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Archaeobotanical and Dendroarchaeological Studies in Ilgarini Cave (Pınarbaşı, Kastamonu, Turkey)

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Abstract: With its historical remains and beautiful travertine formations, Ilgarini cave is important in terms of archaeobotany and natural sciences. In the left part of the cave there are 2 temples and 11 graves. These graves had 3 floors, and wooden materials were used between them. The purpose of the study was to identify the wooden materials taken from the graves in Ilgarini cave and to determine the lifetime of the people who lived in the cave by dating them dendrochronologically. In wood identification analysis, many thin sections were cut, and they were compared with reference wood sections. In dendroarchaeological analysis, tree-ring widths of oak wood were measured and a floating chronology was constructed. As a result of wood identification, we determined that 8 of the wooden materials were oak, and others were 1 chestnut and 1 yew. Oak wood was used between the floors of the graves, but the usage places of the others were not determined. The dating results indicated that 2 usage times of the specimens could be seen. Specimens 12 and 13 were used at around the same time along with specimen 1, and others were used long before them. The last ring of the floating chronology was dated to A.D.977 by dendrochronological methods. With this result we can conclude that the graves and archaeological remains were from the late Byzantine period.

Key Words: Ilgarini cave, archaeobotany, dendrochronology, dendroarchaeology, dating, Turkey

Ilgarini Mağarası'nda (Pınarbaşı-Kastamonu) Arkeobotanik ve Dendroarkeolojik İncelemeler

Özet: Tarihi kalıntılara ve oldukça güzel görünüşlü travertenlere sahip olan Ilgarini Mağarası, arkeoloji ve doğa bilimleri açısından büyük bir öneme sahiptir. Mağaranın girişinden sonra güney yöne ayrılan kol üzerinde üçer katlı toplam 11 mezar ve 2 tapınak kalıntısı bulunmaktadır. Üçer katlı mezarların katları arasında odunsu materyaller kullanılmıştır. Bu çalışmanın amacı, Ilgarini mağarasından alınan odun örneklerinin tanımını yapmak ve dendrokronolojik yöntemlerle kullanım dönemlerini saptamaktır. Odun tanıma analizleri için, çok sayıda ince kesitler alınmış ve referans preparatlarla karşılaştırmalar yapılmıştır. Dendroarkeolojik analizlerde ise, yıllık halka genişlikleri ölçülmüş ve bir hareketli kronoloji oluşturulmuştur. Odun anatomisi sonuçlarına göre, materyallerden sekizi meşe (*Quercus* L.), biri kestane (*Castanea sativa* L.) ve biri de porsuk ağacıdır (*Taxus baccata* L.). Meşeler mezarların katları arasında kullanılmış, diğerlerinin kullanım yerleri ve zamanları saptanamamıştır. Tarihlendirme sonuçlarına göre, odun örneklerinin iki farklı dönemde kullanıldığı görülmektedir. Örnek 12 ve 13, örnek 1 ile birbirine yakın zamanlarda, diğerleri de, bunlardan çok daha önce kullanılmıştır. Elde edilen yıllık halka kronolojisinin son halkası M.S.977 yılına dendrokronolojik yöntemlerle tarihlendirilmiş, mezarların ve arkeolojik kalıntıların Bizanslıların son dönemine ait olduğu sonucuna varılmıştır.

Anahtar Sözcükler: Ilgarini Mağarası, Arkeobotanik, dendrokronoloji, dendroarkeoloji, tarih belirleme

Introduction

Archaeobotany consists of botanical research and studies related to archaeology. In other words, archaeobotany helps archaeologists in evaluating archaeological findings and commenting on them. Archaeobotany also makes significant contributions to understanding life styles and conditions of ancient people who once lived in a particular area, their thinking, level of civilisation and their behaviour towards the environment, as well as vegetation cover and climate at a certain period

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of time based on archaeological discoveries made during excavations carried out at a particular site (Aytuğ, 1967, 1970; Aytuğ and Görcelioğlu, 1996).

