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The History of Dowry Chests Captured in Wood: Dendrochronological Research on Chests from the Palace of the Grand Master of the Knights of Rhodes, Greece

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Abstract

Chests represented important piece of the household and sacral furniture until the end of 18th century. They were commonly used as containers, both for everyday needs and also for special occasions such as in the case of marriage/dowry chests. Nowadays chests can be found in museums, monasteries, palaces, historic buildings, but also in private collections, with some of them having great aesthetic, ethnographic and historical interest. In the current study we present the results of wood examination of five chests exhibited in the Palace of the Grand Master of the Knights in Rhodes, Greece. Most of them were made of walnut, while the one made of conifer was useful for further dendrochronological analysis. Macroscopic examination of timber and cross-dating results suggest that the species used for its construction is most probably *Cedrus libani*, originating from Turkey. 1698 AD is the outermost preserved (most recent) ring, placing the chest's construction during the Early Modern period of Europe, most likely at the beginning of the 18th century. Regarding the timber origin, the chest is an example confirming that during the early 18th century there was a trade between Europe and the East Aegean Islands, which then belonged to the Ottoman Empire.

Abstrakt

Historia skrzyń posagowych ukryta w drewnie: badania dendrochronologiczne skrzyń z Pałacu Wielkich Mistrzów w Rodos, Grecja

Skrzynie stanowiły ważny element wyposażenia domostw oraz budynków sakralnych do końca XVIII wieku. Używane były do przechowywania różnego rodzaju przedmiotów, zarówno w życiu codziennym, jak i przy specjalnych okazjach – przykładem są skrzynie posagowe. Obecnie zabytkowe skrzynie można znaleźć w muzeach, klasztorach, pałacach, budynkach historycznych oraz kolekcjach prywatnych, wiele z nich jest szczególnie interesujących pod względem estetyki, etnografii, historii. W niniejszym artykule prezentujemy wyniki badań drewna pięciu skrzyń należących do kolekcji muzeum mieszczącego się w Pałacu Wielkich Mistrzów w mieście Rodos (Grecja, wyspa Rodos). Większość zbadanych skrzyń wykonana została z drewna orzechowego, jedna z drewna iglastego. Skrzynię wykonaną z drewna iglastego zakwalifikowano do badań dendrochronologicznych. Zarówno obserwacja makroskopowa drewna, jak i wyniki analiz dendrochronologicznych sugerują, że skrzynia została wykonana z drewna cedrowego (*Cedrus libani*) pochodzącego z Turcji. Najmłodszy zachowany przyrost został wydatowany na rok 1698. Uzyskane wyniki pozwalają ustalić powstanie skrzyni na początek XVIII wieku. Pochodzenie drewna potwierdza istnienie kontaktów handlowych pomiędzy Europą a wschodnimi Wyspami Egejskimi, które w tamtym czasie należały do imperium osmańskiego.

Introduction

The Palace of the Grand Master of the Knights of Rhodes, also known as the Kastello, is a medieval castle situated in the city of Rhodes, on the island of

Rhodes in Greece. Since 1948 the palace functions as a museum: The Palace of the Grand Master (Byzantine Museum) (fig. 1) and holds an extensive collection of pieces of art, including several chests[1].

The aim of the current study was to identify the material (tree species) used in the construction of five chests from the Museum's collection, to explore their potential of dating with the use of dendrochronology and to give insights into the timber trade and furniture production on Rhodes.

Wooden chests in the history of furniture

Furniture has been one of the most essential requirements of the household throughout the centuries. Ancient furniture was made of stone, wood or metal[2]. Our knowledge concerning ancient wooden furniture is mainly derived from scenes depicted in early art forms, such as pottery decorations and frescos. Examples of still preserved ancient furniture can be found in Egyptian necropoles and tombs[3], although their number is rather limited. Moving towards the present, the number of preserved pieces of wooden furniture is increasing. Couches, beds, chests, tables, stools and chairs are the commonest household items of the past that can be nowadays found in museums, monasteries, palaces, historic buildings, but also in private collections[4]. Furniture made of wood may be more exposed to various events over time, but simultaneously it is exactly the presence of wood that enables their possible accurate dating through dendrochronology.

Chests were most commonly used for storing clothes, documents, valuables, or other possessions. Chests with flat tops were also sometimes used as seats or beds. First indication of chest's usage dates back to the 18th dynasty (c. 1539–1292 BC) in Egypt, where they have been discovered among others inside the tomb of King Tutankhamun. Egyptians used chests for preservation of their mummies, and particularly suitable were chests and sarcophaguses made of aromatic cypress or cedar wood. In ancient Greece chests were

1 The objects under study belong to the authority of the Ephorate of Antiquities of Dodecanese.

2 Özer Özçelik and Timur Kaprol, "Historical Development of Furniture in the Context of Narrow, Restriction and Transformation concepts," in *IFC 2016 International Furniture Congress 13–15 October 2016*, 320.

