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Interpretative scenarios emerging from plant micro- and macroremains in the Iron Age site of Salut, Sultanate of Oman

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A B S T R A C T

The archaeobotanical research carried out in the Iron Age site of Salut (north Oman) gives insights on various interpretative scenarios: the ancient vegetation surrounding the site, oasis farming, and possible ritual practices. The landscape was dominated by dry shrublands with, among others, acacia, jujube and tamarisk that were exploited for obtaining timber and firewood. Agricultural practices mainly consisted of date palm, cereal and sesame cultivation. By comparing the datasets it was possible to assess that the date palm had various uses in this site: one hypothesis involves its offering in ceremonial practices. This third scenario suggests a new way of interpreting some of the plant remains in an archaeological site as Salut, a multipurpose site including a possibly cultic function.

1. Introduction

In 2004 the Italian Mission to Oman (IMTO) commenced archaeological research in the Iron Age site of Salut (north Oman). In this context, archaeobotanical investigation was programmed with the general aims to reconstruct the palaeovegetation as well as to obtain some insights on the past plant use and economy of south-east Arabia. For these scopes, plant micro- and macroremains were analyzed: pollen mostly for the reconstruction of the landscape surrounding the site in the Iron Age; wood and charcoal to indicate which shrubs/trees were cut for timber and firewood; seeds/fruits to collect information concerning possible farming practices; weaving fibers from a basket to advance hypotheses on particular plant uses.

It is crucial to underline that the very few existing archaeobotanical studies in north Oman are circumscribed to plant macroremain analysis (Tengberg, 2002, 2003), while the work of Urban and Buerkert (2009) is the only devoted to the reconstruction of the palaeovegetation surrounding an archaeological site by means of palynological analysis. Indeed, archaeopalynological analyses were carried out in very few human settlements throughout the Sultanate of Oman: some coastal lagoons in east Oman (Lèzine et al., 2002), and two sites in Dhofar, south Oman (Hoorn and Cremaschi, 2004; Mariotti Lippi et al., 2008a,b, 2011).

As the archaeobotanical study in Salut proceeded and the first results emerged, the main focus was put on a specific interpretative scenario: ancient oasis farming. To support this palaeoethnobotanical consideration arising mostly from the pollen data, a modern surface sample study was carried out in a date palm grove with the main aim of clarifying the pollen representation of the date palm and other crops in oasis agriculture; furthermore, a wild date palm population was investigated to assess the natural dispersal of date palm pollen.

The results from the various archaeobotanical analyses and the study of new peculiar archaeological contexts triggered an evolution in the deciphering of the plant remains in Salut: other palaeoethnobotanical interpretations were put forward such as, for example, the very interesting and intriguing hypothesis of some of the plant remains being traces of plant offerings in ceremonial practices.

1.1. Archaeobotany in arid lands, some methodological considerations

Archaeobotanical studies in arid and semi-arid lands require particular considerations and cautions in drawing any conclusions, which differ from research in forested regions. Preservation is

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especially difficult in arid lands when plant remains are subjected to wetting and drying cycles causing differential deterioration and very severe damage and destruction (Horowitz, 1992; Méry and Tengberg, 2009). The typical strong winds of arid lands play a very important role, particularly for pollen, which can travel very long distances; strong erosion processes carried out by wind, or occasionally by water, may cause re-sedimentation and wide gaps in stratigraphic sequences (Horowitz, 1992; Mariotti Lippi et al., 2011). For pollen analysis it is important to keep in mind that in general woody plants dominate and a great amount of plants are insect-pollinated. Consequently, in pollen spectra from arid lands, wind-pollinated plants are more strongly over-represented than in other regions.

Human influence is obvious in archaeological sites, and while studying the plant remain assemblages from on-site layers it is necessary to reflect carefully on their origin. Plant parts are voluntarily introduced in the site as foodstuffs, storages, ritual offerings, etc., and/or involuntarily transported, introduced together with these materials, or by trampling. The presence of anthropogenic plant deposition directly and/or indirectly affects the natural seed/fruit dispersal and deposition of plant remains, and all these components are found mixed in the on-site sediments. Moreover, the introduction of plant parts, such as branches, seeds/fruits, leaves, flowers, as well as plant products like oils, weavings, and also construction materials for roofing and matting, etc., might also represent a source of micro-remains, which are mixed to the natural pollen rain. It is one of the main tasks of the archaeobotanist to unravel and distinguish the plant remains originating from human activities (voluntary and involuntary) in and around the site, from those originating from the natural vegetation surrounding the site (the so-called "background noise" in archaeobotany). This goal is very challenging, at times quite impossible to fully achieve, especially when the plants in the natural vegetation are the same plants used in the site, as often is the case in prehistory. But in the last years, the number of investigations tackling this issue by contemporarily considering both macro- and micro-remains in archaeological contexts are increasing (Jeraj, 2002; Mariotti Lippi et al., 2003, 2008c, 2009; Mercuri et al., 2006, 2007; Delhon et al., 2008; Jeraj et al., 2009; Allevato et al., 2010; Breitenlechner et al., 2010; Sadori et al., 2010a,b; Sasaki and Takahara, 2011; Bosi et al., 2011). This "new" archaeobotanical research strategy allows producing multiple types of records, and by crossing these different sources more light is shed on the palaeoethnobotanical significance of some plant remains as well as on palaeovegetational reconstruction.

2. Environmental context

The archaeological site of Salut (22°44′50″N, 57°13′58″E, 434 m a.s.l.) is located in the western part of a wide valley north of the town of Bisyah at the confluence of the Wadi Bahla and the Wadi Sayfam (Fig. 1), in the Dakhiliyah region (north Oman).

The area is located at the foothills of the Al-Hajar mountains and constitutes a transitional range classed either as the mountain region or the interior lowlands. The Al-Hajar mountains form a range of hills approx. 700 km long rising up to 3000 m a.s.l. They are dissected by both deep and shallow gorges, and wadis, which widen in the foothills and flow through into the plains.

The climate of this region is arid with irregular but seasonal rainfall ranging from an average of 80 mm in the plains to 250 mm in the mountains. In Nizwa (480 m a.s.l.), the maximum precipitation falls during May–August and is least during September–February. At Saiq (1775 m a.s.l.), rainfall is greatest during July–September and February–April and least during October–January. The mean maximum and minimum temperatures are, respectively: 35.5 °C and 28.2 °C in Nizwa; 30.3 °C and 12 °C, in Saiq (Ghazanfar, 1991; Al-Zidjali, 1996).

The vegetation of the Salut plain is a very open shrubland, characterized by sparse plants typical of the subdesertic areas, for example: *Acacia* spp., *Maerua crassifolia* Forssk., *Ochradenus baccatus* Delile, Chenopodiaceae such as *Arthrocnemum, Salsola*, and *Suaeda*. After rainfall, the rapid growth of the grasses forms a temporary cover, but the only real permanent green areas are formed by the *Phoenix dactylifera* L. (date palm) oases, today in drastic reduction, where many crops are cultivated. The main crop in north Oman is dates, followed by *Medicago sativa* L. (alfalfa) and *Triticum aestivum* L. (wheat), while the exploitation of the ground water resources is achieved either through the traditional *aflaj* systems (canals for transporting water) or through hand-dug wells (Al-Zidjali, 1996).

The foothills and larger wadis of the Al-Hajar range are characterized by open to very open thorn woodlands on gravelly and/or sandy soils with *Acacia* spp., as the main element, *Ziziphus spina-christi* (L.) Willd. and, in most cases, *Prosopis cineraria* Druce. Shrublands with *Euphorbia larica* Boiss., *Blepharis ciliaris* (L.) B.L. Burtt, *Fagonia indica* Burm. f., *O. baccatus*, and *M. crassifolia* are also frequent. *Tamarix* spp., *Nerium oleander* L., and other few species preferably grow in periodically inundated wadis or depressions; *Ficus salicifolia* Vahl is a typical wadi species found near standing or flowing water. On the rocky slopes of the Al-Hajar mountains, below 2000 m, *Olea europaea* L., *Monotheca buxifolia* (Falc.) A. DC., and *Dodonaea viscosa* Jacq. are the dominant species. The higher altitudes of the mountains bear a vegetation of open woodlands dominated by *Juniperus excelsa* M. Bieb. with *Helianthemum* and *Ephedra* (Ghazanfar, 1991, 1992a,b, 2003; Miller and Cope, 1996; Ghazanfar and Fisher, 1998).

3. Salut site

According to local historical narratives, the site of Salut is linked to the dawn of the Omani history and to the origin of the *aflaj* system in Oman. Indeed Omani history begins when Malik bin Fahim al-Azdi, leader of the Azd people, won the semi-legendary battle against the Persians in the plain of Salut, leading to the dominance of the Arabs in Oman. Another legendary event concerning Salut was the visit of Sulayman bin Dawid who, during one of his daily journeys from Persepolis to Jerusalem, saw the castle of Salut and came to Oman where he stayed for ten days, each day ordering his spirits to dig a thousand *aflaj*.

The site, set up on a rocky outcrop of about 22 m above the level of the plain (Fig. 1b and c), shows a massive boundary fortification wall made up of large-size stone blocks. The oval-shaped perimetrical outline is integrated by a tower and a buttress, respectively on the north-eastern and southern side.

At the summit of the hill, two main architectural structures are located: the so-called Burnt Building and the Basement. The Burnt Building is mainly represented by a series of adjoining rooms and can be related with the buttress projecting from the south-west side of the site (Avanzini and Phillips, 2010). A pillared room is located in the south-eastern limit of the Burnt Building (Fig. 2), where a mud-brick pillar, once supporting the roof, was built on a well-done stone slabs floor. The Basement (Fig. 2) forms part of the south-west corner of the fortification wall (Phillips, 2010). Its structure is mainly represented by three small rooms on the west side (rooms 1c, 1d, 1e) and one room on the east side (room 2a), which are accessible by a narrow corridor (room 1a).

