot and d'Alembert, 1765, vol. 10: 347). However, it is of use to clarify that one year may be sufficient for drying oak or beech planks up to 5 cm thick if good natural drying conditions are met and less still for softer woods such as conifers (Hoadley, 2000).

24 The difference between the date of the last ring measured on a piece of joinery or art (generally without sapwood) can be up to several decades (Fraiture, 2012).

25 These were dated by Swedish chronologies from the Dalarna region, a historical province or *landskap* in central Sweden, and the city of Gävle in central Sweden at the mouth of the River Dalälven that drains into the Baltic Sea (www.cybis.se/forfun/dendro). This date is confirmed by English (University of Sheffield, GB) and Ducth chronologies (Van Daalen Dendrochronologie, Deventer, NL, former of BAAC bv) composed of imported material.

26 Bartholin T., Sveriges lantbruksuniversitet, and Wrobel S., Hamburg Universität, pers. comm., 06/09/2012; Baittinger C. and Bonde N., National Museum of Denmark, pers. comm., 14/09/2012; Sass-Klaassen U., Wageningen University, pers. comm., 30/08/2012.

27 Estimation based on sapwoods of 50 to 110 tree rings, applicable to multi-centennial northern Scots pines (Pukienė R., National Museum – Palace of the Grand Dukes of Lithuania, pers. comm., 02/10/2012; Bartholin T., Sveriges lantbruksuniversitet, and Wrobel S., Hamburg Universität, pers. comm., 06/09/2012).

28 These were dated by English chronologies (University of Sheffield, GB) composed of imported material, as well as by archaeological material found in Vilnius at the confluence of the Vilnia and Neris Rivers, Lithuania (National Museum – Palace of the Grand Dukes of Lithuania).

29 Estimation based on sapwoods of 50 to 80 tree rings, applicable to northern Scots pines 100-150 years old (Pukienė R., National Museum – Palace of the Grand Dukes of Lithuania, pers. comm., 02/10/2012).

30 Roubo (1769: 26) and Nosban (1827: 51) also use this qualification to describe pine.

31 For example, in a house Rue Saint-Hubert, Liège, for a 17th-century flooring (archaeological investigation conducted by Mora-Dieu *et al.*, 2004), and on Gérardrie, Liège, for a 19th-century flooring (archaeological investigation conducted by Mora-Dieu, 2014).

32 Authors' translation in the text of: '*de sapin, parce que ce bois est trop tendre et se retire trop*'. For poplar, Roubo (1769: 27) states generally that 'this wood is soft, difficult to work and is used only rarely' (authors' translation of: 'ce bois est mou, difficile à travailler et ne s'emploie que rarement'). For pine, we emphasise that the faults presented by Roubo, particularly shrinkage, are in contradiction with the results of engineering studies since these demonstrate that fir and pine undergo less shrinkage than oak, for example (Barry-Lenger et al., 1999: 124-131).

33 The difference can be striking between the appreciation of the qualities of the wood species used described in treatises from the second half of the 18th century and the treatises of Vitruve, de La Hire and 19th-century treatises, the latter not only not excluding the use of species other than oak but rather the opposite: '*Namque non potest id robur, quod abies, nec cupressus quod ulmus, nec cetera easdem habent inter se natura rerum similitates, sed singula genera principiorum proprietatibus comparata alios alii generis praestant in operibus effectus*' (Vitruve, text established and translated by Callebat L., 2003: 38).

34 Authors' translation in the text of: '*Et au lieu qu'on ne trouvera du Chefne, qu'on y mettre du Eſtre, du Rouure, du Peuplier, Til, du Fresne, de l'Aulne, du Pin, and des Sapins, qui font meilleurs, & Chafteigniers tres bons*' (Delorme, 1561: f°3).

35 Charruadas P., ULB, pers. comm., 09/02/2016.

36 It is specifically this 'economic' quality that excludes it from dendrochronological studies since a date requires more than 20-30 tree rings.