Archaeobotany has contributed a great deal to archaeology by determining the usage of wooden materials and identifying them in studies conducted in Turkey (Kayacık and Aytuğ, 1968; Aytuğ and Görcelioğlu, 1987, 1994; Şanlı, 1989). Furthermore, many dendrochronological dating processes were carried out in Turkey and a 7000-year-long master chronology was constructed (Kuniholm, 1991, 1996, 2001; Hughes et al., 2001). This sub-field of dendrochronology was named dendroarchaeology (Kaennel and Schweingruber, 1995). Another contribution was made to archaeobotany with systematic palynological investigations (Beug, 1967; Aytuğ, 1967; Van Zeist and Bottema, 1982; Bottema and Woldring, 1990; Woldring et al., 1993; Bottema et al., 1993, 1995).

With its historical remains and beautiful travertine formations, Ilgarini cave, located in the Küre mountains, is important in terms of archaeobotany and dendroarchaeology. The brief history of the region may be summarised as follows. The ancient city of Pompeiopolis is located to the north of Taşkoprü, 45 km north of Kastamonu. The borders of Pompeiopolis reach the southern slopes of the Küre mountain chain to the north, the northern side of the Ilgaz mountain chain to the south, on the east to the Halys river and the surroundings of Osmancık to the east, and finally on the west to Pınarbaşı valley, which is also the border of Amastris, to the west. The history of Pompeiopolis during the late Roman and early Byzantine periods can be learn only from the Bishop's Lists. Pompeiopolis had only become important as a bishopric in the middle of 6th century AD. It is believed that Pompeioplis had been abandoned in the late 6th or early 7th centuries because of attacks by Iranians or Arabs and the people had started to live in the nearest castle, which named Kızkalesi. The building materials in the walls of this castle are supposed to have been brought from the remains of Pompeiopolis. Although the region had been conquered by the Turks from the 11th century AD onwards, Pompeiopolis is seen as a city in the Bishop's List until the 14th century AD (Prof. Dr. Nusret Aras-www.kastamonu.gov.tr).

During the first fieldtrip to Ilgarini cave, our collaborator Görkem Kızılkayak, an archaeologist, stated that the archaeological remains could be from the Early Roman period, but he could not give a clear date. Based on this observation, we attempted to determine the lifetime of the people dendrochronologically, to identify the wooden materials taken from Ilgarini cave and to interpret the results with respect to archaeobotany.

Sampled area: Ilgarini Cave

Ilgarini cave is located in the Küre mountains in the West Black Sea region of Turkey. The nearest town to the cave is Pınarbaşı, and the nearest villages are Sümenler and Yamanlar. Its latitude and longitude are 41° 44' N and 33° 05' E, respectively. Alagöz (1944) stated that this cave and its environs are composed of calcareous main rocks with of Jurassic-Cretaceous age.

The cave divides into 2 branches 70 m from the entrance and the southern branch goes down. The deepest part of the cave is at the end of this branch –250 m from the entrance. In the entrance of the cave, there are remnants of an old village with 10 houses probably from the Roman or Byzantine periods. In the southern branch, many archaeological remains such as graves and temples are located. After the first and second zigzagging paths, there are wide level places. The remains of graves and temples are located in these wide level places. In the left part of the first level place there are 6 graves with 3 floors, and 1 temple, totally destroyed by humans. Similarly, in the right part of the second level place there are also 5 graves with 3 floors and 1 devastated temple (Figure 1) (Çetin et al., 1983). The eastern branch is flat and made of travertine. No remains from settlements are seen in this part. Humans have destroyed the remains mentioned by Çetin et al. (1983) and at present most parts of the graves cannot be seen.

Past and present climate and vegetation of the environs of Ilgarini cave: According to the results of pollen analyses made at lakes Abant and Yeniçağa (Bottema and Van Zeist, 1989), there have been no significant changes in vegetation during the last 1000 years. The vegetation around Ilgarini cave 1000 years B.P. was cold high mountain forests, composed of mainly broad-leaved forest trees such as *Fagus orientalis* Lipsky., *Corylus colurna* L., *Carpinus betulus* L., *Carpinus orientalis* Miller, *Ostrya carpinıfolia* Scop., *Castanea sativa* Miller, *Quercus* L. sp. at 700–1000 m a.s.l. and *Abies bornmülleriana* Mattf. The area at present has the same forests. In addition to these species, *Pinus nigra* Arn and

