Quaternary International xxx (2016) 1–14

Contents lists available at ScienceDirect

Quaternary International

journal homepage: www.elsevier.com/locate/quaint

Evaluating the impact of water flotation and the state of the wood in archaeological wood charcoal remains: Implications for the reconstruction of past vegetation and identification of firewood gathering strategies at Tell Qarassa North (south Syria)

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ARTICLE INFO

Article history:
Available online xxx

Keywords:
Anthracology
Flotation
Taphonomy
Vitrification
Vegetation
Method

ABSTRACT

The development of water flotation during the second half of the 20th century constituted a milestone in archaeobotany, since it allowed the systematic recovery of plant macroremains by processing large amounts of sediment for the first time. However, little attention has been paid to the fact that in certain cases, hyper-fragmentation or complete destruction of charred plant macroremains occurs as soon as they come into contact with water. At the early Pre-Pottery Neolithic B site of Tell Qarassa North (south Syria) the destruction of wood charcoal remains was documented during the flotation process. The aim of this work is to evaluate the assemblage and to determine the factors that conditioned the preservation or disintegration of wood charcoal remains. In particular, attention is paid to the distribution of the alterations (e.g. vitrification, decayed wood) by taxa, and the proportions with which they are present before and after flotation. To test some of the patterns observed in the archaeological material a small-scale experiment on modern wood charcoal remains is carried out. The results enable a critic reconstruction of the type of vegetation and firewood gathering strategies at Tell Qarassa North. This work has, overall, important implications for the understanding of the taphonomic factors that affect wood charcoal assemblages.

1. Introduction

Water recovery or “flotation” techniques are nowadays regarded as one of the most common methods to retrieve carbonized plant macroremains in archaeological sites (Pearsall, 2000; White and Shelton, 2014). Water flotation was developed during the 1950s and 1960s in the USA as a laboratory procedure to clean plant remains still covered in soil before taxonomic analyses (Struever, 1968; Watson, 1976). In southwest Asia, Hans Helbaek first applied the flotation system at the site of Ali Kosh (Iran) in 1969, in the context of research into the origins of agriculture and domesticated plants (Helbaek, 1969). In Europe, the machine-assisted flotation was developed at sites such as Franchthi cave in Greece, during the early 1970s (Jacobsen, 1973). The principle is simple: when the soil samples are submerged in water and agitated, materials that are less dense than water (1 g/mL), such as charred plant macroremains, float to the surface and they can be easily gathered in fine meshes and sieves. The importance of flotation relies on the fact that it allows for the systematic processing of large amounts of sediment in a relatively short period of time, using inexpensive materials such as a container, small-sized meshes (e.g. 250 micron mesh for the flot) and water. This allows the recovery of large numbers of plant macroremains with which to carry out inferences about past vegetation and the relationship between humans groups and plants. The development of flotation as a recovery method constitutes a milestone in that it minimised the tendency to recover only certain macroscopic remains such as stone tools, bones and pottery in archaeological sites, and brought the attention to ancient plant macroremains and the information these provide. All this has made water flotation to be regarded as a “revolution” (Watson, 1976).

However, little attention has been paid to the drawbacks of this recovery method. Plant macroremains are most commonly found charred in archaeological sites, which make them very fragile and susceptible to damage (Jacomet, 2007). Several researchers have

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http://dx.doi.org/10.1016/j.quaint.2016.06.030
1040-6182/

highlighted that some plant macroremains split open and even completely disintegrate during their recovery with water (Wagner, 1988). This issue has been raised especially in arid or semi-arid areas. At sites such as Tepe Sabz in Iran (Helbaek, 1969), El-Kowm in Syria (De Moulins, 1997) or Wadi Kubbaniya in Egypt (Hillman, 1989) seeds and wood charcoals were observed to be disintegrating during the flotation process. This phenomenon was linked to the extremely dry conditions of the soil samples processed, to the presence of concentrations of salt, and gypsum and calcium coating of the remains. However, structural studies of modern and fossil charcoal indicate that oxidation is one of the main diagenetic reactions responsible for the degradation of charcoals over time (Weiner, 2010, p. 182). Oxidation converts charred materials which are originally hydrophobic (i.e. that tend to repel water), to hydrophilic (i.e. that attract water), and therefore, easier to disintegrate in water. Unfortunately, there have not been systematic studies that attempted to clarify the factors that contribute to the destruction of plant macroremains during their recovery with water-based systems, and as a result, it has not been possible to evaluate whether water flotation introduces biases in terms of species representation.

