PERGAMON

Quaternary Science Reviews 18 (1999) 711–716

QSR

Charcoal analysis and Holocene vegetation history in southern Syria

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Abstract

Charcoal analysis of three archaeological sites in southern Syria in the vicinity of the Jebel al Arab (formerly Jebel Druze) indicates that during the Early Bronze Age an association consisting predominately of *Pistacia*, deciduous oak and almond was exploited. During the Middle Bronze Age these taxa diminish and are partially replaced by more steppic species or introduced wood such as olive. During the Roman period evergreen oak appeared in the region and gradually replaced the deciduous oak which is now restricted to a small area. The gradual replacement of deciduous oaks by evergreen oaks has been observed in other areas of the Mediterranean basin during the Holocene. Conifer charcoal such as pine and cedar is present on the sites, but it is not clear whether these were local or imported from farther away, for example, the Lebanese highlands. During the Middle Bronze Age olive wood was also used as combustible but here also its exact origin is not known.

1. Introduction

Analyses of charcoal from archaeological sediments gives direct information about the species of wood used for fuel and in some cases for architectural material. Charcoal is generally sampled by hand or by flotation from hearths or as dispersed charcoal from diverse archaeological sediments. The latter are presumed to be the residues of multiple firings of hearths or other structures associated with combustion and are therefore more representative of the past vegetation. It is assumed that the nearest available ligneous species to a site would have been exploited for fuel. In wooded regions fuel would have been gathered in the vicinity of the sites, whereas in desert, tundra and steppe areas wood for fuel would have been frequently imported from a distance. Certain species having particular qualities may have been preferentially selected, while wild fruit trees may have been purposely preserved. For uses other than fuel there is likely to have been a selection and transportation, but these finds are numerically much less significant. Despite the problem of human selection, information from archaeological charcoal can give valuable evidence of vegetation history (Vernet, 1992; Willcox, 1974) which may supplement pollen data from lake sediments particularly in areas where pollen preservation is scarce, such as the Syrian steppe.

Charcoal studies in southwest Asia have been summarised by Willcox (1991, 1992). More recently, sites on the Euphrates in northern Syria have been studied by Roitel (Roitel, 1997; Roitel and Willcox in press, Willcox, 1996). These studies indicate that at the start of the Holocene during the early Neolithic the forest-steppe consisting of *Pistacia atlantica*, *Amygdalus*, *Prunus microcarpa* and (at low frequencies) *Quercus* (deciduous) penetrated further into what is now denuded steppe which today has an annual rainfall of less than 250 mm. Nearer the area concerned here, 33 fragments were examined from Chalcolithic (i.e. mid-Holocene) levels at Jawa near the Syro-Jordanian border (Willcox, 1992). Here deciduous oak was found to dominate but *Amygdalus* and *Pistacia* were also present.

This part of southern Syria is dominated by the volcanic uplands of the Jebel al Arab (formerly Jebel Druze) which rise to 1800 masl. The rich deep soils formed on the basalt substrate lead to luxuriant plant growth in the higher rainfall areas. The area in general shows a steep gradient in the distribution of the isohyets, which fall sharply towards the east. The area under consideration

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0277-3791/99/$ – see front matter
PII: S0277-3791(98)00106-1

(see Fig. 1 and Table 1) can be divided into three vegetation types. First is the Mediterranean forest vegetation (Mouterde, 1953) found on the western slopes and today dominated by *Quercus calliprinos*. This association is restricted to an altitude of between 1000 and 1500 masl. Above this there is a small newly discovered zone with *Quercus ithaburensis*, however, this is not mentioned by Mouterde (1953) (this population was dicovered by Michael Kalos of the Institut Français d'Archéologie du Proche-Orient, Damascus, who sent me herbarium samples, pers. com.). In the more open areas away from grazing, three wild wheats, *Triticum urartu*, *T. boeoticum* and *T. dicoccoides*, occur. Rainfall on the western slopes can be as much as 400 mm per annum. It is in this area that the site of Sia is located. Second, to the west the plains receive 250 mm per annum and are very degraded but could have potentially supported forest-steppe species in favourable situations if human pressure through grazing and agriculture were removed. The site of Bosra is situated in this vegetation zone. Third, to the east of the uplands, the land slopes steeply down to 700 masl and here drainage is internal. The rainfall is low, 80–100 mm per annum, being in the rain shadow of the Jebel al Arab.

