Charcoal

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INTRODUCTION

The destruction of Zeugma by fire following the Sasanian attack in A.D. 252/253 reduced many areas of the town to rubble. The charred remains of numerous structural components of timber and other wooden artifacts have survived, buried in the ruins, until the present day. The recovery of charcoal deposits during the excavations of Zeugma in 2000 has enabled the study of the economic use of wood resources during the Roman occupation, for which there are few comparable data for this part of Turkey.[1] The charcoal analysis identified over 20 species of trees and shrubs, and although the origin of the charcoal was sometimes uncertain (i.e., structural or otherwise), the results demonstrate that the populace had access to a wide range of wood and timber. Some species must have been obtained through long-distance trade routes whereas others, although exotic to the region, were probably in local cultivation.

In charcoal-rich contexts where large fragments represented burnt timbers and structural elements, these were collected by hand. In addition, a large number of environmental samples also produced charcoal. The following criteria were considered when selecting samples for species identification.

- Type and security of the context, feature, or stratigraphy
- Quantity and quality of the charcoal available
- Potential of the charcoal to provide significant data on the use and procurement of wood resources and environmental evidence
- Samples that allowed the comparative analysis of both charcoal and charred plant remains

A total of 58 samples (25 from handpicked material plus 33 from bulk soil samples) were selected for the current study (see tables 1–10). The objectives of the charcoal analysis were:

- to identify the overall range of wood species in the assemblage
- to assess the type and character of timber from structural contexts
- to establish the origin of wood resources and trade implications
- to provide evidence of local horticulture and fruit production by comparative study with the charred plant remains
- to obtain environmental evidence

METHODOLOGY

The preservation of the charcoal was generally good, although some samples were degraded, friable, or vitrified (vitrification appears to be brought about by burning at temperatures exceeding 800 °C, during which the cells walls become plastic and fuse together). A few of the larger beams remained relatively intact in short lengths but none was suitable for dendrochronology.

The charcoal was prepared for examination using standard methods and examined using an incident light source on a Nikon Labophot-2 microscope at magnifications up to 400×.[2] The anatomical structures were matched to reference slides of modern wood held by the author and at the Royal Botanic Gardens, Kew. Reference was made to relevant publications on wood anatomy.[3] When possible, roundwood diameters or radial stem measurements were recorded. The development of wood is strongly influenced by environmental factors (soil type, climate, and aspect), and growth rates may vary considerably in different parts of the tree, even on different sides of the trunk or branch. It is, therefore, unreliable to estimate diametric measurements from radial segments of charcoal. It should be noted that when charred, wood may be reduced in volume by up to 40 percent of its original size.

RESULTS

Taxa Identified

Taxa identified from Zones 1–5 and 10 are shown in tables 1–9. A comprehensive list of taxa identified is included in table 10, which also summarizes results by zone. Scientific and common names are tabulated in table 11. Classification follows that of *Flora of Turkey*[4] and *Flora Europaea*.[5] Group names are given when anatomical differences between related genera are too slight to allow secure identification to genus level. These include members of the Pomoideae (*Crataegus*, *Malus*, *Pyrus*, *Sorbus,* and *Cydonia*) and Salicaceae (*Salix* and *Populus*). In archaeological material it is sometimes difficult to distinguish between unrelated taxa, such as *Fagus* and *Platanus*. Both genera are included in the tables, although it is probable that only one was represented. The anatomical structure of the *Pinus* charcoal was mostly consistent with the *sula* group, which includes *P. halepensis* and subspecies *P. halepensis* var. *brutia*;[6] charcoal in context 2095 in Zone 2 included more conspicuous growth rings (i.e., distinct latewood zones), which could imply a second species.

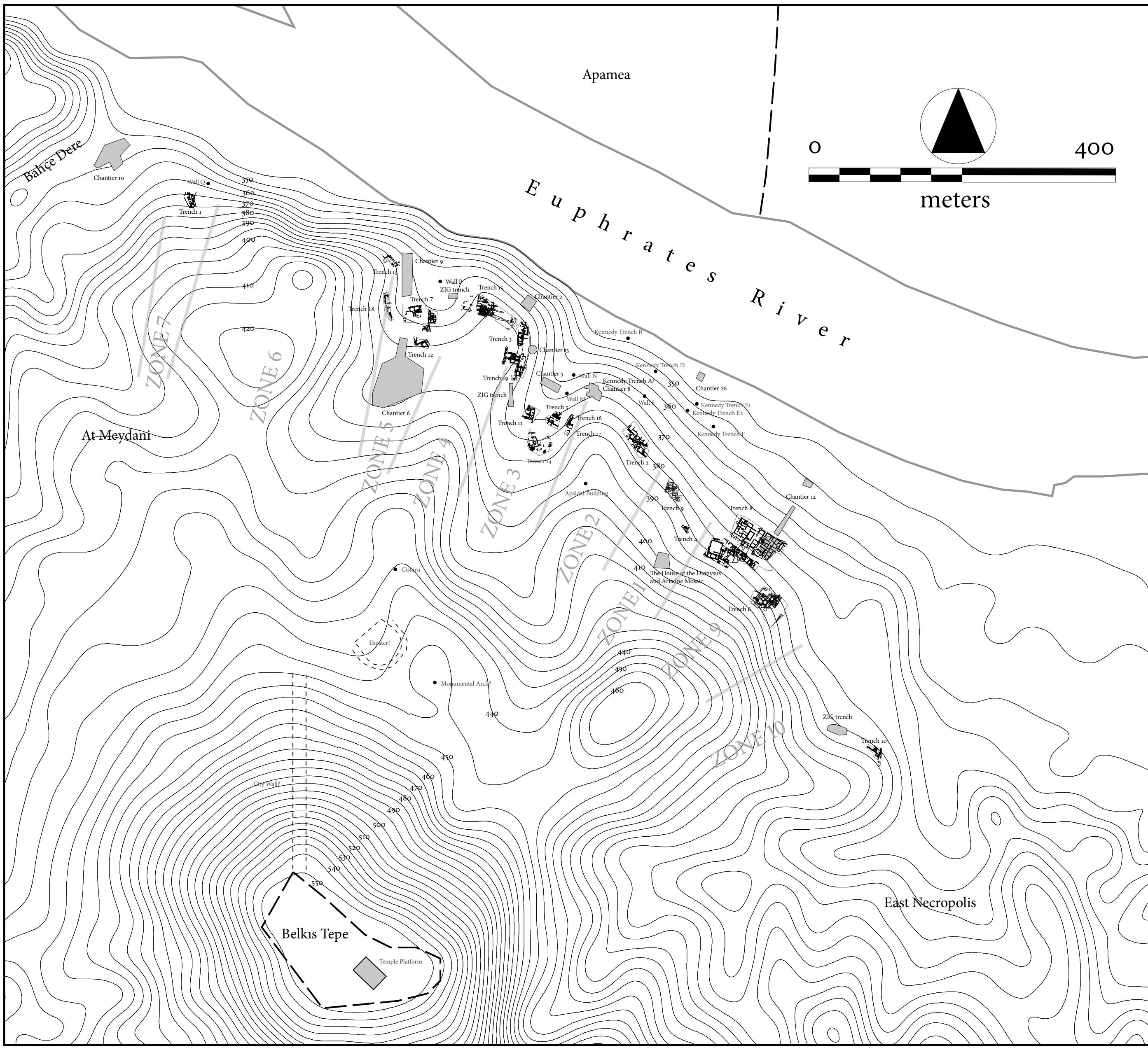

Figure 1. Plan of Zeugma showing zones mentioned in the text.

