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The Study of Buddhist Sculptures from Japan and China Based on Wood Identification

Mechtild Mertz and Takao Itoh

ABSTRACT The present study of wooden Buddhist sculptures from Japan and China is based on the microscopic identification of the wood species. Research on the wood species of Japanese Buddhist sculptures has a forty-year history. In the 1960s Kohara Jirō, a wood anatomist and pioneer of wood identification of Buddhist sculpture, identified the wood species of 615 sculptures. Based on these results, a first attempt was made to describe the evolution of wood species utilized from the Asuka to the Heian period, also taking into account regional differences. Presently, this research is being continued and completed by research teams in Japan composed of art historians and wood anatomists. Buddhist sculptures from China, however, have not yet been investigated in this way. In fact, a great number of Chinese wooden Buddhist sculptures are preserved in Western museums. For the present study we were allowed to collect samples for wood identifications of more than thirty-five Chinese Buddhist sculptures from several European museums. Wood identification and the discussion regarding the utilization of various wood species may provide historians of East Asian art worldwide with new insights and valuable information concerning the era, location, and spiritual context in which the sculptures were made.

Introduction

Research based on wood identification of Japanese Buddhist sculptures has a forty-year history, and it has recently gained public support. The Bunka-chō (Agency for Cultural Affairs) has given our laboratory responsibility for identifying the wood of Buddhist sculptures restored by the Bijutsuin (Cultural Properties Restoration Institute); the Bunka-chō reserves the right of publication. These studies have made it possible for art historians to obtain important information on the wood selection, the evolution of the selected wood species during various eras, and their religious or symbolic significance. These uses induced the authors to undertake the same approach for Chinese Buddhist sculptures. To date no systematic work of this type has been undertaken inside or outside China. Therefore, this work is pioneering, although it still must be considered, after two years, to be at a preliminary stage.

After an introduction to the technical side of wood identification, this article treats the results obtained after several decades of investigation of wood species used in Buddhist sculptures in Japan. Then the authors present the methodological framework of their investigations on Chinese Buddhist sculptures undertaken, so far, on pieces preserved in Western, mostly European museums. Although no definitive conclusions can be drawn from these first analyses, the trends and hypothesis they suggest allow us to present new and useful information for historians who specialize in this field.

Sampling and Methods

Small samples are taken from the sculptures by means of a scalpel. They are removed so as not to harm the integrity of the sculpture—from hollowed-out parts, from the bottom of the sculpture, from cracks, or from damaged areas (fig. 1). The exact location from which the sample is taken is recorded. Most of the sculptures are made by assemblage of several pieces; some of these have been added during restoration. For this reason it is preferable that samples be taken from different parts of the sculpture.



Figure 1. Sampling in a crack (see arrow) of a seated Buddha Shakyamuni, h. 30.5 cm. Völkerkundemuseum, Munich.



Figure 2. Wood sample and microscopic slide.

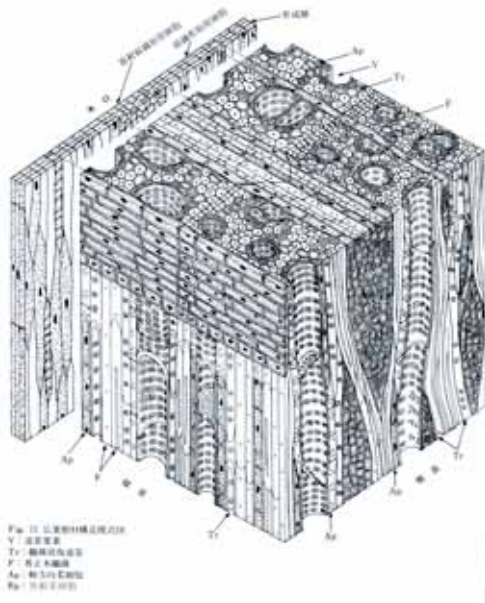


Figure 3. Schematic three-plane drawing of hardwood. After Shimaji and Itoh 1982, 22. V = vessel; Tr = tracheid; F = fiber; Ap = axial parenchyma; Rp = ray parenchyma.

