COST Action FP1302 STSM-report

Reference code: COST-STSM-FP1302-35583

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STSM Topic: "Non-invasive wood identification on historical musical instruments"

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Period: 2017-01-15 to 2017-01-29

1. Introduction

In the field of wooden musical instruments the wood species employed are very important features because they determine the physical and mechanical properties of the wooden artefact, crucial in the prediction of his behaviour to strings tension, to stress and changes in temperature and moisture conditions and, on historical musical instruments, their knowledge is mandatory to allow a correct dendrochronological analysis, which is obviously based on the wood species. In all wooden ancient artefacts the knowledge of the wood is indispensable for the process of historical knowledge, thus helping the attribution to a particular craftsman or artist, and to a particular period of time. In fact, every craftsman of the past had its own preferences about materials and manufacturing techniques. Last but not least, the identification of the wood gives the possibility to identify restorative interventions of the past carried out with different woods from the original ones.
Unfortunately, until now, the identification of the wood in historical musical instruments, and in Cultural Heritage in general, has been too often underestimated and performed only empirically, at a macroscopic level, entrusting it to operators that did not have neither the scientific equipment necessary to perform a microscopic examination, nor the wealth of knowledge and the experience needed to correctly read the microscopic features of wood to obtain a fool proof wood identification. With this STSM project i had the chance to demonstrate the potential of a rigorous and foolproof campaign of wood identification at microscopic level performed on wooden historical musical instruments using non-invasive methods, that are the most appropriate on wooden precious artefacts in which the removal of samples would affect their integrity.
The *Musée des Instruments de Musique* of Brussels (Belgium) has the largest collection in the world of Ruckers *muselaar* (Flemish virginals) and harpsichords. These instruments are an iconic heritage of extreme Flemish expertise in the field of musical instruments production. Despite their value, these instruments have not yet been exhaustively studied in order to widen the historical and organological knowledge about them. To allow it a wood identification campaign at microscopic level was necessary. Due to the great historical value and uniqueness of these musical instruments, wood identification have to be performed by strict non-invasive methods, not involving the removal of wood samples for sectioning, thus, the method that has to be applied is the reflected light microscopy on the wood surfaces.

2. Purpose of the STSM

The aim of the proposed STSM project was to identify, by means of non-invasive microscopic analysis using reflected light microscopy, the wood in the Ruckers musical instruments of the collection owned by the *Musée des Instruments de Musique* of Brussels (Belgium).

3. Description of the work carried out during the STSM

The work was carried out *in situ*, in the museum's *atelier*. A group of 8 keyboard instruments (tab.1) representative of the Ruckers instruments collection of the Museum was studied, identifying the wood on every single visible or attainable wooden part of the musical instruments.

Table 1. Analyzed musical instruments

N°	Type of instrument	Museum inventory n°	Craftsman and year of construction	pictures
1	"mother" muselaar	0275	Ioannes – 1610	
2	"child" muselaar	0275	Ioannes – 1610	
3	harpsichord	0276	Ioannes Couchet – 1646	
4	harpsichord	2510	'Hans' - 1624	
5	4 ½' muselaar	2511	Ioannes – 1629	
6	5' muselaar	2927	Ioannes & Andreas - 1604	
7	4' muselaar	2928	Andreas – 1613	
8	6' muselaar	2930	Ioannes – 1614	

To allow us a complete accessibility of the instrument's parts, jack rails, jacks, name boards, name battens and keyboards were previously separated from the instruments by the museum staff. This allowed the detailed study of the jacks, jack's tongues, keyboard frames, keylevers, coupler dogs, thumbnails, balance rails, racks, stop rails and, in some instruments, lower guides, wrestplanks, upper and lower bellyrails, soundboard ribs and cutoff bars.
Two reflected light portable digital microscopes with a USB interface were used to magnify the wood surfaces: the Dinolite pro AD413T, with eight white LEDs and 10x, 50x and 200x magnification; and the Dinolite premier AM4113ZT4, with a polarized light filter and magnification from 400x to 470x. Both had a resolution of 1.3 Mpixels and were connected to a laptop through USB wires to allow the vision of the magnified wood surfaces on the screen and to allow the capture of the images (fig. 1). The use of special filters, such as the polarized light, facilitated the observation of those surfaces treated with varnishes, making observable anatomical features which otherwise would have been masked.
The wood identification has led to determine the botanical species or its closest *taxon* achievable thru the microscopic anatomic features of wood. The identification followed the anatomical features codified by the International Association of Wood Anatomists (IAWA) [1] [2] and its online identification menu [3] was used.