3 "Furniture Styles," 2004, http://www.furniturestyles.net/, accessed September 27, 2021.

4 Marta Domínguez-Delmás, Martin Bridge, and Arnoud S.Q. Visser, "Dendrochronological Analysis of an English Chest: Contributing to Knowledge about Wood Supply and Chest Production in 16th century England," *Dendrochronologia* 67 (2021): [125828], DOI: 0.1016/j.dendro.2021.125828.

also used for storage, but they were considered as prized pieces of furniture, and were often passed down from one generation to another. In the rest of Europe, chests became popular during the Middle Ages and they constituted an important piece of furniture in the home until the 18th century[5]. In Greece, and most specifically in the Aegean region, chests represented a basic element of the household in the medieval and post-medieval period[6]. They were found both in poor and wealthy houses, used mostly for storing clothes and for sitting on, while from 16th to the 18th century chests (with content) were listed in marriage contracts. Nowadays chests are the most common extant type of medieval furniture[7].

Based on their construction, chests can be divided into four basic types, although mixed types can also be found. The four basic types are: dug-out, boarded, clamped, and framed and paneled. Although the different types seem to follow an evolutionary sequence, several of them co-existed, while the skills of the constructor, the cost and the preferences could also affect the choice of the form of the chest[8]. The type of construction was also dependent on the planed use of the chest – for example medieval so-called "grain chests" were heavily and solidly constructed to protect content from mice and rats[9]. Essentially – chests were regarded as movable objects unlike other pieces of furniture used for storage, like cupboards[10].

Cassoni, also known as *forzieri* or *cofani*, represent a special type of framed and paneled chests, produced in Italy from the early 14th century. They were traditionally made in pairs, as they were usually used as marriage chests, containing the bride's dowry and jewels[11]. During the wedding they

5 "Furniture Styles," Britannica, T. Editors of Encyclopaedia. "Chest," in *Encyclopedia Britannica*, https://www.britannica.com/topic/chest, accessed September 28, 2021.

6 Athanasios K. Vionis, *A Crusader, Ottoman, and Early Modern Aegean Archaeology: Built Environment and Domestic Material Culture in the Medieval and Post-Medieval Cyclades, Greece (13th–20th Centuries AD)* (Archaeological Studies Leiden University 22) (Leiden: Leiden University Press, 2012), 327–337.

7 Christopher Pickvance, "The Canterbury Group of Arcaded Gothic Early Medieval Chests: a Dendrochronological and Comparative Study," *The Antiquaries Journal* 98 (2018): 149, DOI: 10.1017/S0003581518000562.

8 Pickvance, "The Canterbury Group," 149–150.

9 Terje Thun and Elling Alsvik, "Dendrochronological Dating of Four Chests: A Surprising Result," *Dendrochronologia* 27, no. 1 (2009): 71, DOI: 10.1016/j.dendro.2008.07.004.

10 Martin Bridge and Daniel Miles, "A Review of the Information Gained from Dendrochronologically Dated Chests in England," *Regional Furniture* 25 (2011): 25.

11 Christopher Rowell, "Florentine 'Cassoni' at Blickling, Knole and Cliveden," *Furniture History* 51 (2015): 21.

were transported to the house of the groom, to be placed in the matrimonial bedroom. *Cassoni* could be decorated in various ways, with the most elaborate decorative schemes appearing on the front and the sides. More simple painted designs and lettering could also be found on the reverse or inside the structure, particularly under the lid. Painted *cassoni* were made and decorated mainly in Florence, but there were also other areas of production like Siena and Verona during the 15th century[12]. In different centuries and areas different wood species were used for the *cassoni* production.

Different type of chest, quite similar but bigger than *cassone*, is the so-called *cassapanca*. Its Italian name translates as "chest-bench". *Cassapancas* were used both for seating and for storage[13]. In the framework of the current study we examined five chests belonging to the Palace of the Grand Master of the Knights' collection. Three of them are recorded as *cassoni* and two are recorded as *cassapancas* in the list of the Ephorate of Antiquities of Dodecanese (table 1). Little is known about the provenance of these chests and their biographies were never written. Even their use is not clear and only assumptions can be made, based on their decoration. For instance, *cassone* no 4 (ΞΛ69) is most probably a church chest. This chest was opened by accident and a cross sculptured inside the inner side of the lid was discovered, implying its' use in a church. Church chests is a known term and chests found in churches were most likely to be used to store vestments, altar cloths, church plate, jewellery, legal documents, relics, books and money, at least during the Middle Ages[14]. *Cassapanca* no 5 (ΞΛ12) has medieval symbols, stars and bulls which could be the symbols of the wealthy family who was the owner of this chest. The remaining three chests (ΞΛ23, ΞΛ353, ΞΛ10) are most probably marriage chests. It is also unknown whether these chests were related or used in the building, although it is believed that at least some of them were brought to Rhodos by the Italians, during the Italian occupation 1912–1943. The current study attempts to shed some light on all of these questions.

