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Wooden Musical Instruments Special Issue

A non-invasive approach to identifying wood species in historical musical instruments

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ABSTRACT

Identifying the wood species is an important step in the process of studying and preserving historic wooden artefacts. Identification procedures normally applied in cultural heritage contexts are unsuitable for musical instruments, as sampling might alter the aesthetics and functionality of these historically and culturally valuable instruments. Furthermore, macroscopic identification, through the naked eye or a lens, is often inadequate. It is necessary, therefore, to adopt a non-invasive approach, which renders visible the greatest number of anatomical features possible. The purpose of this study was to evaluate the feasibility and reliability of identifying the wood of historical artefacts using microscopes with high magnification and reflected light together with polarized light filters. A total of 117 musical instruments from the "Luigi Cherubini" Conservatory's collection, preserved at the "Galleria dell'Accademia" Museum in Florence (Italy) were examined as case study. The collected data here presented demonstrate that many anatomical features of the wood can be observed in situ, thanks to the portability of the instruments, and that identifying can be done indeed (in almost 6000 observations, only 8% gave no results). In cases where identifying was not possible, the problems involved: the presence of very thick coats of clear varnish, which makes it virtually impossible to see the structure of the underlying wood; the presence of a patina that conceals the wooden surface; and poor surface quality of the wood, which can falsify the appearance and size of wood cells.

1. Research aims

The main objective of this study was identifying the wood of historical musical instruments by means of a non-invasive approach. Portable microscopes with high magnification and reflected light together with polarized light filters were used and the identification was carried out in situ to meet the conservation needs.

2. Introduction

Identifying the wood species in artefacts of art-historical interest represents one of the most important phases in studying a wooden work of art. In fact, knowing the species ensures correct conservation of the artefact [1], but it also helps to clarify its broader cultural significance. Every work of art that has come down to us from the past is, in itself, a testimony of an intangible heritage, nowadays labeled as traditional knowledge; this is the result of complex relationships that developed over time between local communities, available technologies and the environment. Included in this assemblage of knowledge, skills, practices, beliefs and representations, is the reasoning behind the choice of the most suitable species for creating wooden artefacts. This choice is the end result of an empirical selection process consisting of continuous critical review in order to optimize the realization or functionality of the wooden piece. Consequently, interpreting the choice of wood requires input from a variety of disciplines within a solid interdisciplinary framework.

The identification procedures commonly employed for wood [2,3], often cannot be applied to cultural heritage artefacts in general, and to musical instruments in particular, due to a series of limitations imposed by the uniqueness of the objects and by their continued functionality. For example, microscopic identification, requiring a sample removal, is an operation that is obviously precluded for musical instruments as it would compromise their function and aesthetics. Macroscopic identification, on the other hand, allowing the observation of a very limited number of anatomical features, leads, in the best cases, to the determination of taxa of lower grade (i.e. Groups, Divisions, Families.).

In case of musical instruments the observation of the readable surfaces at high magnification represents a useful option that could successfully lead to the determination of the wooden species or, at

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Table 1
Musical instruments observed.

Bowed stringed (75)	Plucked string (31)	Keyboard (11)
Violin (29)	Guitar (6)	Virginal (4)
Viola (17)	Psaltery (4)	Hurdy-gurdy (3)
Violoncello (9)	Mandola (3)	Harpsichord (2)
Tenor violin (6)	Mandolin (3)	Pianoforte (2)
Double bass (5)	Cittern (3)	
Rebāb (2)	Chitarrone (2)	
Rebec (2)	Guinbri (2)	
Erhu (1)	Arched harp (1)	
Kokyū (1)	Bass Mandolin (1)	
Marine trumpet (1)	Kissar (bowl lyre) (1)	
Pochette (1)	Lyre guitar (1)	
Yehu (1)	Sitar (1)	
	Soron (1)	
	Spiked Lute (1)	
	Tā'ūs (1)	

least, of the Genera. This requires that the main anatomical sections (i.e. LR, LT, and T) can be observed (at least two of them) in the different parts of a musical instrument, and that the surfaces would not be completely covered by coatings consisting of varnish, coloring agents and/or patina [4,5] produced by the gradual deposit of waxes or other fatty substances.

Moving from the work carried out in the studies of coals for anthro-ecological research, where a list of more than 300 features directly observable on the samples was established [6], a method based on non-invasive observation has been developed. This approach has been transferred and adapted to the needs in the study of wooden cultural heritage objects [7], finding in musical instruments one of the most fertile fields of application [4,8–10]. The scientific significance of the method has been confirmed by recent studies published on scientific journals and books [5,11,12].