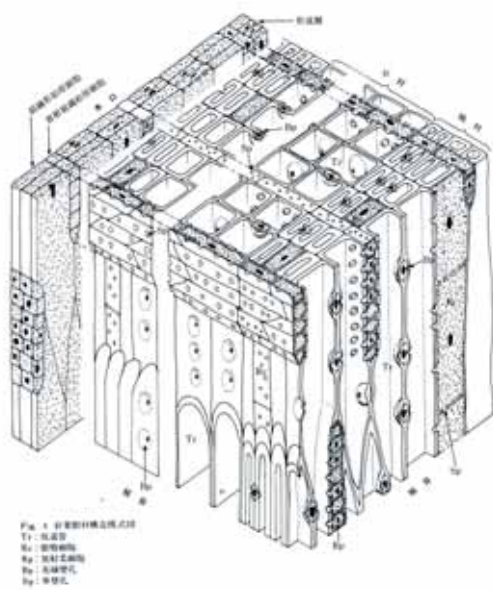


Figure 4. Schematic three-plane drawing of softwood. After Shimaji and Itoh 1982, 6. Tr = tracheid; Rc = resin cell; Rp = ray parenchyma; Bp = bordered pit; Sp = simple pe

First the samples are soaked for several days in water, to soften them. Then thin hand sections are taken in transverse, radial, and tangential directions (10 to 20 μm thick) by means of a double-edged razor blade (fig. 2).

To prepare the microscopic slides, we use water-based gum chloral (a mixture of gum arabic and chloral hydrate) as a slide-mounting medium. The microscopic slides are then ready to be studied under a light microscope. Under magnification of 40–400 \times , the anatomical cell structure of the wood can be studied. The general characteristics of the cell structure of a hardwood and softwood are shown in figures 3 and 4, respectively. Each wood species shows a cell structure specific to its species or genus, which differentiates it from other species or genera. These characteristics allow us to identify a wood at least to family level, mostly to genus level, in some cases even to species level. For a complete documentation, photographs are taken with a camera attached to the microscope. Each sample has to be large enough to allow the cutting of hand sections in transverse, radial, and tangential directions. As long as it shows the tree characteristics of the wood, a sample half the size of a match might be sufficient (see fig. 2). Samples that are small and fragile may be embedded in a polymerizing hard resin (epoxy resin), a method used in electron microscopy. After dehydration in a graded series of alcohol-water mixtures (50%, 70%, 95%, and 100% alcohol) and in propylene oxide, the sample is embedded by using a hard resin like Epon 81 (TAAB, United Kingdom). From the embedded sample sections are taken in the three planes (5–10 μm thick) by means of a rotary microtome. They are then stained with safranin and mounted with a slide-mounting medium such as Bioleit (Öken Co., Tokyo). Generally, we do not recommend this method as it is extremely time consuming and does not invariably reveal the key characteristics that will permit wood identification. Nevertheless, we used this method for three sculptures from the Dunhuang Collection from the Musée Guimet, Paris, for which we only had tiny samples. From the three sculptures, two species could not be identified; the third one, however, yielded a groundbreaking result, which in the end justified this method.

We will now examine how wood identification gives new impulses to art-historical research, first in the case of Japanese Buddhist sculptures, where it is already well established, and then in the case of Chinese sculptures, where it represents a new approach.