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[12] Lorenzo Sbaraglio, "Cassoni: an introduction," in *Christie's. Old Masters, catalogo d'asta* (London: Christie's, 2017), 50–51.

[13] *Sztuka świata. Słownik terminów A–K*, vol. 17 (Warszawa: Wydawnictwo Arkady, 2013), 107. The Metropolitan Museum of Art: Cassapanca (date: 3. quarter of the 16th century, culture: Italian, Florence, accession number: 58.19a, b); https://www.metmuseum.org/art/collection/search/202107, accessed September 27, 2021.

[14] Penelope Eames, "Furniture in England, France and the Netherlands from the Twelfth to the Fifteenth Century," *Furniture History* 13 (1977): 108–137; Pickvance, "The Canterbury Group," 154.

Dating of chests is possible on the basis of the analysis of their construction and the used materials. Meaningful conclusions can be drawn from the analysis of the tool traces visible on the surface of planks, the way of joining individual structural elements (carpentry or metal fasteners), metal fittings, inscriptions and decoration (formal analysis and identification of material e.g. pigments). All of this information can give an approximate date of the construction of the chest, but dendrochronology is the method which can provide much more accurate and precise dating with additional information, for example about the origin of timbers.

Dendrochronology and its application in cultural-heritage research

Dendrochronology is the scientific method that deals with the dating and study of the annual tree rings, in wood[15]. Dendrochronology has been used in several science disciplines including cultural history, archaeology and fine arts[16]. As described by Edvardsson et al. [17] a common demand of dendrochronology in cultural heritage studies comes from the question: "How old is the wooden object of interest?"

Dendrochronology is the most precise known dating method, but there are several requirements that should be met before applying it. Firstly, not all species are suitable for dendrochronology. Apart from having distinct growth rings the trees should also be long-lived, able to grow under a wide ecological amplitudes, have sufficiently durable heartwood to ensure preservation of the wood, and they should have been used over a sufficiently long period of time[18]. Deciduous oaks and several conifer species are among the

[15] Dan J. Smith and Dave Lewis, "Dendrochronology," in *Encyclopedia of Quaternary Science*, ed. S. A. Elias (Amsterdam: Elsevier Ltd., 2007), 459, DOI: 10.1016/B0-44-452747-8/00063-6.

[16] Johannes Edvardsson et al., "How Cultural Heritage Studies Based on Dendrochronology Can Be Improved through Two-Way Communication," *Forests* 12, no. 8 (2021): [1047], 2, DOI: 10.3390/f12081047. And references therein.

[17] Edvardsson et al., "How Cultural Heritage," 2.

[18] Kristof Haneca, Katarina Čufar, and Hans Beeckman, "Oaks, Tree-rings and Wooden Cultural Heritage: A Review of the Main Characteristics and Applications of Oak Dendrochronology in Europe," *Journal of Archaeological Science* 36 (2009): 1, DOI: 10.1016/j.jas.2008.07.005; Jernej Jevšenak et al., "Sapwood Characteristics of 'Quercus robur' Species from the South-Western Part of the Pannonian Basin," *Dendrochronologia* 54 (2019): 64, DOI: 10.1016/j.dendro.2019.02.006.

most commonly used species in timber dating[19]. Another important restriction is the number of preserved rings with at least 50 rings needed to avoid accidental dating[20]. The existence of appropriate regional and supra-regional reference tree-ring chronologies, together with knowledge of wood anatomy, are key factors in determining the possible origin of the wood, through a technique called dendroprovenancing[21].

Dendrochronological dating should always be treated with caution since the given date does not necessary correspond to the date of the construction of the object under study. Only the presence of bark and / or waney edge (i.e. the smooth wood surface after removal of bark and phloem) allows determining the exact year when the tree was cut or died[22]. In such cases the dating is characterized by the greatest precision[23]. For oaks, when sapwood rings are present the cutting year can also be estimated with precision that depends mostly on the species used and the region of its origin[24]. When none of the above-mentioned features are preserved the only date that can be given is a *terminus post quem* or earliest possible felling date[25]. Nevertheless, even in such cases an estimation of the position of the wooden pieces in the trunk can be made based on the tree-ring curvature[26].

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19 Edvardsson et al., "How Cultural Heritage," 5.

20 Daniel Miles, "The Interpretation, Presentation and Use of Tree-Ring Dates," *Vernacular Architecture* 28, no. 1 (1997): 40–42, DOI: 10.1179/03055479778605056.

