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PALAEOENVIRONMENTAL RECONSTRUCTION OF A PHOENICIAN SITE: ARCHAEOBOTANY AT MOTYA (SICILY, ITALY)

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Abstract (ENG)

The present PhD thesis concerns the archaeobotanical analysis of materials found in the archaeological site of Motya, a small island (ca. 40 ha) located in the Stagnone di Marsala, a coastal lagoon of western Sicily. Due to its strategic, harbored position in the middle of the Mediterranean and the presence of fresh-water springs, the site was chosen by Phoenicians as a settlement in the 8^{th} century BC until the siege of Motya in 397/6 BC.

The study of macro-remains, retrieved using bucket flotation, focused on two closed contexts: a votive *favissa* found on the SW side of the Temple of Cappiddazzu (dedicated to Melqart/Herakles), and a big disposal pit in Area D, both dating between the 8^{th} and the 6^{th} century BC. In the latter context, palynological analyses were also performed. The study has yielded a wide set of data which allows to reconstruct different aspects of the human-environment interaction of Phoenicians at Motya.

Concerning the ritual sphere, animal sacrifices were likely accompanied by ceremonial meals. A high concentration of officinal plants is probably correlated to the salvific aspects of Melqart at Motya. Interesting is the find of numerous plants toxic to livestock, which suggests their use to stun animals before sacrificing them. Remains referable to fruit (*Vitis vinifera*) and flower offerings (*Verbena officinalis*), as well as ornamental (*Cupressus* cf. *sempervirens*) plants are also attested.

From the secular perspective, human diet was comprised of cereals (mostly naked wheat), pulses and fruits. Different-sized weeds (such as *Lolium temulentum* and *Phalaris* ssp.) and chaff remains, referable to different stages of crop processing, indicate that crop processing was carried out daily before consumption. This aspect is enriched by the find of cereal pollen, which suggests that threshing (if not even cultivation) was carried on site.

Palynology also indicates an open environment, with little to no forest cover, characterized by complex anthropogenic activities.

Anthracology suggests the presence of typical Mediterranean plant taxa. The presence of a stone pine nut and of *Pinus pinea*/*pinaster* in the pollen rain is noteworthy, suggesting the local occurrence of these Mediterranean pines outside their native distribution range. This represents the first such find in the central Mediterranean. Fossil evidence also allows a comparison of Motya's past and present environment. The disappearance of *Juniperus* sp. and *Erica arborea* from the present-day surroundings of the Marsala lagoon appears to be related to land-overexploitation, aridification or on a combination of the two.

Finally, the role of Phoenicians in the spread and trade of grapevine was investigated through morphometric analyses of the *Vitis vinifera* seeds retrieved from the disposal pit in Area D. These were compared to waterlogged samples from the western Mediterranean sites of Nuraghe S'Urachi (Sardinia, Italy) and Huelva (Spain), associated to Phoenician expansion and cultural interaction. Archaeobotanical samples were compared to ten chosen cultivars from the "Vivaio Federico Paulsen: Centro Regionale per la Conservazione della Biodiversità Agraria" in Marsala (western Sicily), selected as modern reference material.

PCA analyses allowed an inter-site comparison, showing that samples from the three sites are clearly distinguishable based on their morphology. This indicates the use of different varieties which may be due to different factors. Statistical analyses of pip outlines show that archaeological material from these sites is morphologically comparable to that of modern varieties, suggesting that the archaeological finds may be described as "strongly domesticated". Nonetheless, no apparent correspondence to modern cultivars was found. This is partly related to the limited size of the reference collection, to the centuries of history that have had an impact on grape diversity, and to taphonomic factors.

Abstract (ITA)

La presente tesi di dottorato riguarda le analisi archeobotaniche dei materiali provenienti dal sito archeologico di Mozia, una piccola isola (ca. 40 ha) collocata nello Stagnone di Marsala, in Sicilia occidentale. Grazie alla sua posizione strategica e riparata, al centro del Mediterraneo, e alla presenza di sorgenti d'acqua dolce, il sito è stato scelto come insediamento dai Fenici nell'VIII sec. a.C. fino all'assedio di Mozia nel 397/6 a.C.

Lo studio dei macro-resti, separati attraverso flottazione, si è concentrato su due contesti chiusi: una *favissa* votiva sul lato sud-ovest del Tempio del Cappiddazzu (dedicato a Melqart/Herakles), ed un butto nell'Area D, entrambi databili tra l'VIII e il VI sec. a.C. Lo studio ha fornito un ampio set di dati che ha permesso la ricostruzione di diversi aspetti delle interazioni uomo-ambiente dei Fenici a Mozia.

Per quanto riguarda la sfera rituale, i sacrifici animali erano presumibilmente accompagnati da banchetti cerimoniali. Un'alta concentrazione di piante officinali è probabilmente correlata agli aspetti guaritori che il dio Melqart assumeva a Mozia. Il ritrovamento di numerosi taxa tossici per il bestiame risulta interessante, suggerendo il loro utilizzo per stordire gli animali prima di sacrificarli. È inoltre attestata la presenza di resti relative a offerte di frutti (*Vitis vinifera*) e fiori (*Verbena officinalis*), come anche di piante ornamentali (*Cupressus* cf. *sempervirens*).

Dalla prospettiva secolare, la dieta umana era composta da cereali (principalemente frumenti nudi), legumi e frutta. Le piante infestanti di diverse dimensioni (tra cui *Lolium temulentum* e *Phalaris* ssp.) e i resti di pula, attribuibili a diverse fasi di lavorazione del raccolto, indicano che questa venisse svolta quotidianamente prima della consumazione. Questo aspetto è arricchito dal ritrovamento di polline di cereali, il quale suggerisce che la trebbiatura (se non anche la coltivazione) venisse svolta sul sito.

Anche la palinologia permette di ricostruire un ambiente aperto, con poca o nessuna copertura forestale, caratterizzato da complesse attività antropiche. L'antracologica suggerisce la presenza di taxa tipici dell'area mediterranea. La presenza di un pinolo e di *Pinus pinea*/*pinaster* nella pioggia pollinica è degna di nota, suggerendo la presenza locale di questi pini mediterranei al di fuori del loro areale di distribuzione. Questo rappresenta il primo ritrovamento di questo tipo nel Mediterraneo centrale. I resti fossili consentono anche un confronto tra l'ambiente passato e presente di Mozia. La scomparsa di *Juniperus* sp. ed *Erica arborea* dai dintorni dell'attuale Stagnone di Marsala sembra essere correlata allo sfruttamento eccessivo del suolo, all'aridificazione o a una combinazione dei due fattori.

Infine, il ruolo dei Fenici nella diffusione e nel commercio della vite è stato analizzato attraverso delle analisi morfometriche sui semi di *Vitis vinifera* rinvenuti nel butto dell'area D. Questi sono stati confrontati a campioni conservati per sommersione provenienti da altri due siti del Mediterraneo occidentale caratterizzati da influenze fenicie, Nuraghe S'Urachi (Sardegna, Italia) e Huelva (Spagna).

I campioni archeobotanici sono stati confrontati con dieci cultivar del "Vivaio Federico Paulsen: Centro Regionale per la Conservazione della Biodiversità Agraria" di Marsala (Sicilia occidentale), selezionati come materiale moderno di riferimento.

Le analisi delle component principali (PCA) hanno permesso un confronto tra siti, dimostrando che i campioni provenienti da essi sono chiaramente distinguibili in base alla loro morfologia. Questo indica l'utilizzo di diverse varietà, il quale può essere dovuto a numerosi fattori. Le analisi statistiche della forma dei semi d'uva mostrano che i campioni archeologici sono confrontabili morfologicamente a quelli delle varietà moderne, suggerendone la descrizione come "fortemente addomesticati". Tuttavia, non è stata trovata alcuna apparente corrispondenza con dei cultivar moderni. Ciò è in parte legato alla dimensione limitata della collezione di riferimento, ai secoli di storia che hanno avuto un impatto sulla diversità della vite e ai fattori tafonomici.