3. Materials and methods

A total of 117 historical musical instruments from the "Luigi Cherubini" Conservatory's collection, preserved at the "Galleria dell'Accademia" Museum in Florence (Italy) were examined during the period 1999–2014 [9,10,13]. Of these, 105 were from Europe, 6 from Asia and 6 of African origin. The instruments, made between the Seventeenth and Twentieth centuries, were either bowed stringed, plucked string or keyboard instruments (Table 1).

Each of the species, or of the nearest Taxon, was determined for every single visible part of the artefacts; due to the great value of the musical instruments, all observations were performed in situ. The observations were carried out using two portable digital microscopes with a USB interface: the Dinolite pro AD413T, with eight white LEDs and 10 ×, 50 × and 200 × magnification; and the Dinolite premier AM4113ZT4, with a polarized light filter and magnification from 400 × to 470 ×. Both had a resolution of 1.3 Mpixels. 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 terminology used in the anatomical description of the surfaces is the one codified by IAWA [14,15]. For the wood identification the references [5,16–19] were adopted.

Every part of each musical instrument was photographed, documenting the anatomical features useful for identifying the wood species. The features observed were then compared with images of known species, obtained with the same devices, collected in a database owned by the wood anatomy laboratory of Florence University [5]. Features such as color and grain have been taken into consideration with due skepticism, especially color, which varies due to time and human interventions.

4. Results and discussion

The identification process included viewing the structures at progressively higher magnifications. This provided an initial overview of the woody tissue in order to recognize features that would be little or not recognizable at higher magnifications, i.e. growth ring boundaries, eventual false rings, as well as the approximate width of both the rings and of the portion of latewood, which is particularly useful for determining softwood species. Moreover, at lower magnification, it is easy to observe the arrangement and grouping of vessels, axial parenchyma distribution and/or arrangement, aggregate rays, tyloses or deposits in the lumen of the biggest vessels; furthermore, in darker woods, the prismatic crystals in the parenchyma cells show up.

The observation of structural details of the different cell types, made possible by polarized light filters (Fig. 1) and higher magnification, allowed us to detect and distinguish important diagnostic features. For example, in the softwoods, the combination of high magnification and a polarized filter increased the visibility of resin canals, spiral thickenings, bordered pits and parenchyma cells with colored contents, whereas in hardwoods, the structure and type of rays, type of perforation, intervessel pits and the parenchyma distribution and/or arrangement came into view (Figs. 2–7). Moreover, with the use of polarized light filtering it was possible to see prismatic crystals even in the lightest colored woods.

Unfortunately, because of both the magnification levels available and surfaces quality, it was nevertheless impossible to distinguish certain anatomic features. In softwoods, the cross-field pitting were invisible except the fenestriform, and the radial tracheids were clearly visible only in some cases. In hardwoods, instead, it was not possible to see arrangement and size of intervessel pits, fibers, vasicentric tracheids and fibrotracheids in adequate detail.

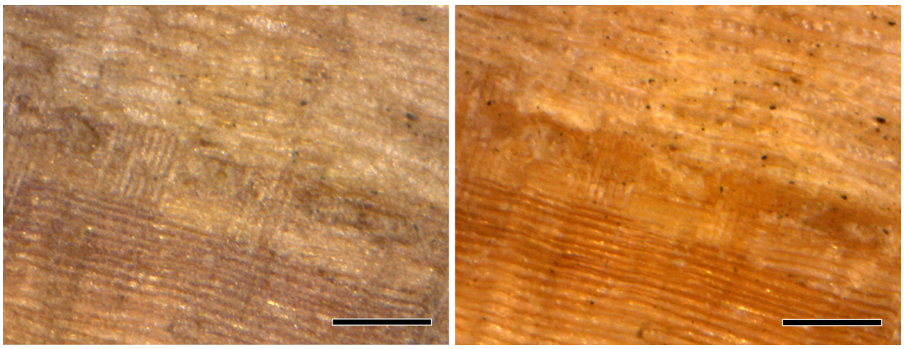

Fig. 1. Milanese mandolin, soundboard. Longitudinal radial section, *Picea abies*. Left: without polarized light filter. Right: with polarized light filter. Scale bar = 200 μm.

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