21 Dieter Eckstein and Sigrid Wrobel, "Dendrochronological Proof of Origin of Historic Timber – Retrospective and Perspectives," in *TRACE – Tree Rings in Archaeology, Climatology and Ecology. Proceedings of the DENDROSYMPOSIUM 2006. April 20th–22nd 2006 Tervuren, Belgium*, ed. Kristof Haneca et al. (Schriften des Forschungszentrums Jülich, Reihe Umwelt/ Environment 33) (Jülich: Forschungszentrum Jülich, 2007), 8–17.

22 E.g. Miles, "The Interpretation," 40; Ronald H. Towner, "Plant Macrofossil Methods and Studies / Dendroarchaeology," in E*ncyclopedia of Quaternary Science*, ed. S. A. Elias (Amsterdam: Elsevier Ltd., 2007), 2309, DOI: 10.1016/B0-44-452747-8/00390-2.

23 Pickvance, "The Canterbury Group," 170.

24 Malcolm K. Hughes, Stephen J. Milsom, and Patricia A. Leggett, "Sapwood Estimates in the Interpretation of Tree-Ring Dates," *Journal of Archaeological Science* 8, no. 4 (1981): 381–390, DOI: 10.1016/0305- 4403(81)90037-6; Miles, "The Interpretation," 40–48; Haneca, Čufar, and Beeckman, "Oaks," 3–4; Edvardsson et al., "How Cultural Heritage," 10.

25 Miles, "The Interpretation," 48; Pickvance, "The Canterbury Group," 170; Panagiotis Makris et al., "Interpreting the Story Old Timber Can Tell: An Example from a 'Venetian' Building in Nafplio," *International Journal of Architectural Heritage* (2021): [7], DOI: 10.1080/15583058.2021.1963505.

26 Barbara Gmińska-Nowak et al., "Dendrochronological Analysis and Radiocarbon Dating of Charcoal Remains from the Multi-Period site of Uşaklı Höyük, Yozgat, Turkey," *Journal of Archaeological Science: Reports* 38 (103078) (2021): [6], DOI: 10.1016/j.jasrep.2021.103078.

Up today and to our knowledge dendrochronological research on chests is restricted to Central and Northern Europe, as well as to the United Kingdom[27], while no such data exist for South-Eastern Europe and Greece, despite the common use of wooden chests in household during the medieval and post-medieval period[28]. One of the reasons possibly explaining why there has not been much research on chests and decorated furniture pieces in southern Europe, is the problem of collecting tree-ring data without damaging valuable decorated wood.

Materials and methods

The material under study was examined in 2018, when we visited the Palace of the Grand Master of the Knights in Rhodes and examined chests with the assistance of the local conservators[29]. According to the decision of the collection's conservators, all the conducted research was non-invasive.

Since the chests were examined for their possible use for dendrochronology, the first necessary step was to identify the tree species the chests were made of. Due to the restrictions (non-invasive research) concerning the extraction of even a small piece of wood, the identification of tree species was made on the basis of macroscopic observations. Usually, for achieving more accurate results of wood identification, micro-slices showing transverse, radial, and tangential sections of studied wood need to be prepared. The further examination of their anatomical features with the use of biological microscope and their comparison with reference material from known tree-types permit the final accurate identification of the tree species[30].

After assessing the suitability of the chests for dendrochronological analysis, a set of high resolution digital photographs of overlapping sections were taken from all possible parts of the chest, were the rings were visible (e.g. fig. 5–6). Measurements from high resolution images were performed with the use of CooRecorder & CDendro v. 9.0.1 April 19, 2017 (Larsson, Cybis

[27] E.g. Bridge and Miles, "A Review of the Information," 25–55; Thun and Alsvik, "Dendrochronological Dating," 71–74; Domínguez-Delmás, Bridge, and Visser, "Dendrochronological Analysis of an English Chest," 2; and references therein.

[28] Vionis, *A Crusader*, 327–337.

[29] Examination was performed after special permission from the Ephorate of Antiquities of Dodecanese.

[30] Ünal Akkemik and Barbaros Yaman, *Wood Anatomy of Eastern Mediterranean Species* (Remagen-Oberwinter: Kessel Publishing House, 2012); Fritz Hans Schweingruber, *Microscopic Wood Anatomy* (Birmensdorf: Wald, Schnee und Landchaft, 1990).

Elektronik & Data AB). This non-destructive data collecting method is commonly used in cases when objects under study are not permitted to be sampled[31]. Since in some of the photographed planks wood surface represented radial section, such as at the inner side of the lid, it is expected to have some differences / distortion in the measurements compared to a cross-section where tree rings are normally measured.