It is important to underline that as some of the archaeological contexts are still under investigation, the results of which are forthcoming, their interpretation presented here should be considered preliminary.

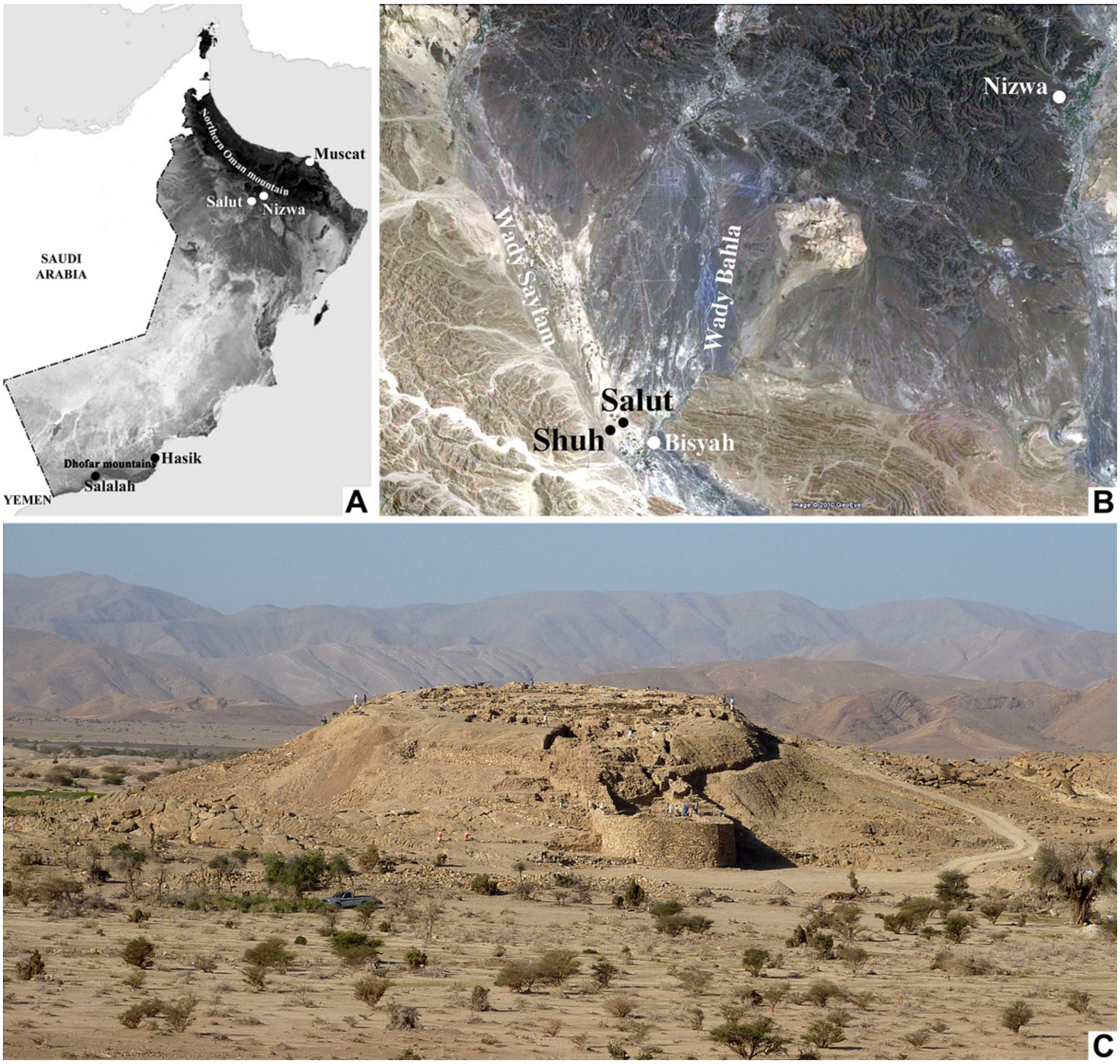

Fig. 1. (A) Map of the Sultanate of Oman showing the location of Salut; (B) The location of Salut and Shuh village, satellite view (elaborated from Google Earth); (C) The site of Salut at the end of the 2010 campaign.

3.1. Chronology

The archaeological excavation showed that the main period of occupation of Salut should be ascribed to the Iron Age (1350–300 BC), even though three periods of settlement have been defined: Early Bronze Age, Iron Age, Islamic (Avanzini and Phillips, 2010). The Iron Age chronological division accepted thus far (Magee, 1996a) has been recently revised on the basis of the new data from Salut (Phillips, 2010; Schreiber, 2010).

According to current excavation information, two major Iron Age building phases can be distinguished at Salut. The earlier phase is well represented by the Burnt Building and the Basement (Fig. 2), and by the impressive external fortification wall (Avanzini and Phillips, 2010); it is from these contexts that the relevant stratigraphic layers forming the subject of the present archaeobotanical study have been sampled. A radiocarbon date from L16 and correlated layers suggest its chronology to 1200–1000 BC (Phillips, 2010).

During the second phase, Salut underwent a general and huge architectural reassessment, mainly represented by the massive construction of terraces and platforms which obliterated part of the earlier buildings (Avanzini and Phillips, 2010).

3.2. Possible destination of the site

It might be inconvenient and restrictive to define the destination of use of Salut as a whole, considering the current limited understanding of the Iron Age society. In spite of this, the monumental architecture of the site, which comprises a developed fortification system, is the only known so far among the eastern Arabia Iron Age sites, while the large amount of artifacts with representation of snakes outlines a possible worship destination of the site. The existence of a cult related to the snake is in fact one of the most unequivocal manifestations of the Iron Age community in south-eastern Arabia, best represented in the Emirates' sites of Al-Qusais, Bithnah, and Masafi with which the materials from Salut find good comparisons (Taha, 1983; Benoist, 2010).

4. Archaeobotanical research in Salut

The archaeobotanical investigations started in 2005. At first, stratigraphical sections were sampled for palynological analysis; successive interventions were aimed to detail the data coming from the palynological analyses and to collect macroremains from layers (L) of special interest.

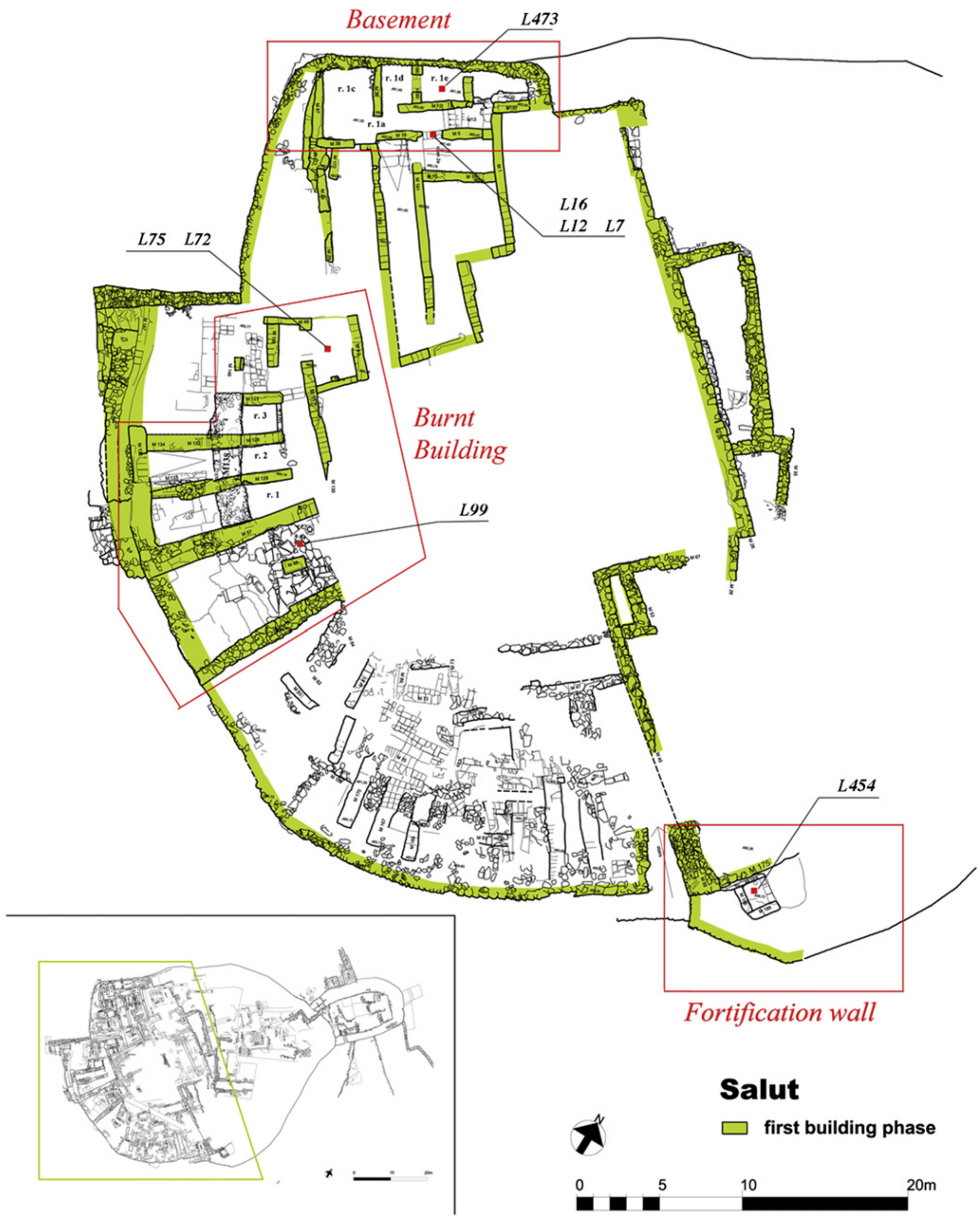

Fig. 2. Map of Salut and location of the archaeobotanical sampling.