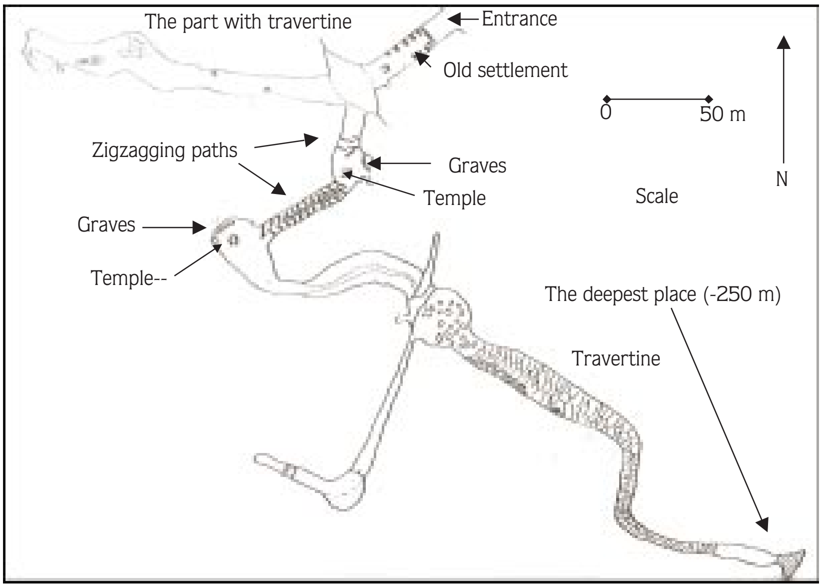

Figure 1. The structure of Ilgarini cave and the historical parts (Çetin et al., 1983)

Pinus sylvestris L. are located in the area. The climate type of the area is humid and mesothermal, and there is a middle level water deficiency in summer. Annual precipitation is about 840 mm.

Materials and Methods

The study materials were taken from Ilgarini cave in September 2000 and May 2001. The materials were 10 pieces of wood used in the graves and temple within the cave. They had maintained their woody characteristics and were not decomposed and 8 of them contained more than 50 tree rings, which means that they were useful in dendroarchaeology. Dendroarchaeology is a sub-field of dendrochronology used in the dating of archaeological materials (Kaennel and Schweingruber, 1995). Some of the wood samples were taken from between the floors of the graves, but others from among the devastated parts of the remains. After the materials were numbered and labelled, they were brought to the laboratory.

The 2 pollen diagrams, from Abant and Yeniçağa, the nearest lakes to the study area (Beug, 1967; Bottema et al, 1995), were used to investigate the relationships between the climate during the lifetime of the people who lived in the cave, and the present climate and vegetation.

The methods used in the present study are explained separately below under the headings wood identification and dendrochronological dating:

Wood identification: The pieces of wood collected were used in the wood identification processes in the wood anatomy laboratory, Faculty of Forestry (Istanbul). Many thin sections (about 30-50 µm) in the transversal, radial and tangential directions of the pieces were cut using a Richert microtome. Since it was impossible to cut thin sections from mostly decomposed pieces their transversal, radial and tangential surfaces were smoothed using a razor blade to see the anatomical characteristics. After the preparation processes, wood identification was carried out using several characteristics of the woods such as the radial and tangential diameters of vessels, wood type (with diffuse pores or ring pores), perforation plate, spiral thickness, ray type, maximum width and length of ray, and the features of wood parenchyma cells in angiosperms. Resin ducts, spiral thickness, diameter of tracheid, type of ray, maximum width and length of rays, type of simple pits etc. were measured and analysed in gymnosperms.

Dendrochronological dating: Tree-ring widths numbered 1, 2, 3, 4, 12, 13, 14 and 15 were measured using an Eclund measuring machine. Eight oak pieces having more than 50 tree rings were appropriate for tree–ring analysis. Pilcher (1990) stated that experience in many laboratories suggests that reliable cross-dating should not be expected for sequences of less than about 40 years. The tree-ring numbers of the samples are given in Table 1.

Table 1. Tree-ring numbers of specimens. The longest one had 307 years, and they were appropriate for dating.

Specimens	Tree-ring numbers (years)
Specimen 1	307
Specimen 2	51
Specimen 3	79
Specimen 4	85
Specimen 12	62
Specimen 13	51
Specimen 14	65
Specimen 15	86

First, individual tree-ring data (*.RW) for each tree were converted to Tucson format (*.RWL) using the CORING program. After constructing standardised individual chronologies for each sample using the ARSTAN program (Grissino-Mayer et al., 1996), they were cross-dated using the XCORINA program. Then a mean floating chronology (not dated) averaging 8 individual chronologies was computed (Fritts, 1976; Schweingruber, 1988).