Tree-rings data obtained from different photographs were measured and synchronized into one single "floating" chronology. Then, the mean floating chronology was cross-dated and synchronized with regional and supra-regional reference chronologies of the same species or with species having similar growth responses to environmental conditions[32]. Cross-dating results were evaluated based on the following parameters: i) *Gleichlaeufigkeit* (Glk), also called "percentage of agreement", a measure of how well the growth of two trees parallel each other in an overlapping set of years; ii) t-value Baillie-Pilcher (TVBP)[33] and t-value Hollstein (TVH) [34] that are sensitive to extreme values, such as marker years[35]; and iii) Cross-Dating Index (CDI), which combines i and ii[36]. The common interval expressed by the number of overlapping years (OVL) was also considered. For Glk and CDI the highest values that can be reached are 100 and 1000 respectively[37], while for t-values 4–5 and higher are considered as significant[38]. Concerning OVL, the longer the

[31] E.g. Thun and Alsvik, "Dendrochronological Dating," 71–74.

[32] Bernhard Muigg et al., „Dendroarchaeological Evidence of Early Medieval Water Mill Technology," *Journal of Archaeological Science* 93 (2018): 18, DOI: 10.1016/j.jas.2018.02.009; Anastasia Christopoulou et al., "Dendrochronology of a Scrapheap, or How the History of Preveli Monastery Was Reconstructed," *International Journal of Architectural Heritage* 15, no. 10 (2019): 7, DOI: 10.1080/15583058.2019.1685023.

[33] Michael G. L. Baillie and Jonathan R. Pilcher, "A Simple Cross-Dating Program for Tree-Ring Research," *Tree-Ring Bulletin* 33 (1973): 7–14.

[34] Ernst Hollstein, *Mitteleuropäische Eichenchronologie: Trierer dendrochronologische Forschungen zur Archäologie und Kunstgeschichte* (Trierer Grabungen und Forschungen) (Mainz am Rhein: Zabern Verlag, 1980), 273.

[35] Anthony M. Fowler and Martin C. Bridge, "Empirically-Determined Statistical Significance of the Baillie and Pilcher (1973) t Statistic for British Isles Oak," *Dendrochronologia* 42 (2017): 51–55, DOI: 10.1016/j.dendro.2016.12.006.

[36] Frank Rinn, "TSAP – Time Series Analysis and Presentation for Dendrochronology and related applications. Version 4.64 for Microsoft Windows – User Reference. Heidelberg, Germany, 2011."

[37] Dieter Eckstein and Josef Bauch, "Ein Beitrag zur Rationalisierung eines dendrochronologischen Verfahrens und zur Analyse seiner Aussagesicherheit," *Forstwissenschaftliches Centralblatt* 88 (1969): 230–250.

[38] Miles, "The Interpretation," 40–41.

overlapping period the more accurate the results of cross-dating are. TSAP software[39] was used for cross-dating and the statistical analyses.

Results and discussion

Tree species identification

The macroscopic examination of the five chests under study revealed three different species. Four (4) of the chests were most probably made wholly or partly of walnut (*Juglans regia* L.). Since we were not permitted to collect samples, our suggestion concerning wood identification is not fully unambiguous, but it is supported with the historical evidence, based on which walnut was the main species used both for *cassoni* and *cassapancas*, at least in Italy, from the 15th till the 19th century[40]. Walnut chests, together with cypress chests for storing clothes and valuable items, were the commonest furniture item in dowries from the 16th century, as suggested for the Aegean region[41]. *J. regia* is a semi-ring / diffuse porous species with visible rings that can be useful for dendrochronology[42], although it is often difficult to identify ring boundaries[43].

Cassone no. 1 was made entirely of walnut (fig. 2). During its examination traces of wood boring insects were found (fig. 3). *Cassone* no. 4 was also made of walnut (fig. 8) and probably was a church chest. *Cassapanca* no. 3 (fig. 7), also seems to be made of walnut, with the exception of the lid, which looks as if it was made of poplar (*Populus* sp.). Poplar is documented to have been used in marriage chest originated from Italy[44] where this type of timber is widely accessible. The second examined *cassapanca* – *Cassapanca* no. 5 was the third chest made entirely of walnut (fig. 9).

The timber used for the construction of the four chests is not useful for dendrochronology, since the rings were too wide and in not sufficient quantity.

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39 Rinn, "TSAP."

40 This is also supported by the documentation of several chests exhibited in the Metropolitan Museum of Art in New York City.

41 Vionis, *A Crusader*, 332.

42 Elisabeth A. Wheeler, "InsideWood – A Web Resource for Hardwood Anatomy," *IAWA Journal* 32 (2) (2011): 199–211, DOI: 10.1163/22941932-90000051.

43 Marta Domínguez-Delmás et al., "X-ray Computed Tomography for Non-Invasive Dendrochronology Reveals a Concealed Double Panelling on a Painting from Rubens' Studio," *PLoS ONE* 16 (2021): [8] e0255792, 10, DOI: 10.1371/journal.pone.0255792.

