IDENTIFICATION OF WOOD FROM BRONZE AGE CONTEXTS AT SIDON

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ETHEL ALLUÉ
DAFYDD GRIFFITHS

Introduction

The immediate aim of this study was to identify five samples of carbonized wood excavated from different Bronze Age contexts at the College site in Sidon. The samples were taken from substantial pieces of carbonized wood that were probably the remains of structural timbers. Previous analyses of wood from Sidon identified the use of wood from the genus *Arbutus* (the strawberry tree) as providing structural building timber (Asouti and Griffiths, 2003).

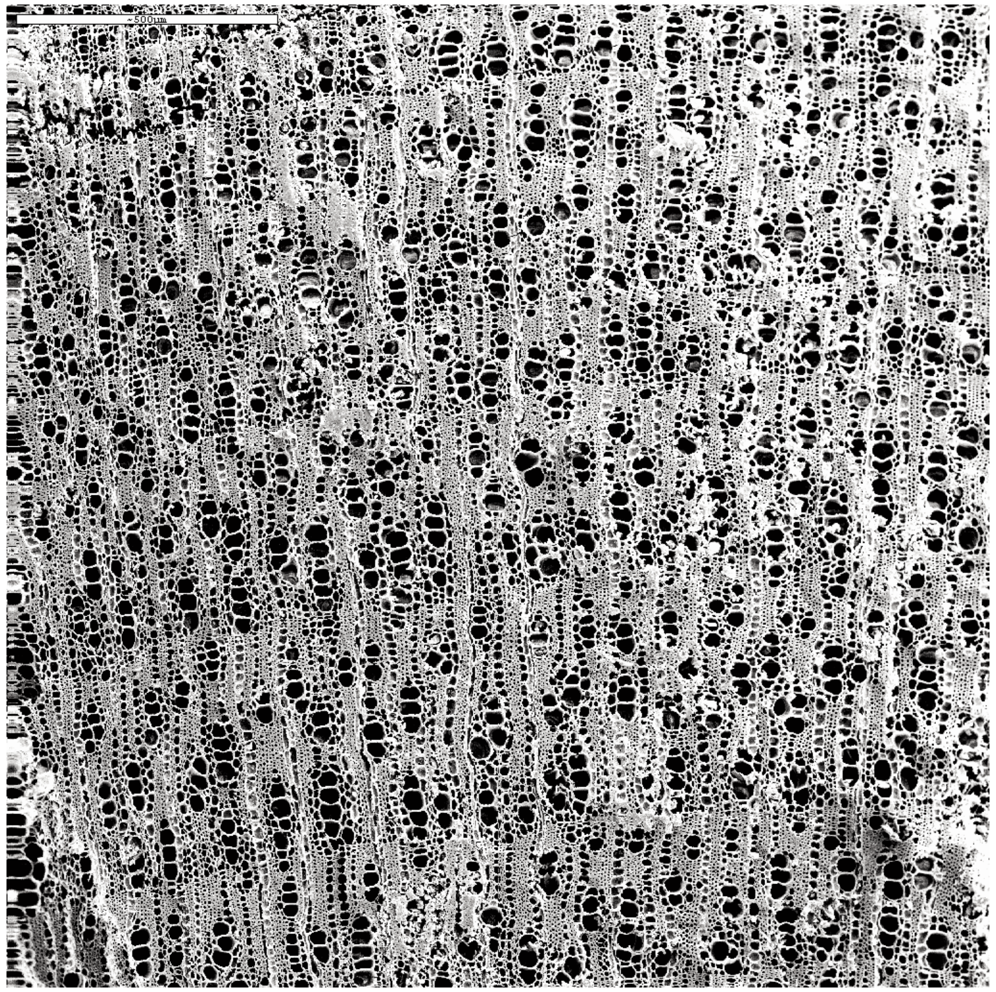


Plate 1. *Olea europaea:* a tranverse section from sample S/130, room 1. The scale bar at the top left is 500 micrometres (0.5 mm) so the field of view is approximately 2 mm wide.

In a broad sense, the purpose of charcoal and wood analyses is the taxonomic identification of tree and shrub species with the aim of obtaining data about the landscape and its exploitation by humans in antiquity. The identification of wood (carbonized or not) from building structures provides information on the exploitation of timber in terms of the species chosen for structural timber as well as information on building technology. The interest of these studies lies in improving our understanding of timber use, exploitation of timber from the landscape and building technology in antiquity.