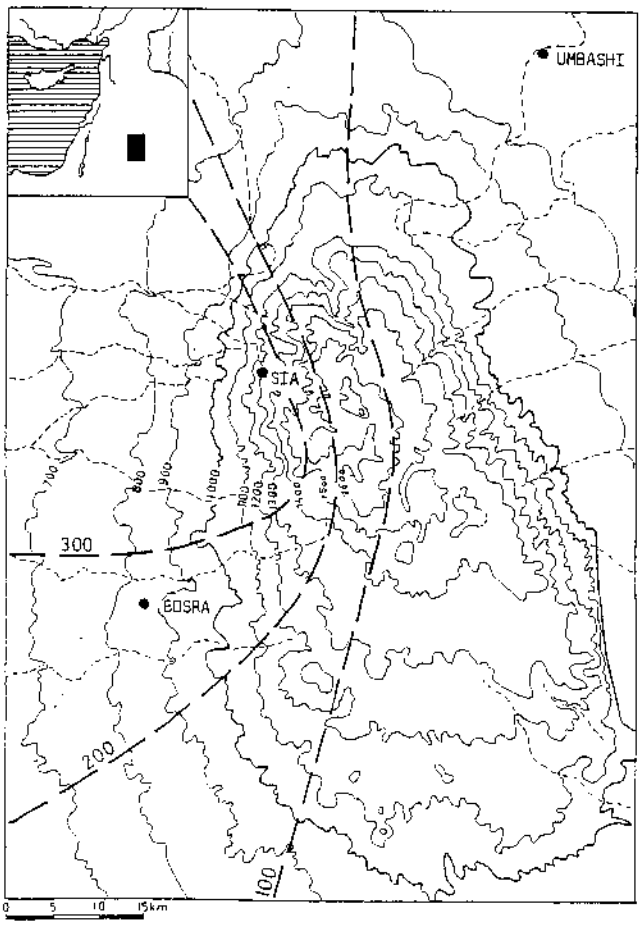

Fig. 1. Map giving the site locations in relation to contours and isohyets for the area of the Jebel al Arab.

This area has a dry steppe vegetation dominated by *Artemisia* and a number of woody chenopod species. Summer temperatures are high.

2. The archaeological sites

Umbashi (650 masl) is a Bronze age site (Braemer and Echallier, 1995) situated in the dry steppe (see Fig. 2 and Table 1). It covers a very wide area, over 50 h. Buildings, mainly habitations, were constructed in local basalt. Archaeological deposits were shallow. For the purposes of this study the site has been divided into two periods, early (3100–2000 BC) and middle (2000–1400 BC) Bronze Age (EBA and MBA, respectively). Evidence provided by the carbonised plant remains suggests that during the Bronze Age agricultural products and by-products were present (Willcox forthcoming). Flotation samples were only obtained from Middle Bronze Age levels where cereal grains occurred frequently, in addition chaff elements and relatively high frequencies of weed seeds are common. The remains of a dam constructed across a wadi were found to be associated with the site. This structure was used to stock water. It would appear, judging from the quantity of animal bones and the position of the site, that the economy was essentially pastoral (Braemer and Echallier, 1995). The severe climatic conditions at the site of Umbashi are best described by reference to the following data compiled from the meteorological stations in the Syrian steppe.

Annual rainfall: 80–120 mm.
Number of days with rain 15–25.
Number of days of continuous summer drought 150–185.
Absolute maximum temperature: 45°.
Absolute minimum temperature: −10°.
Number of nights with frost: 20–25.
Altitude: 650 m.

Sia (1300 masl), a site on the Jebel al Arab (Villeneuve, 1985) is situated in what is today the Mediterranean forest zone. This habitation site provided samples from the Roman period (200–400 AD). Plant remains indicate that vine cultivation was an important part of the economy and this has been confirmed by historical data and the discovery of wine presses in the area dating to the same period.

Bosra (850 masl), to the southwest of the hills in the degraded moist steppe, is a large urban site dating from the Nabatean period, where cereal cultivation was an important part of the agricultural activity. This site (Dentzer and Blanc, in press) provided charcoal samples suitable for assessing the local vegetation from the Islamic period only (1400–1800 AD) (Bertier, 1985). Earlier periods were numerically too poor to be incorporated here and were not obtained from habitation levels.