Wood Species in Japanese Buddhist Sculptures

In 1963 the wood scientist Kohara Jirō published the results of wood identification studies of 615¹ ancient Buddhist sculptures from all over Japan, which he had been investigating since 1950. His results showed the evolution of the wood species from the Asuka period (552–710) to the Kamakura period (1185–1333), taking into consideration regional differences. In 1972 the public at large in Japan became acquainted with this research through publication of his book entitled *Ki no bunka* (The Culture of Wood), and his hypothesis on the evolution of the wood species

used for Buddhist sculptures became commonly accepted. His research revealed that in the Asuka period virtually all wooden sculptures were made of camphor wood (*kusunoki*, *Cinnamomum camphora* [L.] Presl.),² with the exception of the (Hōkan) Miroku bosatsu of the Koryū-ji Temple, Kyoto, which was made of wood identified as a “two-leaved” pine. In the following Nara period (710–794), the process known as “dry lacquer on wood core sculpture” developed. The wood core was made of Japanese cypress (*hinoki*, *Chamaecyparis obtusa*). According to Kohara, the process evolved in the early Heian period (794–1185) into the “single-block, bare wood surface sculpture” (*ichiboku-zukuri*, *shiraki*). Then, from the middle Heian period on evolved the “joined wood block technique” (*yosegi-zukuri*) with *hinoki* as virtually the sole material. The usage of Japanese nutmeg (*kaya*, *Torreya nucifera*) in the middle of the Heian period appeared briefly at the same time. Recent research also based on wood identification calls this theory into question.

A joint research team composed of two art historians and two wood anatomists investigated one hundred sculptures from the seventh to the ninth century and published their results in 1998 and 2003 in two consecutive publications (Kaneko et al. 1998, 2003). Looking especially at the “single-block sculpture” and the “dry lacquer on wood core sculpture,” they found that of fifty-seven investigated sculptures, forty-five were made of *kaya*, twelve were made of various hardwoods, but none was made of *hinoki*. These new results show that *kaya* had a much more important place than was previously thought, especially in the eighth century.

The sculpture made by single-block construction of the Asuka period using *kusunoki* did not evolve, as Kohara once said, into the “dry lacquer on wood core sculpture” made of *hinoki* of the Nara period, which in turn evolved into the “single-block sculpture” made of *hinoki* in the early Heian period. According to Kaneko et al. (1998, 2003), the making of sculptures by “single-block construction” using *kusunoki* in the Asuka period stopped abruptly, and sculptures made of clay and hollow-dry lacquer became dominant. It was at this time that the priest Ganjin (688–763) constructed the Tōshōdai-ji Temple (759), and both the “single-block construction” made of *kaya* and the “single-block construction in association with dry lacquer” made of *kaya* or *hinoki* were developed.

The discussion over the wood species selected for Japanese Buddhist sculpture has attracted the attention of Japanese art historians for many years, and, due to newly discovered results, the reasons are reconsidered. On the question of why the Japanese chose camphor wood for carving the first Buddhist images, the French art historian François Berthier advanced several hypotheses, both technical and religious, in an elaborated discourse (Berthier 1979). It might be thought that camphor wood was chosen for its particular suitability for carving since it is a preferred material of contemporary sculptors such as Funakoshi Katsura (b. 1951), but in fact, due to its interlocked grain it is difficult to carve (Berthier 1979, following Myōchin 1946). Its difficulty was confirmed by the Japanese Buddhist sculptor Eri Kokei (b. 1943), who stated in an interview with the

authors that irregular fibers of camphor wood mean that one is always carving “against the grain” (Mertz 2003). Regarding religious considerations, Berthier (1979) supported an original theory of the art historian Ogawa Kōyō (1964) that traced the choice of camphor wood back to the association of the Buddha with the Japanese *kami* (divinities). The Buddha, who was received as a *marebitogami* (strange visitor from afar), was expected to act like Okuninushi, a divinity in close relationship with the camphor tree. Therefore this wood was chosen to represent the new divinity who arrived by sea (Berthier 1979).