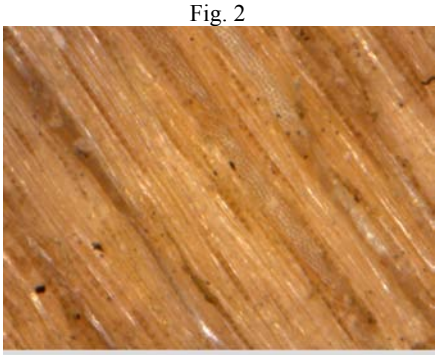
Fig. 1


4. Results

The identification process included viewing the structures at progressively higher magnifications. This provided an initial overview (50X-200X magnifications) of the wood tissue in order to recognize features that would be little or not recognizable at higher magnifications, i.e. growth ring boundaries, the approximate width of both the rings and of the portion of latewood, the arrangement and grouping of vessels, axial parenchyma distribution and arrangement, aggregate rays, tyloses or deposits in the lumen of the biggest vessels; furthermore, in darker woods, the prismatic crystals in the parenchyma cells showed up. Polarized light filter and higher magnification levels (400X) allowed the detection of further important features such as axial resin canals, spiral thickenings, bordered tracheid pits, structure and type of rays, type of perforation, intervessel pits. In fig. 2 some examples of anatomical features visible in single microscopic images are reported.

Fig. 2

1: Wrestplank. Growth ring boundaries distinct, wood ring-porous, vessels in dendritic pattern, earlywood vessels diameter >= 200 µm, Larger rays commonly > 10-seriate, Ray height > 1 mm. *Quercus* sp.



6: keylever n°45. Simple perforation plates, intervessel pits alternate, rays exclusively uniseriate, all ray cells procumbent. *Populus* sp.

8: soundboard. Growth ring boundaries distinct, transition from earlywood to latewood gradual, tracheid pitting in radial walls uniseriate, torus present, axial intercellular (resin) canals present. *Picea abies*

The *taxa* identified during this study are listed in table 2.

Table 2: *taxa* identified

scientific name	common name	family
Acer sp.	Maple	SAPINDACEAE
Betula sp.	Birch	BETULACEAE
Buxus sempervirens	Boxwood	BUXACEAE
Carpinus betulus	European Hornbeam	BETULACEAE
Cedrela odorata	Cigarbox Cedar	MELIACEAE
Diospyros sp.	Ebony	EBENACEAE
Fagus sylvatica	European Beech	FAGACEAE
Juglans regia	European Walnut	JUGLANDACEAE
Liriodendron tulipifera	Tulip Poplar	MAGNOLIACEAE
Picea abies	Norway Spruce	PINACEAE
Pinus sp.	Pine	PINACEAE
Populus sp.	Poplar	SALICACEAE
Prunus sp.	*Prunus* sp.	ROSACEAE
Quercus sp.	Oak	FAGACEAE
Quercus sp.	Bog Oak	FAGACEAE
Rosaceae maloideae	Rosaceae maloideae	ROSACEAE
Softwood	Softwood	PINACEAE
Softwood with axial resin canals	Softwood with axial resin canals	PINACEAE
Swietenia sp.	Mahogany	MELIACEAE
Tilia sp.	Linden	MALVACEAE TILIOIDEAE