Over the years, a huge amount of materials were subjected to archaeobotanical analyses, which, however, were only partially successful mostly owing to the sandy, alkaline soils generally unfavorable for conservation; hereafter are reported only those materials and contexts providing positive results (Fig. 2, Table 1).

In 2005 the collection of samples for pollen analysis involved the Basement, an area related to the earliest Iron Age architectural phase. The research continued in 2006 when another part of the same area was unearthed, within the Burnt Building, and a room-like space was sampled for pollen, seed/fruit and wood/charcoal analyses. During the same season, the pillared room in the Burnt Building was investigated for seed/fruit analysis.

Wood/charcoals from two of the main floor deposits of the Basement were collected in 2009. Finally, in 2010 a stratigraphical layer from the fortification wall fill was sampled for archaeobotanical analyses.

4.1. Basement

Some layers were analyzed: the archeological floor deposits L16 and L473, located respectively inside room 1a and room 1e. They represent very distinct ash layers in the Basement, although not

Table 1
Archaeobotanical sampling in Salut.

Structure		L	Sampling
Basement	Room 2a	7, 12	Pollen
	Room 1a	16	Charcoal
	Room 1e	473	Charcoal
Burnt Building	Room-like space	72, 75	Pollen; seed/fruit; charcoal
		75 (baskets)	Pollen; weaving leaflets, ropes
	Pillared room	99	Seed/fruit
Fortification wall		454	Pollen; seed/fruit; charcoal; leaves; twigs

contemporary. Charcoals, pottery sherds, a large amount of animal bones (L16) and coprolites (L473) were also found in the *strata*.

Some samples were also taken in the eastern limit of room 2a (L12, L7). Samples for pollen analysis were collected along a section (STL205) at about 10 cm intervals, from 120 cm to 10 cm below the soil surface. The discovery of a deep pit of Islamic period in the southern part of the sampled layers involved a second sampling (SLT2010) from the same layers, once the section had been corrected. The medium compact deposit L12 and the overlying deposit L7, still under investigation, are related to the last period of use of the basement (Phillips, 2010).

4.2. Burnt Building

In the Burnt Building, investigations were carried out in the pillared room and the southern side of the building: L99 represents a compact mud and loam deposit/accumulation related to the floor use of the pillared room; L75 is located on the southern side of the Burnt Building (Fig. 2), in a compartment defined by mud-brick walls (M42, M41, M49, M142) and could be related to a later phase of reuse of the original building. Bronze objects (two ladles, a snake and a miniature axe), iron fragments, few pottery sherds, a large amount of semi-burnt animal bones, basketry remains, date stones, charcoals and wood fragments were found. The *stratum* was friable and thick 5–20 cm. It was mainly formed by organic remains with a low percentage of earth. Most part of the organic material has undergone some kind of incomplete combustion process. It was covered by a thin (3–10 cm) medium soft, dark yellow layer composed by lumps of mud mixed with sandy loam (L74). The latter was covered by L72, a thick sandy washed deposit with a foliated matrix, which was also sampled for archaeobotanical investigations (Table 1).

For pollen analysis, a stratigraphy from 120 cm to 60 cm (SLT306) was sampled at 5–10 cm intervals; laminated sediments occurred at 60–100 cm. Pollen analysis was also carried out on samples from two weavings of two different baskets recovered in L75 (Table 1; Fig. 3).

4.3. Fortification wall

L454, as part of the fortification wall fill flanking the top south-eastern entrance of the site (Fig. 2), is in connection with the building of the surrounding wall (first building phase). Located close to the internal face of the fortification wall (M175), it fills a space partly delimited by compartment walls (M183, M188, M189). It is formed by medium compact loam mixed with lumps of mud, small-size stones, charcoals and a very large amount of animal bones and pottery sherds among which several vessels such as spouted jars and long-handled bowls (a specific kind of censer-lamp), bearing a ritual significance. Scattered parts of a thin layer of plant remains (leaves, twigs, branches, seeds and fruits) mixed with charcoals were found at the top. The layer L454 was covered by the thick medium compact *stratum* L493, also forming part of the fortification wall fill, and composed by dark brown loam mixed with ashes and a large amount of small pebbles and pottery sherds.

4.4. Modern surface samples

Shuh village (22°44′44″N, 57°13′28″E, 428 m a.s.l.) is a small date palm oasis nearby the Salut archaeological site. Samples for palynological analysis (soil surfaces, and one moss polster) were collected every ca. 15 m along a transect from the main irrigation canal (*falaj*) passing by the only male date palm of the oasis and ending in the cereal and alfalfa fields.

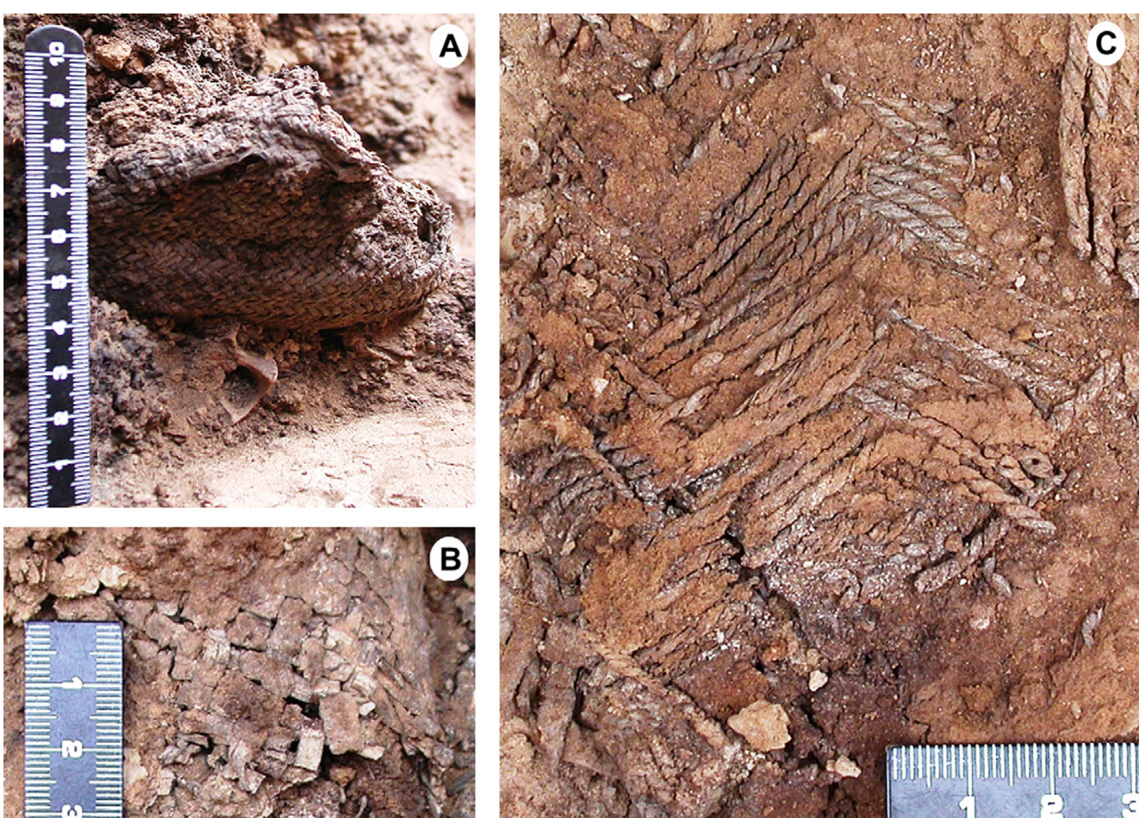

Fig. 3. Basket remains from L75: (A) Basket 1; (B) Basket 1: detail of weaving made of date palm leaflets; (C) Basket 2: weaving made of ropes.

Wadi Ataran (17°26′45″N, 55°15′10″E, 1 m a.s.l.) estuary is located in Dhofar (southern Oman), where date palm is no longer extensively cultivated. The date palms in this site may be considered naturalized. Five soil surface samples were collected every ca. 15 m along a transect starting from a male date palm.

5. Methods

5.1. Palynological analysis

All the material was prepared according to the routine methodologies, including HCl, HF, KOH treatments, and the acetolysis method (Erdtman, 1960). Absolute pollen frequency (APF) was calculated as number of grains per gram of sediment. Pollen identification was performed with the help of literature (Bonnefille, 1971; Andersen, 1979; Bonnefille and Riollet, 1980; Kedves, 1980; El-Ghazaly, 1991; Mariotti Lippi et al., 2007) and reference pollen collections. The pollen diagrams were drawn using TILIA 2.0 (Grimm, 1994–2004); in the diagrams, the term "Chenopodiaceae" indicates Chenopodiaceae plus Amaranthaceae and "wet environment plants" include *Phragmites*/*Sporobolus*, Cyperaceae and *Typha*.

Minute wood fragments of Gymnosperms were observed in the pollen slides. Their identification was performed on the basis of the cytological features using both literature (Fahn et al., 1986) and the identified charcoals of the site.

5.2. Macroremains (seeds/fruits, leaves and charcoals)

Most part of the analyzed macroremains was hand-picked during the excavation. Samples of sediments (about 5 liters each) from the layers of the SLT205 stratigraphy of room 2a of the Basement were dry-sieved with a 0.2 mm mesh to test the presence of macroremains. Other sieving methodologies were tested, but unsuccessfully.