Once past the beginning of the eighth century the Japanese abandoned the camphor wood in the Kinki areas neighboring Kyoto in favor of the Japanese conifers *hinoki* and *kaya* and, as identifications showed, of local hardwoods in the north that grew in areas outside those of the species preferred. As mentioned above, recent discoveries show that *kaya* occupied a more important place than was thought, and one of the hypotheses advanced by Kaneko Hiroaki traces the choice of *kaya* back to the influence of the *Jūichimen shinju shinkyō giryū* (Commentary on the Heart Sutra of the Divine Incantation of the Eleven Heads), in Taishō, *Shinshū Daizō Kyō*, vol. 20, translated into Japanese in the year Tempyō-15 (743). This comment says that for the carving of an eleven-headed Kannon, *hakusendankō* wood, interpreted as sandalwood, should be used, and, in a country where sandalwood does not grow, *hakunoki* (Cupressaceae family trees in China), interpreted as *kaya*, Japanese nutmeg, should be used as a substitute. Kaneko considers this an epoch-making concept in the history of wooden sculpture, as sandalwood probably could not be widely used due to its scarcity. This text, written about the time of Ganjin’s arrival in Japan, must have influenced the selection of woods in the eighth century (Kaneko et al. 1998).

The properties of Japanese cypress, *hinoki*, make it the most suitable wood for Japanese Buddhist sculpture. This sculpture demands a straight-grained wood, easy to split lengthwise, as the two-man frame-saw for rip-sawing timber was introduced from China only in the fifteenth century (Museum of Kyoto 2000). Furthermore, because *hinoki* has an even surface and warps very little, it is the ideal wood core material for sculptures to be lacquered and gilded.

The cooperation of wood anatomists and art historians led to astonishing results, enriching both research fields respectively. In Japan, almost all sculptures under restoration undergo a wood-anatomical testing, and wood identifications now constitute an integral part of Japanese art history. With the aim to expand this research method to the neighboring countries, we undertook a wood identification project for Chinese wooden sculptures.

Wood Species in Chinese Buddhist Sculptures

A great number of Chinese wooden Buddhist sculptures are now preserved in Western museums. We had the opportunity to collect wood samples from thirty-eight Chinese Buddhist sculptures and seven Daoist sculptures preserved in five European museums and one U.S. museum (table 1).

Table 1. Chinese sculptures studied.

Museum	Sculpture	
	Buddhist	Daoist
Museum für Ostasiatische Kunst, Cologne, Germany	4	
Völkerkundemuseum, Munich, Germany	10	
Museum Rietberg, Zurich, Switzerland	9	
Musée Guimet, Paris, France	8	
Musées Royaux d'Art et d'Histoire, Brussels, Belgium	2	5
Spencer Museum of Art, University of Kansas, Lawrence	5	2

Table 2. Wood identifications of Chinese sculptures.

Wood	Number	Research Institution
<i>Identifications by the Authors (42)</i>		
Linden or limewood, <i>Tilia</i>	8	
Willow, <i>Salix</i>	6	
Poplar, <i>Populus</i>	6	
Euphrates poplar, <i>Populus euphratica</i>	1 (+ maybe 5)	
Boxwood, <i>Buxus</i>	1	
Foxglove tree, <i>Paulownia</i>	9	
Formosan sweet gum, <i>Liquidambar formosana</i>	1	
Cupressoidae (a subgroup of the cypress family)	1	
Not identified	4	
<i>Identifications by Others (2)</i>		
<i>Salix</i>	1	Rijksherbarium, Leiden
<i>Paulownia</i>	1	Jodrell Laboratory of the Royal Botanic Gardens, Kew, London
<i>Populus</i>	1	?
Fig tree, <i>Ficus</i>	1	?