Of course, timber is not just timber. It occurs in many species and these in turn yield wood with many different properties. The aspect of choice of material thus becomes a matter of interest and a further potential means of improving our understanding of human behaviour in antiquity. As with many materials used by man in antiquity, the choice of particular types of wood is subject to a wide range of influences, not all of them immediately apparent.

At first consideration, it may seem that choice of timber for building would be constrained by practical considerations such as its availability in a size suitable for the purpose, abundance and the logistics of transport from the location of growth. Availability may not always equate to frequency of use, however, as there may be many other technological, economic, political or cultural influences on the extent of use of particular species for particular purposes. These and other influences (not least taphonomic processes) interact in a complex manner to generate the archaeological record that we now seek to interpret to yield an understanding of past society.

On a technological level, the choice of timber for use in a particular context may have been influenced by awareness of the specific properties of different species such as durability and resistance to rot and insect attack. The ease or difficulty of working the timber into the required form may also have influenced the type of timber used in a given context. Experience would soon show that certain woods were best suited to particular purposes while perhaps being distinctly unsuitable for others. This knowledge, although derived initially from direct practical experience, could very probably become a matter of custom and tradition over time. Particular woods might start to carry particular associations and connotations which might be perceived in antiquity or interpreted in the present as cultural influences on choice of material, albeit with origins in practical experience and technological suitability.

Economic influences on frequency of use of specific timber species may also be more complicated than might at first seem apparent. If a particular wood was widely available in an area, it might be expected that it might be widely used for such purposes as were suited to its properties. It is worth considering, however, the possibility that the value of a particular type of timber as an exchangeable or exportable commodity might reduce the likelihood of it being chosen for any but the grandest purposes in the locality of its origin. It is worth noting that some timbers from the geographical area of the Lebanon, such as cedar or oak, have been valued as items suitable for exchange and export on account of their good quality or high reputation (Willcox, 1992; Asensi Amorós, 2002; Loffet 2004).

Desirability and economic value often predisposes a commodity to become the subject of political control. This in turn may also strongly influence the extent and context of use of a commodity independent of its simple geographical availability. Political control might affect the distribution and use of wood as much as any other valuable commodity.

On a more cultural level, aesthetic qualities of wood such as colour or smell may have influenced the choice of species. Furthermore some types of wood may have carried a symbolic significance such as that accorded to cedar (*Cedrus libani*) (Asouti and Griffiths, 2003; Talhouk *et al.*, 2001). The selection of certain species may also be subject to cultural influences and customs related to a specific activity or context, such as burial. Whatever the reasons for a particular wood being desired, once the wood became sufficiently desired it became worth transporting the wood over long distances, perhaps exporting it from one region and importing it into another (Wilcox, 1992; Asensi, 2002; Asouti, 2003; Loffet, 2004).

These introductory paragraphs have sought to show that, while the immediate task may be to identify the species of timber recovered from various archaeological contexts, the purpose of seeking this information is to provide basic evidence that can lead to far wider understandings of society in antiquity.

The sample contexts

The five samples under study are carbonized woods from Bronze Age contexts. They were taken from substantial pieces of carbonized timber that may well have been the remains of structural timbers. The preservation of timber in archaeological deposits is often related to fire (Drysdale, 1999, p. 11-13 & 182-190). Preservation of cell structure in charcoal may quite often occur in the middle of a large piece of timber not entirely consumed by fire. Once converted to charcoal the wood is no longer subject to attack from insects or micro-organisms.

Sample 130 is from a beam from an Early Bronze Age building immediately south of the Early Bronze Age "kitchen" area (see p. 22). Sample S/130 is from room 1 of the building (see fig. 1, p. 18 in this issue). Sample S/150 is from the adjacent room 2 of the building (fig. 1-3, p. 18-20). A sample of another beam from the room 2 and containing at least thirty tree rings has been subjected to accelerator radiocarbon dating at Oxford (see Ramsey & Doumet-Serhal, in this issue p. 18-22). Sample S/123 is from room 3 of the same Early Bronze Age building.

Sample S/93 comes from immediately on top of a Middle Bronze Age burial (burial 44).