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INTRODUCTION

Archaeobotany, also known as palaeoethnobotany, concerns the study of plant material recovered from archaeological contexts. It explores past human-plant relationships, focusing on food related practices and past landscapes (Branch, 2014). This discipline takes into consideration different typologies of plant fossils, which can be divided, based on their size, into macro- and micro-remains. The first category includes seeds, fruits, wood and basketry, while the latter is constituted by pollen, non-pollen palynomorphs (NPPs) phytoliths and starch grains (Mercuri et al., 2010).

Although the origins of this field of research can be traced back to the nineteenth century, when Oswald Heer carried out the first studies of archaeological plant remains recovered from waterlogged Swiss Neolithic and Bronze Age lake-side sites, archaeobotany was properly introduced in the 1960s (Fuller and Lucas, 2014). While plant remains were previously retrieved through dry-sieving, wet-sieving or hand-picking – techniques that have disadvantages in the retrieval of small-sized macro-remains – the development of the flotation technique constituted a real innovation (Van der Veen et al., 2007). This represents an efficient method to separate charred and mineralized plant remains, along with other macro-remains such as shells, fish scales, bones, and artifacts (Shelton and White, 2010).

Archaeopalynology is a formerly peripheral area of archaeological research, and has been investigated with increased regularity since the '80s (Bryant and Holloway, 1983). This discipline is usually associated with landscape reconstruction, keeping in mind that it is necessary to separate between data concerning the environment and those deriving from cultural activities. Nonetheless, it can allow researchers to gather information about rituals, use of plants, diets, use of certain types of artifacts etc.

A multidisciplinary approach, which involves the combination of carpological (seeds and fruits), anthracological (charcoals) and palynological (pollen) analyses within a single site, allows us to obtain a panoramic view of the interaction of its inhabitants with plants. Each type of evidence does, in fact, provide different and complementary information.

Other than the standard archaeobotanical analyses, morphometrics (the statistical analysis of form and its (co)variation) deserves some attention. It has played a key role from the beginning of the 20th century for the study of grape pips retrieved from archaeological contexts, allowing researchers to distinguish wild and domesticated seeds (Stummer, 1911; Mangafa & Kotsakis, 1996). The approach, initially based mainly on the measurement of the length and breadth of the whole pip has developed to include more parameters, such as the length of the stalk or position of the chalaza (Rivera Núñez et al., 2007) and further evolved with geometric morphometrics and, more precisely, outline analysis (Terral et al., 2010). Although only genetic analyses can allow for establishing the descent of modern cultivars from archaeobotanical specimens (Guasch-Jané, 2019), geometric morphometric analyses are useful in archaeobotany, where shape is often the only remaining datum (Portillo et al., 2020). Since most of the plant parts usually preserved are seeds, outline analyses that do not require landmarks are particularly suitable and were successfully used for numerous studies (eg. Ekhvaia & Akhalkatsi, 2010; Terral et al., 2010; Orrù et al., 2013; Ros et al., 2014; Pagnoux et al., 2015; Sabato et al., 2015a; Bonhomme et al., 2017; Bourgeon et al., 2018; Boso et al., 2020).

The present PhD project focuses on Motya (also known as San Pantaleo), a small island (ca. 45 ha) located near the westernmost edge of Sicily, in the Marsala Lagoon, between Trapani and Marsala. Thanks to its harboured and strategic position in the middle of the Mediterranean, as well as to the presence of fresh-water sources (Di Mauro et al., 2011; Spagnoli, 2014), the site has been inhabited since at least the 17th century BC, and was chosen by Phoenicians as a colony in the 8th century (Nigro and Spagnoli, 2017). Although the Phoenician-Punic occupation lasted until the siege of Motya in 397 BC, the island continued to be inhabited in the following centuries (Nigro, 2007).

"Phoenicians" is the label given by Greeks to a mixture of cultures native of the coast of the Levant, which spread across the Mediterranean between the 2nd and the 1st millennium BC. They sailed during daylight hours and stopped in favorable landmarks along the way, such as promontories and islets, where it was easier to disembark and be protected from the strong winds at nighttime (Moscati, 1988). In all these areas, commercial and agricultural settlements were newly established or created in association with existing indigenous ones, and the relations between Phoenicians and local communities became a key aspect of the economic and social transformation of these regions. Since direct written sources are mostly limited to funerary or sacred inscriptions, part of our current knowledge about Phoenicians derives from indirect sources in the form of descriptions left by other populations (Polzer and Reyes, 2007). Although the on-going archaeological investigations have helped to shed light on them, a lot is still to be understood. Knowledge regarding their use of plants and their impact on the environment is limited. Nonetheless, they are believed to have favoured the spread of *Olea europaea* L. (olive; Buxò, 1997), *Pinus pinea* L. (Mediterranean stone pine; Mutke et al., 2019), *Punica granatum* L. (pomegranate; Nigro and Spagnoli, 2018) and *Vitis vinifera* L. (grapevine; Buxó 2008; Pérez-Jordà et al., 2017; Ucchesu et al., 2015) in the Mediterranean basin. Archaeobotanical studies on Phoenician plant fossils are restricted to Sardinia, Italy (e.g. Ucchesu et al., 2017; Sabato et al., 2019), southern Iberia (e.g. Buxò, 2008), Tunisia (van Zeist et al., 2001), Morocco (Grau Almero, 2011) and Lebanon (Badura et al., 2016; Orendi and Deckers, 2018). These studies focus on macro-remains, with pollen sometimes being introduced as a complementary tool (e.g. van Zeist et al., 2001; Sabato et al., 2015b).

The "Missione Archeologica a Mozia" of Sapienza University has been responsible for excavations on the island of Motya since 1964, under the leadership of Prof. Lorenzo Nigro starting from 2002.

The archaeological mission is characterized by its multi-disciplinarity, involving, among others, studies in the field of archaeozoology (Alhaique, 2012), petrography (Fabrizi et al., 2020a; Fabrizi et al., 2020b) and metallurgical techniques (Bernabale et al., 2019). However, the only (preliminary) archaeobotanical analyses concerned cores from the submerged street connecting the islet to the mainland (Terranova et al., 2009). A recent addition is constituted by the analysis of dental calculus of the inhabitants of Motya, where some starch granules, pollen grains and plant trichomes were found (D'Agostino et al., 2020).

This PhD project aims to reconstruct the human-plant relationship of Phoenicians at Motya. This includes plant cultivation and processing, diet, ritual use of plants and choice of timber. A focus is placed on *Vitis vinifera*, one of the key plants in the Phoenician world. Another aspect investigated is the past environment, compared to the present-day one.

The present thesis is divided in two sections based on the applied archaeobotanical approach. **SECTION 1** is characterized by a classical approach, focused on the reconstruction of paleodiets, agricultural practices, ritual use of plants and past environment. It is divided in two chapters based on the studied context. **SECTION 2**, in contrast, is based on the application of morphometrical

geometry of grape seeds. In this section, materials from the Western Mediterranean sites of Huelva and Nuraghe S'Urachi, associated with Phoenician expansion and cultural interaction, are also taken in consideration and compared with those from Motya to comprehend the role of this set of populations in the spread of grape varieties.
This manuscript is a collection of several papers on archaeobotanical data from Motya (Moricca et al., 2020; Moricca et al., accepted; Moricca et al., under review) written by the candidate within her PhD research project. They are displayed according to the journal formatting. All the papers have been peer-reviewed and published or under review to Journals indexed in Scopus and Web of Science. All the chosen journals are in the Q1 quartile (archaeology) quartiles according to the Scientific Journal Report (SJR).

