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Oak charcoal from northeastern Syria as proxy for vegetation, land use and climate in the second half of the Holocene

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ABSTRACT

Charcoals from archaeological sites in Syria and Turkey have been investigated with a multi-tiered approach to gain insight into the density and composition of the vegetation.
The results show that oak woodland occurred further south into northern Syria throughout much of the second half of the Holocene. The data however also shows that the oak woodland may have had some shrub-like appearance, particularly when an intensive phase of urbanization took place in this region during the 3rd millennium BC and pastoral activities were intense. This is indicated by the (in some cases extremely) slow radial growth of oak. Some charcoal fragments also seem to suggest impact on the wood structure from herbivore browsing. Additionally, possibly due to the rather small mass of the oak woodland present dung was being used as an additional fuel source.
A pilot carbon stable isotopic study on oak charcoal has been undertaken to reconstruct the climate. The results of this study were considered together with those from previously published studies. At best, moderate correlations were found between the isotopic results and minimal and maximal April temperatures, and between average May and October rainfall and the isotopic values.

"*Before embarking on the oaks he pauses to ask what it is for a land to have no trees.*" (*Meiggs, 1982*).

1. Introduction

Today, much of northern Syria is treeless. Satellite analysis and observations in the field show that the nearest stands of woodland are located in northern Turkey, about 10–15 km north of the Syrian border (Fig. 1). According to TAVO map A IV.4 of 1984, this region is dry-farming agricultural land receiving more than 250 mm of annual rainfall, with progressively more rainfall in the north, up to between 400 and 600 mm near Qamishly (near the Turkish border in the Upper Khabur Basin). However, more recent rainfall data indicates that this region has become drier in the period between 2000 and 2012 (www.worldweatheronline.com). For example, at Qamishly average annual rainfall was only ca. 220 mm and only ca. 200 mm at Jerablus (near the Turkish border on the Euphrates). Towards the south on the Euphrates, at Raqqa, on average only ca. 110 mm annual rainfall were received between 2000 and 2012.

For a long time, hardly anything was known about former vegetation changes in the study area because of a lack of pollen archives. The first indication of the woody vegetation's more southward distribution towards northern Syria was mentioned by Willcox (1999). However, it is only due to the last decade's worth of systematic anthracological analysis of many sites and periods that a clearer pattern is emerging — one stressing a more southward distribution of deciduous oak in northern Syria (e.g. Charles et al., 2010; Deckers, 2010a; Deckers and Pessin, 2010; Engel, 1993; Pessin, 2004, 2007; Willcox, 1999).

Nonetheless, from charcoal identifications alone, it is impossible to gain insight into the density and form of the woodland (like has mostly been done in this region). For that reason, this study utilizes multiple approaches in order to gain more insight into how this woodland looked, how it was exploited and whether its remains can provide us with palaeoclimatic data for this region. This multi-tiered research moves from summarizing the anthracological data of a large number of sites, to applying numerous methods to the study area with the aim of increasing our insight into the density and composition of the vegetation. More precisely, ancient woodland exploitation and appearance has been investigated through GIS land use modeling, diameter measurements on deciduous oak charcoal fragments and examinations of charcoal-to-seed ratios. Additionally, measurements of seasonal ring width growth have been performed with the purpose of gaining climatic information. Finally, the stable isotopic data is also considered for its possible palaeoclimatic implications.

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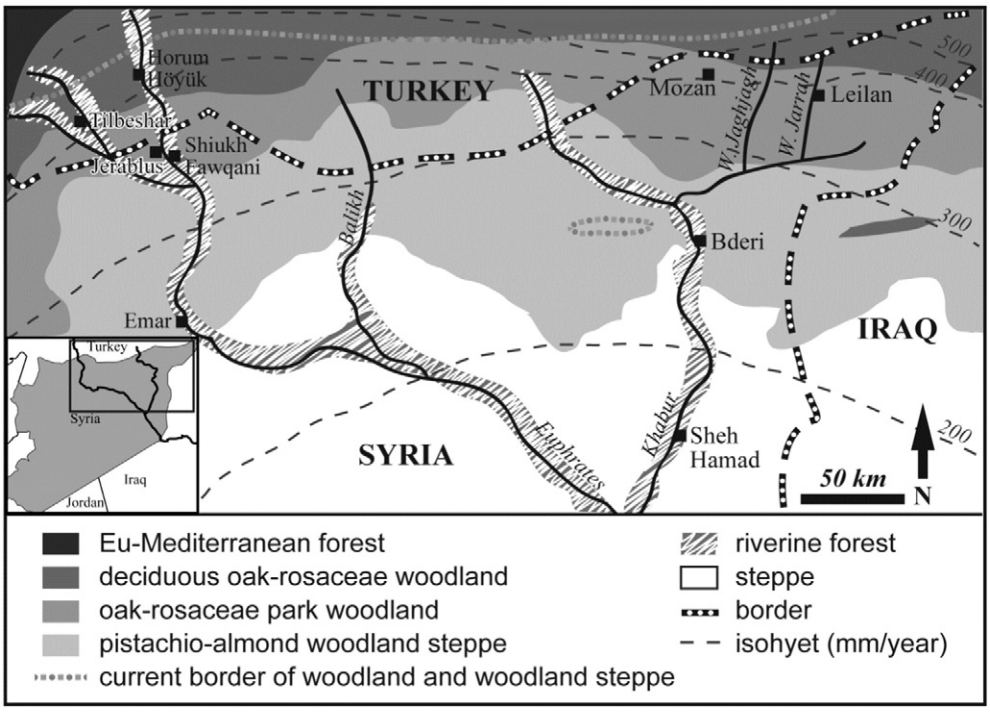