Sample S/ 95 comes from a monumental building dating to the Late Middle Bronze Age and continuing in use into the Late Bronze Age (see Collins in this issue p. 106).

Sample preparation

For the analyses, each charcoal sample was fragmented manually to observe the three mutually perpendicular sections of the wood anatomy. Manual fragmentation creates fracture planes that follow lines of weakness in the structure. These might in principle give a less than wholly representative view of the structure of a true plane section. Nevertheless, most features of interest are revealed to some extent and manual fracturing avoids obscuring the diagnostic features by the crushing of the fragile charcoal structure that might accompany an attempt to cut or grind a plane section. Transverse sections across the grain perpendicular to the length of a branch or trunk show the annual growth rings, tissue and pores representing vessels. Another view of the structure of the wood is obtained from a radial longitudinal section obtained by splitting the wood along the length of the branch or trunk in a plane joining the centre of the branch to its circumference, following the line of radii and cutting the tree rings at right angles. A tangential longitudinal section is perpendicular to the transverse and radial sections and cuts the growth rings at an angle. These sections together give a good overview of the cell structure which in turn may permit identification of the genus or species.

The carbonized wood samples were analyzed at the Institute of Archaeology, University College London. Initial analysis was conducted using reflected light optical microscopy at magnifications up to 400x. Samples were also examined using scanning electron microscopy as this provides higher resolution and better depth of field. All the plates in this paper are scanning electron micrographs.

In order to identify the Sidon samples, observations of the sections were compared with published descriptions in atlases of wood anatomy (Fahn *et al.*, 1986; Schweingruber, 1990) and compared with known samples in the reference collection at the Institute of Archaeology, University College London.