Results by Zone and Trench

Zone 1, Trench 9

Trench 9 was sited in Area B in a district of terraced platforms for houses built into the natural bedrock (table 1). This part of the town appears to have been densely occupied and associated with commerce. Charcoal, probably mostly structural in origin, was collected from destruction layers. For example, samples from context 9076, possibly from roof timbers, included *Fagus* or *Platanus* and *Salix* or *Populus*. If from roof timbers, *Populus* would have been more likely in this context (see under "Discussion"). *Salix* or *Populus* was also present in fallen structural debris (ash, burnt clay, and mud-brick) in context 9228, associated with *Pinus*. A further destruction layer, context 9138, included *Pinus*, *Olea*, and a fragment from a monocotyledon (e.g., grass, reed, or rush). A single large fragment of *Pinus* was recovered from the fill of a pot in context 9195.[7]

Zone 2, Trench 2

Trench 2 was cut into the base of the valley (table 2). The bulk of the charcoal examined was associated with the collapse of structural elements, related to the Sasanian sacking of the city in the third century A.D. Much of the charcoal was collected from burnt debris lying on the floors of the buildings. In some instances, large portions of relatively intact beams or roof timbers were recovered as, for example, the wide roundwood beam 2045 from context 2008 in Room 2F, identified as cf. *Cupressus*. This beam is the largest in the current study. The widest preserved area provided a radial measurement of 60 mm. Sample 2008, *Pinus* roundwood (radial measurement 35 mm; 20+ growth rings), was recovered from a burnt lens associated with beam 2045. Sample 2021, also associated with beam 2045, included *Pinus* roundwood, *Cupressus*, *Cedrus,* and *Prunus*.

Cedrus was also recorded from a plank in deposits of mud-brick collapse (context 2010) in Room 2I and from a large beam (context 2295). The latter, which measured some 10 cm in diameter, was only partially charred. *Pinus* and *Juglans* were identified from charcoal deposits in mudbrick collapse in Trench 2 and also from sand, silt, and burnt material lying over a mosaic floor (context 2095). The remains of *Pinus* structural timbers were also recovered from burnt layers in contexts 2278 and 2383 (over mosaic floor **M19**) and in a silt layer that contained ash and roof tiles (context 2141) — charcoal from the latter almost certainly represents the remains of a roof timber or door. Rubble collapse in the upper levels of Room 2G (context 2013) included *Pinus* roundwood (diameter 20 mm) and *Olea*. Similar species were identified from poorly preserved charcoal from within mud-brick, context 2029, and also from a layer of collapsed materials next to a wall (context 2012) although here *Fagus* or *Platanus* and *Quercus* were also present.

Other areas associated with the burning and collapse of buildings or structures from which charcoal was examined included context 2031, a layer of mud-brick and colluvium at the east end of the trench, which contained large chunks of *Pinus*, and a burnt layer between floors 2195 and 2513, context 2512, from which *Pinus* and *Tamarix* were recorded. In addition, a large quantity of charcoal was recovered from a burnt layer (context 2376) above a mosaic from which *Juglans*, *Pinus*, *Fagus* or *Platanus*, *Fraxinus,* and *Acer* were named. A quantity of burnt *Olea* and *Vitis* wood was associated with fine silt in a circular depression (context 2463) overlain by floor surface (context 2464) thought to be part of the leveling layer for the floor. Small, sparse fragments of *Pinus* and *Juglans* were also present in context 2082, a destruction layer of fine ash.

Pieces of burnt *Pinus* were also contained in the fills of various vessels, for example, **PT452** and **AM148** from contexts 2016 and 2017, respectively, in Room 2H, as well as **PT312**, from context 2176, a large cookpan which may have contained the remains of a meal.[8] It seems likely that this charcoal accrued during the conflagration from falling debris, perhaps from roof or upper floor joists.

Three further samples included a few tiny scraps of *Pinus* from a pocket of burning in a robber trench (context 2032); a single fragment from a burnt layer (context 2242) provisionally named as *Rhus*; and a sample from context 2041 that included *Juglans*, *Olea*, *Salix* or *Populus*, *Ziziphus,* and *Pinus*.

Zone 3, Trench 5

Trench 5 was sited on the eastern side of Zone 3 in Area A and related to an urban area of townhouses (table 3). Charcoal was recovered from the fill of a hearth (context 5060) and thus probably represents fuel debris, but, owing to its degraded condition and fragmentation, it was only possible to make a provisional identification of *Olea*. A further sample, from a clay and silt make-up level (context 5075), interpreted as possibly garden soil and spot-dated to the late fifth or sixth century, included *Olea*, *Juglans,* and *Pinus*.

Zone 4, Trench 15

Trench 15, on the headland in Area B, included public areas with impressive landscaping and terracing (table 4). Charcoal deposits were sparse but were obtained from context 15007, the backfill from near wall 15005, and from context 15231, an ashy layer from a hearth dump or burning event. It is possible that these samples were comprised of fuel debris, although other origins (e.g., house fires) can not be ruled out. *Olea* and *Pinus* occurred in both contexts, with the addition of *Fagus* or *Platanus* in context 15007.

Zone 5, Trenches 7, 12, 13, and 18 (tables 5–8)

Trench 7 was located towards the base of the valley in Area A, in what was defined as a commercial area. Associated charcoal was generally rather sparse and degraded but probably derived from structural components and/or artifacts. *Pinus* debris, for example, occurred in silt and ash in a destruction layer (context 7006), and material from a compact floor surface (context 7074), included *Olea*, *Salix* or *Populus*, an unidentified conifer and probably *Vitex*. Charcoal fragments from the fill of a pithos (context 7180) included *Pinus*, *Juglans,* and a deciduous species of *Quercus*.

Trench 12 was situated behind Trench 7 in Area B. Charcoal was examined from contexts 12011 and 12037, both from destruction layers. *Olea* and *Fagus* or *Platanus* were identified from the former, and *Pinus*, *Juglans*, *Pistacia,* and *Fagus* or *Platanus* from the latter.

Trenches 13 and 18 were sited on the headland in the western boundary of Zone 5 in Area B. Charcoal was examined from 4 contexts in Trench 13, associated with dumping events and the backfilling of a disused house, and spot-dated to the mid-Roman period. Layers 13033 and 13034 (underlying 13033) both included *Pinus* and *Olea* and, in the latter, *Fagus* or *Platanus* was also present. Context 13036, a layer formed after the collapse of the roof and probably incorporating material washed down from upslope, included *Juglans*, *Salix* or *Populus*, *Olea*, *Pinus*, *Vitis,* and two small fragments provisionally identified as *Celtis* and *Rhus*, and a monocotyledon (e.g., grass, reed, or rush). The diverse range of taxa in this context may be attributable to colluvial movement introducing burnt material from further uphill, perhaps from garden specimens or street trees destroyed in the conflagration, or from fuel debris. A wide range of taxa was also identified from a large sample of charcoal from the abandonment layer of a backfilled room (context 13062), which included *Salix* or *Populus*, *Pinus*, *Juglans*, *Fagus* or *Platanus*, *Olea*, *Fraxinus*, *Tilia*, possibly *Rhus*, and a monocotyledon.

From Trench 18, samples 18002 and 18022 from collapsed mud-brick material (context 18001) were identified as (vitrified) *Olea* roundwood and *Pinus*, respectively. Each appeared to have derived from a single specimen, possibly from structural remains that had subsequently fragmented. Large chunks of *Pinus* were also recovered from a destruction layer (context 18070) below context 18001. Degraded charcoal, from a further layer of burning debris (context 18084), sealed by context 18001, consisted of *Olea*, a member of the Ulmaceae (*Ulmus* or *Celtis*), and an unidentified conifer.

Charcoal was also examined from several other destruction layers in Trench 18, including contexts 18008 (above a mortar floor), 18048, 18054, and 18071. The taxa identified included *Fagus* or *Platanus*, *Pinus*, a member of the Pomoideae, *Olea*, *Tamarix,* and *Salix* or *Populus*.

A group of three pits, which appear to have functioned as seating for partially sunken storage vessels, was spot-dated to the late Hellenistic or early Roman period. A small quantity of charcoal was recovered from the fill of these pits (context 18098) and identified as *Pinus*, deciduous *Quercus*, *Salix* or *Populus,* and a member of the Ulmaceae. The origin of this charcoal is unknown, although it could relate either to the gradual accumulation of charred debris over a period of time or to the subsequent use of the pits for dumping fuel debris. Pit 18114 had been sealed with a layer of stones and, thus, it would seem more likely that the contents represented dumped material, possibly fuel debris. Associated charcoal was extremely sparse and friable, and provisionally named as *Quercus*.