37 Oak has a mean volume weight of 600-800 kg/m³ with a moisture content of 12%, pine 500kg/m3 and poplar 350-450 kg/m³ (Barry-Lenger *et al.*, 1999: 44-45).

38 Oak undergoes a total tangential shrinkage of 10%, radial shrinkage of 5% and total volume shrinkage of 15%; Scots pine has a tangential shrinkage of 8%, radial shrinkage of 5% and total volume shrinkage of 13% (Barry-Lenger *et al.*, 1999: 131).

39 Poplar undergoes a total tangential shrinkage of 9%, radial shrinkage of 5% and total volume shrinkage of 14% (Barry-Lenger *et al.*, 1999: 131).

40 A similar observation is made by Sebastian Nemestothy (see article no. 9).

41 Such plank widths were also recorded at the Hôtel de Merode in one of the angle pavilions built during the last quarter of the 17th century and at the Ferme Rose in Uccle during 18th-century renovations.

42 Of a sample of 93 planks, 91% have a thickness between 2 and 3 cm while 3% are less than 2 cm and 5% are between 3 and 4 cm (Sosnowska, 2013: 54-55).

43 It would be tempting to apply this width range for Brussels buildings in general. Out analyses show that, of 41 buildings, 58% have widths between 5 and 7 m; to these values can be added buildings less than 5 m which represent 14% of the group studied (Sosnowska, 2013: 51-52).

44 Authors' translation in the text of: '*autre chose qu'un assemblage jointif de planches de chêne ou de sapin* […]'.

45 Authors' translation of: *'à tête rond*', '*à tête plat*' (Roubo, 1769: 259) and '*à tête rabattue*' (Diderot and d'Alembert, 1765: 565).

46 For example *Prinsjesdag. Herberginterieur met een gezelschap dat de geboorte van prins Willem III viert*, 1660-1679, Rijksmuseum, Amsterdam, NL; *Jonge vrouw spelend op een klavecimbel* (acta virunt probant), The National Gallery, London, GB; *Het doktersbezoek*, 1660-1665, Philadelphia Museum of Art, John G. Johnson Collection, Philadelphia, US.

47 For example in a bourgeois interior dated to 1671 and conserved in the Staten Museum for Kunst, Copenhagen, DK.

48 For example in a family portrait dated to 1631 and conserved in the Koninklijk Museum voor Schone Kunsten Anwterpen, Antwerp, BE.

49 For example in his portrait of the Flamen family dated to 1637 and conserved in the Openbaar Centrum van Maatschappelijk Welzijn, Herentals, BE.

50 Roubo describes nails as follows: 'it has only a width similar to the thickness of the nail, and the ordinary width of the other. These nails were used to attach parquets and floorings, and even any other work for which one does not want the heads of the nails to be visible' (authors' translation of: '*elle n'a de largeur sur un sens que l'épaisseur du clou, and la largeur ordinaire de l'autre. Ces clous servent à attacher les parquets and les planchers, and même tout autre ouvrage où l'on veut que la tête des clous ne soit pas apparentes*') (Roubo, 1769: 259).

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Summary

This contribution presents the main results of a study conducted on the use of wood planks as floorings in Brussels between the late 16th and 19th centuries. The dataset of ten sites was examined via an in situ archaeological study, and dendrological and dendrochronological analyses. The floorings were documented with respect to the choice of wood species utilised, primarily Scots pine and poplar, cutting modes and shaping of the planks, and assemblage techniques for the floorings. These have enabled the establishment of a typo-chronology whose variants reflect the desire of the builder to increase the resistance of the structures, a development that does not appear in ancient treatises. Some aspects of attachment and finishing work are also addressed. Alongside an until now poorly documented local supply source, dendrochronological dates have shown the use of resinous woods obtained via international commerce with Northern Europe, particularly Scandinavia and the Baltic countries. The corpus, both well-documented and dated, is used as a basis for new considerations of a rarely studied type of structure, and underlines the technical research done by the carpenters and joiners of the Ancien Régime, demonstrating the richness of the knowledge and skills of these craftsmen.