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Anatomical and chemical analyses on wooden artifacts from a Samnite sanctuary in Hirpinia (Southern Italy)

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ABSTRACT

Objects of this study are the wooden artifacts discovered in the archaeological excavation of Mephitis goddess sanctuary in the Ansanto Valley (Rocca San Felice – AV, Southern Italy). At the moment of discovery, in the mid of last century, woods were waterlogged and mineralized, and they were restored to allow their preservation. Purpose of this work was the wood identification, in order to gain information on some technological aspects, and the analysis of wood preservation state.

Wood species were identified by means of magnifiers or optical and scanning electron microscopes, while the state of preservation was studied through microscopy and chemical analyses (FTIR-ATR, ash content and pH measurement). Four different *taxa* have been identified with certainty among all the findings: *Quercus sp.*, *Fagus sylvatica* L., *Rosaceae*, *Populus/Salix*. It was not possible to identify the wood of all the findings, because some sampled fragments were too small or because of the deformation of wood tissues. The state of preservation showed a great variability over the analyzed findings. A general damage degree was observed, sometimes also macroscopically visible. The polarized light microscope and FTIR-ATR spectroscopy demonstrated the absence of cellulose in the analyzed samples. The wood cell wall was not detectable by means of SEM because it is completely covered by restoration material. Because of the lack of visibility, it was impossible to identify the type of biological damage occurred to the wood.

1. Introduction

Around the half of the 1st millennium BC, goddess Mephitis was venerated in Hirpinia, in a sanctuary in the Ansanto Valley (in the municipality of Rocca San Felice, near Avellino, in the Campania region – Southern Italy), by Hirpini population, one of the four Samnite groups. Samnite economy was essentially tied to agriculture (cereals, viticulture, cultures of fruit trees and vegetables), timber sales and pastoralism; they plundered the neighboring territories, as well as they were mercenaries (practice testified by the belts and the weapons in male graves), but the wealth introduced by these activities was small and of short duration (Tagliamonte, 2005).

Some wooden objects were discovered in this sanctuary (Onorato, 1960). Their discovery has a great importance because of the rare finding of archaeological wood in Southern Italy, but, in this case, the importance is increased by the great historical-artistic and religious value of some of these objects. They are in particular wooden carvings sacred to the goddess.

The necessity to ensure the preservation over time to these objects and the possibility to increase the knowledge about Hirpini population were the main motivation driving this work. The wood species and the state of preservation of the findings were analyzed. The knowledge of wood species provides important information

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about the woodworking technology or the provenience of the wood (Corona, 2002; Macchioni and Lazzeri, 2008). It is well known that different species of wood have different characteristics and properties, depending on wood anatomy. Also prehistoric men well knew the properties of different types of wood and selected them in relation to the more appropriate wood characteristics for the intended purpose (Acanfora, 1970; Stotzer et al., 1976; Perini, 1988; McIntosh, 2009; Hodges, 2009). Sometime other reasons, not tied to wood characteristics, underlie the human choice of a wood species, such as the availability in the site or the religious worship.

Archaeological wood, in whatever way has been preserved, is often affected by deterioration. Microorganisms are one of the main causes of damage: they are mainly bacteria and fungi, deteriorating mostly cellulose, but also lignin. The kind of biological damage is usually investigated through the analysis of wood cell wall (Blanchette et al., 1991; Blanchette, 2000; Relini and Faimali, 2003; Caneva et al., 2007; Capretti et al., 2008; Čufar et al., 2008): in particular the use of different microscopes, like light microscope equipped with polarized mode and SEM (Scanning Electron Microscope), allow to highlight the aspect of degraded cells and what layer of the wall is attacked (Macchioni et al., 2013). Soft rot fungi and erosion bacteria cause often holes and strong deformations mostly into the secondary wall because they feed on cellulose: the consequence of this phenomena is the loss of birefringence observed in degraded wood (Čufar et al., 2014); when the decay is at a very advanced level, the holes join together and the wall becomes completely deformed (Pizzo et al., 2013a). The extent of the attack by biodeteriogenes and its consequence on the residual chemical composition of objects is usually evaluated by means of conventional (wet) analyses (Pizzo et al., 2010, 2013b). Yet, those analyses usually require a large amount of material, which is not always available in archaeological contexts. However, also spectroscopic measurements have shown to give reliable insights about the quantitative chemical composition of archaeological wood (Pizzo et al., 2013c). In general, the knowledge of the kind and of the level of deterioration allows the choice of the best conservative process for the objects.