A morphometric analysis following the parameters in Nesbitt (1993) was carried out on the date stones.

The charred woods were fractured following the diagnostic sections and observed under Philips XL20 scanning electron microscope (SEM), after gold coating (sputtering chamber Emitech K550). In L16 the charcoals were very numerous: the larger ones (1–5 cm^3) were examined one by one, while the smaller ones were randomly selected and observed under light microscope to verify the occurrence of the same taxa. Identification was performed with the aid of literature (Fahn et al., 1986; Schweingruber, 1990; Neumann et al., 2000) and was carried out using local reference material kept in the Erbario Tropicale di Firenze (FT).

Hand-made sections of the leaflets (basket 1) and ropes (basket 2) of the basket weavings in L75 were gold coated and observed at scanning electron microscope. The fibres of the ropes were also investigated at polarizing microscope.

6. Results

6.1. Palynological analyses

The results of the SLT205, 210 and 306 short pollen sequences will be grouped according to the layers and will be described from the bottom to the top of the sequences.

6.1.1. Basement

SLT205 (Fig. 4A)

L12 (120–70 cm) – In the six samples of the bottom layer the pollen concentrations rang from ca. 1000 to 500 grains/g and their decreasing trend roughly follows the increasing sandy component of the sediments. Compositae Cichorioideae dominate, together with Gramineae of different pollen morphotypes, some tentatively attributed to Cerealia *Hordeum* group, others to Cerealia *Triticum* group. The pollen grains of Cerealia are often found clumped. Asteroideae, Capparaceae (mainly *Maerua*), Chenopodiaceae/Amaranthaceae and Leguminosae are also well represented and include herbaceous and shrubby plants mostly confined to dry environments. Leguminosae include *Acacia*, *Senna*, *Indigofera* and *Prosopis*, representing woody plants still widespread in the area. The occurrence of low percentages of *Typha* pollen is to note. A somewhat discontinuous presence of *Asphodelus* pollen, often clumped in groups, and a significant presence of *Sesamum* pollen in the sample at 90 cm (5%), appearing only sporadically in the other samples of the sequence, is recorded. To note, the occurrence of Palmae cf. *Phoenix* pollen.

L7 (60–30 cm) – In the three samples of this layer the pollen concentrations do not vary significantly from those of the previous layer. Once again, the herbaceous pollen taxa dominate even though Cichorioideae record lower percentages than previously, and Cerealia pollen (some attributed to *Triticum* group and continuing to appear clumped) attains the highest percentage of the sequence (53%); also higher are the Leguminosae (mainly *Senna* and *Prosopis*) and Resedaceae cf. *Ochradenus* percentages. To note, the presence of grains of *Ocimum*, while *Sesamum* decreases quite abruptly comparing to the previous layer. A significant presence of Capparaceae and Compositae pollen is still recorded.

SLT210 (Fig. 4B)

Of the four control samples collected from L12 and L7, two are devoid of pollen grains, while the other two have comparable pollen concentrations to the SLT205 pollen sequence.

The sample from L12 is dominated by herbaceous plant taxa, Gramineae, including Cerealia, being the best represented; Cichorioideae, Capparaceae, Leguminosae and Asteroideae are also significant. The same taxa are present in the sample from L7, but Leguminosae (mainly *Indigofera*) and Capparaceae pollen have a higher percentage than Cichorioideae. To note, the occurrence of *Ziziphus* and *Tamarix* pollen. Interestingly, pollen of *Sesamum* and *Ocimum* are present in both samples.

6.1.2. Burnt Building

SLT306 (Fig. 4C)

L75 (120–100 cm) – The pollen concentrations of the three samples of this layer are slightly higher than those of the layers discussed above, in particular the sample at 100 cm with 3500 grains/g. The list of pollen taxa, on the other hand, is similar to that of the previous layer but the pollen percentages are quite different: at the bottom these samples record low percentages of Cichorioideae, and high percentages of Capparaceae (mainly *Maerua*), Cruciferae and Convolvulaceae, while at the top high percentages of pollen of plants from wet environments, mainly *Phragmites*/*Sporobolus*, Cyperaceae and *Typha* are recorded. At the same time, high percentages of Chenopodiaceae/Amaranthaceae also occur. Noteworthy is also the presence of Palmae cf. *Phoenix* pollen in the sample at 110 cm where it attains the highest percentage of all the pollen sequences of the site (3%). Similarly to the previous sequences, there are high percentages of Gramineae pollen, including Cerealia (*Hordeum* and *Triticum* groups). To note, the occurrence of *Ocimum* and *Asphodelus* pollen.

L72 (90–60 cm) – The pollen concentrations of these upper four samples start off by being lower and then return to attain similar values to the previous layer. In fact, the first sample with the lowest pollen concentration is also characterized by the highest percentage of pollen morphotypes particularly resistant to soil degradation like Cichoriorideae. The lower samples of L72 are characterized by a scarce representation of woody plants, which increases in the higher samples and is formed firstly by

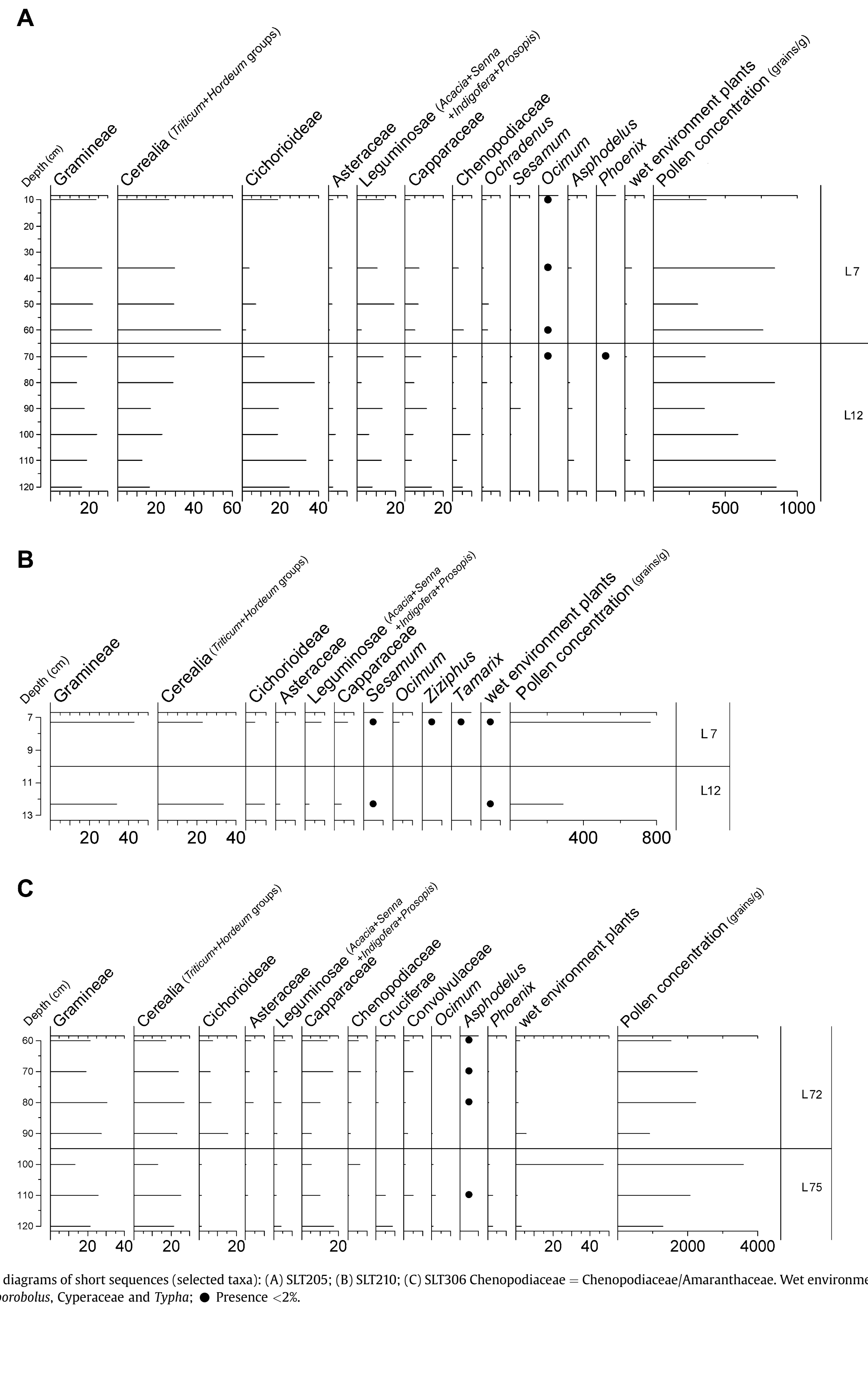

Fig. 4. Pollen diagrams of short sequences (selected taxa): (A) SLT205; (B) SLT210; (C) SLT306 Chenopodiaceae = Chenopodiaceae/Amaranthaceae. Wet environment plants include *Phragmites*/*Sporobolus*, Cyperaceae and *Typha*; ● Presence <2%.

Leguminosae (overall *Prosopis*) and then by Capparaceae (mainly *Maerua*). To note, the overall low percentages attained by the sum of the plants of wet environments and of Palmae cf. *Phoenix* which almost completely disappears in the highest samples.

L75 – Baskets (Table 2A) – Two samples were collected from the weavings of the baskets recovered in L75. Only the one from Basket 1 is significantly rich in pollen grains. The palynological analysis shows the overall dominance of *Phoenix* cf. *dactylifera* (85%). The only other significant taxa are Gramineae (8%), including Cerealia (6%).