Zone 10, Trench 10

This trench was located on the eastern boundary of the site in Area B and exposed the drains of a public latrine that may have formed part of the bathhouse complex (table 9). Charred *Olea* wood was recovered from the backfill of the drain (context 10041). Material on the floor surface (context 10019) was less well preserved and partially vitrified; the taxa included *Olea*, *Quercus,* and, probably, *Pistacia*. *Olea* and deciduous *Quercus* were also present in deposits on the surface of the alleyway (context 10004).

DISCUSSION

The current analysis is based on a total of 58 samples of charcoal, mainly recovered from the destruction layers of buildings from residential, commercial, and public areas of the site in Zones 1–5 and 10. Twenty-eight of the samples relate to Trench 2, where a large number of buildings were sited near the base of the valley in Zone 2. Ten samples refer to Trench 18, where housing was located in a more elevated position on the headland in Zone 5. The remaining samples represent Trench 9, an area of commercial buildings in Zone 1; Trench 5, an urban area of townhouses in Zone 3; Trench 15, public quarters with landscaping and terraces in Zone 4; Trenches 7, 12, and 13 (all in Zone 5), which included commercial areas (Trenches 7 and 12) and housing on the headland (Trench 13); and Trench 10, a public latrine sited close to a bathhouse complex on the eastern edge of the city in Zone 10.

The dating of some samples is problematical, and although most probably originate from the Sasanian sacking event of A.D. 252/253, a few contexts were spot-dated to either earlier or later phases. For example, contexts from Trench 13 dated to the mid-Roman period (thus predating the Sasanian destruction) included 13033, 13034, 13036, and 13062; and a make-up level (context 5075) in Trench 5 related to the late fifth or sixth century.

The destruction layers consisted of collapsed masonry, mud-brick, roof-tiles, charred structural beams and household debris thought to date mostly from the Sasanian sacking of the stone-built city in the mid-third century A.D. The speed of this attack is unknown but, in the haste of abandonment, it seems likely that the greater proportion of the populace would have been unable to salvage any but the most portable or valued possessions, leaving the contents of most buildings to perish in the flames. Wooden artifacts such as domestic or kitchen equipment, caskets, storage chests, furniture, decorative panels, and sculptures would have been reduced to charcoal, and in some instances the remains of such items were probably included in the samples examined. Some samples may also include the remains of firewood or charcoal fuel destined for, or debris from, hearths, ovens, braziers, and kilns; for example, deposits from a possible hearth in context 5060 (Trench 5). Occasionally, quite substantial portions from burnt structural beams remained intact in the fallen debris; examples of such were recorded on the floors of houses in Zone 2, where pieces of *Pinus* timber (contexts 2278 and 2383) and *Cedrus* and *Cupressus* beams and planks (contexts 2045, 2010, and 2295) were recovered. *Pinus* roof timbers were implicated in context 2141 where sherds from roof tiles were present.

The artifactual nature of the charcoal brings into question the procurement of wood and timber. A large proportion of the furniture and smaller household items was probably constructed in workshops in the artisans' quarters or by independent craftsmen scattered throughout the town. Buildings excavated in 2000 revealed tools for carpentry, including saw blades.[9] Craftsman probably used both local supplies and more exotic woods and inlays for luxury items. Larger structural timbers named from the charcoal, e.g., *Pinus*, and precious or prestigious woods, such as *Cedrus* and *Cupressus*, would have been imported.

The Economic Use of Timber and Wood Resources

Comparisons of the range of taxa identified from the different zones and trenches (table 10) show that there is a strong correlation between the number of taxa identified and the number of samples examined; Trenches 2 (Zone 2) and 18 (Zone 5) included the broadest range of taxa. Conversely, however, a rather similar range of species to those in Trench 18 was recorded from comparatively few samples in Trench 12, located nearby. In total, 21 taxa were named, including some provisional identifications from poorly preserved charcoal.

Structural Components

While principally constructed in stone, many of the buildings in Zeugma incorporated timber roof beams and rafters and other wooden members such as floorboards, doors, and door jambs. Woodworking tools recovered from excavations in 2000 included numerous saw blades, attesting to the on-site conversion of timbers and more general carpentry.[10] The frequency of *Pinus* in destruction layers across the site suggests that this was the most commonly used building timber. While it was not possible to identify the species (possibly two were used), these may have included *Pinus halepensis* or *P. halepensis* var. *brutia*. The latter seems more likely, since not only would this species have been more accessible (see "Procurement of wood resources") but the quality of the wood is superior and would have supplied timbers of larger dimensions.[11] In the Near East and Central Asia, both *Pinus* and *Populus* have traditionally supplied rafters and roof beams.[12] Archaeological evidence of *Pinus halepensis*, *P. halepensis* var. *brutia*, or both was obtained from the burnt remains of timbers recovered from the ground-floor ceiling of a two-story house at Tell el-Kerkh, northwestern Syria, dated to ca. 5500 B.C.[13]

The aromatic red wood of *Cedrus* and *Cupressus* was highly prized in the ancient Mediterranean world and Near East for monumental building works, roofing beams, pillars, and doors,[14] and evidence from the charcoal suggests that similar status was accorded to building practices in Zeugma; both taxa were identified from beams in contexts in Zones 2 and 4. The dimensions of buildings incorporating wooden beams and pillars would have been limited by the size of the timber available.[15]

Olea was also relatively frequent in the destruction layers and may have been used structurally. The wood is hard, strong, and durable, takes a fine polish, and often has a decorative grain. The use of *Olea* for smaller structural elements, such as door posts, is recorded from temples in the Holy Land.[16] Other uses of *Olea* wood are discussed below.

Furniture and Other Artifacts

Contemporary texts and reliefs describe the design of household furniture in Central Asia and the Near East in the centuries preceding and during the Roman occupation of Zeugma.[17] The basic materials of construction consisted of wood and reeds, which, in the wealthier households, were lavishly decorated or inlaid with precious metals and ivory. Few examples, however, have survived in archaeological contexts, and secure evidence of the use of wood species in cabinetmaking and carpentry is correspondingly sparse.

The derivation of some charcoal fragments recovered from the destruction layer at Zeugma may relate to furniture or other artifacts, and it is worth considering the merits of the wood species identified for carpentry and allied uses.

Fruitwoods, of which several were named from the charcoal deposits, are often highly decorative. *Juglans*, for example, produces an attractive dark, gray-brown timber that is hard, heavy, resilient, and easy to work, although susceptible to beetle attack.[18] It is interesting that despite its popularity with cabinet-makers in recent centuries, references to the use of *Juglans* wood by classical writers in the Roman period are surprisingly sparse.[19] The frequency of *Juglans* in the charcoal deposits at Zeugma may imply either that the wood was more fashionable here than in other parts of the Roman Empire, or that *Juglans* was more readily available than other types of timber and thus commonly used for furniture or architectural details. As previously discussed (see "Structural components"), *Olea* wood has numerous applications, especially for small domestic items, tool handles, and as fuel.[20] *Vitis* wood is reputed to be durable and, although it rarely attains large dimensions, it was used in the Greek and Roman periods for statues, bowls, and other small items.[21] Woods from *Prunus* species and members of the Pomoideae are hard and close-grained; ranging in color from a rich red in *Prunus* species to golden browns, they were important for furniture, turned work, and small domestic items.[22] *Ziziphus* wood is also hard and durable and was valued in the ancient world for small carpentry work and other items.[23]

Fagus or *Platanus* charcoal was also relatively frequently found at the site (see table 1). As already noted (see "Results"), it is often difficult to distinguish these genera, especially from small fragments of archaeological material. Both taxa are capable of producing large timbers, but neither is suited to outdoor use. In the ancient world, both woods were used for furniture (e.g., beds, tables, chairs); and *Fagus*, in particular, for food vessels (e.g., drinking cups, bowls, and platters).[24] Similar uses applied to the golden and often beautifully figured grain of *Acer*.[25] *Acer* wood is strong and even-grained; burr wood (not found at Zeugma) was specially valued for decorative items and commanded high prices.[26] The strong, durable wood of *Quercus* was used for domestic items, furniture (e.g., couches), and for some types of structural work.[27] Hepper[28] notes that stools were made from *Salix*, *Tamarix,* and *Prunus*, and the soft timber of *Populus* was used for other types of carpentry.