44 Again this is supported by the documentation of chests exhibited in the Metropolitan Museum of Art in New York City.

Cassone no. 2 (fig. 4) is the only one of the examined chests made of conifer. According to local conservators the cassone was used twice. Macroscopic examination suggests that it could be made of cedar (*Cedrus* sp.). Cedar wood is also documented to have been used in Italian cassone and chests throughout the 17th and the 18th century. Cedar is a high-quality wood, durable and easy to process[45] and its wood has been important commercially for millennia[46]. Cedar wood and its essential oils are natural repellent of months and therefore, cedar is still be used as a lining for chests and wardrobes in which woollens are stored[47]. This could be the reason why this chest is in better state of preservation that the others made of walnut, some of which have extended damages from wood boring insects. *Cedrus* species are suitable for dendrochronology, since the ring boundaries are rather distinct and the transition from early wood to latewood is usually continuous[48]. Planks in *Cassone* no. 2 have sufficient number of rings (figs. 5–6). Therefore, further dendrochronological study has taken place.

Table 1. Examined chests and their characteristics. Codes following the coding given by the Ephorate of Antiquities of Dodecanese with ΞΛ corresponding to "object made of wood"*

Object	Code	Species		Figures
		Scientific name	Common name	
Cassone no. 1	ΞΛ23	*Juglans regia*	walnut	Fig. 2, 3
Cassone no. 2	ΞΛ353	*Cedrus* sp.	cedar	Fig. 4, 5, 6
Cassapanca no. 3	ΞΛ10	*Juglans regia*, *Populus* sp.	walnut, poplar	Fig. 7
Cassone no. 4	ΞΛ69	*Juglans regia*	walnut	Fig. 8
Cassapanca no. 5	ΞΛ12	*Juglans regia*	walnut	Fig. 9

* ΞΛ is an acronym for the Greek word for wood "ξύλο".

45 Nili Liphshitz and Gideon Biger, "Cedar of Lebanon ('Cedrus libani') in Israel During Antiquity," *Israel Exploration Journal* 41, no. 1/3 (1991): 168.

46 Barbaros Yaman, "Anatomy of Lebanon Cedar ('Cedrus libani' A. Rich.) Wood with Indented Growth Rings," *Acta Biologica Cracoviensia Series Botanica* 49, no. 1 (2007): 19.

47 Andreas Douros et al., "Volatile Components of Heartwood, Sapwood, and Resin From a Dated 'Cedrus brevifolia'," *Natural Product Communications* (2019): 1, DOI: 10.1177/1934578X19859125.

48 Fritz Hans Schweingruber, *Trees and Wood in Dendrochronology: Morphological, Anatomical, and Tree-Ring Analytical Characteristics of Trees Frequently Used in* Dendrochronology (New York: Springer-Verlag, 1993), 47–54.

Dendrochronological analysis and timber dating

As above mentioned only *Cassone* no. 2 was suitable for dendrochronology. From the series of high resolution photos we selected 27 of them in which we had more than 30 visible rings and we measured the tree-rings width. These photos correspond to different parts of the chest including the inner side of the lid, the back and front side boards and the vertical stiles. We succeeded in matching together into a mean chronology 11 segments that had between 36 and 72 rings (fig. 10). The developed mean chronology has 77 rings (table 2) and its' mean series intercorrelation (MC) is 0.583 (± 0.098). Some of the segments reach very high cross-dating scores, suggesting that they correspond to planks originating from the same tree.

In none of the examined parts of the chest the bark, or the waney edge were preserved, which means that the date of the final preserved ring can give only a minimum cutting and timber use date.

Table 2. Mean chronology for *Cassone* no. 2

Sample	Number of segments	Average no. of rings per series (range)	Total no. of years	Years AD
CASRH002	11	57 (36–72)	77	1622–1698

The developed chronology for *Cassone* no. 2 CASRH002 was cross-dated against several chronologies for different conifer species due to the uncertainty concerning the species identity. Moreover, we used chronologies from different countries since we did not have enough information concerning the possible timber origin. The best cross-dating results were obtained against cedar chronologies, most of them originating from Turkey. Two *Cedrus libani* A. Rich. reference chronologies from Turkey[49] gave the identical ending year: 1698 AD (table 3), with the best cross-dating results obtained against the Hüseyin Kuyusu cedar chronology from Western Antalya (fig. 11). The same ending

[49] Ramzi Touchan et al., "Reconstructions of Spring/Summer Precipitation for the Eastern Mediterranean from Tree-Ring Widths and its Connection to Large-Scale Atmospheric Circulation," *Climate Dynamics* 25 (2005): 75–98, DOI: 10.1007/s00382-005-0016-5; Ramzi Touchan and Malcolm K. Hughes, "NOAA/WDS Paleoclimatology – Touchan – Elmali (Huseyin Kuyusu & Kocaguney) – JUEX – ITRDB TURK016. [Paleoclimatology-Tree Ring]," NOAA National Centers for Environmental Information, 2007, https://www.ncei.noaa.gov/metadata/geoportal/rest/metadata/item/noaa-tree-5130/html, accessed September 30, 2021.