6.1.3. Fortification wall

L454 (Table 2B) – The pollen concentration of the sample collected here is quite low and the grains are not in the best preservation state, as exemplified by the rather high percentage of indeterminate grains (4%) and highly resistant grains like Cichorioideae (17%). Nevertheless, this sample also shows a high percentage of Cerealia pollen grains (31%); to note the presence of *Sesamum* and *Ocimum* grains. Also noteworthy, the presence of very numerous minute wood fragments attributed to Cupressaceae on the basis of the morphology of the pit-pairs in the cross-fields, which appears very similar to that of *Juniperus*.

6.1.4. Modern surface samples

Shuh village oasis – Pollen analysis of the oasis samples shows rather high concentrations, never falling below 4000 grains/g and reaching up to 10,800 grains/g. The samples are characterized by the overrepresentation of *Chenopodium* pollen grains and the general higher representation of weed taxa (e.g. Compositae Asteroideae) respect to crop taxa, even if pollen of all of the main crops is recorded like *Phoenix* cf. *dactylifera*, *Hordeum* group, and *Medicago*, together with other cultivated plants such as *Punica granatum* and *Citrus*; an exception is the moss sample that has a lower amount of *Chenopodium* pollen, and the highest value of *Phoenix* cf. *dactylifera* pollen (33%). The soil sample collected directly beneath the male date palm records a much lower percentage of *Phoenix* cf. *dactylifera* pollen (3.3%).

Wadi Ataran – One of the five samples is devoid of pollen grains, while in the others the pollen concentrations are quite variable ranging from ca. 1000 to 23,000 grains/g. Regarding *Phoenix* cf. *dactylifera* pollen percentages, the sample collected directly beneath the male date palm shows the highest percentage (96%), followed by that recorded by the sample at 15 m (30%); the furthest samples from the male date palm have substantially lower *Phoenix* cf. *dactylifera* pollen percentages (3% and 1%, respectively).

Table 2
(A) Pollen spectrum of Basket 1 (L75); (B) Pollen spectrum of the fortification wall (L454). Chenopodiaceae = Chenopodiaceae/Amaranthaceae.

A – L75 Basket 1	*n*	%
Gramineae	31	8.1
Hordeum group	12	3.1
Triticum group	9	2.4
Capparaceae	1	0.3
Brassicaceae	2	0.5
Sesamum	1	0.3
Ocimum	1	0.3
Phoenix	323	84.6
Cyperaceae	1	0.3
Juniperus	1	0.3
TOT	382	
Pollen concentration	2327 grains/g	
B – L454	***n***	**%**
Gramineae	72	27.3
Hordeum group	37	17.5
Triticum	23	10.9
Cichorioideae	45	17
Asteraceae	5	1.9
Leguminosae	11	4.2
Capparaceae	9	3.4
Chenopodiaceae	8	3
Crucifereae	2	0.8
Labiatae	6	2.3
Sesamum	1	0.4
Ocimum	2	0.8
Tribulus	1	0.4
Asphodelus	2	0.8
Phoenix	3	1.1
Cyperaceae	2	0.8
Juniperus	1	0.4
indet.	11	4.2
TOT	264	
Pollen concentration	1128 grains/g	

6.2. Macroremain analysis

As a general consideration, it is important to stress that macroremains, especially seeds/fruits, are very rare in the site and that only a few assemblages are found in peculiar layers probably forming some type of storage. For the most part the macroremains are charred.

6.2.1. Basement

L16 – The layer is very rich in charcoal fragments. Some of them are minute, but 314 are over 1 cm^3 in volume. Most of them (ca. 90%) belong to *Ziziphus* cf. *spina-christi*; the others to *Acacia* sp. (10 fragments) and *Tamarix* sp. (12 fragments) (Fig. 5). Elongated fragments of wood, in very bad preservation state, also belong to *Ziziphus*.

Ziziphus cf. *spina-christi* presents diffuse porous wood with large solitary vessels or in short or long radial chains, thick-walled fibres, vasicentric parenchyma or in short tangential bands; simple vessel perforation plates; heterocellular rays with rectangular, procumbent cells, 1-, rarely 2-seriate, up to 40 cells high, with square to rounded cells and sometimes upright marginal cells.

Acacia sp. has diffuse porous wood with large solitary vessels or in groups of 2–3, thick-walled fibres, paratracheal parenchyma, generally vasicentric, aliform; simple vessel perforation plates; homocellular rays mostly 2-, 3-, but also 1-seriate, 10–20 cells high.

Tamarix sp. presents semi-porous wood with solitary vessels or in small groups up to 4 cells, thick-walled fibres with parenchyma paratracheal, vasicentric; simple vessel perforation plates; heterocellular rays 6- to 20- seriate, up to 2 mm high with one or two square and upright marginal cells.

L473 – The two charcoals recovered from this layer are identified as *Acacia* sp., and *Ziziphus* cf. *spina-christi.*

6.2.2. Burnt Building

L72 – A charcoal fragment is attributed to *Acacia* sp.

L75 – Two large charcoal fragments, measuring 6 × 6 × 2 cm and 9 × 3.5 × 2 cm, belong to *Juniperus* sp., three to *Ziziphus* and one to *Acacia sp.* Elongated wood fragments (no. 5), more than 10 cm long, also belong to *Ziziphus* sp.

Juniperus sp. presents distinct growth ring boundaries with gradual transition early-latewood, parenchyma cells grouped in solitary or tangential bands; uniseriate tracheids pits; homocellular rays 1-seriate 2- 5- and up to 20 cells high; cross-fields with cupressoid pits.

Numerous burnt stones of date palm were recovered. Only some of them are complete, even if very fragile because of the carbonization; most part of the stones are broken and deformed. Many of them present fragments of the mesocarp. Small circular holes, about 1 mm in diameter, are observed in many stones. Morphometric analysis of the unbroken stones is reported in Table 3. Some other dates (fruits and stones) are clumped in groups (Fig. 6A). The

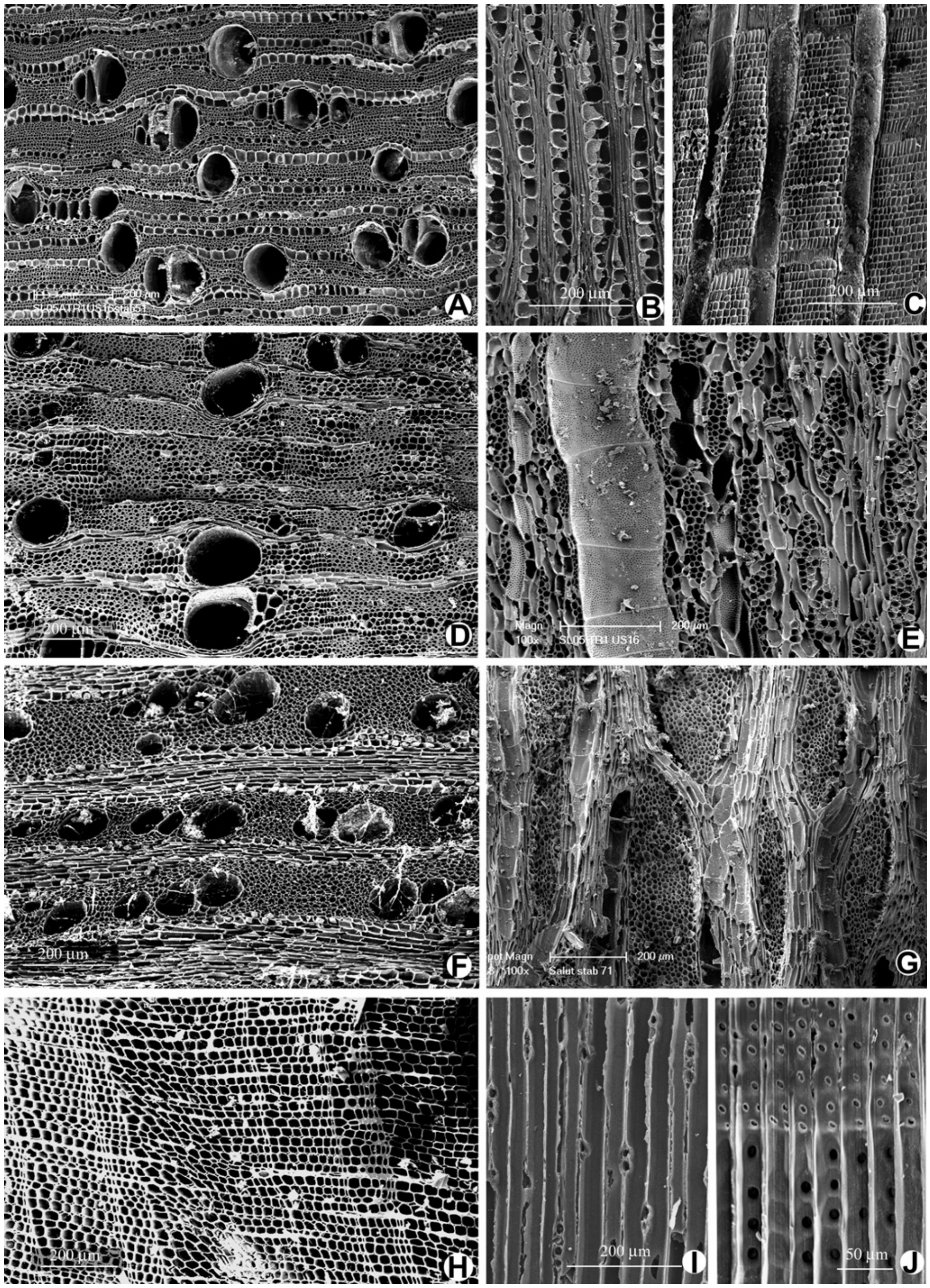

Fig. 5. Charcoals from Salut. (A–C) *Ziziphus* sp. (L16): (A) transverse section; (B) tangential longitudinal section; (C) radial longitudinal section. (D,E) *Acacia* sp. (L16): (D) transverse section; (E) tangential longitudinal section. (F,G) *Tamarix* sp. (L16): (F) transverse section; (G) tangential longitudinal section. H-J. *Juniperus* sp. (L454): (H) transverse section; (I) tangential longitudinal section; (J) radial longitudinal section.

morphology of the larger groups shows a marked convexity on one of the longer sides.