The data collected has shown that certain species recurred in specific roles. For instance, Norway Spruce was found mainly in soundboards and stop rails whereas for case sides and baseboards Poplar was the most common species although some additional species from previous restorations were found, such as Tulip Poplar, Linden etc. Poplar was also the largely prevailing species in keyboard frames, keylevers, balance rails and racks. Oak has been found typically in wrestplanks and in some lid parts. Bog oak has been found in all the original sharps. Beech was frequently found in nuts, bridges, jacks, jack's tongues and wrestplanks. Jacks and jack's tongues were also frequently identified as Rosaceae maloideae.
Occasionally found species were: Birch, Boxwood, Cigarbox Cedar, Ebony, European Hornbeam, European Walnut, Mahogany, Maple, Pine, *Prunus* sp.
The only cases where wood identification was not possible were parts completely covered with paint and/or paper and some inner parts of the instruments (e.g. wrestplank, lower guides, soundboard ribs and cutoff bar) inaccessible with the portable microscope due to the insufficient height of the keyboard slit to allow the entrance of the hand and the microscopic device. In fig. 3 a couple of examples of wood surfaces covered with various layers hiding the wood structure.

Fig. 3

8: left bridge. Paint completely covering the wood.

4: hitchpin rail. Preparatory layer and gilding are hiding the wood surface.

In table 3 identification successes and failures, missing parts and inaccessible parts are reported in detail for each musical instrument.

Table 3

Inventory number	275	275	276	2510	2511	2927	2928	2930
soundboard	*	*	*	*	*	*	*	*
wrestplank	*		*	*				*
wrestplank veneer			*	*				
nuts			*	*				
bridges	*	*	*	*	*	*	*	
harpicordium						*		
hitchpin rails	*					*		
toolbox	*					*	*	*
jackrails		*	*	*	*	*	*	*
jack rail holders					*	*	*	*
registers			*	*				
lower guides	*		*	*			*	*
lower guide support	*			*				*
upper bellyrail			*					
lower bellyrail			*					
nameboard	*		*		*	*	*	*
namebatten			*	*				
case sides	*	*	*	*	*	*	*	*
mouldings	*	*	*	*	*	*	*	*
baseboards	*	*	*	*	*	*	*	*
legs	*							
keyboard fixing blocks	*		*	*				*
lid			*	*	*	*	*	*
lid flap			*	*				
lid stick	*		*					
fallboard					*			*
keyboard frame	*		*	*	*	*	*	*
balance rail	*		*	*	*	*	*	*
rack	*		*	*	*	*	*	*
stop rail	*		*	*	*	*	*	*
keylevers	*	*	*	*	*	*	*	*
coupler dogs		*		*				
thumbnails				*				
sharps	*	*	*	*	*	*	*	*
jacks	*	*	*	*	*	*	*	*
tongues	*	*	*	*	*	*	*	*
soundboard ribs	*						*	*
soundboard cutoff bar	*						*	*

*	wood successfully identified
	unidentified wood (due to paint, gilding, patina etc.)
	inaccessible parts
	missing or absent parts

5. Future collaboration with the host institution

In the Museum, during this collaboration, 7 of the 13 original Ruckers musical instruments were studied. It can be very interesting to continue this study on the remaining 6 original instruments. At the MIM there are plenty of wooden musical instruments that were never studied before regarding the identification of the wood species, and the Museum can surely benefit from the precious information obtainable with non-invasive wood identification. It can be very interesting for the MIM and for us to continue this collaboration that can give an important contribution to the organological knowledge about these objects, can allow the performing of dendrochronological studies and can enrich catalogues with many useful details and information. Moreover, several ethnic musical instruments conserved in the deposits of the host institution are of unknown origin and the institution is interested to perform a campaign of non-invasive wood identification that, together with the names of the woods employed, will supply them with precise indications about the natural ranges of the wood species, thus facilitating the geographical attribution of the artefacts.

6. Confirmation by the host institutions of the successful execution of the STSM

The confirmation letter of the host institution of successful execution of the STSM is attached in the file.

7. Authorization to post the report at the Action website

I agree that this report is posted at the Action website.

8. References

[1] IAWA Committee. IAWA list of microscopic features for hardwood identification. IAWA Bulletin n.s., vol. 10 (3), 1989.
[2] IAWA Committee. IAWA List of Microscopic Features for softwood identification. IAWA Journal, vol. 25 (1), 2004.
[3] InsideWood. 2004-onwards. Published on the Internet.http://insidewood.lib.ncsu.edu/search.