SECTION 1, Chapter 1 concerns the analysis of carpological and anthracological remains from a sacred *favissa*, on the SW side of the Temple of Cappiddazzu, dedicated to Melqart/Herakles, where the buried remains of seven bovines were found. Plant remains, preserved mostly by mineralization, provide information about ritual practices. It consists of the paper titled "Plant assemblage of the Phoenician sacrificial pit by the Temple of Melqart/Herakles (Motya, Sicily, Italy)" authored by Moricca C., Nigro L., Spagnoli F., Sabatini S., Sadori L., published in *Environmental Archaeology: the Journal of Human Palaeoecology*.

Plant macro-remains are also studied in **SECTION 1, Chapter 2**. Here, the analysis focuses on a big disposal pit, datable to between the first half of the 8th and the mid-6th century BC, identified in Area D. Palynological analyses were also performed on sediment collected from each filling layer. The study allows us to gather precious information regarding the Phoenicians living at Motya and their plant use. Information about human diet, crop processing and plant cultivation is provided. Furthermore, anthracological and palynological evidence contributes to the reconstruction of the past environment, highlighting changes that occurred during the last two millennia. This chapter consists of the paper titled "Cultural landscape and plant use at the Phoenician Motya (Western Sicily, Italy) inferred by a disposal pit" authored by Moricca C., Nigro L., Masci L., Pasta S., Cappella F., Spagnoli F., Sadori L., accepted by *Vegetation History and Archaeobotany*.

In **SECTION 2, Chapter 3** the *Vitis vinifera* seeds retrieved from the context studied in **Chapter 2** are studied using geometric morphometry and compared to waterlogged samples from the Western Mediterranean sites of Huelva and Nuraghe S'Urachi. Ten cultivars collected from the "Vivaio Federico Paulsen: Centro Regionale per la Conservazione della Biodiversità Agraria" in Marsala (western Sicily) were selected as modern reference material (http://vivaiopaulsen.it). This chapter contributes to the investigation of the role of Phoenicians in the spread and trade of grapevine. It consists of the paper titled "Grapes and vines of the Phoenicians: morphometric analyses of pips from modern varieties and Phoenician archaeological sites in the Western Mediterranean" authored by Moricca C., Bouby L., Bonhomme V., Ivorra S., Pérez-Jordà G., Nigro L., Spagnoli F., Peña-Chocarro L., van Dommelen P., Sadori L., under review in *Journal of Archaeological Science: Reports*.

In the final chapter (**Chapter 4**) a summary of the data provided in **SECTIONS 1** and **2** is presented. The conclusions represent the effort of the candidate to reconstruct plant cultivation and plant use of the Phoenicians at Motya. Furthermore, aspects regarding past environment and changes in the present-day vegetation are also discussed. Future perspectives include the collection and analysis of samples from other areas of the site, aimed at completing the archaeobotanical image of Phoenician Motya. Morphometric analyses of grape pips could not only be enriched by more samples from the Sicilian site but could also take into account material from other Phoenician settlements and a broader modern reference collection.

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SECTION 1

Archaeobotany: plant data in archaeological studies

CHAPTER 1

Plant assemblage of the Phoenician sacrificial pit by the Temple of Melqart/Herakles (Motya, Sicily, Italy)

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Plant Assemblage of the Phoenician Sacrificial Pit by the Temple of Melqart/Herakles (Motya, Sicily, Italy)

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ABSTRACT
Archaeobotanical remains from the Phoenician – Punic site of Motya, set in the Marsala Lagoon in Western Sicily (Italy), were collected through flotation and sieving during the excavation campaigns of 2017–2019. Analyses focused on a sacrificial *favissa*, on the SW side of the Temple of Cappiddazzu, dedicated to Melqart/Herakles, where the buried remains of seven bovines were also found. Plant remains, preserved mostly by mineralisation, provide information about ritual practices. The retrieval of toxic plants to livestock (some Boraginaceae and Euphorbiaceae, and *Anagallis arvensis*) suggests their use to stun animals before sacrificing them. Additionally, remains referable to fruit (*Vitis vinifera*) and flower offerings (*Verbena officinalis*), as well as ornamental (*Cupressus* cf. *sempervirens*) and officinal plants (*Borago officinalis*) were also found.

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Introduction

The island of Motya lays on the western coast of Sicily, Italy (Figure 1(a)), 1 km from the coast, between Trapani (north) and Marsala (south; Figure 1(b)). Its small size of just over 40 ha, and its strategic position in the centre of the Mediterranean within a harboured lagoon, enclosed by the 'Isola Grande', as well as the presence of a freshwater source, have made it a favourable setting for Phoenicians from the eighth century BC. Despite the Phoenician and Punic occupation constituting the main occupational phases of the site, the island has been inhabited continuously starting from the seventeenth century BC, and after the siege of Moya in 397 BC, which caused a destruction of the city (Nigro 2012), serving as an industrial centre (Nigro 2015a).

One of the historical excavation areas of the joint mission of Sapienza University of Rome is the Temple of 'Cappiddazzu', set at one of the highest points of the island (ca. 5 m a.s.l.), not far from the Northern Gate (Nigro and Spagnoli 2004; Figure 1(c)). The Temple of Cappiddazzu was one of the two major temples of Motya, most probably dedicated to Melqart/Herakles (Nigro 2015a). It was erected on a limestone spur on the northernmost edge of the island, where freshwater was captured. Five major phases have been distinguished in the temple constructive history (Nigro 2009). The third one (seventh century BC) is the first monumental one, characterised by the use of ashlar blocks. The temple is subdivided into three naves, and the central one hosts the cult focus with the sancta sanctorum aligned with the main entrance from the eastern façade. A 5 m wide and 2 m deep pit (also called a *favissa*) reaching the bedrock was excavated in the space just south-west of the western wall of the sacred building (Figure 1(d)), supposedly used for discharging votive material, especially remains of food offerings and sacrificed animals. This *Favissa* (F.7057) was ritually closed with the disposal of selected, partially articulated, parts of seven bovines all around it (a sort of *hecatomb*), and several offerings, including a Punic painted plate (MCZ.18.7031/18), then buried under a layer of ashy soil.

Sheep and goats are believed to have been reasonable alternatives to sacrificing children in *tophets*, sacred areas typical of Phoenician and Punic sites. At the *Tophet* of Motya, the incinerated remains of infants are accompanied by those of small animals (volatiles and lambs; Nigro 2018), and, in smaller quantities, by bovine bones showing clear signs of slaughter (D'Andrea 2017). Bovine bones and teeth were also identified amongst the remains of the votive offerings outside the temple of Astarte at Motya, along the northern wall (Nigro 2015b; Spagnoli 2019), in the sacred well on the southern side of the Kothon (Alhaique 2012b), in the *favissa* of Baal 'Addir in the sacred area of area C (Alhaique 2012a), and in small pits excavated in the bedrock at the temple of Cappiddazzu (Tusa 2000). Iconography of votive steles confirms the sacrificial use of bovids, as can be seen on a Carthaginian votive one from the second century, which depicts a priest holding an incense burner in front of the head of a slaughtered