Some woods were very uncommon in the deposits. *Tilia*, for example, was only recorded from context 13062. The wood is pale, soft, and compact, and although unsuited to construction work, it is excellent for carving small domestic items and for architectural embellishments. In the ancient world, Theophrastus[29] and Pliny[30] recommended its use for boxes and measures. *Fraxinus* was also rather sparse but occurred in the same context as *Tilia* and also in contexts 2376 and 2027 (the fill of a vessel). *Fraxinus* wood is hard and resilient and ideal for tool handles. Theophrastus[31] refers to its use for beds, bentwood items, and carpenters' tools. *Celtis* was provisionally identified from a single context 13036; the dark wood was valued for carving and sculpture.[32]

Aromatic softwoods such as *Cedrus* and Cypress (see Structural components) were renowned for their longevity, beauty, and resistance to beetle attack and were particularly valued for storage boxes and such like.[33]

Fuel

With an estimated population in Zeugma of up to 50,000, the pressure on the fuel industry for domestic and industrial firewood and charcoal must have been enormous.[34] Since a major part of the town was destroyed by fire, it was difficult to distinguish genuine hearth contents from the general spread of refuse that accrued from the collapse of burnt buildings. Context 5060, however, was ascribed as a hearth, and the rather degraded charcoal from its ashy fill was provisionally identified as *Olea*. Although it was common practice in Romanized towns throughout Europe to utilize both firewood and charcoal for domestic heating and food preparation,[35] we do not know whether the fuel used in the Zeugma hearth consisted of firewood or charcoal. Charcoal would certainly have been necessary for metallurgy and perhaps for other industrial purposes.

We can speculate that fuel was available in various grades, with cheaper firewood consisting of scrubby roundwood, woodworking off-cuts and decayed or discarded building materials, and possibly driftwood. The more desirable wood species with higher calorific values and better burning properties would have attracted higher prices. The resinous wood of *Olea*, for example, which provides a fierce heat, can be burnt green (unseasoned) and emits a pleasant odor.[36] Other species particularly valued as high-energy wood fuel in Central Asia today include *Amygdalus*, *Pistacia*, *Tamarix*, *Juniperus,* and members of the Chenopodiaceae.[37]

Prunings and tree surgery from viticulture, fruit gardens, groves and orchards, street trees, and garden plots would have provided a local source of firewood and kindling. In common with present-day practice in Mediterranean countries, bundles of *Vitis* prunings were probably used on the hearth. In addition, some areas may have been planted and managed specifically for timber and fuel production — perhaps using *Populus* and *Tamarix* groves along the banks of the Euphrates, using similar methods to the timber husbandry (probably coppicing, using tamarisk) described on Sumerian tablets dating from the third millennium B.C.[38] These documents indicate that *Populus euphratica* and *Tamarix* were grown in gardens to provide wood for tools and implements, while large timbers were obtained from *Populus* trees grown in woodland and *Tamarix* along the field margins.

Charcoal provides a fuel with roughly twice the calorific value of firewood and was essential for ironworking and other industries using metals.[39] Charcoal production at Zeugma and its environs was probably similar to methods observed in modern-day Iran (i.e., in pits).[40] The persistent demand for charcoal over the past centuries and the high rate of wood consumption for its production (approximately seven units of wood are required to produce one unit of charcoal), combined with unchecked stock grazing, has degraded or denuded previously well-wooded steppe or forest-steppe regions of Turkey and northern Iran.[41] At Zeugma, however, it is possible that managed woodland (including fruit gardens and olive groves) provisioned all or at least part of the wood supplies to charcoal burners. Similar practices were recorded in parts of ancient Greece.[42]

Other types of fuel used in the Near East and Central Asia include reeds, rushes, dung cakes, and caked pulp from olive oil pressing mixed with grape skins and seeds.[43] In many regions of Turkey, evidence of increased dependence on dung cakes correlates with diminishing supplies of wood fuel.[44]

Discarded ash and charcoal debris was probably used as a fertilizer and soil improver for arable crops and fruit orchards. The insecticidal properties of wood ashes may also have been exploited, as in other parts of the Mediterranean, in its application to the walls and floors of buildings.[45]

Environmental Evidence for the Town and Its Environs

Zeugma was sited on the west bank of the Euphrates in a region of southeastern Turkey near Birecik, which, in botanical terms, lies on the boundary of the phytogeographical zones of Amanus (southern Anatolia) and Mesopotamia (east Anatolia) (i.e., on the borders of steppe and Mediterranean regions, associated with Irano-Turanian vegetation),[46] with the Amanus mountain range to the west and the steppe lands of northern Syria to the south. The underlying soils at the site are composed of limestone. Regional bedrock in southern Anatolia is dominated by hard limestone, although basic igneous rocks, shales and slates also occur; limestone is scarce, however, in the Amanus, where basic igneous rocks predominate.[47]

The Irano-Turanian element divides roughly into two vegetational types.[48]

1. Deciduous scrub or open forest, which may represent an originally forested area. The exploitation of woody vegetation within recent centuries has reduced and degraded this environment in many areas.
2. Areas of treeless "true" steppe or moist steppe. It is difficult to assess the natural character of the many steppe

regions owing to longstanding farming and woodcutting activities, which have impoverished the soils and diminished the arboreal vegetation. Zohary[49] discusses tree and shrub species that survive in the present as vestigial communities in these regions.

In Turkey, the Irano-Turanian scrub is best developed in the west and north of central Anatolia and typically includes *Quercus infectoria*, *Q. cerris*, *Juniperus oxycedrus*, *J. excelsa*, *Pistacia atlantica,* and members of the Rosaceae (e.g., *Pyrus elaeagrifolia*, *Prunus macrocarpa*, *Amygdalis orientalis,* and *Crataegus orientalis*).[50] In scrub areas of eastern Anatolia, *Juniperus* and deciduous *Quercus* species form the dominant woodland.[51]

Today, the arboreal landscape around Zeugma is restricted to cultivated groves of *Pistacia vera*, sometimes mixed with *Olea europaea*, *Vitis,* and rare stands of *Pinus*. *Capparis* and small xerophytic subshrubs are occasionally dotted about. Fruit gardens are said to have been cultivated along the banks of the Euphrates prior to the construction of the dam. The present-day landscape bears no resemblance to the natural environment. Although it is not possible to establish when these changes began, it seems probable that the effects of urbanization were already manifest in the landscape by the Roman period. In view of the local topography, the natural vegetational climax in the vicinity of Zeugma may have resembled that of the moist-steppe zone suggested for areas of northern Iraq, which was probably dominated by small trees including *Pistacia* and *Quercus*.[52] Archaeological evidence from Neolithic and Bronze Age sites in southeast Turkey, northern Syria, and northern Iraq indicate that the natural distribution of steppe forest (predominantly *Pistacia*, *Quercus,* and *Amygdalus*) was more widespread than previously thought.[53]

The arboreal community along the more humid corridor associated with the river and floodplain of the Euphrates may have been similar in character to wooded stretches recorded on floodplains in semiarid regions in Central Asia (e.g., *tugai* in Turkmenistan).[54] These typically support riparian forest species such as *Populus*, *Salix*, *Ulmus*, *Fraxinus*, *Vitis,* and *Tamarix*. Similar species were recorded from early Holocene sites on the Syrian Euphrates.[55] Vestigial remnants of riverine species may have been maintained on the Euphrates at Roman Zeugma and managed as described above (see "Fuel") to provide timber, fuel, and carpentry wood.