In this study wood anatomy analysis (by means of magnifiers, stereoscope, optic microscopes and SEM) was useful for the wood species identification and the preservation state evaluation; chemical analyses (i.e. pH and ash content measurements and FTIR-ATR spectroscopy) were performed in order to analyze the current state of preservation of the restored findings respect to "non-restored" or "differently restored" ones. This is important for determining the correct conservation conditions to which the findings should be subjected and for the decision about new consolidation work on the damaged wooden findings.

2. Study area

The Ansanto Valley is an area of calcareous formation (Sinno, 1969; Capano et al., 2013), crossed by a small river (Ansanto River) and a rivulet. It is characterized by gas exhalation phenomena (mainly CO_2, N_2 and H_2S; Chiodini et al., 2010): the gases arise from the subsurface and they diffuse in the atmosphere through cracks in the soil and small lakes with boiling mud (Manzi, 1997).

In the second half of the 1st millennium BC a sanctuary sacred to goddess Mephitis was present in the area. During Samnite period (6th to 4th century BC) the sanctuary was probably an enclosed sacred area of the forest (Rainini, 2003, 2008) and the sacrifice and offering rites took place near the biggest lake or the Ansanto River (characterized by strong gas emissions too). During the last centuries many landslides occurred because of the deforestation and the rock erosion, caused by the acid ground (Ortolani and Pagliuca, 2008; Gambino, 1991). The landslide has restricted the river bed, forcing the water to erode the right bank. The erosion has brought to light the votive objects of Mephitis sanctuary, buried for centuries, which were carried downstream by water (Gambino, 1991). Among the votive objects, the wooden findings were found during the archaeological excavations of Onorato in 1950s (Onorato, 1960; Gambino, 1991); some wooden artifacts were among those findings (Bottini et al., 1976).

3. Materials

The objects found in the excavation are thirteen sculptures (*xoana*), one ritual plate (*patera*) and many other worked pieces, most of which were identified as fragments of a wooden throne and some others not identified. The sculptures are dated from 6th to 4th century BC on the base of their style (Bottini et al., 1976). Radiocarbon analyses partially confirmed this dating (unpublished results).

In this study the *xoana*, the *patera*, eight fragments of throne and two not identified pieces were analyzed (Table 1). The throne pieces have small dimensions (<35 cm) and all present joint elements. Most of the sculptures are small too and they don't have a clear gender indication (Fig. 1): only two of them portray clearly a man, one a woman. Only one sculpture is exceptionally big, the *xoanon* n. 1499, which is about 1.40 m high.

Before the restoration, the woods were in waterlogged conditions, because of their long burial in the wet ground nearby the riverbed, and mineralized. The minerals affecting the woods, described below, were the consequence of the presence of gases arising from the ground and diffusing also in the water sources. Some objects were immediately restored after the archaeological excavations (Augusti, 1959; Augusti, 1961) and preserved in the Museo Irpino of Avellino, partially in the exhibition hall and partially in the basement, located in a modern moldy wooden box, without any protection (Table 1). As highlighted in a previous study (Capano et al., 2012), the findings preserved in the basement were not restored or restored differently with respect to the exhibited ones: the *xoanon* n. 3305 is the only one showing an evident restoration work, consisting in the fixing of spare parts with glue (Capano et al., 2012).

Before the restoration, Augusti performed some chemical analyses on the materials, discovering a deep alteration of the wood, affected by a mineral permeation. According to those analyses, the organic substances still present in the wood of some analyzed finds had an amount from less than 50%–70%. Instead, the mineral concentration varied between 15% and 40%, while in fresh wood normally it is around 1% (Augusti, 1961). The inorganic substances discovered by Augusti (1959) in wood ashes were: Fe^{3+}, SiO_2, sulfur and its oxidation products (e.g. SO_4^{2-} and S^-) and ground compounds (e.g. Ca^{2+}, CO_3^{2-} and Cl^-).

The restoration was performed in two steps: I) removal of water with denatured alcohol, followed by consolidation in a bath of collagen glue and NaF, used as antiseptic, and a bath in tannic acid solution at 3%, in order to make the glue insoluble; II) refilling of cavities in the wood, appeared after the first step, with a wood pulp obtained by the mix of wood powder with a powder of tannin and glue (Augusti, 1959, 1961).

Because of the minerals absorbed in the Ansanto Valley and the alteration in the chemical composition, introduced by restoration, the consistency is different respect to that of a normal wood, being more similar to charcoal.

In addition to the archaeological artifacts, other woods were investigated as test samples for the chemical analyses: I) the wood of a modern deciduous oak (*Quercus* sp.) from Pietrastornina (named Q_Pietra, described in Capano et al. 2012), a village about 30 km far from the Ansanto Valley; II) the wood of a modern