Table 1
Lists giving the presence of ligneous species (left) in the three different contemporary habitats and their charcoal equivalent taxa (right) from the three archaeological sites. At the bottom right are the species which are absent from the region today

Steppe	Moist steppe	Forest Jebel Druze	Umbashi Bronze Age	Sia	Bosra
			750	1300	850
			80–100 mm	350 mm	250 mm
			3100–1400 BC	200–400 AD	1400–1800 AD
		Acer micropyllum	*Acer*		
		Rhus coriaria	*Rhus*		*Rhus*
		Quercus calliprinos		*Quercus*	*Quercus*
		Pyrus syriaca	*Crataegus/Pyrus*	(evergreen)	(evergreen)
				Crataegus/Pyrus	*Crataegus/Pyrus*
	Crataegus spp	*Crataegus spp*	*Crataegus/Pyrus*	*Crataegus/Pyrus*	*Crataegus/Pyrus*
	Amygdalus	*Amygdalus*	*Amygdalus*		*Amygdalus*
	Rhamnus palaestina	*Rhamnus palaestina*	*Rhamnus*	*Rhamnus*	
	Capparis				*Capparis*
	Prunus microcarpa		*Prunus*		
Tamarix	*Tamarix*		*Tamarix*		
Noea mucronata	*Noea mucronata*		*Chenopod*		
Pistacia atlantica	*Pistacia atlantica*	*Pistacia atlantica*	*Pistacia*		*Pistacia*
Artemisia	*Artemisia*		*Artemisia*		
Salsola			*Chenepod*		
		Quercus ithaburensis	*Quercus (deciduous)*	*Quercus (deciduous)*	*Quercus (deciduous)*
			Pinus	*Pinus*	*Pinus*
			Olea	*Olea*	*Olea*
			Juniperus		
			Fraxinus		*Fraxinus*
			Cedrus	*Vitis*	*Vitis*

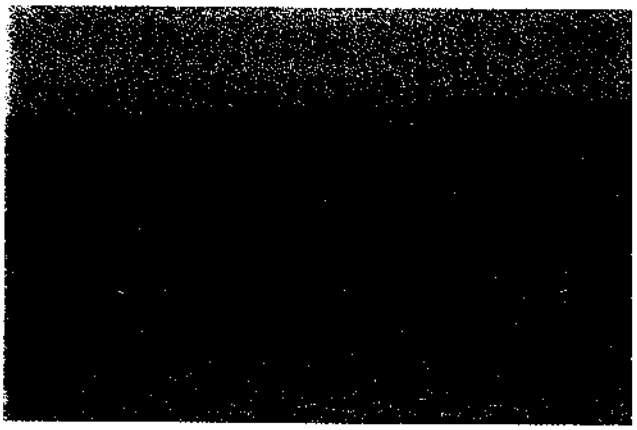

Fig. 2. Photograph taken near the site of Umbashi showing the desolate environment of the Black Desert.

3. Methods

1,860 charcoal fragments were examined from three sites. Charcoal fragments were sampled using both dry and wet sieves and flotation. Standard laboratory techniques were used (see Vernet, 1992), and observations were made on fresh fractures using a light microscope with dark and light fields. Only samples from habitation layers were used for this study, which excluded samples from Roman levels at Bosra. Identifications were based on comparisons with reference material collected in the field by the author from a large number of locations in the Near and Middle East. In addition three atlases of wood anatomy were consulted (Greguss, 1959; Schweingruber, 1990; and Fahn *et al.*, 1986). However, the use of reference material was essential because a number of species are not fully treated in the atlases. The diversity of species in the Near and Middle East made specific identifications difficult except in a small number of cases. For example, there are about 30 species of oak, 28 of buckthorn (*Rhamnus*) and 17 of almond (Zohary, 1973).

4. Results

The results are given in Table 1 and Fig. 3. The percentages are based on the number of fragments. At Umbashi during the early Bronze Age the major taxa represented are *Quercus* (deciduous), *Pistacia atlantica*, *Amygdalus* and steppe species. This forest-steppe association in the Near East today is restricted to areas with higher available moisture than occurs in the area of the site. Steppe taxa such as *Tamarix* and the chenopods occur in the local steppe vegetation. During the middle Bronze Age the most frequent taxa are the chenopods and *Olea*.