The results of the charcoal analysis demonstrate the availability and use of at least 20 species of trees and shrubs in an area that, for many of these species, was remote to their natural range. Given the size and status of the town, it could be argued that a high proportion of these were probably cultivated as crops or ornamentals. The use of trees for urban improvement probably dates from the Hellenistic period,[56] and the widespread planting of ornamentals may already have been established at Zeugma prior to the Roman occupation. The Romans were renowned for introducing exotic species to areas well beyond their native habitat. *Platanus orientalis* and *Celtis australis*, for example, were esteemed for their shade and beauty and were essential for fashionable parks and gardens in Italy.[57] Formal plantings may have consisted of a wide variety of flowering trees and shrubs, and probably included some of the more decorative fruit trees (e.g., *Citrus* and *Punica granatum*), which may have been cultivated in garden plots, containerized in courtyards of the wealthier town-houses, or planted in public gardens and squares. For the Romans, *Pinus pinea* was also important, for in addition to the edible and nutritious nuts, the tree had religious significance. The remains of the cones and seeds have been excavated from Roman sites throughout Europe (e.g., at the Temple of Mithas at Hadrian's Wall, Britain),[58] and it is not inconceivable that *Pinus pinea* trees were planted in auspicious places at Zeugma (it is probable that the wood from such trees was also regarded as sacred). Trees and shrubs growing within the town precincts, especially those with resinous foliage and wood, would have perished in the devastating fires that swept through the streets and, thus, may be represented in the charcoal residues.

Evidence from both the charcoal analysis and that of the charred plant remains (Challinor and de Moulins, this volume) suggests that fruits and nuts, including peaches, cherries, figs, pomegranates, pistachios, grapes, olives, and walnuts, were grown locally. In common with recent practice, fruit gardens were probably established on the rich, moist soils on the banks of Euphrates or, for the more drought tolerant species (e.g., *Olea*, *Vitis,* and *Pistacia*), in groves on the more fertile soils of the surrounding hills. Corroborative evidence of the local cultivation of these species is supplied from the charcoal deposits, which included wood from most of the fruit trees named. When mature, the majority of these species could have provided wood of useful dimensions for the carpenter; even smallwood or prunings would have been of some value, e.g., as firewood. The only exceptions from the charcoal deposits were *Ficus* (fig) and *Punica granatum* (pomegranate).

Procurement of Wood Resources

The topography and geology at Zeugma suggests that the natural vegetation would have been similar to that of comparable limestone areas in the Irano-Turanian regions of Central Asia and was probably characterized by open woodland, small trees, and shrubs, although variations in the local climate and ecozones would have influenced the amount of woodland cover.[59] However, in view of the longstanding occupation and (probable) cultivation at the site predating the Roman occupation, it is likely that the "wild" element in much of the locality was already substantially altered at the time of the Roman conquest. Hepper[60] provides a useful catalogue of timber trees of Western Asia and their present-day distribution.

Some areas of scrub or light woodland typical of steppe or Mediterranean shrub vegetation may still have existed on the low limestone hills around Zeugma in the early centuries of the first millennium although, given the size and longevity of the town, wooded areas were probably already degraded and impoverished through the activities of wood-gathers, charcoal-burners, and livestock. The large number of taxa identified from the charcoal implies the use of, and access to, a wide-ranging source of timber and wood. Defining the area of origin of this source, however, is less clear-cut, especially since both cultivated (fruit orchards and possibly managed woodland) and "natural" reserves are implicated, and there is also strong evidence to suggest the importation of exotic timbers. The latter would have entered Zeugma through the ancient trading network (probably established in the fourth millennium B.C.) that linked the eastern Mediterranean ports to Iraq and Iran, via the Euphrates River.[61] The strategic siting of Zeugma on the Euphrates enabled access to long-distance trade routes and thus to exotic supplies of ready-made luxury goods (e.g., wooden caskets and boxes) and basic raw materials (e.g., timber and wood). Possible evidence of trading between distant towns on the Euphrates was recorded by Kenrick, who noted similarities in the pottery at Zeugma to that found at Lidar Höyük and Kurban Höyük, on the southern watershed of the Anti-Taurus Mountains, and Aşvan Kale, even farther north.[62] Precious timbers, native to these regions, including *Cedrus libani*, may also have been traded via the Euphrates to more southerly towns. Examples of the early movement of timber (including cedar, cypress, and pine) from the Amanus Mountains to Lagash and other southern towns are provided by texts dating from the old Babylonian period.[63] Neo-Assyrian reliefs illustrating the transport of timber by water indicate that large timbers were either towed or loaded onto boats.[64] Rafts made from reeds and hollow gourds and inflated goatskins also conveyed cargoes of wood down the Euphrates, while overland transport of smaller timbers used manpower and ox-carts.[65]

To enable a better understanding of the possible sources of (noncultivated) local and exotic species (i.e., nonindigenous in the region around Zeugma), ecological data pertaining to the species identified from the charcoal residues are included in the following section.

Xerophytic and Semi-Xerophytic Species

Pistachio species native to the Mediterranean and Central Asia include *Pistacia atlantica*, *P. lentiscus*, *P. palaestrina*, *P. khinyuk,* and *P. vera*.[66] All produce edible nuts, but those of *P. vera* are the largest. *P. atlantica* forms a tree up to 20 m in height with a trunk diameter of 1 m or more and grows in limestone and sandy soils in Central Asia (including southeastern Anatolia to Syria) and the eastern Mediterranean.[67] *P. atlantica* sometimes forms the dominant element in open communities of semisteppe or steppe forest, often with *Quercus* or *Pinus*, or *Juniperus* with other xerophytic shrubs (e.g., *Amygdalus*).[68] *P. vera* extends eastwards from the Caspian Sea[69] and is therefore less likely to have been represented in the natural environment around Zeugma. This species thrives in steppe-forest, steppe, or semidesert and is extremely drought tolerant. *P. vera* has a long history of cultivation; propagation is usually by grafting, often on to the stock of *P. atlantica*.[70] In the present day, large groves of *P. vera* dominate the landscape at Zeugma. No secure archaeological finds of *Pistacia* have been made in the Near East before classical times.[71]

The wild olive or oleaster (*Olea europaea* var. *oleaster*) is a small spiny evergreen tree growing to about 5 m or more on poor, stony well-drained soils at altitudes up to 400 m.[72] The natural distribution of olive is uncertain since cultivated varieties (*Olea europaea*) have been grown in similar conditions in the eastern Mediterranean since the fourth millennium B.C.[73] Olive is a true Mediterranean species and cannot survive in temperatures below 10° C.

A number of *Quercus* species typically grow in scrub or steppe-forest, often in association with *Pistacia*, fruit trees (e.g., *Amygdalus*, *Punica granatum,* and *Pyrus*), and other xerophytic shrubs.[74] These fruit trees also grow in scrub and on dry stony slopes and gorges on calcareous soils.[75] *Ziziphus spina-christi* and *Z. jujuba* are both spiny evergreen shrubs of scrub, often in dense thickets, and are especially characteristic of low Mediterranean woodland in some parts of western and Central Asia.[76] Although widely cultivated for their edible fruits, the natural range of *Ziziphus* in the Near East is restricted to warm, wet areas.[77]

Mesic or Forest Species

The Amanus mountain range was probably the closest natural source for many of the larger forest trees named from the charcoal deposits at Zeugma (e.g., *Fagus*, *Platanus,* and *Fraxinus*). These often occur in specific communities: for example, *Fraxinus excelsior* and *F. angustifolia* in deciduous associations of *Fagus orientalis* and *Carpinus betulus,* or in mixed forests of *Abies* and *Fagus* or *Picea* and *Fagus*.[78] Several species of *Acer* are indigenous in the Amanus region, one of the most frequent being *A. monspessulanum*, which forms a small tree or shrub in open forests of *Cedrus*, *Juniperus,* and *Quercus*, or on sunny exposed slopes with xerophytic shrubs.[79] *Fraxinus excelsior*, *Ulmus*, *Salix*, *Populus,* and *Tamarix* also grow in open riverine forest.