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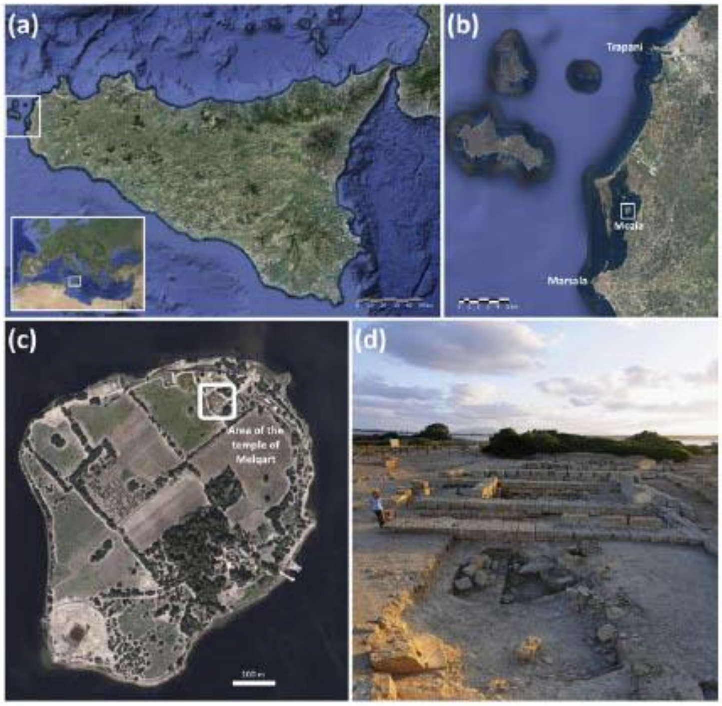

Figure 1. Setting of the island of Motya (a) within Sicily; (b) between the cities of Trapani and Marsala. (c) The area of the temple of Melqart within the island; (d) seen from the SE side, F.7057 is visible in the front.

bovine (Alain n.d.). Additional information can be obtained from the Marseille Tariff, two stone blocks recovered nearby the French city, that regulated the price to be paid to the priests of the temple for different sacrifices (*KAI* 69 = *CIS*, 1, 165; Amadasi Guzzo 1988). However, there is no mention of plant use in the rituals. Archaeobotanical studies carried out so far have not helped to shed a light on this issue either. *Favissa* F.7057 and the small votive pit F.7012 have been chosen for analysis in the present study in order to assess a potential contribution of plants in Phoenician – Punic animal sacrifices.

Materials and Methods

Favissa F.7057, identified as a sacrificial context of the southern side of the temple of Cappiddazzu, was selected for archaeobotanical analysis. During the excavation campaign of 2019, approximately 6 litres of sediment were collected from six different spots of the pit, totalling 35 litres. Additionally, the content of a nearby small votive pit (F.7012; 6 litres) excavated in the bedrock, and collected in 2017, was also chosen for the analysis. The sediment was processed on-site by bucket flotation using a 250 µm net, while the heavy fraction was water sieved through a 1 mm mesh. The light fraction was later sieved in-lab using a set of piled up meshes of size 2, 1 and 0.5 mm in order to facilitate the sorting process. The resulting material was sorted under a Leica M205C stereomicroscope with a magnification between 8x and 78x. The heavy fraction underwent an analogous process, being first sieved on a series of piled up meshes of size 5, 2 and 1 mm, and later sorted under a stereomicroscope. Carpological remains were observed under the same microscope, and identified using atlases (Cappers and Bekker 2013; Cappers, Neef, and Bekker 2009), scientific articles (for Urticaceae: Wolters, Bittmann, and Kummer 2005) and samples from the Didactic Herbarium of the Sapienza University Herbarium (RO). Anthracological fragments collected from the 5- and 2 mm sieves were analysed using a Normarski Interference Contrast microscope and identified against Schweingruber (1990). Botanical nomenclature follows Euro+Med (2006) for carpological remains, Schweingruber (1990) for anthracological remains, and Cambini (1967) for *Quercus* taxa.

Results

A total of 774 carpological remains (including fragments) belonging to 35 taxa and 19 families were found in the two deposits (Table 1). The main modality of preservation is mineralisation (88%) although some remains are also preserved by charring (12%). The average concentration is of ca. 18 remains per litre, with outliers of 0.6 and 76 remains per litre in proximity of the articulated spine of a bovine. The most represented taxon is *Ajuga iva* Schreb. (Figure 2(f)), followed by *Anagallis arvensis* L. and *Echium parviflorum* Moench (Figure 2(g)). Asteraceae and Boraginaceae are the most represented families, with respectively five and four taxa, and a total of 43 fruits/fruit fragments of the former and 195 of the latter. Other well represented families include Brassicaceae, Euphorbiaceae, Lamiaceae and Urticaceae. Despite of seeds and fruits representing most of the assemblage, a mineralised *Cupressus* cf. *sempervirens* L. twig (Figure 3(b)) and a charred *Triticum dicoccon* (Schrank) Schübl. spikelet fork were found. Other charred remains include cereals (*Hordeum vulgare* L. and five badly preserved indeterminate caryopses), weeds (*Phalaris* sp., *Thymelaea* cf. *hirsuta* (L.) Endl.) and fragmented grape pips in pit F.7012.

The assemblage of pit F.7012 is distinguished from *favissa* F.7057 by the presence of *Borago officinalis* L., as well as by a higher concentration of *Echium*

Table 1. The carpological assemblage of F.7012 and F.7057 (C – charred; M – mineralised).

			US7012	US7057						
				A	B	C	D	E	F	Average
	volume (L)		6	6	6	5	6	6	6	5.86
	remains/L		10.83	3.33	7.50	0.60	37.67	7.33	6.17	10.49
	Plant part									**TOTAL**
Ajuga iva	nutlet	M	2	2	2		56	7	2	71
	nutlet w/o embryo						28	8	1	37
	nutlet fr.		1		2		44	5		52
	embryo						11	3		14
Anagallis arvensis	seed	M		10	14		90	16		130
Apiaceae	mericarp	M						1		1
		C				1				1
Astragalus cf. *bôetiaus*	seed	M		1			2			3
Borago officinalis	nutlet	M	4							4
Brassicaceae	seed	M			1				1	2
Brassicaceae small	seed	C			4	1	12	4		21
Calendula arvensis	fruit	M					1			1
Caryophyllaceae	seed	M			1			1		2
Cereal indet.	caryopsis fr.	C			1		2	1	1	5
Chenopodium murale	seed	M					1			1
Cichorium cf. *intybus*	fruit	M			1		1			2
cf. *Cupressus sempervirens*	twig	M		1						1
Cyperaceae	fruit	M		1				2		3
Dittrichia graveolens	fruit	M			5		26	2		33
Echium parviflorum	nutlet	M			4		2		1	7
	nutlet fr.			4	7		36	14	25	86
Echium plantagineum	nutlet	M	26	1	1		7	5	1	41
	nutlet		4		2			1	1	8
Euphorbia helioscopia	seed	M					1		3	4
	seed fr.				2		9			11
Euphorbia peplus	seed	M	1		5		13			19
Ficus carica	achene	M							1	1
Galactites tomentosa	fruit	M					7			7
Heliotropium europaeum	nutlet	M			3		38	1		42
	nutlet fr.			1			8			9
Hordeum vulgare	caryopsis fr.	C			1					1
Medicago polymorpha	seed	C					1	2		3
	seed fr.							1		1
	seed	M			1		3	1		5
Medicago cf. *truncatula*	seed	M						1		1
Malva sp.	fruit	M					4	1		5
	seed	C		1					1	2
Mercurialis annua	seed	M	1	1	2		9	1	1	15
	seed fr.		1	2	2		29	1	1	36
Phalaris sp.	fruit	C				1		1		2
Sisymbrium cf. *irio*	seed	M		1						1
Thymelaea cf. *hirsuta*	seed	C	1				1			2
Triticum dicoccon	spikelet fork	C						1		1
Urtica membranacea	seed	M		1	1		3	1		6
Urtica urens	seed	M					8			8
Verbena officinalis	fruit	M	7	1				1		9
Vitis vinifera	seed fr.	C	20		1					21
		M					2			2
indet.				4						4
TOTAL			65	20	45	3	226	44	37	440