Long tree-ring chronologies for Turkey were constructed by Kuniholm (1991, 1996). Some of them can be downloaded from the site: http://www.ngdc.noaa.gov/paleo/treering.html. Some other long chronologies were constructed by Akkemik (2000) and Touchan et al. (2003). Touchan's chronologies can also be downloaded from the same internet address. Many of these chronologies were used to date the mean floating chronology, but none of them was sufficient for dating. After this process at the dendrochronology laboratory of the Faculty of Forestry (İstanbul), dating was carried out using the XCORINA program in the tree ring laboratory at Cornell University. This mean floating chronology was dated by P. I. Kuniholm using oak chronologies from Anatolia.

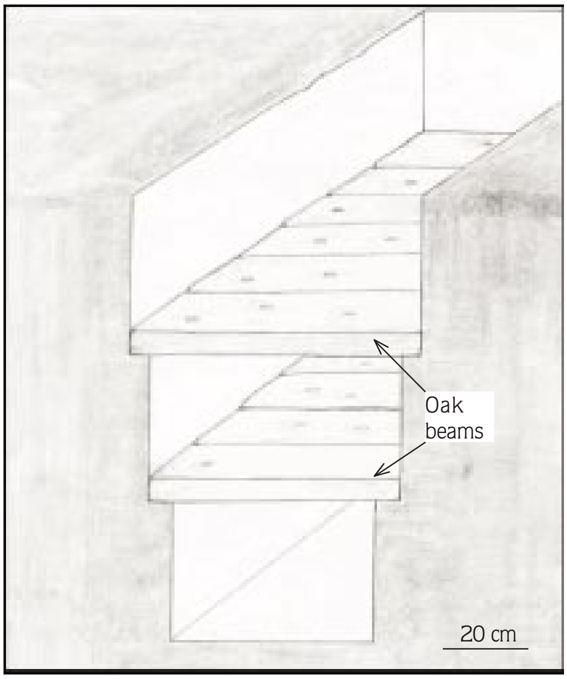

Figure 2. A section of a grave with 3 floors. Wooden beams were used between the floors.

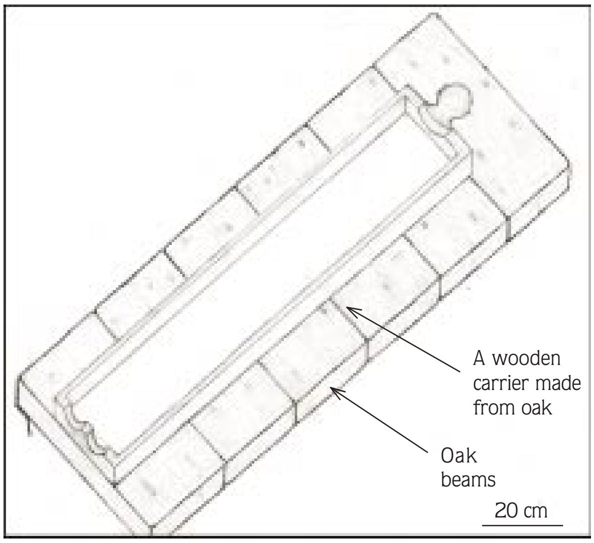

Figure 3. The wooden carrier used for dead bodies and its appearance in the grave. This wooden carrier had 307 tree-rings, and was very useful in the dating process.

Results

The shapes of the graves are given in Figure 2. The graves consist of 3 floors. While the upper floor is wide, the middle one is narrow and the bottom one is the narrowest. Wooden beams (about 6-7 x 20-25 cm) were used between the floors. As seen in Figure 3, the dead body was laid on a wooden carrier.