Cedrus libani is native to the Taurus, Anti-Taurus, and Amanus regions of Turkey at altitudes of 1000–2000 m, either as the dominant tree or in mixed forest.[80] *Pinus halepensis* also occurs here, although successful seed germination restricts its distribution to the less arid chalky soils. *Pinus halepensis* is therefore less common in the eastern Mediterranean element, where it tends to be replaced by *P. halepensis* var. *brutia*.[81] *Cypressus sempervirens* is not recorded as growing in the Amanus region today but occupies slopes and limestone rocks from 300–1200 m in the Taurus, eastern Mediterranean, and northern Iran.[82]

Juglans regia grows in semihumid to semiarid habitats and is native in mesic, temperate, deciduous forests in

Iran and northern India; its natural status in other parts of central Asia and the Near East is uncertain.[83] It has been cultivated extensively for its edible nuts, and although wild colonies have been recorded in deciduous forests of the Balkans, north Turkey, the south Caspian region, the Causasus, and Central Asia, it is probable that these represent feral colonies from cultivated derivatives.[84]

In its natural habitat in deciduous forest close to water, *Vitis sylvestris* scrambles over trees and shrubs. *Vitis* is native to southern Europe, the Caspian, and the Himalayas but has been cultivated in Central Asia since the Early Bronze Age;[85] the dried and fresh fruits and wine have formed a major part of commerce since this time. Vines are propagated vegetatively and need regular pruning.

Tilia species known in the Taurus and Amanus Mountains and north Iran include *Tilia platyphyllos*, growing in limestone crevices in mixed forest, and *T. argentia*, in deciduous forest.[86]

Environmental Evidence from Other Sites in Western Asia

Even with the benefit of comprehensive sets of data from pollen, charcoal, plant macrofossils, and other environmental studies, the interpretation and assessment of temporal and spatial fluctuations of vegetation and woodland in a given region can be problematical.[87] Archaeobotanical analysis is, nonetheless, an invaluable tool in the study of past vegetational change and is especially useful when assemblages of material are obtained from long chronological sequences.[88] Although charcoal deposits from archaeological sites are generally biased towards the economic use of the wood or timber, the evidence obtained has the potential to indicate the vegetational history of the site, evidence of woodland management, and possibly progressive deforestation. The present-day paucity of scrub or open woodland in steppe regions in Central Asia is attributed mainly to climate change in the early-mid Holocene, a shift in farming practices dating from the Early Bronze Age due to major demographic changes, and to the consequences of long-established local activities such as woodcutting, stock grazing, and agriculture.[89]

Published reports for Roman sites in southeast Turkey, i.e., those comparable to Zeugma, are rare. The following data, however, provide some insight into the impact of human intervention in the Irano-Turanian and surrounding environments from periods as early as the Neolithic. At Aşvan, for example, in central eastern Anatolia, charcoal from multiperiod sites from the Chalcolithic to the Islamic occupation indicated the early exploitation of climax forest (e.g., *Acer*, *Alnus*, *Fraxinus*, *Juniperus*, *Platanus*, *Quercus,* and *Ulmus*) and the gradual replacement of the tree community.[90] Evidence of steppe woodland in regions now devoid of trees was forthcoming from three aceramic Neolithic sites in Turkey recorded at Can Hasan, in southern Anatolia: *Amygdalus*, *Celtis*, *Crateagus* (Pomoideae), *Juniperus*, *Pinus*, *Pistacia*, *Quercus*, Rosa, Salicaceae, and *Ulmus*; Cafer Höyük, in central eastern Anatolia: *Celtis*, *Fraxinus*, *Pistacia*, *Quercus,* and Salicaceae; and Çayönu, in eastern Anatolia: *Amygdalus*, *Fraxinus*, *Pistacia*, *Quercus* and *Tamarix*.[91] A detailed reconstruction of the environment at Neolithic sites in the Konya Basin, central southern Turkey, recognized significant changes in the previously floristically rich woodland communities during the occupation of the site, which were attributed to climatic and edaphic factors and human intervention.[92]

Recent studies of 10 sites on the Euphrates represented differing ecological zones ranging from high altitude/high rainfall in central southern Turkey (starting at Aşvan in the north) to arid steppe in northern Syria (the most southerly site being Jerf el Ahmar) and provided evidence of deforestation dating from the Bronze Age or earlier; similar findings were recorded from three sites in the vicinity of Jebel al Arab in southern Syria.[93] Comparable evidence was recorded at a Neolithic site at M'lefaat in northern Iraq, dated to the eighth to ninth millennium B.C., where typical moist-steppe vegetation included *Acer*, *Fraxinus*, *Quercus*, *Pistacia*, Salicaceae, and *Tamarix*.[94]

Overall, these studies provide conclusive evidence from the Neolithic period onwards of degraded woodland communities in previously species-rich regions, largely due to anthropogenic activities such as woodcutting, stock grazing, and land clearance in extreme antiquity.

CONCLUSION

This report includes the analysis of charcoal deposits from destruction layers associated mainly with the Sasanian sacking of the town in the mid-third century. Furniture and other household items and personal effects were probably abandoned during the rapid evacuation of the burning town. Charcoal deposits were relatively abundant, and origins from structural elements were sometimes evident. In other contexts, however, the origin of the charcoal was less certain, especially when multiple wood species were recorded. Major structural components, including roof beams, appear to have consisted mainly of *Pinus* sp., with some use of *Cedrus* and *Cupressus*. *Olea*, *Juglans*, and *Fagus sylvatica* or *Platanus* were also relatively frequent and may have supplied building and carpentry materials (e.g., door posts, doors, architectural details, and furniture). Less frequent taxa, possibly from burnt artifacts, included *Acer*, *Fraxinus*, *Prunus*, *Quercus*, *Tamarix*, *Pistacia*, *Tilia*, *Vitis*, *Vitex*, and *Salix,* as well as *Populus*, *Ziziphus*, and, probably, *Rhus* and *Celtis*. Alternative origins suggested for some of the charcoal include the burnt remains of shrubs or trees cultivated in gardens and streets or public areas, and fuel (either stored as firewood, and charcoal or as spent fuel from kitchens and hearths).

Since much of the wood was of artifactual origin, and therefore biased towards preferential selection, an environmental assessment of the region was rather difficult. This was further complicated by the identification of wood from species that could have been obtained either from "wild" communities or from cultivated fruitwood (e.g., *Olea*, *Juglans*, *Vitis*, *Prunus*, *Pistacia*, Pomoideae, *Ziziphus*) or managed woodland (e.g., *Populus*, *Salix*, *Tamarix*, as practiced in other parts of Central Asia). In addition, timbers from large montane species, such as *Pinus*, *Cedrus,* and *Cupressus*, were almost certainly sourced from distant forests north of Zeugma and transported via the Euphrates (or possibly from the Amanus mountain range west of Zeugma). The river may also have provided access to other wooded habitats less distant from the site. In view of the large-scale Hellenistic city at the site it seems likely that climax vegetation around Zeugma was already impoverished by farming and woodcutting by the Roman occupation, although some areas may have retained scrub and small trees, typical of steppe or steppe-forest in other parts of the region.