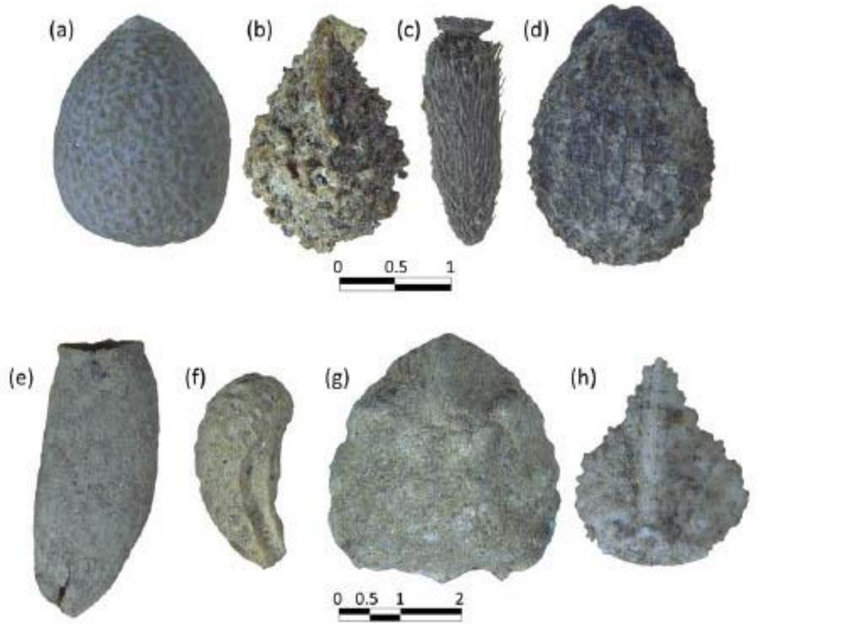

Figure 2. Plants poisonous to livestock: (a) *Mercurialis annua*; (b) *Heliotropium europaeum*; (c) *Dittrichia graveolens*; (d) *Euphorbia helioscopia*; (e) *Galactites tomentosa*; (f) *Ajuga iva*; (g) *Echium parviflorum*; (h) *Echium plantagineum*.

plantagineum L. (Figure 2(h)), *Verbena officinalis* L. (Figure 3(a)) and *Vitis vinifera* L. (Figure 3(c)).

Regarding the anthracological assemblage (Table 2), a total of 486 charcoal fragments were analysed and identified. They include arboreal (*Fraxinus* sp., *Juglans regia* L., Maloideae, *Olea europaea* L., *Pinus* sp., *Prunus* sp., *Quercus* sect. *suber* and a conifer) and shrubby-lianescent taxa (*Erica arborea* L., *Erica arborea/multiflora*, Faboideae, *Pistacia lentiscus* L., *Rhamnus/Phillyrea* and *V. vinifera*). *O. europaea* prevails in pit F.7057 (77% of fragments), and *P. lentiscus* in pit F.7012 (80%). These are followed by *Quercus* sect. *suber* (evergreen oaks; 7%) and *V. vinifera* (3%) in the former, and *Rhamnus/Phillyrea* (9%) and Maloideae (7%) in the latter.

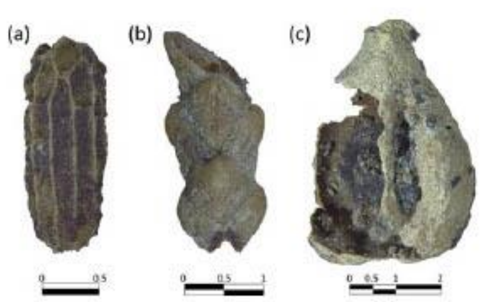

Figure 3. Possible ornamental plants and offerings: (a) *Verbena officinalis*; (b) *Cupressus* cf. *sempervirens*; (c) *Vitis vinifera*.

Discussion

The carpological assemblages of F.7057 and F.7012 depict the past flora of Motya as similar to the present-day one, with all wild/spontaneous taxa (except *Echium parviflorum* and *Phalaris* sp.) being currently found on the island (S. Pasta, personal communication, September 16th, 2019). Most of them are ruderals and occur on disturbed ground (Figueiral et al. 2010; Pepe et al. 2013), while *Chenopodium murale*

Table 2. The anthracological assemblage of F.7012 and F.7057.

	US 7012	US 7057						
Volume (L)	6	6	6	5	6	6	6	
Taxa		**A**	**B**	**C**	**D**	**E**	**F**	TOTAL
Erica arborea					1	2		3
Erica arborea/ multiflora		1						1
Faboideae		1				2		3
Fraxinus sp.				1				1
Juglans regia		1			1	1		3
Maloideae	7							7
Olea europaea		83	33	66	19	54	47	302
cf. *Pinus* sp.							1	1
Pistacia lentiscus	76						1	77
Pistacia sp.						1		1
Prunus sp.				1		2	2	5
Quercus sect. *suber*	1	13	5	1	2	4	3	29
Rhamnus/Phillyrea	9	2					1	12
Vitis vinifera		4	5	1				10
Conifer					1			1
indet.	2		5	7	7	4	5	30
TOTAL	95	105	48	77	31	70	60	486

and *Phalaris* sp. also occur as weeds of respectively summer and winter crops (CABI 2019; Dhima, Eleftherohorinos, and Vasilakoglou 2000). The unusual state of conservation makes it necessary to evaluate causes of fossilisation and taphonomic aspects before proceeding with an interpretation of the plant remains in the studied context.

Whereas in the Mediterranean region the main modality of preservation of plant remains is charring (Renfrew 1973), the main preservation method detected in pit F.7057 and pit F.7012 is mineralisation. This process occurs when minerals replace the organic material (seeds, fruits or other plant parts), reproducing, partially or totally, the morphology of the original seed. This situation tends to take place in contexts with a high concentration of organic material (human faeces, bones or other discarded organic remains), which provide a source of calcium phosphate (Peña-Chocarro and Pérez-Jordà 2019). Fossilisation by lithification may also be induced by silicates, gypsum, carbonates or calcite (Miksicek 1987). The presence of a noticeably higher concentration of plant remains in proximity of bones, in particular next to an articulated bovine spine, makes it reasonable to believe that these were in fact the direct cause of mineralisation of other plant taxa in the studied deposits. Furthermore, some seeds/fruits undergo biomineralization, a process induced by their intrinsic properties. The research group lead by Prof. Postorino (Sapienza University) is developing a research method to analyze such (bio)mineralised remains through Raman spectroscopy. These include Boraginaceae (Bugloss family), highly represented in the current study, that contain high amounts of biogenic carbonate, commonly accompanied by silica and/or calcium phosphate (Mustafa, Ensikat, and Weigend 2018). For this reason, members of the Boraginaceae family usually appear in archaeological layers uncharred and without endosperm, and are common in Mediterranean and Near Eastern sites (Pustovoytov, Riehl, and Mittmann 2004). Their interpretation commonly raises doubts on whether they were deposited along with the cultural layers or during following events in the form of intrusions caused by burrowing animals, such as subterranean mammals or small invertebrates (Van Zeist and Bakker-Heeres 1982). A detailed visual inspection of the pits F.7057 and F.7012 was carried out, showing no signs of bioturbation by small mammals in the form of fossil molehills or burrows. Van Zeist and Bakker-Heeres (1982) noted that some indications may be given by the appearance of the fruit wall (colour, some degree of corrosion, etc.), although only the presence of the remains of the carbonised contents in nutlets can strongly suggest that they became part of the archaeological layer at the time of deposition.

