The Activities of the Laboratory of Archaeobotany and Palaeoecology at Shahr-i Sokhta

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1. Introduction

In 2017, as part of the *Multidisciplinary Archaeological International Project at Shahr-i Sokhta* (MAIPS), the Laboratory of Archaeobotany and Palaeoecology of the University of the Salento began a series of research activities aimed at the systematic recovery of plant macro-remains from the new areas of excavation at the site of Shahr-i Sokhta and the spatial, chronological and stratigraphic contextualisation of the data arising from the previous archaeobotanical research.[1] The analyses described in this study focused on the material sampled in the 2017 excavation campaign, in particular from the so-called *Building 33*, a structure [2] characterised by at least three phases of occupation. Two of these phases were structural, corresponding to late Period II and Period III of the site, i.e. 2600/2500-2450/2400 BC and 2450/2400-2350/2300 BC. The building is positioned between the central area of the site of Shahr-i Sokhta to the east and the large depression to the west. The latter probably represents the legacy of what once was a lake inside the site. The archaeobotanical sampling strategies and the objectives of the research were determined by the size of the structure (which probably had an upper floor), its key position beside the lake and the diversification of the rooms in terms of function, with some of them probably used for the management, storage and processing of foodstuffs.

2. Sampling strategies and methods of analysis

In the course of the excavations of *Building 33* in 2017, systematic sampling was conducted in areas that were potentially interesting from the archaeobotanical point of view, such as ovens and open-air areas. Both sediment and charred plant material were sampled, the latter by naked eye. A total of 12 samples were taken, from the environments corresponding to the most ancient phases of the building (L.15, L.16), the rooms used for the preparation and cooking of food (L.33, L.36), the state rooms (L.4, L.21) and the residential area (L.6). Of particular interest was L.19, an open-air environment linked to both the staterooms and the residential area. It yielded much information regarding the processing of cereals before storage and subsequent preparation as food. Given the mainly sandy nature of the terrain, sediment samples were dry-sieved through 4.0, 1.0 and 0.5 mm meshes in order to recover plant macro-remains in a range of size classes. After selecting the organic component using a stereo-microscope, the plant component was sorted into seeds/fruits, parts of these and combusted woody tissue.

3. Materials and methods

A total of 845 fragments of carbonised woody tissue pertaining to trees and shrubs underwent anthracological analysis. In almost all cases, the remains are characterised by a good state of conservation and good legibility of the anatomic features. In addition, the region's dry climate has enabled not just the recovery of combusted plant material, but also the conservation of fragments of non-combusted wooden artefacts (Costantini 1977b). The anthracological remains were identified with reference to the three fundamental sections of woody tissue. The anatomical features were therefore observed in the three main planes (transversal, tangential and radial), obtained by manual fracture. The diagnostic elements were examined by inverted microscope (Nikon Eclipse 501) at a range of magnifications (from 100x up to a maximum of 400x). For the taxonomic determination, anatomical atlases of wood[1] and samples of modern vegetation in the area were used.

Regarding the carpological analysis, a total of 109 seeds/fruits or parts of cereal spikelets (chaff remains), all in a charred state, were recovered. The morphological and biometric examination of the remains was conducted in the three fundamental views (dorsal, ventral, lateral) using a stereo-microscope. The taxonomic determination was based on comparisons with carpological atlases[2] and the Laboratory's extensive reference collection of modern plants.

4. Results

Anthracological analysis

Recognition of the anatomical elements still visible on the charred fragments made it possible to distinguish four taxa with non-random spatial distribution, while a modest number of fragments (104) remained indeterminate (Tab. 1).

taxa	Locus 4	Locus 21	Locus 19	Locus 33	Locus 36	Locus 6	Locus 13	Locus 15	Locus 16	Locus 28	Locus 45	Totale
Tamarix sp.	122	61	70	2	5	10	10	110	60	15		**465**
Capparis sp.	22	22	22	2		1	1	78	29	83		**260**
Populus/Salix sp.	1	1	6					1			1	**10**
Chenopodiaceae			1			1			4			**6**
Indeterminati	24	16	37			3	4	10	8	2		**104**
Totale	**169**	**100**	**136**	**4**	**5**	**15**	**15**	**199**	**101**	**100**	**1**	**845**