One charred wheat grain was found, but more specific identification is impossible, due to the lack of distinctive features.

The analysis of the baskets (Fig. 3) shows that the leaflets of the first weaving (Basket 1) belong to date palm. The fibers of the ropes from Basket 2 are similar to the fibers of the date palm, even if the state of preservation does not allow a definite identification.

L99 – Many date stones and fruits (Fig. 6B) come from this layer. They are extremely fragile, and frequently fall apart, even if handled with care. Morphometric analysis was performed on the available complete stones (Table 3).

6.2.3. Fortification wall

L454 – The layer at the top of L454 is almost totally constituted by leaves, twigs, branches, fruits and seeds of *N. oleander*. Few parts of the date palm fibrous leaf sheath and a fragment of Monocotyledon leaf are present. All these remains are uncharred and present a very good state of preservation. Two charcoal fragments were recovered and are attributed to *Juniperus* sp. (Fig. 5).

Table 3
Date palm fruits and stones and their dimensional range. L = Length; W = Width; T = Thickness.

	L75 (stones)						L 99 (stones)					
	Measurements (mm)			Ratios			Measurements (mm)			Ratios		
	L	*W*	*T*	*L/W*	*L/T*	*T/W*	*L*	*W*	*T*	*L/W*	*L/T*	*T/W*
	14.49	5.61	6.10	2.59	2.38	1.09	15.11	5.01	4.15	3.02	3.64	0.83
	14.34	8.79	5.68	1.63	2.53	0.65	15.14	4.98	3.88	3.04	3.90	0.78
	12.58	6.77	4.31	1.86	2.92	0.64	16.50	6.71	5.28	2.46	3.13	0.79
	14.26	5.79	5.20	2.46	2.74	0.90	16.80	5.65	5.58	2.98	3.01	0.99
	16.02	4.18	4.14	3.83	3.87	0.99	14.98	6.01	5.01	2.49	2.99	0.83
	17.87	7.36	4.73	2.43	3.78	0.64	15.01	6.38	5.15	2.35	2.92	0.81
	11.62	6.30	5.45	1.85	2.13	0.86	14.01	5.58	5.05	2.51	2.78	0.91
	13.65	6.12	3.98	2.23	3.43	0.65	13.85	5.61	4.98	2.47	2.78	0.89
	10.86	6.25	6.02	1.74	1.80	0.96	13.98	5.21	5.18	2.68	2.70	0.99
	19.10	7.76	6.09	2.46	3.13	0.78	14.15	5.25	5.28	2.70	2.68	1.01
	11.23	6.77	5.20	1.66	2.16	0.77	14.05	5.18	5.05	2.71	2.78	0.97
	17.75	6.17	2.91	2.88	6.09	0.47	14.24	5.35	5.25	2.66	2.71	0.98
	10.55	6.62	4.73	1.59	2.23	0.71	13.85	5.15	5.08	2.69	2.72	0.99
	11.62	6.37	3.98	1.82	2.92	0.63	14.11	5.35	5.29	2.64	2.67	0.99
	13.27	6.72	4.35	1.97	3.05	0.65	11.92	6.58	5.91	1.81	2.02	0.90
	17.31	7.86	3.81	2.20	4.54	0.48	11.65	6.48	5.51	1.80	2.11	0.85
	16.24	7.02	3.29	2.31	4.94	0.47	15.57	6.01	6.18	2.59	2.52	1.03
	17.32	4.95	5.25	3.50	3.30	1.06	15.87	6.28	5.51	2.53	2.88	0.88
	13.20	8.07	6.22	1.64	2.12	0.77	17.14	5.71	4.62	3.00	3.71	0.81
	16.95	6.18	5.61	2.74	3.02	0.91	15.94	6.61	5.65	2.41	2.82	0.85
	16.53	8.05	3.66	2.05	4.52	0.45	13.81	5.98	5.25	2.31	2.63	0.88
	14.69	7.01	3.88	2.09	3.79	0.55	15.74	5.65	5.45	2.79	2.89	0.96
	12.22	6.06	5.67	2.02	2.16	0.94	14.41	5.98	5.28	2.41	2.73	0.88
	13.43	7.06	5.47	1.90	2.45	0.77	16.14	6.18	5.28	2.61	3.06	0.85
	16.13	5.95	3.96	2.71	4.07	0.67	13.41	5.65	5.41	2.38	2.48	0.96
	15.81	7.49	3.76	2.11	4.21	0.50	12.85	7.27	6.6	1.77	1.95	0.91
	13.02	5.18	4.78	2.51	2.72	0.92	13.68	5.81	5.25	2.35	2.61	0.90
	17.58	7.17	5.88	2.45	2.99	0.82	13.65	6.84	6.18	1.99	2.21	0.90
	12.91	6.46	5.15	2.00	2.51	0.80	14.74	7.01	6.18	2.10	2.39	0.88
							16.89	6.28	5.81	2.69	2.91	0.93
							17.76	7.34	7.14	2.42	2.49	0.97
							16.96	6.53	5.61	2.60	3.02	0.86
							18.79	6.18	5.88	3.04	3.20	0.95
							14.91	6.31	5.28	2.36	2.82	0.84
							15.31	7.27	6.84	2.11	2.24	0.94
							18.26	5.88	5.84	3.11	3.13	0.99
							15.11	5.58	4.95	2.71	3.05	0.89
							13.35	5.61	5.45	2.38	2.45	0.97
							15.84	5.48	5.41	2.89	2.93	0.99
							13.31	5.35	4.88	2.49	2.73	0.91
							15.94	5.71	5.41	2.79	2.94	0.95
Mean	14.57	6.63	4.80				14.99	5.97	5.44			
Mode	11.62	6.77	5.20				15.11	5.65	5.28			
Min	10.55	4.18	2.91	1.59	1.80	0.45	11.65	4.98	3.88	1.77	1.95	0.78
Max	19.10	8.79	6.22	3.83	6.09	1.09	18.79	7.34	7.14	3.11	3.90	1.03

Total number of date palm remains: L75 = 79 stones; L99 = 100 stones + 8 fruits.

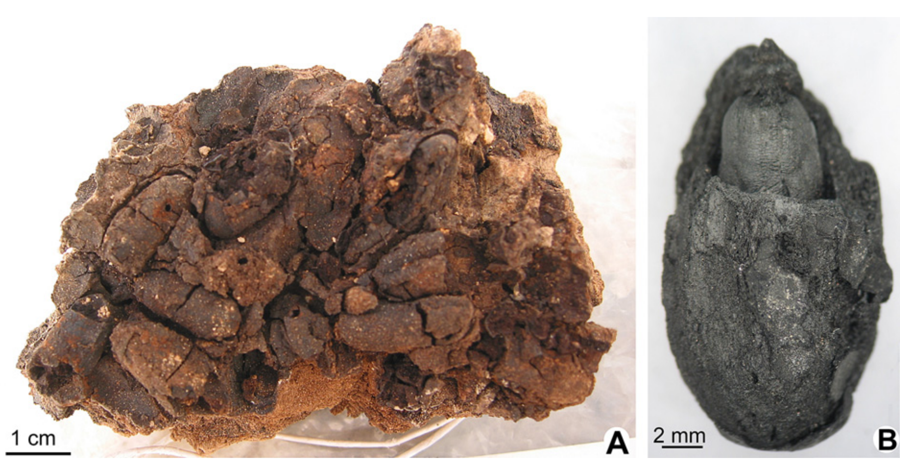

Fig. 6. (A) Palm dates clumped in groups from L75; (B) A date from L99.

7. Interpretative scenarios emerging from the plant remains in Salut

7.1. Palaeovegetational reconstruction

The environment emerging from the pollen record of the Salut site is quite dry and characterized by shrubby vegetation. The best represented shrubs/trees are Capparaceae, mainly *Maerua*, Leguminosae, mainly *Acacia* and *Prosopis*, Chenopodiaceae and Compositae Cichorioideae. Among charcoals, *Ziziphus* sp. (jujube) is most commonly found in the site, followed by *Acacia* sp. (acacia) and *Tamarix* sp. (tamarisk). Even if jujube and tamarisk do also occur in the pollen spectra, they are sporadically recorded (Fig. 4). Therefore, each plant is more or less abundant in the archaeological context depending on the type of remains considered; this is particularly evident for jujube, which is recorded as pollen in one level only, but widely diffused as charcoal on the site (Table 4). By crossing the data, it is possible to suppose that jujube, acacia and tamarisk were growing not far from the site. They could have been part of the arid shrubby vegetation emerging from the palynological data. A similar arid palaeovegetational scenario, but more distinctly dominated by Compositae, also emerges in the palynological analyses in late Quaternary sediments at Maqta (Urban and Buerkert, 2009), in correspondence of the same span of time. The presence of acacia in association with jujube in archaeological contexts was also attested by studies carried out in the interior of the Arabic peninsula for the Bronze and Iron Ages (Tengberg, 2002).