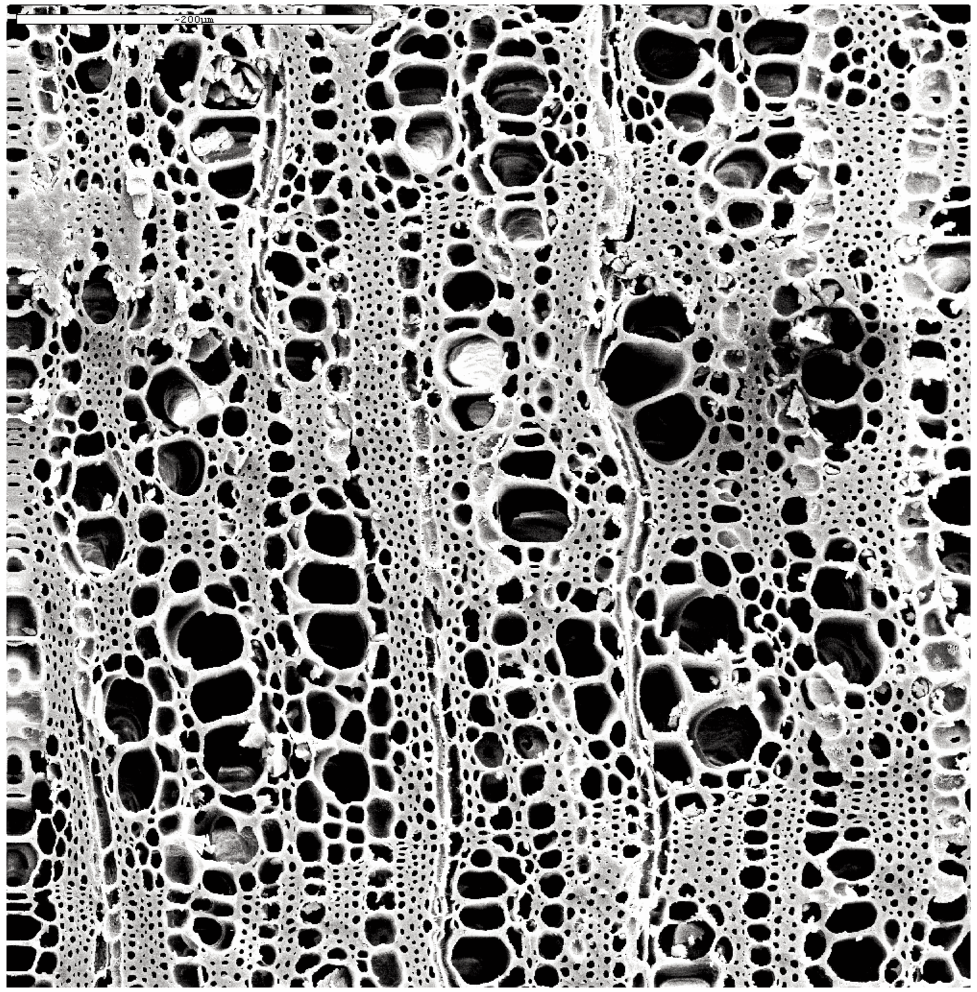


Plate 2. *Olea europaea:* a tranverse section from sample S/130, room 1. The scale bar at the top left is 200 micrometres (0.2 mm) so the field of view is approximately 0.6 mm wide.

Analytical results

The results of the analyses from the five samples have yielded two taxa: *Quercus* sp. deciduous (deciduous oak) and *Olea europaea* (olive/wild olive) (see Table 1 below). Two samples from the Early Bronze Age correspond to *Quercus* sp. deciduous and one to *Olea europaea.* The Late Middle Bronze Age sample is once more *Olea europaea.*

Charcoal samples in which the cell structure of the wood is well-preserved will generally fracture along planes of weakness to give fracture surfaces that show the cell structure clearly. As seen in Plate 9, however, the Middle Bronze Age sample from carbonized wood immediately above burial 44 fractured more like an amorphous material to reveal a surface showing conchoidal fracture and few remnants of the cell structure. Therefore the taxonomic identification of this sample was not possible. (See below for discussion of factors influencing the identification of archaeological wood.)

Table 1.

Results of the taxonomic identification of the samples from Sidon.

Sidon Location	Sample	Taxa	Period
Room 1	S/130	*Olea europaea*	Early Bronze Age
Room 2	S/150	*Quercus* sp. deciduous	Early Bronze Age
Room 3	S/123	*Quercus* sp. deciduous	Early Bronze Age
	B44	Undeterminable	Middle Bronze Age
	S/95	*Olea europaea*	Middle/Late Bronze Age

The transverse section of *Olea europaea* is characterized by a diffuse porous structure. The pores are distributed in radial rows of up to 4 pores. The rays are bi- or tri-seriate with marginal elongated cells and heterogeneous. The inter-vessel and ray vessel pits are small and numerous (Schweingruber, 1990). (See Plates 1-5.) Distinction between the wild and cultivated *Olea* is not possible on the basis of wood anatomy.

The high percentage of *Olea* pollen in sediment cores from around the harbour in Sidon is considered by Marriner *et al.* (2004, p. 88) to indicate cultivation of *Olea* in the area surrounding the ancient harbour. The use of olive as timber has been identified on other sites but it is commonly associated with uses other than structural timber. Olive has a hard and fine grained wood which is suitable for furniture because its resistance to putrefaction. Surprisingly the olive wood samples from Sidon, appear to correspond to large structural timbers such as beams. This in turn implies the availability of large olive trees for use as timber. It may be that the yield of olives declines after trees reach a certain age and that they then become more useful as sources of timber.

The transverse section of *Quercus* sp. deciduous is characterized by a ring porous structure. The vessels are solitary in a radial flame-like pattern. The rays are heterogeneous, uniseriate and multiseriate (Fahn *et al.,* 1986; Schweingruber, 1990). Examples of the *Quercus* sp. deciduous microstructure of sample S/123 from room 3 are shown in Plates 6-8. The microstructure of the *Quercus* samples studied here corresponds to several possible species that cannot be distinguished on the basis of the wood anatomy. Around the Eastern Mediterranean, several species of deciduous oaks are found, including *Q. aegilops, Q. infectoria* and *Q. cerris.* At present they grow between 800 and 1200 m above sea level. Deciduous oaks have an important commercial value not only because of timber but due to its edible fruits and excellent properties for fuel. The decrease of these species in the landscape shown by different archaeobotanical studies may be related to over-exploitation but also to climatic changes related to rainfall distribution (Western, 1971; Willcox, 1999; Marriner *et al.*, 2004). The use of timber for different purposes including export could be a cause of the landscape transformation.