year was also given against a *Juniperus excelsa* M. Bieb. chronology[50] also from Turkey. Cedar and juniper are species that can be cross-dated against each other and they are sometimes used in mixed chronologies[51], although there are disagreements on this, especially on short sequences containing few samples[52]. Cross-dating results can be considered as valid, although the relatively short sequence of 77 years and the t-values suggest caution. Nevertheless, such results can be explained for species like cedar and by the fact that some of the measurements were done in radial section, based on what was available. Since we did not have any evidence of bark or waney edge, and because of unknown time of wood processing and seasoning, 1698 AD represents the *terminus post quem*, suggesting that the *cassone* was constructed during the Early Modern period of Europe, most likely at the beginning of the 18th century.

Table 3. Cross-dating results of the developed chronology CASRH002 with two reference chronologies. TVBP/TVH are t-values sensitive to extreme values, such as marker years; CDI = Cross-Dating Index; Glk = *Gleichlaeufigkeit* (statistical significance of Glk*=95.0%, **=99.0%, ***=99.9%), a measure of how well the growth of two trees corresponds to each other in an overlapping set of years

Reference Chronology Code	Species	Region	Time span of the reference chronology (no. of years)	TVBP/ TVH	CDI	Glk	No. of overlapping years
ElmalıRa[53]	*Cedrus libani*	Hüseyin Kuyusu	AD 1449–2000 (552)	4.4/5.7	37	69***	77
Turk005[54]	*Cedrus libani*	Antalya, Elmali Isletmesi	AD 1370–1988 (619)	3.9/4.0	24	61*	77

50 Touchan and Hughes, "NOAA/WDS."

51 Peter Ian Kuniholm et al., "Dendrochronological Dating in Egypt: Work Accomplished and Future Prospects," *Radiocarbon* 56, no. 4 (2014): [S96], DOI: 10.2458/azu_rc.56.18344; Peter Ian Kuniholm, Charlotte L. Pearson, and Tomasz J. Ważny, "Hathor and Shaft Grave V: A Dendrochronological Report," in *From Past to Present. Studies in Memory of Manfred O. Korfmann*, ed. Stephan W. E. Blum et al. (Bonn: Verlag Dr. Rudolf Habelt GmbH, 2020), 335.

52 Brita Lorentzen, Peter I. Kuniholm, and Tomasz Ważny, "Dendrochronological Dating and Provenancing of the Late Ottoman Buildings," in *Excavations at the Ottoman Military Compound (Qishle) in Jaffa, 2007, 2009*, ed. Yoav Arbel (The Jaffa Cultural Heritage Project Series 4) (Münster: Zaphon, 2021), 325–335.

53 Touchan et al., "Reconstructions of Spring/Summer," 75–98.

54 Peter Ian Kuniholm, "NOAA/WDS Paleoclimatology – Kuniholm – Antalya Elmali Isletmesi – CDLI – ITRDB TURK005. [Paleoclimatology – Tree Ring]," NOAA National Centers for Environmental Information, DOI: 10.25921/zg3q-bx42.

Conclusions

The obtained results of wood identification suggest that most of the chests (*cassoni* and *cassapancas*) exhibited in the Palace of the Grand Master of the Knights of Rhodes are made of walnut, following the Italian tradition. *Cassone* no 2 is the only one made of conifer, most probably cedar. This *cassone* was the one that was useful for further dendrochronological analysis. Macroscopic examination and cross-dating results suggest that the species used is *Cedrus libani*, originating from Turkey. Based on cross-dating with different reference chronologies the outermost ring measured is 1698 AD, which means that the age of the cassone should be placed at the beginning of the 18th century. Our results may suggest that chests were manufactured in Italy and then imported to Greece, as documented in previous studies[55], while timber trade during the early 18th century between Italy/ Europe and the East Aegean islands, which formed then part of the Ottoman Empire, is also suggested by other studies[56]. Another possible explanation is that carpenters on Rhodes with knowledge of Venetian/ Italian woodworking used timber materials imported from nearby Anatolia to create local furniture pieces. Export of cedar timber from southern Anatolia to the Aegean region has been documented elsewhere[57], while the presence of one of the Ottoman shipyards and timber depots on Rhodes during this time period makes the supply of available cedar timber on the island even more certain[58].

The current study, despite its limitations, represents one of the first efforts to apply dendrochronology with non-invasive methods on chests and decorated furniture pieces in southern Europe. Increasing use of

[55] Vionis, *A Crusader*, 331.