The samples were prepared as described above and observed under the light microscope. The wood species identified to genus level are *Salix* spp. (willow, *liu*), *Populus* spp. (poplar, *yang shu*), *Tilia* spp. (limewood or linden, *duan mu*), *Paulownia* spp. (foxglove tree, *pao tong*), and *Buxus* spp. (boxwood, *huang yang shu*). At species level we identified *Populus euphratica* (Euphrates poplar, *hu yang*) and, additionally, a sculpture from the Musée Guimet identified

in 2002, *Liquidambar formosana* (Formosan sweet gum, *feng xiang shu*). As the discussion on the Daoist sculptures goes beyond the scope of this presentation, they are the subject of a future publication.³ To complete the list of the Chinese Buddhist sculptures identified so far known to us, we can add the results from other investigations, such as of a Guanyin at the Victoria and Albert Museum, London, which was identified as being made of a *Paulownia* sp. (Larson and Kerr 1985), and one at the Rijksmuseum, Amsterdam, identified as being made of *Salix* sp. except for three fragments made of *Paulownia* sp. (Lorne et al. 2002). A Guanyin at the Ashmolean Museum, Oxford, is stated to be made of a kind of fig wood, *Ficus* sp. (*rong shu*) (Tregear 1982–83), and a bodhisattva at the Metropolitan Museum of Art, New York, of poplar wood (Apollo 2001). As a microscopic identification is not mentioned for the two latter examples, we consider these data with reserve. Three sculptures preserved in the Sennyū-ji Temple, in Kyoto prefecture, were identified in our laboratory in 2001. Two are made of *Paulownia* sp., and one belongs to the Cupressoideae (a subgroup of the cypress family), which increases the number of identified Chinese sculptures to forty-four (table 2).

Identifications of Wood Species

The origin of most of the sculptures, which are now preserved in Western museums, are often uncertain, as are some of their dates, so that the data have to be considered with great care. Nevertheless, while being aware of these caveats, it is interesting to present the evolution of the identified wood species on a time axis (table 3).

Although the number of identified sculptures is too small to draw a definitive conclusion, we can see that the wood species used for Chinese sculpture are very different from those used for Japanese sculpture. Among the 615 sculptures identified by Kohara, only two are made of a wood species used for Chinese Buddhist sculpture: a “heavenly garment” (*teni*) of the Amida-nyorai of the Tenpōrin-ji Temple, Hyōgō prefecture, which is made of *Tilia*, and the bodhisattva Kokūzō bosatsu (Akasagarbha) of the “northern priests’ temple quarters” in Nara prefecture, made of paulownia (Kohara 1963). Among the 100 sculptures identified by Noshiro and Fuji (Kaneko et al. 2003), only the wood core of a standing bodhisattva of the Tōshōdaiji is made of paulownia.

Table 3. Wood species according to date of the identified Chinese Buddhist sculptures.

	Salix	Populus	Populus euphratica	Paulownia	Tilia	Liquidambar formosana	Buxus	Cupressoidae
Tang dynasty (618–907)		4	1			1		
Five Dynasties (907–960)			1 (or Salix)					
Song dynasty (960–1279)	4		1 (or Salix)	5	1			
Yuan dynasty (1279–1368)	1		1 (or Salix)					
Ming dynasty (1368–1644)		2	1 (or Salix)	2	4			
Qing dynasty (1644–1911)			1 (or Populus)		2			
Not dated	1			2	1		1	1

In order to understand the great difference between the wood species used in Japan and in China, we investigated the criteria of wood selection of the Chinese sculptor in a first step of an empirical approach. Besides the selection of a local tree suitable for carving, religious and symbolic criteria are considered as well. For the woods identified to genus level, we attempt to propose species.

Distribution of the Wood Species and Some Technical Aspects

The genus *Tilia* consists mostly of tall trees of the mountain forests, growing primarily in temperate zones. Of the twenty-eight species mentioned in the *Flora of China*, only a few are cultivated. The botanist Hui-Li Li writes that the most widely cultivated species are the Manchurian linden, *Tilia mandshurica*, growing in northern China, and *Tilia miqeliiana*, the most frequently grown species in eastern China (Li 1958a). They are valued not only as shade and ornamental trees but also for their wood and bark. As the wood is essentially soft, straight-grained, and easy to work, it is appreciated for carving.