Currently, acacia species still form open bushlands in the plains, foothills and large wadis, where jujube and tamarisk species also occur. The present flora in the surroundings of the site seems not to have consistently changed from what emerges from the archaeobotanical analyses in Iron Age Salut; further investigations in undisturbed off-site stratigraphies will be necessary to confirm the present palaeovegetational reconstruction.

7.2. Plant use in Salut

The utilization of the wood of jujube, acacia and tamarisk in the Salut site is evident from the archaeobotanical record. The presence of jujube charcoal fragments could represent traces of cooking or fire activities, in consideration of its high quality charcoal, even if they might have also been the remains of superstructures as in the case of L473 and L16 (Fig. 5, Table 4), floor deposits of the Basement (Fig. 2; Table 2). Since ancient times, jujube wood has numerous uses: it was appreciated for its high density and resistance and, mostly, for its high natural durability; only the small dimensions of the trees limited its employment (Gale and Cutler, 2000). The jujube also has sweet fruits and thus its presence in the record can also be related to a possible exploitation or cultivation for nutritional purposes, as testified in the island of Qal'at al-Bahrain from the end of the 3rd millennium until about 300 BC (Tengberg and Lombard, 2001).

The presence of acacia and tamarisk can be connected to similar uses as the jujube. Indeed acacia wood was appreciated since antiquity for the manufacture of furniture, dowels, coffins, boxes even if its wood is dense, hard but strong. Also *stelae*, bows and arrows were produced in the Near East and Egypt (Meiggs, 1982; Gale and Cutler, 2000). Tamarisk was especially used in arid regions where wood was scarce. Although it is coarse, it had a characteristic use ranging from statues and sculptures to *stelae*, chariot wheels and clubs (Gale and Cutler, 2000).

In the pollen records, human activities are strongly signaled by the occurrence of anthropogenic indicators, including cultivated plants, like *Sesamum*, *Ocimum*, Cerealia, and also *Phoenix* (Fig. 4).

7.2.1. Sesamum

The presence of *Sesamum* (sesame) should be stressed since its pollen amount in certain levels could suggest an introduction and/or rapid expansion of this plant in the surroundings of the site: this could be the evidence of an ancient use of sesame for flour or oil production. Interestingly, numerous 'censer-lamps' have been recovered on the site (Avanzini and Phillips, 2010). Furthermore, GC–MS analysis on burnt organic remains found inside one of the *reservoirs* of these lamps showed the presence of a substantial quantity of fatty acids retraceable to the use of animal fat or vegetable oils (Colombini and Ribechini, 2008: personal communication). Indeed, sesame pollen in the archaeological levels could come from oil or seeds introduced in the site (see e.g. van Haaster, 1990) and/or from the pollen rain of cultivated fields outside; its diffusion in the Salut layers (Table 4) could favor the last hypothesis.

Archaeobotanical investigation has shown that sesame was domesticated in India and was taken to Mesopotamia by the Early Bronze Age (Fuller, 2003; Bedigian, 2004). Evidence from Bahrain (Tengberg and Lombard, 2001) indicated that by 1400 BC sesame was being cultivated in the Persian Gulf. Today, sesame grows wild in the Arabian Peninsula (in Yemen), but it is not recorded wild in Oman; it was extensively cultivated in Oman till very recently, but now largely abandoned because insufficiently remunerative.

Table 4
Outline of the main plant taxa recovered in Salut. + Occurrence; ++ Abundant finding.

Structure	L	Remain	*Hordeum* gr.	*Triticum*	*Acacia*	*Sesamum*	*Ocimum*	*Ziziphus*	*Tamarix*	*Asphodelus*	*Phoenix*	*Juniperus*	*Nerium*
Basement	7	Pollen	+	+	+	+	+	+	+	+		+	
	12	Pollen	+	+	+	++	+			+	+	+	
	16	Charcoal			+			++	+				
	473	Charcoal			+			+					
Burnt Building	72	Pollen	++	++		+	+			+	+	+	
		Charcoal			+								
	75	Pollen	+	+		+	+			+	+	+	
		Seed/fruit		+							++		
		Charcoal			+			+				+	
	75 (baskets)	Pollen	+	+		+	+				++	+	
		Leaflet									+		
		Fibre									+		
	99	Seed/fruit									++		
Fortification wall	454	Pollen	++	++	+	+	+			+	+	+	
		Seed/fruit											+
		Charcoal										+	+
		Leaf									+		+
		Twig											+

7.2.2. *Ocimum*

Pollen grains of *Ocimum* were found in many layers throughout the site, even if in small amount (Table 4). *Ocimum forskolei* Benth. and *Ocimum basilicum* L. (sweet basil) at present grow wild in Oman: the first is considered a native species; the second possibly escaped from cultivation and is still grown as culinary or medicinal plant (Miller and Morris, 1988; Ghazanfar, 1993). Throughout the Middle East, sweet basil is cultivated in ornamental gardens as well as in graveyards (see Dafni et al., 2006). In India, *Ocimum sanctum* L. (tulsi or thulasi) is cultivated for medicinal and religious purposes and is considered one of the most sacred plants; in fact, its leaves/shoots are an important divine worship offering in Hindu temples. Strikingly, sesame and sweet basil seeds were both found in Iron Age levels of Deir Alla (Neef, 1989), a temple tell site in Jordan.

7.2.3. Cereals

Cereal pollen was recorded everywhere in the site (Table 4) and a possible diffused source in this case may be represented by straw and chaff used as temper in the mud-bricks (Horowitz, 1992; van der Veen, 1999; Zahran and Willis, 2009). However, palynological analyses in mud-bricks from another archaeological site in Oman (Mariotti Lippi et al., 2008b) have revealed quite low pollen concentrations suggesting that in the archaeological layers the pollen input from mud-bricks might not be as significant as other on-site accumulation activities. Moreover, the resedimented pollen grains, in this case from the mud-bricks, should present a worst state of preservation with respect to those directly accumulated in the sediments, and a differential preservation state of the pollen grains was not observed in the samples. The constant presence of cereal pollen together with the sudden appearance of sesame pollen in the on-site sediments and the noteworthy records of palm tree remains (see below) rather recall oasis farming. To this respect, the presence of pollen in good preservation state of plants from wet environments in the rooms of the Burnt Building, where pollen of cultivated plants (cereals and date palm) was also recorded in higher amount than elsewhere (Fig. 4), should be noted. In arid lands, farming activities are always connected to some form of water management with water bodies such as man-made canals or pools where wet environment plants can thrive.

It is worth mentioning that cereals are typical food plants in offerings, together with pulses and various fruits/nuts (see e.g. Ellison et al., 1978; Megaloudi, 2005; Rovira and Chabal, 2008; Rottoli and Castiglioni, 2011). The relatively low amount of weed pollen recorded in the on-site sediments where the cereal pollen amount is noteworthy suggests attributing the cereal pollen to anthropic accumulation rather than to the pollen rain from surrounding oases: in fact, the modern surface sample study showed that weeds dominate the oasis pollen spectra, while the crop taxa pollen percentages are generally low, except for in the moss polster. This result is consistent with traditional agricultural practices having a low management of the weeds in the fields. Nonetheless, some weeds were recorded in the Salut archaeopalynological record, even if in very low percentages; they possibly included *Asphodelus* (asphodel), charred seeds of which were found at the Bronze Age site of Bat in the Al-Hajar mountains of Oman and interpreted as the result of cereal field weed eradication (Tengberg, 2003).

Overall, the pollen evidence alone is not enough to interpret the cereal record in Salut as a trace of storage or even offering practices: cereal pollen showed high percentages in many on-site samples, and not exclusively in the possibly ritual deposits, and the only burnt cereal caryopsis recovered is insufficient proof.

7.2.4. Date palm and its possible use in rituals

Date palm micro- and macroremains were recovered in many of the studied layers of Salut, and this agrees with its wide diffusion and the common uses of its products in the Arabian Prehistory, e.g. as food, roofing, matting and basketry (for an exhaustive list of date palm findings see Nesbitt, 1993; Tengberg, 2002, 2003; Boivin and Fuller, 2009).

Palm dates were recovered all over the site, but the main assemblages of burnt date stones were found in L75 and L99 (Table 4). Several assemblages showed a marked convexity on one of the longer sides, suggesting that dates were stored in bowls (Fig. 6A). Similar large assemblages of charred date fruits and stones were also recovered in the UAE Iron Age site of Muweilah (Magee, 1996b; Tengberg, 2003).

The presence in Salut of whole dates and fragments of the mesocarp attached to many of the stones (Fig. 6) suggests that all the remains were originally fruits, as observed at Ra's al-Jinz, a Bronze Age site in Oman (Costantini and Audisio, 2000). The size of the stones in Salut (Table 3) are similar to those reported for Ra's Al-Jinz and Failaka, a Bronze Age site in Kuwait (Nesbitt, 1993). The occurrence of small circular holes on the palm dates from Salut suggests the presence of the parasite *Coccotrypes dactyliperda*, a coleoptera which is known to be present in Oman also during the Bronze Age (Costantini and Audisio, 2000).

The fact that large assemblages of dates were found burnt inside an intentional deposit (L75) with a ritual connotation, in virtue of the artifact typology, hints to the idea that palm dates had a ritual value in Salut. Moreover, the low percentage of ashes found mixed with the earth in the *stratum*, together with the absence of fire-traces on the mud-brick walls defining the compartment where L75 was located, suggest that the combustion/fire took place elsewhere. Also, the baskets show no traces of burning and this suggests that they could have been used to carry the material and then left there. All of these features contribute to exclude the possibility of accidental burning of the dates in L75 and to strengthen the hypothesis of intentional burning of the fruits. As a matter of fact, burnt date stones are common findings in deposits connected to religious ceremony contexts: from Ancient Mesopotamia (Ellison et al., 1978) to Greece (Megaloudi, 2005), Roman France (Rovira and Chabal, 2008) and Italy (Rottoli and Castiglioni, 2011). In the Arabian Peninsula, a particular significance of palm dates as food offering in funerary contexts was observed in the Hili North Bronze Age grave, UAE (Méry and Tengberg, 2009).