Radiocarbon dating has been chosen as a solution for this problem by Pustovoytov, Riehl, and Mittmann (2004) by ^{14}C dating seven nutlets of *Lithospermum arvense* and successfully ascribing them to the occupational phases of the site of Khirbet ez-Zeraqon (Jordan). Another aspect that point towards the plant remains, particularly Boraginaceae, being contemporaneous to the deposit, is the absence of *Echium parviflorum* (the third most represented taxon in the assemblage) in the present-day flora of Motya. This rules out the possibility of *E. parviflorum* constituting a recent inclusion, having been brought from open wild green areas (field/meadow) to the deposit by burrowing animals. Furthermore, association of Bugloss plant family fossils, cattle and ovicaprines remains has been documented in several archaeological contexts (Ghosh et al. 2008; Mercuri 1999, 2008; Spaulding 1974). Nonetheless, the possibility of later intrusions cannot be entirely ruled out.

General Interpretation of the Context

Animal sacrifices are a well-documented practice in the Phoenician-Punic world. There is evidence of periodic, public celebrations, which took place in the open courtyard facing major temples. The Sapienza Team has recently resumed the excavation of the monumental temple known as the 'Cappiddazzu Temple' in the northern region of the island of Motya, identifying the titular deity of the temple with the Phoenician (Tyrian) God Melqart, identified with the Greek Herakles. This god is the dynastic god and his temple, linked to the reigning dynasty, was rebuilt by the kings of Motya in large squared blocks of local sandstone, most likely at short distance from their palace. This divinity has the appearance of a young man who skewers a dragon or a griffin with a long spear: an iconography reminiscent of the later one of Saint George. Nonetheless, Melqart in Motya also includes some salvific aspects of Eshmun, another major Phoenician healer god, who was equivalated to Apollo by the Greeks.

Ancient sources refer some main feasts and rituals connected to Melqart, such as the 'day of the burial of the deity' (Ribichini 1988). Epigraphic evidence, in the form of Punic tariffs found in North Africa from the fourth–third centuries BC, has provided information regarding the provisions for each ritual. Animals could be sacrificed in different ways, with offerors being able to either donate them in their entirety or by subdividing parts of them for consumption. The deriving meat could be boiled or roasted. Bulls were the most prestigious victims, followed by calves or deers, goats, sheep and birds (Middlebrook 2010). Analogously to Greek traditions, the food value was an important element of Phoenician-Punic rituals, with a meal possibly accompanying every animal sacrifice (Amadasi Guzzo 2008). The archaeobotanical evidence in the contexts under study could, in fact, correspond to the remains of a ritual meal. Two mineralised fragments of *Vitis vinifera* (grape) seeds were recovered from *favissa* F.7057 (next to the articulated bovine spine), while twenty charred ones were retrieved from pit F.7012, constituting a significant part of the assemblage. This could indicate the consumption of table grapes. Grape holds a high symbolical value, being associated with divinities, frequently represented in art and being related to specific rituals, where its symbolic interpretation as the blood of earth and life force played a key role (Savo, Kumbaric, and Caneva 2016). *V. vinifera* remains have been found in a series of burnt offering deposits in the Mediterranean area, for example in Roman and pre-Roman Pompeii (Italy; Robinson 2002) and in the Phoenician site of Santa Giusta, in Sardinia, in association with animal remains (Debono Spiteri, Salazar-Garcia, and Vella 2015).

Other indications of a ritual meal are given by the presence of charred cereal fragments and possibly one mineralised *Ficus carica* (fig) achene.

The presence of mineralised *Cupressus* cf. *sempervirens* (cypress) twig characterised by small, scaly, rhombic leaves, raises a certain interest in a Phoenician funerary context. This remain was distinguished from *Juniperus phoenicia* (Phoenician juniper) based on the size of the leaves, that are slightly smaller (0.8–1.2 mm) and less compact than those of cypress, whose size range is between 1.2 and 1.8 mm (Šoštarić and Küster 2001). However, this identification must be taken with caution due to the small size of the remains. While Phoenician juniper is a pioneer plant (Boratyński et al. 2009), cypress, supposedly one of the earliest documented cases of trees introduced by humans solely for ornamental purposes, is thought to be native to the Middle East and to have been imported to the Western Mediterranean by Phoenicians and Etruscans (Zocca et al. 2008), although Bagnoli et al. (2009) suggest that it may be native to Italy. The cultivation of cypress as an ornamental plant in Italy is attested since ancient Roman times (Bosi, Mercuri, and Bandini Mazzanti 2009). Since ancient times, humans have used cypress as a symbol of the underworld (Edmonds 2010) and it in antiquity it is mostly present in funerary contexts (e.g. Chabal et al. 2012; D'Auria, Teobaldelli, and Di Pasquale 2020; Robinson 2002). Cypress was also chosen for the funerary furniture of the tomb of Tutankhamun (Rifai and El Hadidi 2010). *C. sempervirens* timber is very hard and durable, highly resistant to decay and suitable for obtaining long straight logs for construction (Liphschitz 2015). It was chosen for the lining of wells in pre-Roman sites (D'Auria, Teobaldelli, and Di Pasquale 2020), it was later used for ship-building, with particular employment for planking during the first —third century AD in the Tyrrhenian ports (Sadori et al. 2015), and has been identified in shipwrecks built during the Roman-Byzantine period, which sank off the Mediterranean coast of Israel and Turkey (Liphschitz 2015).

Fodder plants have also been retrieved in the studied context. *Medicago polymorpha* L. (burr medic), whose seeds were found in the assemblage both in the mineralised and the charred form, is one of the self-generating legumes present in pastures of the Mediterranean area and it is a common forage for all classes of livestock, with the exception of horses and mules (USDA NRCS 2002). It has a high palatability, a particularly high leaf/stem ratio – an indicator of forage quality – and a high nutritional value (Porqueddu 2001). Three *Astragalus* cf. *böeticus* L. (Swedish coffee) seeds preserved by mineralisation were also found in the assemblage. Swedish coffee is a member of the largest genus of vascular plants (*Astragalus*; Prohens et al. 2014), many species of which are grazed by livestock or fed as fodder (Niknam, Ebrahimzadeh, and Maassoumi 2003). Resistant to very low rainfall, *A. böeticus* has also been cultivated for its seeds, which can be used as coffee upon roasting (Prohens et al. 2014).

Cichorium intybus, whose mineralised fruits were retrieved from *favissa* F.7057, is also an important forage plant, is highly digestible for animals, may improve protein efficiency and reduce intestinal parasites in animals (Saeed et al. 2017).

Finally, the retrieval of high concentrations of fruits of *Ajuga iva* and Asteraceae (particularly *Dittrichia graveolens*) may also be interpreted as flower offerings. These species possess attractive features to humans, such as the brightly coloured flowers, respectively pink-yellow and yellow.

While *favissa* F.7057 and pit F.7012 present similar carpological assemblages, some differences exist. Despite of the latter being richer in *Echium plantagineum* (Paterson's curse; ca. 40% of the assemblage), *Echium parviflorum* (small-flowered Viper's Bugloss) and *Heliotropium europaeum* (heliotrope; Figure 2 (b)) are absent. They are instead replaced by *Borago officinalis* (borage), a food plant, whose flower buds and sometimes leaves are eaten (Deforce et al. 2019). For this reason, borage is often found in archaeological pollen samples whilst being absent in assemblages of macro-remains (Deforce 2017).

Verbena officinalis (vervain), is more abundant in the assemblage of pit F.7012. A high concentration of vervain seed fragments in piazza Garibaldi, Parma (Northern Italy) has been interpreted as an indication of flower offering, also due to 'verbena' meaning 'a bouquet of various plants employed in rituals' (Bosi et al. 2011). The same explanation can be advanced for the deposit at Motya.