Both the willows and the poplars belong to the willow family, Salicaceae. This family is restricted primarily to the temperate zones of the Northern Hemisphere. According to the *Flora of China* the genus *Salix* contains 275 species (189 endemic), and the genus *Populus* contains 71 species (47 endemic). Hui-Lin Li specifies that of *Salix*, the most widely cultivated species in China are *Salix babylonica* and *S. matsudana*. The former does not grow well in colder and dryer areas; therefore, the latter takes its place in northern China, around Beijing, for instance. Of eastern Asiatic origin are the Chinese white poplar, *Populus tomentosa*, and Chinese aspen, *P. adenophora* (Li 1958b). One poplar we could actually identify to species level is the Euphrates poplar, *P. euphratica*. It is the representative species of northwestern China, growing in a warm, temperate to dry, subtropical climate, where it likes humid areas such as riverbanks and oases (Doutrelepon et al. 1997). It is found in Gansu, western Inner Mongolia, Qinghai, and Xinjiang (*Flora of China*). One sculpture from the Dunhuang Collection at the Musée Guimet could clearly be identified as made from this wood.

While *Salix*, *Populus*, and *Tilia* are trees of the northeastern part of China, with the exception of *Populus euphratica* distributed in the northwest, *Paulownia*, *Liquidambar formosana*, and the Cupressoidae group are mostly found in middle China or even in the subtropics, like most species of *Ficus*.

Of *Paulownia*, only six species are native to China, the two principal ones being *Paulownia tomentosa* (*mao pao tong*) and *P. fortunei* (*bai hua pao tong*). We hope it will be possible in the future to distinguish both species anatomically. *P. tomentosa* is up to 20 m tall and distributed (cultivated or wild) in the provinces of Anhui, Gansu, Hebei, Henan, Hubei, Hunan, Jiangsu, Jiangxi, southern Liaoning, Shaanxi, Shandong, Shanxi, and northern Sichuan. *P. fortunei*, a tree up to 30 m tall, is found farther south in the provinces of Anhui, Fujian, Guangdong, Guangxi, Guizhou,

Hubei, Hunan, Jiangxi, and Sichuan, and in Taiwan (*Flora of China*). This wood has been used for carving since ancient times. Wood identifications performed in 2003 by the College of Wood Science of the Nanjing Forestry University on unearthed wooden sculptures of the Shishui site (north of Nanjing) dating from the Han dynasty (206 B.C.E.–220 C.E.) revealed that paulownia was primarily used. The wood is light and soft, but extremely resistant to humidity and fire. Of boxwood, *Buxus* spp., seventeen species grow in China, mostly south of the Yangtze River. It is a small tree or shrub yielding an excellent wood for fine carving. A sculpture now preserved in a Japanese temple was identified as belonging to the Cupressoidae group of the cypress family (Cupressaceae), which grows mostly in middle or southern China. The most probable candidate is a cypress, *Cupressus* sp. A Guanyin of the Tang dynasty (618–907) examined in 2002 for the Musée Guimet is made of a storax tree (*Liquidambar formosana*, *fēng*), a tree attaining a height up to 40 m found in central and southeastern China. It once formed a considerable proportion of the ancient forest of China and also grew in Taiwan and Hainan. It is a fine shade tree, but the wood offers little resistance to damp and termites (Shaw 1914). *Liquidambar formosana* became popular in botany during the Tang dynasty (Needham et al. 1986). A sculpture in the Ashmolean Museum, Oxford, is said to be made of fig wood, *Ficus*, a tree mostly distributed in subtropical areas. Due to the undocumented identification, however, this result has to be considered with reservation.