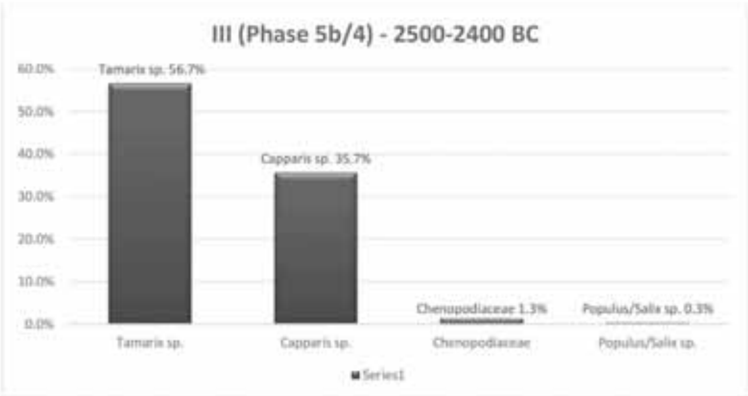
Tab. 1: anthracological analysis of *Building 33* and the spatial distribution of the remains.

The specimens belonging to the *Tamarix* genus have characteristic diagnostic features: distribution of vessels in porous and semi-porous rings, with vessels of medium size, mostly solitary with simple perforations; the heterogeneous rays are very wide (up to 20 cells).

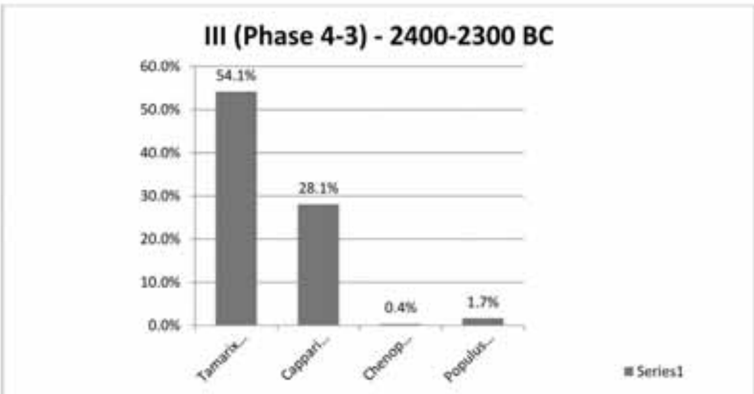
1. Crivellaro - Schweingruber 2013; Fahn *et al*. 1986; Neumann *et al*. 2000; Pajouh - Schweingruber 2001; Schweingruber 1990.
2. Jacomet 2006; Nesbitt 2006.

The *Capparis* genus was recognised on the basis of the rather solitary distribution of the vessels, sometimes present in small groups, simple perforations of the vessels and heterocellular rays from 1 to 10 cells wide.

Populus/Salix was identified on the basis of the semi-porous distribution of the vessels, arranged in small radial groups, simple perforations and monoseriate rays. The distinction between the two genera is problematic due to the limited number of fragments available and the variability of the homocellular or heterocellular character of the cells of the rays.



Graph 1: Anthracological diagram of *Building 33*, phase 3. Period II of the site (Phase 5a)



Graph 2: Anthracological diagram of *Building 33*, phase 1. Period III of the site (Phases 4-3)

The Chenopodiaceae are recognisable thanks to the presence of concentric or foraminate phloem in groups of 2-3, simple perforations and rays that are not easily distinguishable.

The taxa are distributed homogeneously across the two chronological phases attested, with a slight increase in *Populus/Salix* from the more ancient to the more recent phase, at the expense of the Chenopodiaceae (see Graphs 1 and 2):

The spatial distribution of the taxa is characterised by greater variability in the loci pertaining to the dumping of material removed from structures of combustion (L. 4 – L. 21) and charred material in open-air spaces (L.19).