Wood identification: According to wood identification analysis, these 8 materials, which were used as a carrier for the dead and as beams between the floors, were from species of the white oak (*Quercus* sp.) group. Identifying oak wood is very easy due to its wood characteristics such as ring pores, and size differences between spring (very wide) and summer (very narrow) vessels. The rays are uni-, bi- and very wide multiseriate (Figure 4). The identification of oak species is very difficult using their

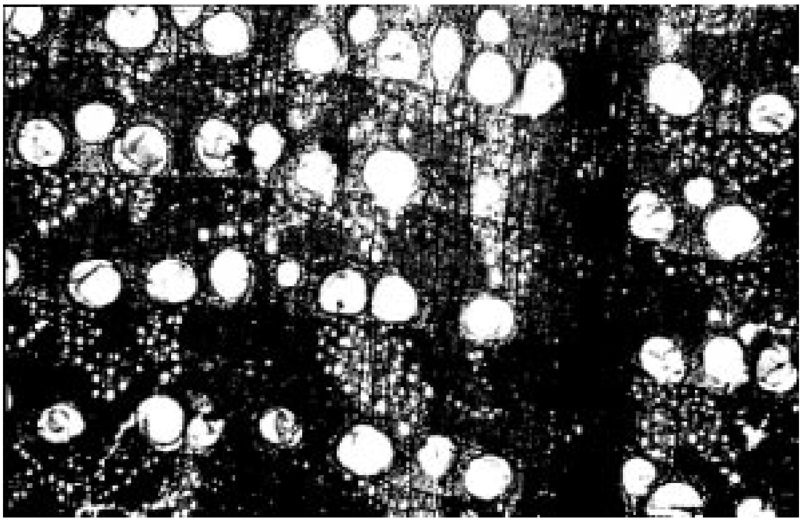

Figure 4. A transversal section of oak (*Quercus* sp.) (X20). This wood was used around AD 977 in the cave, and it began to decompose within this time period (from AD 977 to the present).

transversal sections. In contrast, some species can be identified by some of their wood characteristics (Merev, 1998). Based on Merev's findings, we can conclude that our oak wood may be from *Quercus robur* as it has slightly unclear axial parenchyma cells within the scleranchyma tissue in transversal sections. This species grows with other oak species such as *Q. petraea* subsp. *iberica, Q. macranthera, Q. frainetto, Q. infectoria* and *Q. cerris* in the region (Hedge and Yaltırık, 1982; Yaltırık, 1984).

Another wooden material was found among the remains and its usage place and purpose could not be determined. This wooden material was chestnut (*Castanea sativa* L.). The identification characteristics of the species are as follows: rings porous; pores in wide tree rings with oblique to dendritic orientation; tyloses in earlywood pores in heartwood present; axial parenchyma apotracheal and paratracheal, rays generally uniseriate, rarely biseriate, and maximum height 30 cells; and rays homogeneous and perforation plate normally simple. Therefore, the chestnut wood was mostly decomposed, it was impossible to cut microslides. Because of this, the identification was carried out using an upper light source under a microscope.

Another wood sample found among the remains was a piece of yew (*Taxus baccata* L.) (Figures 5 and 6). The diameter of the wood was 15 cm, wider than the oak pieces, but its tree-ring number was less than 50. Therefore, it could not be used in dating processes. The identification characteristics of this species are resin canals and axial parenchyma absent; rays narrow and upper limit 20 cells; spiral thickenings are conspicuous in longitudinal tracheids (Figure 6); and rays homogeneous and cross-field pits cupressoid. The usage place and purpose of this wood could not be determined.

Dendrochronological dating: First, the individual chronologies were cross-dated. Specimens 2, 3, 4, 14 and 15 were well correlated (Figure 7). The correlation coefficients between these specimens were very high, and statistically significant at the 0.999 confidence level (Table 2). These specimens might be different pieces of the same tree because it is very diffcult to see high correlations like these between individual trees. Specimen 2 might be from the upper part of that tree, because its first ring is later than the others. Similarly, specimens 12 and 13 might be different parts of one tree (Figure 8). The correlation coefficient between them was also high, and statistically significant at the 0.999 confidence level (Table 2). After these processes, mean chronologies of specimens 2, 3, 4, 14 and 15, and of specimens 12 and 13 were cross-dated with those of specimen 1 (Figure 9). Two usage times of specimens were seen. Specimens 12 and 13 were used at around the same time as specimen 1, and the others were used long before them. As the last rings were absent, it is impossible to determine the exact time between these 2 usage times.