Symbolic and Religious Criteria

Written sources also contribute to understanding the criteria for wood selection by ancient people. An important source illustrating how a sculpture representing the Buddha should look is the story of King Udyana, a convert of the Buddha, who, once desperate after the Illuminated had departed to teach his mother in the Heaven of the Thirty-Three Gods, was consoled by a sculpture of sandalwood (*Santalum, tanmu*) that was made for him. A copy of that sculpture was brought to China by the Chinese pilgrim Xuanzang (600–664) around 630, which in turn was copied again for making a sculpture that the Japanese pilgrim Chōnen (938–1016) brought to Japan during the Northern Song dynasty (960–1127) (Soper 1959; Rösch 2004).

In Japan, due to the scarcity of sandalwood, Japanese nutmeg, *kaya*, was considered as an appropriate substitute. In China, however, paulownia seemed to be the recommended material, as it is pointed out by Rösch (2004). She refers to a story recounted by the Tang monk Daoxuan (596–667), in which a magistrate wanted to donate a sculpture with a missing halo. He was thus advised by a monk to use paulownia for the missing part (Rösch 2004).

A specific religious significance attached to a tree may also render a wood suitable for a Buddhist sculpture. Such a tree is the linden. The Buddhists call the linden *pu ti shu* or bodhi tree, a name originally applied to *Ficus religiosa*, a tropical tree under which the historical Buddha attained enlightenment. In later years cuttings from this sacred tree

were taken and planted in different parts of India and Sri Lanka, and from these trees cuttings were brought to southern China, where they were planted in temple precincts. This tropical tree does not grow in northern China, and “in a kind of desperation” (Burkill 1946, 355) the name was transferred to *Tilia*, due to the slight resemblance in the leaves and the uniqueness of the fruit clusters (Li 1958a). Burkill (1946) sees, rather, a resemblance to the shape of poplar leaves. The species cultivated as bodhi trees by Buddhists on temple grounds are *Tilia mandshurica* in northern China and *T. miqueliana* in eastern China. It seems that this attribute was accorded deliberately by priests five or six hundred years ago (Li 1958a; Burkill 1946).

The willow tree is also charged with a symbolic meaning. The Buddhist priest Tanaka of the Manpuku-ji Temple, Uji, Kyoto prefecture, explained that a dowsing rod, a forked willow twig, is used to detect water in the ground, a custom also associated with purifying the ground. A simple willow twig is also used for purification rites. The willow twig and a vase filled with water are symbols associated with Guanyin (Tanaka, priest of the Manpuku-ji Temple, Uji, personal communication, 2005). An interesting representation is the Yōryū Kannon, literally “Willow Kannon” or “Kannon with a willow branch.” Since the Tang dynasty it has been believed that the offering of a willow twig and pure water to Kannon would ward off disasters (JAANUS: entry Youryuu Kannon).

Conclusions

Although, at this stage it is difficult to fulfill the expectations of historians who might hope that wood identification will allow an analysis of the sculptures by region and by era, it provides us with scientific data that enable us to raise new questions in art history regarding the context in which the sculptures have been created. It seems that wood selection is determined, first, by the availability of a tree species and its suitability for carving, but then also by a religious or symbolic meaning attached to the tree. Assembling information associated with each wood species and considering these data against each other should help us slowly to understand the criteria underlying wood selection. Knowledge about the use of the trees, which was handed down from generation to generation since ancient times, is a precious knowledge that has to be preserved as it will provide art historians with new insights. The joint research of art historians and wood anatomists also encourages researchers in wood anatomy to refine wood identification, ideally to species level. For the near future we hope that more wood identifications will be done not only in other Western museums but also in China and Korea.

Acknowledgments

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Notes

1. The number of wood identifications, specified in the report as 627, also includes some *gigaku* masks, halos, and pedestals.
2. “(L.) Presl” indicates the author(s) who published the valid scientific name. The author’s name makes the scientific name accurate and complete, but for clarity, we omit the author’s name here.
3. The identified wood species of the Daoist sculptures are *Cunninghamia lanceolata* (Chinese fir, *shan mu*), *Cinnamomum camphora* (camphor wood, *zhang mu*), and *Rhododendron* sp. (rhododendron, *du juan shu*).

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