In the pollen sequence corresponding to the Bronze Age of Sidon (Marriner *et al.*, 2004), both the *Olea* and the *Quercus* taxa are present in relatively high percentages. The authors consider, however, that the vegetation landscape in the vicinity of Sidon was already heavily modified by human activities. Furthermore, charcoal analyses of different sequences from elsewhere in the Eastern Mediterranean show a pattern consistent with the over-exploitation of wood (Willcox, 1999).

Plate 3. *Olea europaea:* a tangential longitudinal section from sample S/ 130, room 1. The scale bar at the top left is 200 micrometres (0.2 mm) so the field of view is approximately 0.6 mm wide.

Factors influencing the identification of archaeological wood

As noted above, it was not possible to identify the type of wood used immediately above Middle Bronze Age burial 44 because it had suffered alteration that prevented clear observation of the cell structure in a fractured specimen (see Plate 9). It may thus be useful to consider some of the factors that might prevent identification of the type of wood or charcoal recovered from an archaeological deposit.

Several factors may prevent the identification of wood or charcoal from archaeological deposits. Sometimes microscopic observation does not permit precise identification to species level because several species share similar characteristic features in their wood anatomy (Schweingruber 1990). In other cases a sample may be too small to permit observation of all the representative features necessary for precise identification. Therefore some wood and charcoal analyses only achieve identification to the level of family or genus.

Plate 4. *Olea europaea:* a radial longitudinal section from sample S/ 130, room 1. The scale bar at the bottom left is 200 micrometres (0.2 mm) so the field of view is approximately 0.6 mm wide.

A further cause of wood or charcoal being beyond the bounds of identification by microscopy is related to preservation and other processes which can modify or alter the wood cell structure. Wood structure modifications can occur during any of the different processes that take place between the growth of the plant and its eventual excavation at the archaeological site. During the growth of the plant, agents such as micro-environment, climate or human activities such as pruning can cause changes in wood anatomy (Schweingruber 1988; Gorczynski and Molki 1969, Allué 2002).

Changes in wood anatomy due to carbonization generally produce only limited changes to cell structure, sometimes causing punctual alterations, but these do not generally prevent identification of well-preserved samples (Prior and Gasson 1993).

Wood decay due to insects, fungi or other micro-organisms is the main cause of wood structure alteration, both macroscopic and microscopic (Rowell and Barbour 1990; Gorczynski and Molki 1969). The extent of