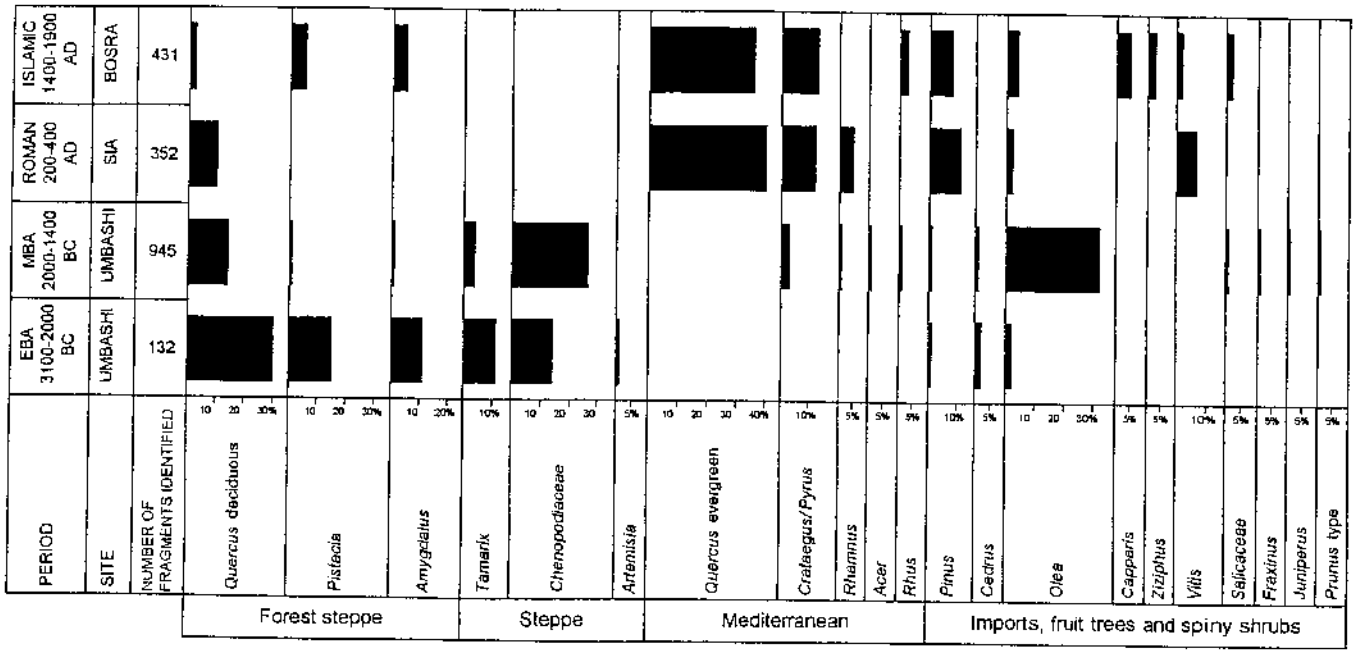

Fig. 3. Diagram giving the percentage frequencies based on the number of fragments identified for each taxon. Because of the nature of the sites, bias may have been introduced through sampling and selection; however the overall trends reflect changes in exploitation and availability of fuel.

The latter may represent prunings used for fuel. It is possible that much of the wood represented at Umbashi was not local (see discussion below) and was imported. This is clear for taxa such as pine, olive and cedar. For the Roman period charcoal samples came from the site of Sia situated on the Jebel al Arab in a high rainfall area. Here, we see the presence of evergreen oak, but deciduous oak is also present with *Pistacia*, *Vitis*, pine, *Crataegus/Pyrus* and some olive. The Islamic period is represented at the site of Bosra, situated in the moist steppe. Here deciduous oak becomes rare and evergreen oak dominates. At the same time the forest-steppe species are well represented.

5. Conclusion and discussion

The differences in local environments between the sites are, as to be expected, reflected in the findings from charcoal analysis. Despite these differences changes in the vegetation for the area can be seen from the results.

The early Bronze Age forest-steppe association of *Quercus* (deciduous), *Pistacia atlantica* and *Amygdalus* from Umbashi is found today in more continental upland areas such as the Jebel Sinjar and Jebel Abdul Aziz. Further south deciduous forests occur on the slopes of the Jordan valley. The forest-steppe association under present-day conditions requires a minimum of 350 mm per annum. However, there is now strong evidence that during the Neolithic this association was much more widespread and penetrated further into what is today the arid steppe at lower altitudes now devoid of tree species (Willcox, 1996; Roitel and Willcox, in press). Thus, it is probable that this association could have extended further east well beyond the present-day limits, for example on the eastern slopes of the Jebel al Arab and thus much nearer the site. *Amygdalus* and *Pistacia atlantica* are more tolerant of arid conditions than *Quercus* and may therefore have occurred nearer the site. Indeed isolated relict communites of the *Pistacia/Amygdalus* steppe are to be found above 800 masl in a few rare locations in the Syrian interior and relicts of *Pistacia atlantica* have even been found at Safa, 15 km to the east of Umbashi at an altitude of 850 m (Braemer, pers. comm.).