Wood charcoal is one of the most common plant macroremains found in archaeological sites (Smart and Hoffman, 1988), but its complete absence has been highlighted at several sites (Thiébault, 1980; Théry-Parisot, 1998, 2001; Berger and Thiébault, 2002). Whilst various causal factors exist that explain why wood charcoals (and other non-woody plant macroremains) are not always preserved (Dennell, 1976; Wood and Johnson, 1978; Schiffer, 1987; see also Courty, in press), attention has recently been brought to the role that the state of the wood (i.e., healthy, decayed) may have in their survival (Théry-Parisot et al., 2010, p. 150). The characterisation of the state of the wood is based on the recording of several taphonomic alterations that commonly represent wood in different states such as decayed, green or healthy (Marguerie and Hunot, 2007; Théry-Parisot and Henry, 2012; Henry and Théry-Parisot, 2014). These analyses have become increasingly common in Europe (Théry et al., 1995; Théry-Parisot, 1998, 2001; Ntinou, 2002; Badal, 2004; Badal and Carrión, 2004; Carrión-Marco, 2005; Théry-Parisot and Texier, 2006; Marguerie and Hunot, 2007; Euba, 2008; Heiss and Oeggl, 2008; Allué et al., 2009; Moskal-del Hoyo et al., 2010; Martin-Seijo, 2012; Henry and Théry-Parisot, 2014; Monteiro et al., in press), and they are also starting to be part of wood charcoal analyses in regions such as southwest Asia (Asouti, 2005, 2013; Balbo et al., 2012; Arranz-Otaegui, 2015) and south America (Scheel-Ybert, 1998; Caruso-Fermé, 2012). With some exceptions (e.g. Théry-Parisot, 2001; Chrzavzez, 2013), these taphonomic analyses are usually carried out with the aim of assessing the wood gathering strategies adopted in the past (e.g. collection of deadwood, woodcutting) (Théry-Parisot, 2001; Badal, 2004; Asouti and Austin, 2005; Carrión-Marco, 2005). As a result, there is yet little data with which to evaluate the extent to which the state of the wood influences the survival of wood charcoal remains to depositional and post-depositional processes, including the recovery methods.

At the Neolithic site of Tell Qarassa North (south Syria), the presence of wood charcoal remains hyper-fragmenting and disintegrating was noticed during the flotation process. The aim of this work is to evaluate whether the assemblage is biased and whether the state of the wood affected the preservation of the wood charcoal remains. To assess this, two recovery methods were applied (the *in situ* handpicking of the remains and water flotation), and the frequency with which wood taxa and alterations were present in these two assemblages was recorded. In addition, a small-scale experimental study of modern wood charcoal remains was carried out to test some of the patterns observed in the archaeological material. Based on the results obtained, this work provides a critic assessment of the wood charcoal assemblage from Tell Qarassa North that takes into consideration the biases that affected the assemblage, and in so doing, offers a more reliable interpretation of the remains in terms of past vegetation and wood gathering strategies. Overall, this work contributes to the understanding of wood charcoal taphonomy and the factors that influence the composition of wood charcoal assemblages from archaeological sites.

2. Anthracological materials and methods

In this study, archaeological wood charcoal remains and modern experimental material were analysed. The archaeological material was recovered at Tell Qarassa North, which is located in the Leja basaltic plain, 20 km from the city of Sweida, southern Syria (Fig. 1) (Ibañez et al., 2010). The site comprises two main excavation areas, area XYZ-67/68/69 that includes different domestic structures made of basaltic stones, and area VU-67, which constitutes a small-scale rescue excavation (Ibañez et al., 2010). Ten radiocarbon dates show the site was occupied between 10.7 and 9.9 ka cal BP, which is commonly ascribed to the early Pre-Pottery Neolithic B (EPPNB, 10.7–10.2 ka cal. BP) in the Levant (Kuijt and Goring-Morris, 2002). Two different wood charcoal datasets from the site were analysed; one that corresponds to a primary wood charcoal assemblage from an *in situ* burnt roof structure (Chabal's 1997, "heterogeneous deposit"), and the other that comprises scattered or dispersed wood charcoal remains from different occupation phases of the site and accumulated over a long period of time (Chabal's 1997, "synthetic deposit").

In 2010, excavations in area XYZ-67/68/69 uncovered an *in situ* burnt roof structure inside one of the excavated rooms (Balbo et al., 2012). After the roof structure was completely exposed, a total of 48 beams were identified and retrieved by handpicking (two additional samples corresponded to a mixture of different beams, see Balbo et al., 2012). The samples comprised beams >20 mm in diameter and the wood charcoals analysed were all >4 mm in size. After the 48 wood charcoal samples were retrieved, three flotation samples (a total of 94 L) were taken to recover the remnants of the wooden timbers, along with the non-woody plant macroremains used in the construction of the building (an additional flotation sample was taken from the post-hole located in the centre of the room, see Balbo et al., 2012). The size of the wood charcoals from the flotation samples included fragments >2–4 mm and >4 mm (Salicaceae commonly comprised fragments 2–4 mm in size). The application of handpicking and flotation in this assemblage allows evaluating whether the original taxonomic composition of the roof (the species present and their frequency), which is represented by the handpicked remains, is maintained in the samples processed with flotation or whether differences exist between these two assemblages. The taphonomic analysis of the remains enables testing whether alterations in the wood charcoals are equally represented before and after flotation, and whether they constitute a taphonomic factor that influences the survival of wood charcoal remains.

At Tell Qarassa North, a total of 64 flotation samples were taken to recover dispersed woody and non-woody plant macroremains. From these, 48 samples (1326.5 L) were selected to carry out both taxonomic and taphonomic analyses on wood charcoal remains, results of which are described in this paper (see Arranz-Otaegui, 2015; Arranz-Otaegui et al., in preparation for the results of the rest of the samples retrieved at the site). The samples derived primarily from three domestic structures in area XYZ-67/68/69 (space 1, 2 and 3, occupation phases I–VI; only one sample from area VU-67 was included in these analyses), and it is therefore likely that the wood charcoal remains represent long-term firewood activities. The wood charcoal pieces comprised fragments

Please cite this article in press as: Arranz-Otaegui, A., Evaluating the impact of water flotation and the state of the wood in archaeological wood charcoal remains: Implications for the reconstruction of past vegetation and identification of firewood gathering strategies at Tell Qarassa North (south Syria), Quaternary International (2016), http://dx.doi.org/10.1016/j.quaint.2016.06.030