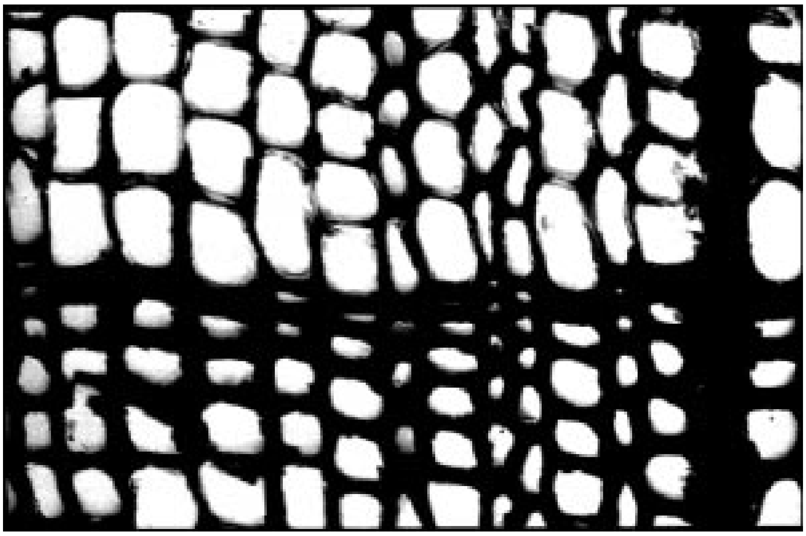

Figure 5. A transversal section of yew taken from the graves (X300).

Figure 6. Radial section of yew taken from the graves (X300). Spiral thickening, which can clearly be seen, is characteristic for this tree.

Table 2. Correlation coefficients between the standardised individual chronologies.

	SPE.1	SPE.2	SPE.3	SPE.4	SPE.12	SPE.13	SPE.14	SPE.15
SPE.1	1							
SPE.2	0.34***	1						
SPE.3	0.39***	0.68***	1					
SPE.4	0.40***	0.89***	0.61***	1				
SPE.12	0.51***	---	---	---	1			
SPE.13	0.30***	---	---	---	0.48***	1		
SPE.14	0.33***	0.67***	0.87***	0.61***	---	---	1	
SPE.15	0.37***	0.80***	0.60***	0.87***	---	---	0.64***	1

*** all coefficients are significant at the 0.999 confidence level; SPE is an abbreviation of specimen

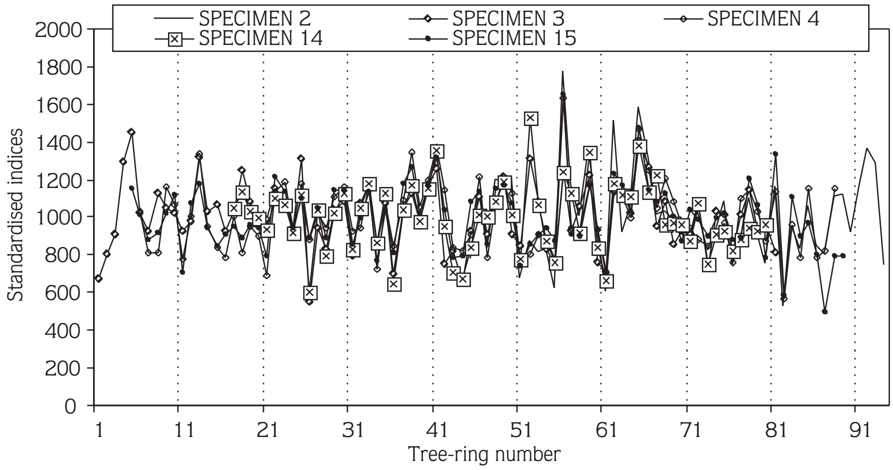

Figure 7. The individual chronologies of specimens 2, 3, 4, 14 and 15. These beams might have been taken from the same tree, because there is a high correlation between them.

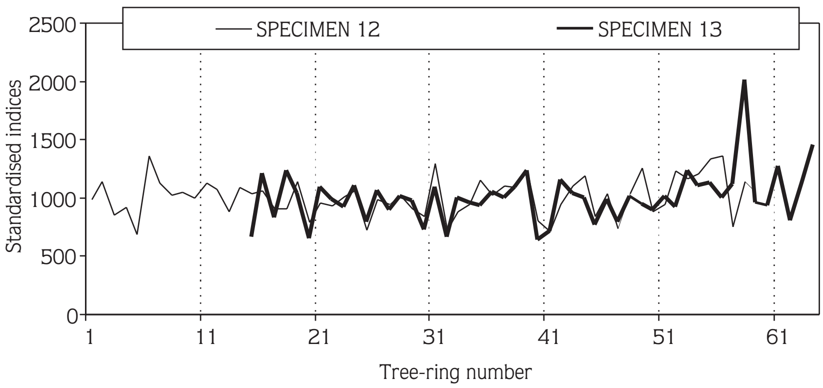

Figure 8. The individual chronologies of specimens 12 and 13. These beams might also have been taken from one tree, because there is a high correlation between them.