The spatial distribution of anthracological remains does not mirror the carpological assemblage. While the concentration of seeds and fruits is highest in the soil collected next to the articulated bovine spine, the same sample yielded the lowest concentration of wood charcoal. Furthermore, the sample with the fewest carpological remains is characterised by an average concentration of anthracological remains. This is easily explained, as wood fragments are preserved by charring, therefore the proximity of mineral sources was not a factor involved in their fossilisation. It is probable that the wood remains are evidence of ritual fires that took place alongside the sacrifice. The most represented taxon in pit F.7057 is *Olea europaea* (77%), followed by *Quercus* sect. *suber* (7%) and *V. vinifera* (3%). Nigro (2017) hypothesised that 10% (ca. 4 ha) of the surface of Motya was occupied by olive trees during the Phoenician occupation in order to counter the need for oil of the local population. The abundance of evergreen oak in Mediterranean contexts is considered a normal result of wood exploitation (Chabal et al. 2012). Grapevine, complemented by seed remains, indicates local cultivation (Deckers 2005). Three fragments of *Juglans regia* (walnut), a noble hardwood of temperate regions, which produces fruits and high-quality timber (Malvolti et al. 2010), is more curious. Walnut, native of the western Himalaya in the Iran-Afghanistan region (Mercuri et al. 2013), is now found in Italy from the Alps to Sicily, at all altitudes under 1500 m.a.s.l. (Malvolti et al. 2010). Fossil records show the presence of *Juglans* pollen in Sicily since the eighth—seventh century BC (Sadori 2013). Walnut was probably selected by the inhabitants of Motya due to its high-quality timber and imported from other parts of Sicily. Other interesting finds include a fragment of *Pinus* sp. and one fragment of a conifer, whose further identification was not possible due to poor preservation.

A striking difference between the two contexts is the abundance of *Pistacia lentiscus* in pit F.7012 (80%) in contrast to pit F.7057 where it was absent. Lentisk was probably collected locally and was chosen due to high availability.

Plants with Toxic/Medicinal Properties

Interestingly, many of the species comprising the carpological assemblage present officinal properties and are used in traditional medicine (Table 3). *Ajuga iva* (English bugle), the most represented taxon in the carpological assemblage of the deposit, is a popular medicinal plant in Africa and Asia, being used as a cure for a variety of diseases including hyperthension, digestive and gastro-intestinal disorders. Numerous taxa from F.7057 and F.7012 have been traditionally used for the treatment of skin disorders and wound healing (*Anagallis arvensis, Borago officinalis, Cichorium intybus, Euphorbia helioscopia* – Figure 2(d), *Euphorbia peplus* and *Mercurialis annua* – Figure 2(a)), urinary inflammations (*B. officinalis, Echium plantagineum, Heliotropium europaeum* and *Urtica urens*), respiratory conditions (*B. officinalis* and *Dittrichia graveolens* – Figure 2(c)) cardiovascular diseases (*Galactites tomentosus*; Figure 3(e)) and other pathologies. Additionally, some of the species retrieved are also used in veterinary medicine, being used to promote milk production (*B. officinalis*), reduce intestinal parasites (*C. intybus*) and cure paralysis (*Verbena officinalis*).

The deposition of medicinal plants next to the temple of Melqart/Herakles, could find an explanation in the symbolism of the god. Melqart ('king of the city') was in principle the god of agriculture (Marìn Martínez 2011), Tyrian colonisers and resurrection, believed to represent of the faces of Baal (De Lima 2019). His relationship to vegetation is furtherly enforced by the iconography of a first century BC coin, showing the god with a cornucopia and accompanied by a cereal spike (Marìn Martínez 2011). Despite of Melqart/Herakles not being directly linked medicine, he is often associated to Eshmun – referable to the Greek Asclepius – the god of healing (Hvidberg-Hansen 1992; Amadasi Guzzo and Xella 2005).

The case of Motya does not represent a unique example of retrieval of plants with properties attractive to humans, both medicinally and aesthetically, in animal burials. This association is documented in Middle Holocene cultures in the Sahara desert, where bovine bones were accompanied by remains of the daisy family (with coloured flowers, some of which have medicinal properties), *Rumex cyprius* and *Rumex vesicarius*, also coloured and with numerous applications in traditional medicine (Di Lernia et al. 2013).

Another aspect that seven of the retrieved taxa have in common is their toxicity, which has made them accountable for the poisoning of sheep and cattle. The Boraginaceae present in pit F.7057 – *Echium parviflorum* (small-flowered Viper's Bugloss), *Echium plantagineum* (Paterson's curse) and *Heliotropium europaeum* L. (heliotrope; Figure 2(b)) – contain pyrrolizidine alkaloids (PAs), potent liver toxins, that are meant to protect the parent plant from herbivores (Mercuri 1999). Ingestion of repellent plants, which are usually not palatable, is more likely in periods when other, non-toxic sources of forage are scarce (Shimshoni et al. 2015). Even though *E. plantagineum* is usually more abundant in pastures than *H. europaeum*, more losses in cattle are attributed to the latter due to its higher palatability (Harris 1998). Similar effects can be caused by Euphorbiaceae, well represented in the votive pit. This is due to the presence of diterpene ester type toxins, which are known

Table 3. Effects on livestock and medicinal uses of selected taxa from *favissa* F.7057 (AP – aerial parts; EO – essential oil; F – flower; L – Lymph; PJ – plant juice; R – roots; S – seed; WP – whole plant)

Taxon	Effects on livestock	Uses in traditional medicine	Parts of plants employed	References
Ajuga iva	–	Stomachic; tonic; cephalic; treatment of diabetes, hypertension; diarrhea, fever, gonorrhea	WP	Hendel et al. (2012), Leporatti and Ghedira (2009)
Anagallis arvensis	accountable for sheep poisoning, consisting of a severe toxic nephrosis	Dermatological purposes regarding wound healing properties	AP	Schneider (1978), López et al. (2011)
Borago officinalis	promote milk production in cows about to calve or after calving	Treatment of disorders of the respiratory system, urinary tract, arthritis and skin problems, hypertension; laxative and purgative	S (int.), AP (ext.)	Pieszak, Mikolajczak, and Manikowska (2012), Tahraoui et al. (2007), Viegi et al. (2003)
Cichorium intybus	favors growth, may improve protein efficiency and reduce intestinal parasites in animals	Wound healing; treatment of cancer of the uterus; purifying medicine	AP, F, S, R	Al-Snafi (2016), Street, Sidana, and Prinsloo (2013)
Dittrichia graveolens	oxalate poisoning	Loosening mucous and deep congestion; treatment of acute and chronic respiratory conditions (coughs, colds, sinusitis laryngitis and bronchitis); antimicrobial agent against different kinds of microbial spoilage	AP, EO	Aghel, Mahmoudabadi, and Darvishi (2011), Mahboubi (2011), Pieroni et al. (2006), Preston (1997)
Echium parviflorum	acute liver failure, including anorexia, depression, icterus, visceral edema, and ascites	–	–	Stegelmeier, Gardner, and Davis (2009)
Echium plantagineum	acute liver failure, including anorexia, depression, icterus, visceral edema, and ascites, lethargy, increased aggression towards humans	Diaphoretic and diuretic	AP	Noble et al. (1994), Stegelmeier, Gardner, and Davis (2009), Ünsal et al. (2010)
Euphorbia helioscopia	General poisoning	Treatment of malaria, bacillary dysentery, osteomyelitis, skin infections (wounds, burns, ulcers)	AP	Jabeen et al. (2008), Lu et al. (2008), Ramezani et al. (2008), Zayed et al. (2001)
Euphorbia peplus	toxic to goats, with effects seen on the heart, lungs and liver, finally leading to death	Treatment of skin cancer, warts, corns, waxy growth, asthma and catarrh	L	Green and Beardmore (1988), Nawito et al. (1998), Teng et al. (2009)
Galactites tomentosus		Treatment of cardiovascular diseases	N/A	González-Tejero et al. (2008)
Heliotropium europaeum	acute liver failure, including anorexia, depression, icterus, visceral edema, and ascites, lethargy, increased aggression towards humans	Treatment of urinary inflammations	AP	Stegelmeier, Gardner, and Davis (2009), Noble et al. (1994), Passalacqua, Guarrera, and De Fine (2007)
Mercurialis annua	constipation or diarrhea, dullness, hemolytic anemia and red urine	Healing wounds, sores and ulcers, burns and suppurations; cure for constipations and gynecological disorders	AP	Lorenz et al. (2012), Vandenbroucke et al. (2010)
Urtica urens	–	Antiasthmatic; depurative; diuretic; haemostatic; hypoglycaemic; adrenal tonic; astringent; cholagogue; circulatory stimulant; expectorant; kidney tonic; mucolytic; nutritive; parturient; styptic; thyroid tonic	A, R, S	Elkarmi and Eideh (2006)
Urtica membranacea	–	Tussis; tonsillitis; gum inflammations; nose hemorrhages	AP, PJ	Passalacqua, Guarrera, and De Fine (2007)
Verbena officinalis	fed to cattle to cure paralysis	Anti-inflammatory; regulation of menstrual flux, milk secretion; antidiarrhoea; treatment of bronchitis, acute dysentery, enteritis, amenorrhea and depression	AP	Beigh, Nawchoo, and Iqbal (2004), Hernández, Tereschuk, and Abdala (2000), Lai et al. (2006), López et al. (2008)