Carpological analysis

All the carpological remains analysed come from a single environment, Locus 19, identified as a courtyard or in any case as an open-air environment. In this central space, on to which several rooms faced, it was possible to recognise caryopses of cereals belonging to various species of hulled and naked wheat (*Triticum monococcum*, *Tr. aestivum/durum*), barley (*Hordeum vulgare* in both hulled and naked varieties) and plants and fruits pertaining to wild and synanthropic vegetation (see Table 2 and Graph 3). Most of the remains of wild plants are of the Chenopodiaceae family, but there are also Graminaceae and a small quantity of grape pips (*Vitis vinifera*). Of considerable importance for the purposes of interpretation is the discovery of chaff remains, a by-product of the processing of grain. The presence of remains of forks, glumes, palea, rachides and fragments of culm, in addition to those of caryopses, makes it possible to better determine the taxonomic variability of the cereals, highlighting the two main species of hulled wheat (*Triticum monococcum* and *Tr. dicoccum*) (see Graph 4 and Graph 5). It also helps to identify the types of processing and the specific function of the spaces.

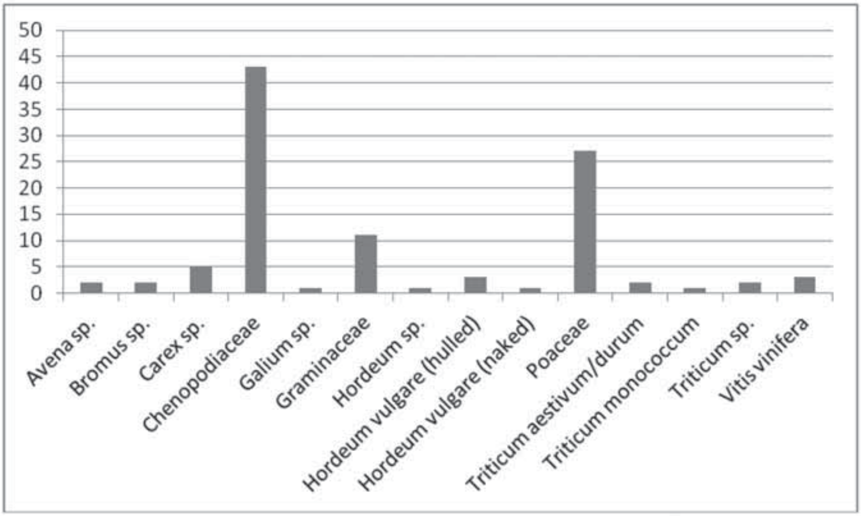
5. Discussion

Despite the reasonable size of the sample analysed (845 charcoals and 109 seeds/fruits), the archaeobotanical analyses conducted to date in *Building 33* have

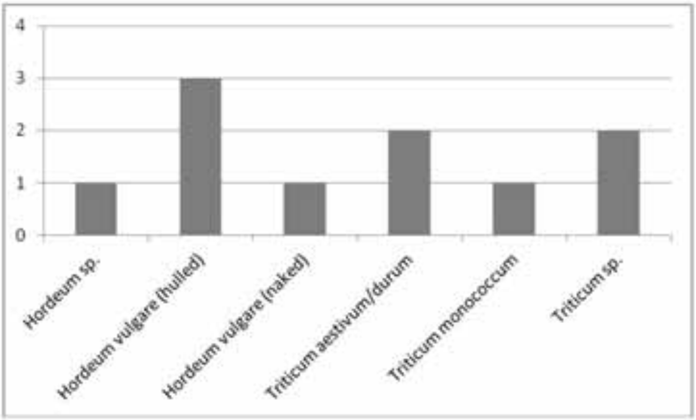
Seeds/Fruits	
taxa	Locus 19
Avena sp.	2
Bromus sp.	2
Carex sp.	5
Chenopodiaceae	43
Galium sp.	1
Graminaceae	11
Hordeum sp.	1
Hordeum vulgare (hulled)	3
Hordeum vulgare (naked)	1
Poaceae (wild)	27
Triticum aestivum/durum	2
Triticum monococcum	1
Triticum sp.	2
Vitis vinifera	3
Undeterminate	5
Totale	109

Chaff remains	
taxa	Locus 19
Hordeum sp.	7
Triticum aestivum/durum	5
Triticum monococcum	17
Triticum dicoccum	1
Cereal culm	3
Undeterminate	2
Totale	35