[56] Christopoulou et al., "Dendrochronology of a Scrapheap," 13; Anastasia Christopolou et al., "Aegean Trees and Timbers: Dendrochronological Survey of the Island of Symi," *Forests* 11, no. 12 (2020): 1266: 11–12, DOI: 10.3390/f11121266.

[57] Lorentzen, Kuniholm, and Ważny, "Dendrochronological Dating," 331.

[58] Idris Bostan, "Shipyards in the Eastern Mediterranean During the Late 18th and Early 19th Centuries as Attested in Ottoman Archival Materials," in *The Evolution of Wooden Shipbuilding in the Eastern Mediterranean During the 18th and 19th Centuries. First International Workshop*, ed. Kōstas A. Damianidēs (Athens: National Hellenic Research Foundation / Centre for Neohellenic Research, 1993) 19–23.

non-destructive scanning and image collection methods[59] is expected to further enhance the potential of relevant studies and the information they can provide.

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[59] Francien G. Bossema et al., "A Novel Method for Dendrochronology of Large Historical Wooden Objects Using Line Trajectory X-ray Tomography," *Sci Rep* 11 (2021): [11024], DOI: 10.1038/s41598-021-90135-4; Domínguez-Delmás et al., "X-ray Computed Tomography."

Fig. 1. The Palace of the Grand Master of the Knights of Rhodes, also known as the Kastello in Rhodes, Greece in comparison to reference chronologies used for dating the developed mean chronology CASRH002

Fig. 2. Cassone no. 1 (ΞΛ23) made probably of walnut. Photo: the authors

Fig. 3. Inner wall of the cassone no. 1 (ΞΛ23). Tangential section with traces of wood boring insects. Photo: the authors

Fig. 4. Cassone no. 2 (ΞΛ353) made most probably of cedar. Photo: the authors

Fig. 5. Right vertical stile of the cassone no. 2 (ΞΛ353). A transverse section (cross-section) is visible and tree-rings width can be measured. Photo: the authors

Fig. 6. Cassone no. 2 (ΞΛ353): inner side of the lid where tree-rings width was measured. Photo: the authors

Fig. 7. Cassapanca no. 3 (ΞΛ10). The lower part of the chest is probably walnut. The lid seems to be poplar. Photo: the authors

Fig. 8. Cassone no. 4 (ΞΛ69) made of walnut with a sculptured cross at the inner side of the lid. Photo: the authors

Fig. 9. Cassapanca no. 5 (ΞΛ12) made of walnut. Photo: the authors

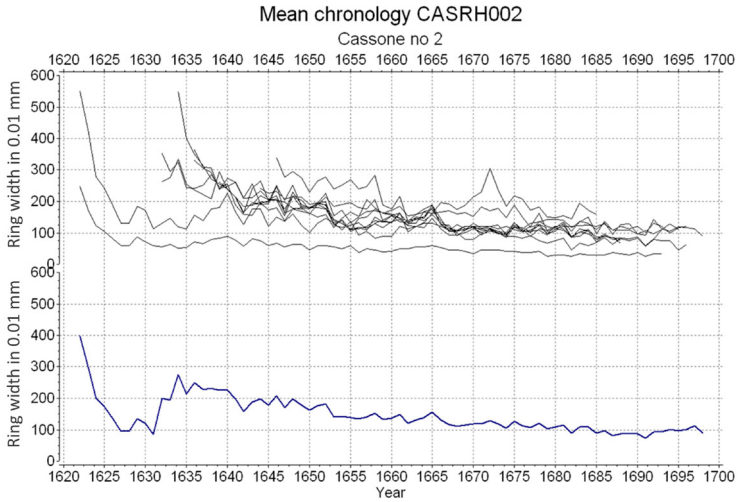

Fig. 10. Tree-rings width of the 11 segments used for the development of the mean chronology (upper part) and developed mean chronology for Cassone no. 2 (blue curve). Calendar years are based on cross-dating results (see the following paragraph)

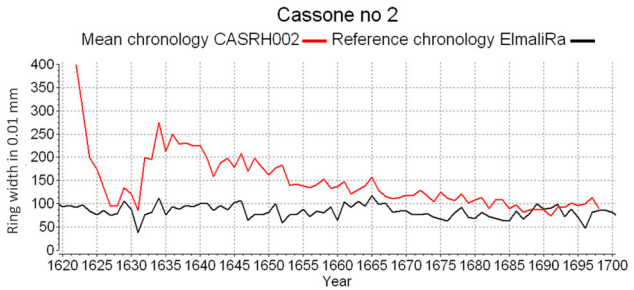

Fig. 11. Visual cross-matching of the CASRH002 chronology (in red) with the *Cedrus libani* chronology from Turkey (ElmalıRa, in black). Only the overlapping period of the two chronologies is presented here

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