NOTES

1. I am grateful to Professor Peter Crane, Director of the Royal Botanic Gardens, Kew, for allowing access to the reference collection of wood specimens for microscopy (held in the Jodrell Laboratory) and the Herbarium Library.
2. Gale and Cutler 2000, 12.
3. Parsa Pajouh and Schweingruber 1985; Fahn et al. 1986.
4. Davis 1965.
5. Tutin et al. 1964–1980.
6. Phillips 1948, 34.
7. SF 833, not catalogued in the ceramic chapters in volume 2.
8. For **PT312** and **PT452**, see Kenrick, volume 2. For **AM148**, see Reynolds, volume 2.
9. Carpentry tools are catalogued by Scott, this volume, **IR40–53**.
10. Nails for joining timber were also found in large number. See Scott, this volume, **IR559–564** and table 24.
11. Meiggs 1982, 44.
12. Constantini 1977, 105; Hepper 1992, 158; Willcox 1992, 25.
13. Noshiro and Fujii 2000.
14. Hepper 1992, 31 and 158; Meiggs 1982, 78; Rackham 2001, 36–7.
15. Rackham 2001, 36.
16. Hepper 1992, 158.
17. Crawford 1993, 33–9; Curtis 1993, 233–44.
18. Hepper 1992, 12.
19. Meiggs 1982, 296.
20. Meiggs 1982, 255.
21. Pliny *HN* 14.1.9; Theopr. *HN* 14.1.9.
22. Gale and Cutler 2000, 183–4 and 196.
23. Hepper 1992, 155.
24. Theopr. *Hist. pl.*, 5.6.–5.7; Pliny *HN* 14.15.; 14.84; Meiggs 1982, 298.
25. Theophr. *Hist. pl.* 5.7.
26. Meiggs 1982, 297.
27. Meiggs 1982, 292 and 298.
28. Hepper 1992, 73 and 160.
29. Theophr. *Hist. pl.* 5.7.
30. Pliny *HN* 16.14.
31. Theophr. *Hist. pl.* 5.6. and 5.7.
32. Meiggs 1982, 308–9; 312; 316.
33. Meiggs 1982, 292–3; Rackham 2001, 36.
34. Kennedy 1998.
35. Allason-Jones 1989, 96–7.
36. Hepper 1992, 42.
37. Horne 1982.
38. Powell 1992, 99–122.
39. Horne 1982.
40. Horne 1982.
41. Davis 1965, vol. 1, 1–26; Guest 1966, 80–1.
42. Rackham 2001, 27–33.
43. Hepper 1992, 42; Nesbitt 2002.
44. Nesbitt 2002.
45. Hakbijl 2002, 15.
46. Davis 1965, vol. 1, 1–26.
46. Davis 1965, vol. 1, 1–26.
47. Davis 1965, vol. 1, 1–26.
48. Davis 1965, vol. 1, 1–26; Guest 1966, vol. 1, 59–60; Zohary 1973, vol. 1, 87–92.
49. Zohary, 1973, vol. 25, 82–88.
50. Davis 1965, vol. 1, 1–26.
51. Davis 1965, vol. 1, 1–26; Zohary 1973, vol. 2, 582–8.
52. Guest 1966, vol. 1, 80–81.
53. Willcox 1999 and Willcox 2002; Savard et al 2003.
54. Popov 1994.
55. Willcox 1999 and Willcox 2002.
56. Meiggs 1982, 273.
57. Meiggs 1982, 274–5; 277.
58. Blackburn 1951.
59. Davis 1965, vol. 1, 1–26; Guest 1966, vol. 1, 59–60; Zohary 1973, vol. 1, 87–92.
60. Hepper 1993, 1–16.
61. Moorey 1994, 6; Redford 1998, 13.
62. Kenrick, volume 2.
63. Leemans 1960, 126.
64. Mallowan 1966, 446; Meiggs 1982, 345–6; Fontan 2001.
65. Canby 1974, no.18B; Read 1986, 14; Redford 1998, 13; Fontan 2001.
66. Zohary 1973, vol. 2, 358–70; Hepper 1992, 122.
67. Zohary 1973, vol. 1, 368–70; Browicz et al. 1988, vol. 6, 5–8.
68. Browicz et al. 1988, vol. 6, 5–8.
69. Browicz et al. 1988, vol. 6, 5–8; map 5, 39.
70. Zohary 1952.
71. Zohary and Hopf 1993, 180.
72. Zohary and Hopf 1993, 137.
73. Zohary 1973, vol. 1, 372; Zohary and Hopf 1993, 141.
74. Davis 1965, vol. 3, 22, 164, 173.
75. Ibid.
76. Fet 1994, 164–5.
77. Zohary and Hopf 1993.
78. Davis 1965, vol. 6, 149–50.
79. Davis 1965, vol 2, 510; Browicz and Zelinsky 1988, vol. 7, 20.
80. Davis 1965, 7, vol. 1; Zohary 1973, , vol. 2, 345–6.
81. Davis 1965, vol. 1, 74; Zohary 1973, vol. 2, 343; Meiggs 1982, 44; Hepper 1992, 32.
82. Davis 1965, vol. 1, 71.
83. Zohary 1973, vol. 2, 352; Hepper 1992, 123.
84. Zohary and Hopf 1993, 177.
85. Davis 1965, vol. 2, 521; Hepper 1992, 99; Zohary and Hopf 1993, 143.
86. Davis 1965, vol. 2, 423–4; Zohary 1973, vol. 2, 373.
87. Rackham 2001, 13–25.
88. Nesbitt 2002.
89. Guest 1966, vol. 1, 72; Willcox 1999 and 2002; Nesbitt 2002.
90. Willcox 1974.
91. van Zeist 1972; Willcox 1991 and 1999.
92. Asouti and Hather 2001; Fairbairn et al. 2002.
93. Willcox 1999 and 2002.
94. Savard et al. 2003.

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TABLES

Sample	Context	Description	*Olea*	*Platanus/Fagus*	*Salicaceae*	*Pinus*	*Monocot*
9004	9076	Burnt layer of sandy silt	–	22	15	–	–
9011	9228	Charcoal, ash, burnt clay, and a mud-brick layer	–	–	1	16	–
9026	9138	Silt, ash, and charcoal layer	2	–	–	3	1
9030	9195	Inside pot 833	–	–	–	1	–

Table 1. Charcoal from Zone 1, Trench 9. The number of fragments identified is indicated.

Sample	Context	Description	*Acer*	*Cedrus*	*Cupressus*	*Fraxinus*	*Juglans*	*Olea*
2000	2095	Sand/silt with burnt material	–	–	–	–	5	–
2005	2141	Silt layer containing ash, roof tile, etc.	–	–	–	–	–	–
2008	2039	Burnt lens associated with wooden beam 2045	–	–	–	–	–	–
2013	2012	Collapse layer next to wall	–	–			–	3
2012	2013	Rubble collapse	–	–	–	–	–	8
2014	2010	Plank from mixed mud-brick collapse and colluvium	–	1	–	–	–	–
2015	2011	Mud-brick collapse	–	–	–	–	8	–
2017	2016	Fill of vessel	–	–	–	–	–	–
2018	2017	Pot fill	–	–	–	–	–	–
2019	2031	Mixed mud-brick and colluvium	–	–	–	–	–	–
2020	2139	Collapse associated with burning	–	–	–	–	–	–
2021	2046	Burnt lens ass. with wooden beam 2045	–	3	cf. 6	–	–	–
2025	2179	Pot fill	–	–	–	–	–	–
2036	2278	Burnt layer	–	–	–	–	–	–
2037	2032	Friable burnt material	–	–	–	–	–	–
2038	2376	Burnt layer	1	–	–	4	43	–
2039	2377	Fine ashy pot fill	–	–	–	–	9	–
2041	2463	Fine silt in circular depression overlain by floor surface 2464	–	–	–	–	–	3
2042	2383	Burnt layer over mosaic floor 2432	–	–	–	–	–	–
2045	2512	Burnt layer in between floors	–	–	–	–	–	–
2055	2082	Fine ashen layer containing charcoal	–	–	–	–	1	–
2059	2029	Charcoal deposit within mud-brick	–	–	–	–	–	4
2062	2242	Burnt layer	–	–	–	–	–	–
2063	2027	Fill of intact vessel	–	–	–	1	–	–
2066	2095	Sand/silt with burnt material	–	–	–	–	–	–
2288	2295	Large beam	–	1	–	–		
–	2041	–	–	–	–	–	1	1
–	2045	Large beam	–	–	cf. 1	–	–	–

Table 2. Charcoal from Zone 2, Trench 2 (continued on facing page).