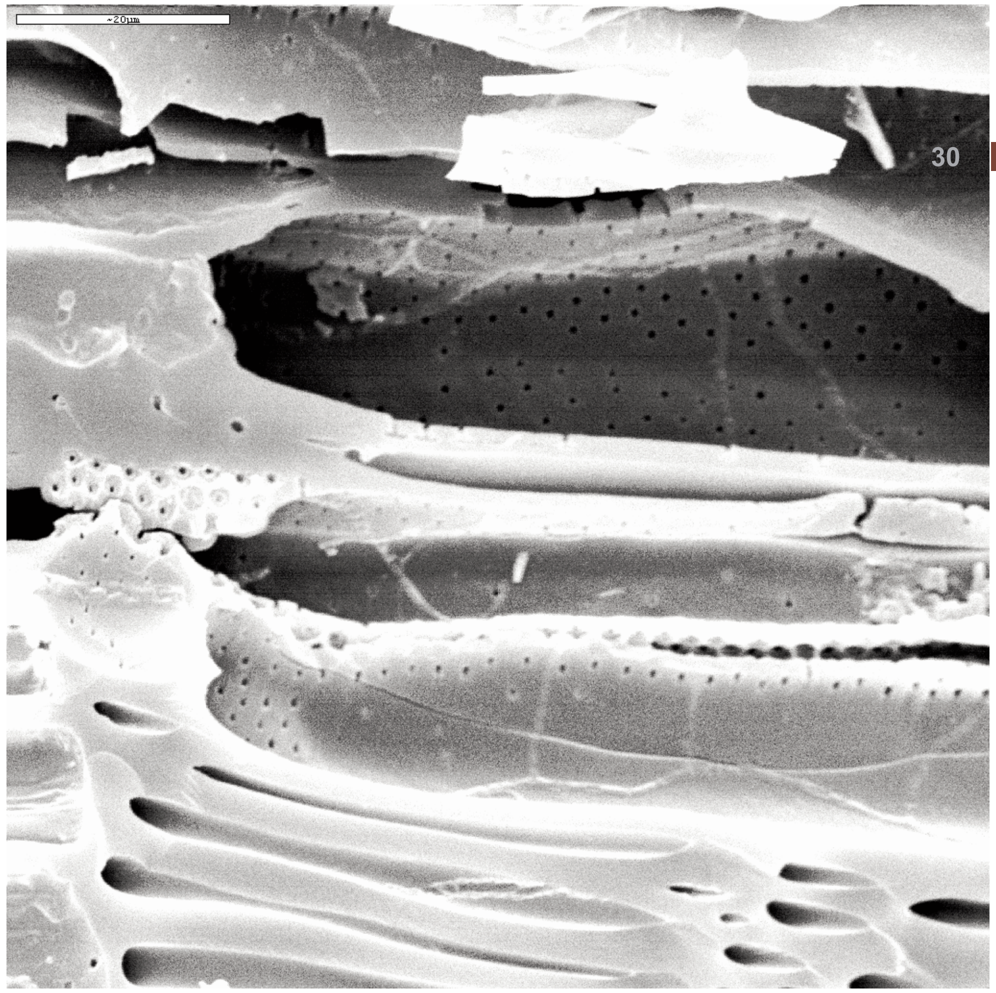


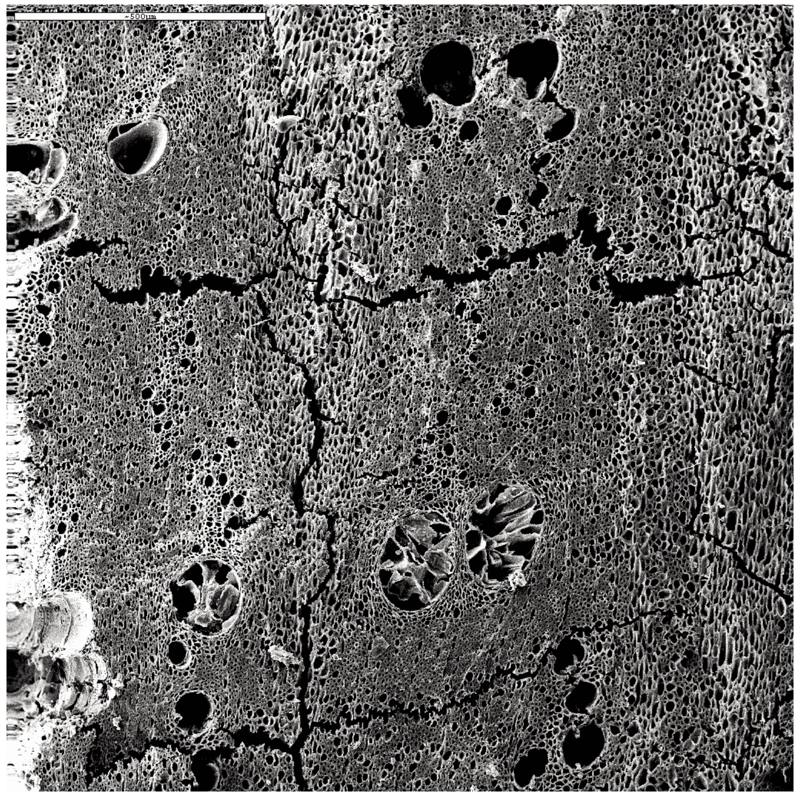
Plate 5. *Olea europaea:* a more highly magnified view of radial longitudinal section from sample S/130, room 1. The scale bar at the bottom left is 20 micrometres (0.02 mm) so the field of view is approximately 0.1 mm wide.

decay is often related to the species of wood, the part of the tree, the environment in which the wood was used and the environment in which it was deposited (Gorczynski and Molki 1969). Such factors may lead to highly different rates of preservation of different species, and to differential preservation related to environmental factors during use and burial. The frequency with which different types of wood are represented in the archaeological record may be different to the frequency of their occurrence when they were in use in antiquity. This is due not only to diffe-rences in resistance to decay but also to differences in the contexts of use and deposition.