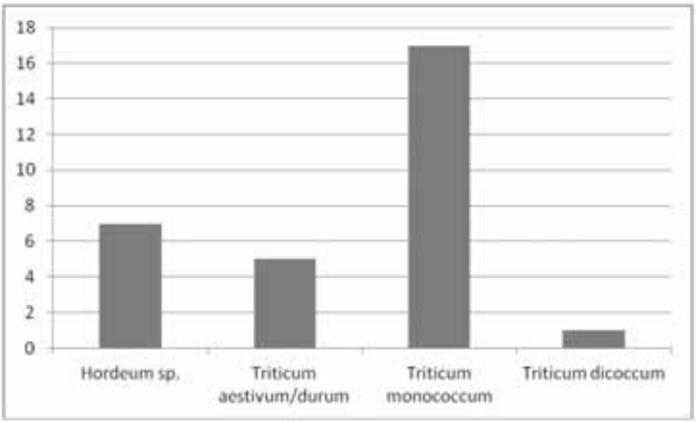
Tab. 2: analysis of the carpological remains and chaff remains from *Building 33*.



Graph 3: carpological diagram.



Graph 4: Taxonomic variability of the caryopses of cereals



Graph 5: Taxonomic variability of the cereals on the basis of the features of the chaff remains

yielded few taxa for the trees and shrubs used as fuel, while greater variability has been found for the plant macro-remains of seeds/fruits.

Despite the limited taxonomic variability of the anthracological analyses, what emerges is a clear distinction between the strictly steppe-type elements characterised by Chenopodiaceae and *Capparis* with respect to plants that are more sensitive to the presence of water such as *Tamarix* and *Populus/Salix*. A similar pattern was also seen in previous anthracological analyses conducted on other areas of the site associated with different phases of the settlement. Specifically, the analyses conducted in 2006 (Shirazi - Shirazi 2012) on charcoals dated to Period II of the site (1218 charcoals) and Periods II-III (264 charcoals) highlighted a gradual shift from vegetation characteristic of steppe environments in Period II to plants requiring greater moisture in Periods II-III. The Period III anthracological data analysed in this study confirm the greater presence of riparian vegetation, indicating progressively higher availability of water in the period 2450-2300 BC. This tendency may be due to the different nature of the archaeological contexts analysed, or the vicinity of *Building 33* to the depression, which functioned as a reservoir. It may also reflect micro-variations in the climate that influenced seasonal rainfall patterns. Although the palaeolimnological analyses conducted in the area of the Hamoun basin (Hamzeh *et al.* 2016) highlighted complex palaeo-environmental dynamics in the course of the mid-Holocene, the chronological resolution of these data does not allow for precise correlation with the various phases of occupation of Shahr-i Sokhta. In this regard, during the 2018 campaign, a pit was excavated inside the depression to the west of *Building 33*, the results of which have yet to be published, in order to gather information on the palaeo-environmental dynamics of this basin in relation to the life of the settlement.

In a semi-desert environment characterised by high temperatures in summer and low average annual rainfall (below 150 mm/year), the presence of more or less stable water resources is clearly a factor of attraction in the cultivation and management of crops. In this regard, the analyses of the plant macro-remains highlighted the presence of a range of cereals (barley and various species of wheat), which however might also be the result of a complex network of exchange of foodstuffs from other areas. The discovery of the remains of weeds and chaff, a by-product of the processing in loco of cereals, seems however to indicate that they were cultivated in the vicinity of the settlement, in a period when sufficient water was available for rainfed crops and the presence of vines may have been the result of greater water flows in the basin of Hamoun as a whole. The research currently in progress will seek to investigate these aspects more thoroughly, using new methods such as carbon and nitrogen stable isotope analysis of archaeobotanical remains, which has had promising results in arid and sub-arid environments elsewhere (Fiorentino *et al.* 2015).

1 See Costantini 1977 a; 1977b; Shirazi - Shirazi 2012.

2 For a greater understanding of the dynamics associated with the structure called *Building 33*, see in this volume Ascalone (‘Preliminary report on the 2017 excavations in Area 33 in Shahr-i Sokhta’).

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