Fig. 1. Potential vegetation map of the study region (after Hillman in Moore et al., 2000). Present day woodland and woodland steppe borders were delineated based on satellite image analysis and field observations (rainfall distribution according to older maps).

2. Materials and methods

For this study, charcoal data from twelve sites in northern Syria and southern Turkey were analysed. The sites were dated between the 4th millennium BC and 13th century AD. More than 58,000 fragments and 410 samples were considered within this research and were, for a large part, identified by the author and are already partially published (Deckers, 2005, 2010a, 2010b; Deckers and Pessin, 2010; Riehl and Deckers, 2009). Furthermore, some published data from other researchers were also included in this study (e.g. Charles et al., 2010; Engel, 1993; Frey et al., 1991; Pessin, 2004, 2007), as well as newly analysed material (Tell Hamoukar). The contexts that were included were domestic. Most data were derived from floated samples. A range of contexts were analysed (see e.g. Deckers, 2005 for details of Emar and Deckers, 2010a for details of Tell Mozan), mostly deriving from secondary fill deposits. Charcoal samples from a few abandonment layers, hearths and construction wood were also included here within the overview. The latter context was represented only in very few cases.

2.1. General assumptions for distribution maps

Firstly, the identification data from all these sites were summarized with the purpose of reconstructing the composition of the local vegetation. Although other factors may have played a role in the representation of woody taxa at an archaeological site, it is often assumed that, especially in the case of firewood, they approximate the relative abundance of taxa in the vegetation of the area (Asouti and Austin, 2005). Based on this assumption, the amount of a charcoal taxon within samples and its ubiquity throughout the samples from a site are used as indicators of the relative abundance in the local vegetation (Smart and Hoffman, 1988). Since it has been demonstrated that weighing samples provides comparable results to counting (Chabal, 1991; Miller, 1985), and because fragments within this area were counted in previous studies, we only report results based on fragment counts. Considering the large number of data, fragment percentages were grouped into six vegetation categories; these are: open oak woodland, pistachio woodland steppe, riverine forest, cultivated taxa, imported taxa, and an indeterminate class.

Deciduous *Quercus* (oak), *Pistacia* (pistachio), *Amygdalus* (almond), Pomoideae, *Prunus*, *Juniperus* (juniper), *Rhamnus* (buckthorn), *Lycium* (boxthorn), *Paliurus* (Christ's Thorn), and *Ziziphus* (Christ's-thorn) were interpreted as belonging to open woodland or woodland steppe (Zohary, 1973). Within this region, the main woody taxon of the open woodland would consist of *Quercus*, whereas *Pistacia* would indicate woodland steppe (Moore et al., 2000). It is sometimes problematic to draw a clear line between what species belonged to the oak woodland and what species belonged to the pistachio woodland steppe since these vegetation groups form a continuum from moister to drier conditions and include some overlapping species. However, it was decided if *Quercus* was clearly dominating over *Pistacia*, *Pomoideae*, *Prunus*, *Juniperus*, *Rhamnus*, *Paliurus*, and *Ziziphus* would be included in the oak woodland. These latter six taxa are mostly present then in minor quantities. However, in Hamoukar, where *Quercus* and *Pistacia* were present in almost equal quantities, both oak woodland and pistachio woodland steppe were mapped (Fig. 2: 4400–3000 BC). It is thought that this site was located close to the border of these two vegetation zones.

Salix (willow)/*Populus* (poplar), *Tamarix* (tamarisk), *Fraxinus* (ash), *Phragmites* (reed), *Alnus* (alder), *Clematis*, *Platanus* (plane), *Eleagnus Angustifolia* (oleaster), and *Ulmus* (elm) were classified as taxa of the riverine forest (Zohary, 1973).

Although it is impossible to distinguish wild from cultivated fruit trees by means of basic wood anatomy, we classified *Vitis* (grapevine), *Ficus* (fig), *Phoenix* (palm tree), and *Olea* (olive) as cultivated taxa. While the present day natural distribution of *Vitis* and *Ficus* indicates some may have been growing wild in the local surroundings (Zohary and Hopf, 2000), we classified them among the cultivated taxa since seeds of these fruits were also found at the investigated sites (Deckers and Riehl, 2007; Riehl, 2010a, 2010b). Some texts, particularly for the Late Bronze Age (LBA), also confirm the presence of vineyards (Beckman, 1996; Westenholz, 2000). *Olea* and *Phoenix* charcoal were