The use of wood as structural timber may predispose such wood to preservation. Wood may be chosen for rot resistance or it may be used or treated in a way that improves rot resistance or impedes insect attack. Such "treatment" may have been effected knowingly or inadvertently, perhaps by exposure to smoke above a fire or by covering with lime. Being of large dimensions or perhaps through being encased in lime or mud would also help to preserve some of the timber in the event of a fire, with the heat of the fire itself turning the wood to charcoal and so ensuring its future resistance to attack by insects and micro-organisms.

Decay can produce a total destruction of the cell structure even if the external shape of a wooden object is preserved. Post-depositional processes can produce important modifications to both wood and charcoal cell structure, some of which may impede identification. On the other hand some post-depositional environments (waterlogged, anoxic or arid) are highly conducive to the preservation of a characteristic cell structure.

Plate 6. *Quercus* sp. deciduous: a tranverse section from sample S/123, room 3. The scale bar at the top left is 500 micrometres (0.5 mm) so the field of view is approximately 1.5 mm wide.



Taphonomic studies of archaeological deposits can improve understanding of the preservation of archaeobotanical remains, and thus make more secure the interpretations of ancient society that are built upon them. Such studies need to be conducted within a framework that includes experimental work and an understanding of the formation processes (chemical, biological, geological and cultural) of the deposits studied.

Conclusions

Study of the microstructure of three samples of carbonized structural timber from an Early Bronze Age building at Sidon showed the use of *Olea euroapea* (olive wood) and *Quercus* sp. (deciduous oak). A timber sample from a Late Middle Bronze age to Late Bronze Age structure was identified as *Olea europaea*.

While use of *Arbutus* (Asouti and Griffiths, 2003), *Olea* and deciduous *Quercus* sp. has now been identified firmly, there is still the need for caution in interpreting these findings. Other species such as cedar, palm, pine or other taxa are suggested by other archaeological evidence or by documentary sources to be present in the landscape around Sidon, even though wood or charcoal from these species has not yet been recovered from the excavations. As is argued above, several possible factors may influence what is preserved. It must also be considered that the present picture may be unrepresentative even in terms of the material used for structural timber as the number of samples so far recovered from the site is quite small.

It will therefore be important to analyse all future finds of preserved wood from the Sidon excavations in order to obtain a fuller picture of the exploitation and use of wood as a natural or cultivated resource. This knowledge will be a further step in improving our understanding of society in Sidon and its environs during the Bronze Age.

Plate 7. *Quercus* sp. deciduous: a tangential longitudinal section from sample S/123, room 3. The scale bar at the top left is 500 micrometres (0.5 mm) so the field of view is approximately 1.3 mm wide.

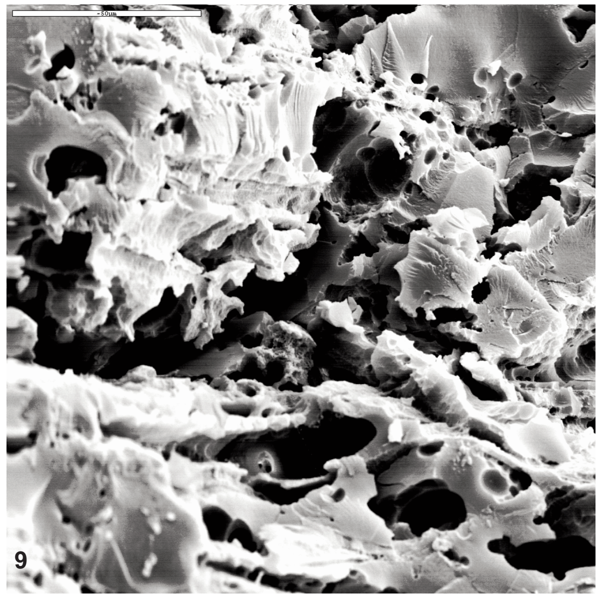


Plate 8. *Quercus* sp. deciduous: a tangential longitudinal section from sample S/123, room 3. The scale bar at the top left is 200 micrometres (0.2 mm) so the field of view is approximately 0.8 mm wide.

Plate 9. Fracture through a sample of carbonized wood from immediately above burial 44. The surfaces show chonchoidal fracture. There are still some remnants of cell structure to be seen but they are not clear enough to permit identification of the type of wood to be made. The scale bar at the top left is 50 micrometres (0.05 mm) so the field of view is approximately 0.15 mm wide.

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