Pinus	*Platanus/Fagus*	*Prunus*	*Quercus*	*Rhus*	*Salicaceae*	*Tamarix*	*Vitis*	*Ziziphus*
44 (from 2 species)	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–
26	4		1					
1	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–
40	–	–	–	–	–	–	–	–
23	–	–	–	–	–	–	–	–
24	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–
4	–	1	–	–	–	–	–	–
3	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–
3	–	–	–	–	–	–	–	–
42	3	–	–	–	–	–	–	–
31	–	–	–	–	–	–	26	–
–	–	–	–	–	–	–	–	–
8	–	–	–	–	–	–	–	–
12	–	–	–	–	–	36	–	–
1	–	–	–	–	–	–	–	–
1	–	–	–	–	–	–	–	–
–	–	–	–	cf. 1	–	–	–	–
103	–	–	–	–	–	–	–	–
12	–	–	–	–	–	–	–	–
		–		–	–	–	–	–
3	–	–	–	–	1	–	–	1
–	–	–	–	–	–	–	–	–

Sample	Context	Description	*Juglans*	*Olea*	*Pinus*
5000	5060	Ashy material, in situ burning	–	cf. 2	–
5001	5075	Clay/silt	1	7	12

Table 3. Charcoal from Zone 3, Trench 5.

Sample	Context	Description	*Olea*	*Platanus/Fagus*	*Cupressus*
15006	15007	Silty sand infill	2	1	6
15034	15231	Ashy deposit	9	–	6

Table 4. Charcoal from Zone 4, Trench 15.

Sample	Context	Description	*Juglans*	*Olea*	*Quercus*	*Salicaceae*	*Vitex*	*Pinus*
7000	7006	Silt and ash	–	–	–	–	–	2
7002	7180	Fill of pithos	3	–	1 (deciduous)	–	–	3
7003	7074	Floor surface	–	1	–	1	cf. 1	1

Table 5. Charcoal from Zone 5, Trench 7.

Sample	Context	Description	*Juglans*	*Olea*	*Pistacia*	*Platanus/Fagus*	*Pinus*
12004	12011	Burnt deposit under floor	–	3	–	1	–
12006	12037	Destruction layer	5	–	3	3	41

Table 6. Charcoal from Zone 6, Trench 12.

Sample	Context	Description	*Celtis*	*Fraxinus*	*Juglans*	*Olea*	*Platanus/ Fagus*	*Rhus*	*Salicaceae*	*Tilia*	*Vitis*	*Pinus*	*Monocot*
13002	13033	Ash layer	–	–	–	30	–	–	–	–	–	5	–
13003	13034	Ash layer	–	–	–	6	1	–	–	–	–	1	–
13006	13036	Sand layer under colluvium	cf. 1	–	2	2	–	cf. 1	1	–	1	2	1
13008	13062	Abandonment layer	–	2	12	1	1	cf. 1	25	1	–	25	1

Table 7. Charcoal from Zone 5, Trench 13.

Sample	Context	Description	*Olea*	*Platanus/ Fagus*	*Pomoideae*	*Salicaceae*	*Ulmaceae*	*Pinus*	*Quercus*	*Tamarix*
18001	18008	Destruction layer above floor	–	13	1	–	–	23	–	–
18002	18001	Collapsed mud-brick material	–	–	–	–	–	1	–	–
18015	18054	Destruction layer	–	1	–	1	–	24	–	–
18019	18071	Burnt area of mud-brick destruction layer	1	–	–	–	–	–	–	–
18020	18084	Destruction deposit	2	–	–	–	cf. 1	cf. 1	–	–
18022	18001	Collapsed mud-brick material	1	–	–	–	–	–	–	–
18025	18048	Ash layer	1	–	–	–	–	2	–	2
18028	18098	Clay/silt fill of 3 pits	–	–	–	1	cf. 1	1	cf. 1 deciduous	–
18029	18070	Destruction layer	–	–	–	–	–	48	–	–
18033	18114	Charcoally pit fill	–	–	–	–	–	–	cf. 1	–

Table 8. Charcoal from Zone 5, Trench 18.

Sample	Context	Description	*Olea*	*Pistacia*	*Quercus*
10000	10041	Backfill of latrine	2	–	–
10008	10019	Floor surface	10	cf. 1	1
10011	10004	Alleyway surface	2	–	3 deciduous

Table 9. Charcoal from Zone 10, Trench 10.

Zone	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 5	Zone 5	Zone 5	Zone 10
Trench	9	2	5	15	7	12	13	18	10
Description	Low-status housing/ commerce	Medium-status housing	Medium-status housing	Public areas	Shops	Shops	High-status housing on headland	High-status housing on headland	Public latrine
Total no. of samples	4	28	2	2	3	2	4	10	3
Acer	–	1	–	–	–	–	–	–	–
Celtis	–	–	–	–	–	–	cf.1	–	–
Fraxinus	–	2	–	–	–	–	1	–	–
Juglans	–	6	1	–	1	1	2	–	–
Olea	1	5	2	2	1	1	4	4	3
Pistacia	–	–	–	–	–	1	–	–	cf. ?1
Platanus/ Fagus	1	2	–	1	–	2	2	2	–
Pomoideae	–	–	–	–	–	–	–	1	–
Prunus	–	1	–	–	–	–	–	–	–
Quercus	–	1	–	–	1	–	–	2	2
Rhus	–	cf. 1	–	–	–	–	cf. 2	–	–
Salicaceae	2	1	–	–	1	–	2	2	–
Tamarix	–	1	–	–	–	–	–	1	–
Tilia	–	–	–	–	–	–	1	–	–
Ulmaceae	–	–	–	–	–	–	–	cf. 2	–
Vitex	–	–	–	–	cf. 1	–	1	–	–
Vitis	–	1	–	–	–	–	–	–	–
Ziziphus	–	1	–	–	–	–	–	–	–
Cedrus	–	3	–	–	–	–	–	–	–
Cupressus	–	2	–	2	–	–	–	–	–
Pinus	3	23	1	–	3	1	4	7	–
Monocot	1	–	–	–	–	–	2	–	–

Table 10. Summary of taxa identified from each zone and trench. The number of samples in which each taxon was recorded is shown.

Family	Scientific name and authority	Common name	Comments
Aceraceae	*Acer* sp., L.	Maple	–
Anacardiaceae	*Pistacia* sp., L. *Rhus* sp., L.	Pistachio Sumach	– Provisional identification
Fagaceae	*Fagus* sp., L.	Beech	Anatomically similar to *Platanus*; although *Fagus* can not be ruled out, the charcoal examined is probably more likely to be *Platanus*
	Quercus sp., L.	Oak	Including deciduous oak
Juglandaceae	*Juglans* sp., L.	Walnut	–
Oleaceae	*Fraxinus* sp., L.	Ash	–
Platanaceae	*Platanus* sp., L.	Plane	Anatomically similar to *Fagus*
Rhamnaceae	*Ziziphus* sp., Miller	–	–
Rosaceae: Pomoideae	*Crateagus* sp., L. *Malus* sp., Miller *Pyrus* sp., L. *Sorbus* sp., L. *Cydonia* sp., Miller	Hawthorn Apple Pear – Quince	These taxa, including cultivars of fruit trees, are anatomically similar
Rosaceae: Prunoideae	*Prunus* sp., L.	Cherry, plum, almond, peach and apricot	Includes a wide range of cultivated fruit trees
Salicaceae	*Populus* sp., L. *Salix* sp., L.	Poplar Willow	These taxa are anatomically similar
Tamaricaceae	*Tamarix* sp., L.	Tamarisk	–
Tiliaceae	*Tilia* sp., L.	Lime	–
Ulmaceae	*Celtis* sp., L. *Ulmus* sp., L.	Lotus or nettle tree Elm	– –
Verbenaceae	*Vitex* sp., L.	Chaste tree	Provisional identification
Vitaceae	*Vitis* sp., L.	Vine	–
Cupressaceae	*Cupressus* sp., L.	Cypress	–
Pinaceae	*Cedrus* sp., Trew. *Pinus* sp., L.	Cedar Pine	– Mostly cf. *sula* group, which includes *P. halepensis* var. *brutia*; possibly a second, unidentified, species in context 2095, Zone 2.

Table 11. Taxa and groups of taxa identified from the charcoal.