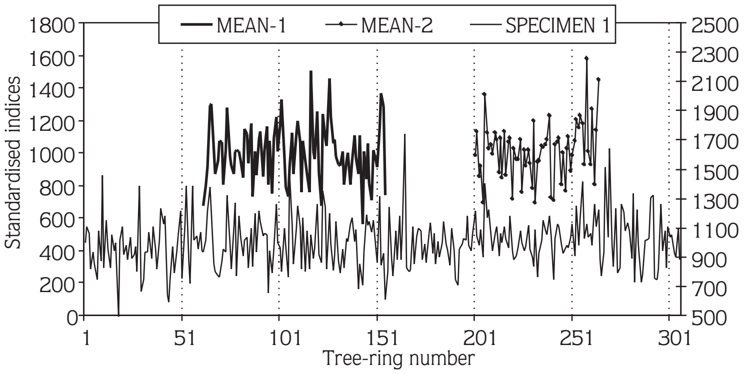

Figure 9. Two mean chronologies of specimens 2, 3, 4, 14 and 15 (MEAN 1) and 12 and 13 (MEAN 2) and the individual chronology of specimen 1. This individual chronology, which was the longest one, covered 307 years. The mean chronologies dated to different places on the chronology of specimen 1.

The mean floating chronology obtained averaging 8 individual chronologies was constructed. Later the last ring of the floating chronology was dated to AD 977 on the master chronology of Anatolia at Cornell University. Since the last rings were absent, this date is not the cutting date of the tree. This date can give us the usage period of the wood. Therefore, we can conclude that these archaeological remains were from the late Byzantine period.

Discussion and Conclusion

Oak is very hard and resistant to decay for hundreds of years. This tree is abundant in the forests around the cave. In spite of the occurrence of other species such as beech, hornbeam, fir and Scots and black pine in the forests, they were not used in the graves or temples; instead mostly oak was used. The usage place and purpose of the oak woods were determined but those of other specimens, chestnut and yew, could not be determined. Based on this result and since oak has been used continuously for hundreds of years (Kuniholm, 1996, 2000; Akkemik and Dağdeviren, 2004), we conclude that the people of that time used wooden materials consciously and were aware of the characteristics of the woods they were using. During our observations in villages in the Black Sea egion, we saw that oak was also used in the lower parts of "Kütük ev" (building made completely of wood). Kayacık and Aytuğ (1968) stated that the logs used in the graves at Gordion were probably transported along the ground from not too far away. In contrast to the present steppic character of the vegetation in the area, there used to be forest vegetation from where the timber was obtained for the royal tomb. Biger and Liphschitz (1993) stated that in most areas of the world local wood is used in construction. However, in semi-arid or arid regions where trees have always been rare and forests almost absent, wooden houses were scarce, and timber import was essential for building activity. Therefore, archaeobotanical and dendroarchaeological studies like this can also add valuable information concerning past forest structures and the timber trade. In the present study, we concluded that the logs could have been cut from the forest around the cave, because this forest is composed of dense broad-leaved trees together with oak species such as *Quercus robur, Q. petraea, Q. infectoria, Q. macranthera* and *Q. cerris*. Other species, identified as chestnut and yew, also grow in the forest around the cave.

Pollen analysis (Aytuğ and Görcelioğlu, 1996), wood identifications and dating processes provide archaeobotanically valuable information to archaeologists. In the present study, we think that the dating result (AD 977) could be a valuable piece of information for archaeologists. Dendroarchaeological results also showed that the life span in the cave covered a short or long time. Using the C14 method on the old bones in and around the graves, the life span can be determined. At that time, the people built a village with 10 houses in the entrance of the cave, and they buried their dead within the same cave. Because the cave is hidden among small hills and dense broad-leaved trees, it is impossible to find the entrance without a local guide. According to the pollen analysis of lakes Abant and Yeniçağa (Beug, 1967; Bottema et al., 1995), there were no dramatic changes in climate or vegetation around AD 977. Based on the findings we concluded that these people led a hidden life and should be studied by an archaeologist.

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