To this effect, the use of date palm products in Salut is also recalled by the baskets from L75, whose weavings were made with date palm leaflets (Basket 1; Fig. 3A and B) or fibers (Basket 2; Fig. 3C).

A large amount of date palm pollen (85%) was recovered in the weaving sample of Basket 1 (Table 2A) and it is conceivable that this pollen was originally adhering to the leaflets. However, such hypothesis is made improbable by the large amount of pollen recorded. Pollen analyses on basket weavings are not common, so not many useful comparisons are available, but two studies can be mentioned here: the palynological study of a Bronze Age burial mound in Georgia (Kvavadze and Kakhiani, 2010), where the sample corresponding to a basket made of "willow branches with attached willow pollen grains" did not record a high percentage of willow pollen; pollen analysis of the soil underneath a basket in a Roman town in Italy (Sadori et al., 2010a,b) did record some pollen of Gramineae, which could include the grass from whose leaves the basket was made, but in very low quantities.

Thus, the interpretation of this unusually high date palm pollen record required deepening our knowledge on the dispersal and diffusion of date palm pollen. The results of the modern surface sample study in the Shuh palm oasis showed that date palm pollen percentages are always low, the highest value (33%) being recorded 10 m from the male date palm, in a moss sample which presented pollen grains in a very good state of preservation. Accordingly, a study in sediments of a modern date palm oasis in Egypt (Ritchie, 1986) showed extremely low or insignificant date palm pollen percentages, while slightly higher percentages (max. 5%) were recorded in the Tauber trap samples.

In the wild, i.e. Wadi Ataran, the pollen percentage recorded right below the male palm tree (96%) was extremely higher than the one recorded beneath the male date palm in the Shuh village oasis (3.3%). In any case, the natural dispersal is spatially limited since in Wadi Ataran the percentage dropped below 3% beyond 30 m from the male palm tree.

Therefore, it is clear that in palm groves, the artificial pollination practice negatively influences the natural dispersal of pollen: in fact, the peculiar man-controlled breeding of the cultivated date palm involves cutting the immature male inflorescence from the tree and storing the inflorescence for artificial pollination of female inflorescences. Thus the date palm pollen representation in the wild is very different from that in the cultivated oasis and it is the latter that is generally weakly recorded in pollen analyses from archaeological contexts. This information is very useful for the interpretation of the palm pollen percentages in the on-site samples: high percentages are attained only in close vicinity of the male inflorescence. Therefore, the presence of date palm inflorescence/s inside the basket or close to it, possibly in connection to ritual practices, is the more credible hypothesis in this case. Similar interpretations of high date palm pollen percentages in archaeological layers were made in Fezzan, Lybia, for the Garamantes culture (Mercuri et al., 2005).

The peculiar plant offering scenario arising from archaeobotanical research in Salut tentatively recalls those religious ceremonies, perhaps fertility rites, involving date palm (the “sacred tree”), depicted in the renown Assyrian bas-reliefs (Sarton, 1934). Indeed, artificial fertilization of the date palm has played a fundamental role in the history of Middle-Eastern horticulture (Gandz, 1935; Goor, 1967), and, interestingly, nowadays male date flowers still have an elevated commercial value in Omani *suqs.*

As stated above, the archeological contexts represented by L75 and L454 are still under investigation, but the evidences are tempting toward the ritual offering interpretation of at least one of the deposits, above all in consideration of the typology of the discovered materials but also of the deposit location in the site. Facing the ritual offering topic, it is important to stress the absence of epigraphic sources or iconographic data concerning cult practices in Iron Age south-eastern Arabia. Moreover, from the archaeological point of view, there are no elements of comparison with the stratigraphy of Salut, even if there are features, mainly artifacts, which seem to connect Salut to the cultic sites of Bithna, Masafi3, and Al-Qusais (Benoist, 2007, 2010). In any case, since archaeobotanical data are not yet available for other cultic sites in Arabia, direct comparison with the records from Salut is not possible.

Indeed, basing on the typology of the artifacts and the location in the site, and in view of the archaeobotanical records, it is very likely to talk of ‘ritual deposit’ in the case of L75. This stratigraphical context is located very close to a possibly cultic building, the so-called Burnt Building. Several of the recovered objects hint to ritual practices, in particular two bronze ladles and a bronze snake. It is in fact renown that in south-eastern Arabia this kind of artifacts have been found only inside peculiar architectural contexts with public functions, such as ‘columned halls and cultic sites’, where it is presumable that specific ceremonies took place (Benoist, 2010; Magee, 2003). Another main component of the ritual offering interpretation is the large amount of unarticulated animal bones found in the *stratum*; from the faunistic study (in press) it results that burnings in low temperature are frequent and that these remains mainly belong to young sheep and goats (Wilkens B., 2007: personal communication).

In this scenario, the plant remains may represent an important component of the ritual act, specifically the offering of palm dates and palm flowers.

7.2.5. Other plants possibly used in rituals

A layer of plant remains, evident at first glance, was found on the top of the intentional deposit L454, part of the fortification wall fill. It mainly consists of leaves, twigs, but also seeds and fruits of oleander. The meaning of this *stratum* is not clear: oleander is not a typical plant in offerings; the plant was considered ornamental, but if flowers were placed in the deposit then they should have been recorded in the pollen analysis. Oleander wood is unsuitable both for architectural use, because of its poor resistance, and, obviously, also for fuel, in view of the high toxicity of the entire plant.

The unusual presence of oleander inside L454 finds no comparison with records from other Iron Age sites in the Gulf, but there are many mentions of its medicinal use from ancient Roman (Pliny the Elder, *Naturalis Historia*, 16.33 and 24.53) and Arab (ibn Wahshiyya, *The Book on Poisons*, in Levey, 1966) written sources as an effective snakebite cure, and this is particularly true especially in the Middle East (Houghton and Osibogun, 1993). Oleander is well-known as a poisonous plant because of its glycoside content (Bruneton, 1999). However, it is worth stressing that very often in antiquity poisonous plants were used both to make poisons and to cure a poisoning/intoxication from the same plant.

Also the archaeological interpretation of L454 is less explicit, especially considering that the analysis of the discovered materials is still in progress. Apparently, the huge amount of peculiar pottery sherds (carinated bowls, spouted jars and long-handled bowls) and animal bones could also in this case suggest a ritual meaning, together with its location in close proximity to one of the main entrances of the site. However, no more specific ritual objects and no date stones were recovered, which makes it harder to answer the question: intentional and ritual deposit or simply waste?

The presence of *Juniperus* (juniper) charcoals and micro-charcoals in both L75 and L454 (Table 4) should be emphasized. Juniper, in fact, does not belong to the same vegetational belt of the other plants identified in the site of Salut. Consequently, its finding testifies the conscious choice of that specific wood for a precise purpose, unfortunately yet unknown. Currently, *J. excelsa* grows in the summit of the Al-Hajar Mountains, on Jebal Akhdar (about 1500–3000 m a.s.l.), in open evergreen woodlands, as mentioned above.

8. Conclusion

Archaeobotanical research in Salut gives insights on various interpretative scenarios: palaeovegetational reconstruction, oasis farming and ritual practices.

Regarding the first scenario, palaeovegetational reconstruction, pollen analysis gave us an idea of the landscape surrounding Salut in the Iron Age that was dominated by dry shrublands, while wood and charcoal analysis indicated which shrubs/trees were cut for timber and/or firewood. The list of charcoals includes plants which currently belong to different vegetation belts of the mountain relieves of north Oman. Acacia, tamarisk and jujube were probably diffused not far from the sites, at the foot of the relieves surrounding the Salut plain or in the wadis. On the contrary, juniper is part of a higher vegetation belt and the collection of its timber required frequentation of a relatively long-distance area.

Regarding the second scenario, the archaeobotanical record immediately recalls farming activities, namely date palm oasis agriculture, considering the co-occurrence of date palm, cereals, sesame, and basil.

Regarding the third scenario, ritual practices, this is particularly interesting in a site as Salut, which does not fit with a settlement site but more with a representative, possibly also cultic, site, where the remains of cultivated plants could be interpreted as direct evidences of offerings and indirect evidences of subsistence activities. The pollen percentages of date palm and cereals in some cases are so high that they more likely represent anthropic accumulation from activities in the site rather than the pollen rain from nearby oasis farming, as shown by the results of the modern surface sample study. Obviously, this does not rule out the hypothesis that agriculture was occurring in the surrounding plain; rather it validates the occurrence of farming activity in the area, whichever was its distance from the site.

Once again, it is essential to stress that the absence of archaeobotanical data from other sites with similar archaeological contexts hinders our current possibility of developing and confirming the interpretations presented here.

In Salut, comparing the plant micro- and macroremain datasets resulted crucial for deciphering the origin and significance of specific plants in peculiar archaeological contexts, as in other case-studies (see e.g. Mariotti Lippi et al., 2009). Specifically, pollen analysis on archaeological levels was particularly productive in signaling the occurrence of plants otherwise unnoticed, like sesame and basil, thus increasing the ancient floristic list, possibly including cultivated plants; pollen analysis on unusual materials, such as basket weavings, was especially useful in unveiling ritual practices otherwise missed involving date palm flowers. Although their interpretation is arduous, these remains in these contexts stimulate interesting palaeoethnobotanical considerations, as in this case the plant offering scenario. This is plausible for dates and date palm flowers and this record enriches the present knowledge on the south-eastern Arabian Iron Age plant use.

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