During the middle Bronze Age there is a reduction in the frequency of forest-steppe taxa but they continue to be present. Olive wood and xeric chenopods increase in frequency (Fig. 3). This strongly suggests a change in availability of timber, perhaps brought about by degradation of the vegetation. This could have been brought about either by over-exploitation of the forest-steppe and/or the onset of more arid climatic conditions. In view of the long occupation and the pastoral nature of the site, exploitation in conjunction with grazing may have prohibited regeneration of woody species. However, one cannot exclude the possibility that this difference in frequencies resulted from sample bias or use preference given the nature of the data. For example, there is evidence of spatial differentiation of species; thus in the northern sector chenopods were common, in the west olive

wood and in the south, oak. This could relate to preferential use for different activities in different areas of the site.

Olive cultivation during the Bronze Age is widely attested both from the coastal areas and from the Jordan valley, where both wood and olive stones have been recovered (Neef, 1990). Both olive stones and wood were recovered from Umbashi. Today non-irrigated olive cultivation has its limit at between 200 and 250 mm of rain per annum. Plantations are common on basalt soils.

Cedar wood which was found in two restricted areas of the site may have been imported for a special purpose. Cedar was also imported into Mesopotamia during the Bronze Age but in this case it appears to have been used in building (Willcox, 1992). The present-day distribution of cedars, which are restricted to high altitudes in the Lebanese highlands and the Taurus, probably represents a much reduced area which has diminished due to overexploitation during several millennia. Thus, it is possible that cedars grew much nearer the site than the relic stands we see today.

Oak charcoal is of interest because oaks in their natural habitat form the dominant species. Deciduous oak charcoal, common during the early Bronze Age, as we have seen, could have been brought in from further west at a higher altitude on the slopes of the Jebel al Arab. At present *Quercus ithaburensis* is found in a restricted zone on the Jebel al Arab and on the upper slopes of the Jordan valley, for example near Ajlun some 120 km away. Significantly, evergreen oak (presumable *Quercus calliprinos*) does not appear in the archaeological sequence until the Roman period. It was present at high frequencies at Sia during the Roman period and at Bosra during the Islamic period. Deciduous oak, on the other hand, shows a progressive reduction and at Bosra it represents only three percent of the total charcoal. As we have seen, *Quercus calliprinos* is today the dominant tree on the Jebel al Arab and deciduous oaks occupy only a small area. Pollen diagrams from Lake Kinneret in the Jordan valley (Baruch, 1990) corroborate these findings on a more regional level. They indicate that the frequencies of deciduous oak pollen diminish and evergreen oak pollen increases. Similarly, the Ghab pollen diagram also indicates a decline in deciduous pollen, in this case only slight, which may be because the lake was situated nearer the coast in a more moderate climate (Bottema and Woldring 1990). A similar forest history was recorded on the Dalmatian coast (Jahns 1990). Much further afield, charcoal analyses from southern France indicate also an increase in evergreen oak at the expense of deciduous oak at a somewhat earlier date (Thiébault and Vernet, 1992; Vernet, 1995).

A vegetation history indicating a decline of deciduous oak and an increase of evergreen oak appears to be widespread in the Mediterranean area. Thus, over a large area of the Mediterranean basin deciduous oak was far more widespread at the end of the Pleistocene, and was probably better adapted to the cooler and more continental conditions, whereas the evergreen oaks were restricted to small favourable conditions near the coast. With the post-glacial warming continuing into the Holocene the evergreen oaks expanded at the expense of the deciduous oaks. The difference in dates between the western and eastern Mediterranean could result from increased human pressure in the western Mediterranean at an earlier date. Factors such as fire, grazing and felling may have considerably accelerated the process. Indeed, it has been suggested, that for southern France these changes result more from human disturbance, which favours the regeneration of evergreen oak, than the delayed effect of climatic change. Given the dates for southern Syria which correspond to periods of intense human activity, it would appear that here also human impact was the key factor.

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