to be highly active tumor promoters (Zayed et al. 1998). Finally, *A. arvensis*, one of the most numerous finds in pit F.7057 (19%, but absent in pit F.7012) is also accountable for sheep poisoning, consisting of a severe toxic nephrosis (Schneider 1978). In archaeobotanical contexts, *Echium* sp. is seldomly found in the form of pollen in dung (e.g. Ghosh et al. 2008; Mercuri 1999). To explain the high concentration of *Echium* pollen in the Uan Afuda cave in Central Sahara, Mercuri (1999) hypothesises purposeful animal poisoning, also as a mean to gain knowledge on the empirical effects those plants on humans and different types of animals. Slow, deliberate poisoning could have been a way to domesticate animals and keep them calm. A similar hypothesis can be suggested for the case of Motya. Boraginaceae and other poisonous plants could have been given to cattle before sacrificing it, inducing lethargy, and therefore a calming effect. This is coherent with the retrieval of nutlets of the Bugloss family, as the concentration of PAs is highest in seeds, flowers and leaves, and lower in stems (Galey 2009). Taking in consideration that the highest concentration of mineralised plant remains was found in proximity of an articulated bovine spine, it is possible to assume that they represent stomach contents. Another hypothesis is that the animals were hauled, bringing either the fruits/seeds they had been given or gathering fresh living plants naturally growing with them. However, casual accumulation, by swiping the sediment and nearby plants cannot be entirely ruled out.

Conclusions

The present study brings new elements to the sacrificial and votive rituals at the Phoenician site of Motya, focusing on plant culture, never explored before. The archaeobotanical analysis of the contexts in the proximity of the Temple of Melqart/Herakles indicates the consumption of ritual meal accompanying the sacrifice, evidenced by the find of grape, fig and cereals. Both sacrificial pit F.7057 and the votive deposit F.7012 have highlighted a high concentration of plants with medicinal properties, whose deposition may be linked to the cult of the god to whom the temple was dedicated. Furthermore, some of these taxa, namely Boraginaceae (*Echium parviflorum*, *E. plantagineum* and *Heliotropium europaeum*), Euphorbiaceae (*Euphorbia helioscopia*, *E. peplus* and *Mercurialis annua*) and Primulaceae (*Anagallis arvensis*) are poisonous to livestock. To find such plants in a context where animals were sacrificed possibly indicates an intentional poisoning. However, plants suitable as fodder (*Astragalus* cf. *böeticus*, *Cichorium intybus*, *Medicago polymorpha* and *Medicago* cf. *truncatula*) were also present, but in lower concentrations.

Another category of plants retrieved is represented by flower offerings (*Dittrichia graveolens*, *Galactites tomentosus*), ornamental and prestigious plants, with high symbolical value (*Cupressus sempervirens* and *Vitis vinifera*). The anthracological assemblage indicates a choice of local timber, with a preference for *Olea europaea*, and *Juglans regia*, which was probably imported for its high-quality timber.

The assemblage of votive pit F.7012 introduces new taxa and is distinguished for the lower diversity of toxic plants, although the concentration is very similar. Other taxa are mostly referable to fruits (fragmented pips of *V. vinifera*), flower offerings (*Verbena officinalis*) and medicinal plants (*B. officinalis*).

Practical and symbolic roles of plants in the votive context of the Temple of Melqart/Herakles at Motya, and their possible connections with animal sacrifices, shed a new light on the ritual performed in *Favissa* F.7057. Bovines were possibly fed on stupefying plants before sacrifice, and then buried with fruits (grape), flowers and ornamental plants (cypress).

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CHAPTER 2

Cultural landscape and plant use at the Phoenician Motya (Western Sicily, Italy) inferred by a disposal pit

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Vegetation History and Archaeobotany

Cultural landscape and plant use at the Phoenician Motya (Western Sicily, Italy) inferred by a disposal pit

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Abstract:	The present study concerns the Phoenician-Punic site of Motya, a small island set in Western Sicily (Italy), in the Marsala Lagoon (Stagnone di Marsala), between Trapani and Marsala. A big disposal pit, datable between the first half of the 8 th and the mid-6 th century BC, was identified in Area D. Such context was sampled for plant macro-remains through bucket flotation. Palynological treatment and analysis were also performed on soil samples collected from each of the identified filling layers. The combination of the study of macro- and micro-remains has shown to be effective to answer questions concerning introduced food plants and agricultural practices, and native plants, including timber use. Here we wonder if a waste context can provide information about Phoenicians at Motya and their impact on the local plant communities. We found that human diet included cereals (mostly naked wheat), pulses and fruits. A focus was placed on weeds (including Lolium temulentum and Phalaris spp.) referable to different stages of crop processing. This aspect was enriched by the finding of cereal pollen, which suggests that threshing (if not even cultivation) was carried out on site. Palynology also indicates an open environment, with little to no forest cover, characterized by complex anthropogenic activities. Anthracology suggests the presence of typical Mediterranean plant taxa, including not only the shrubs Pistacia lentiscus and Erica multiflora , but also evergreen oaks. The presence of a stone pine nut and of Pinus pinea / pinaster in the pollen rain is noteworthy, suggesting the local occurrence of these Mediterranean pines outside their native distribution range. This represents the first such find in the central Mediterranean.

	Finally, the present study allows us to compare Motya's past environment with the present one. The disappearance of *Juniperus* sp. and *Erica arborea* from the present-day surroundings of the Marsala lagoon appears to be related to land-overexploitation, aridification or a combination of both processes.

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Cultural landscape and plant use at the Phoenician Motya (Western Sicily, Italy) inferred by a disposal pit

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Abstract

The present study concerns the Phoenician-Punic site of Motya, a small island set in Western Sicily (Italy), in the Marsala Lagoon (Stagnone di Marsala), between Trapani and Marsala. A big disposal pit, datable between the first half of the 8th and the mid-6th century BC, was identified in Area D. Such context was sampled for plant macro-remains through bucket flotation. Palynological treatment and analysis were also performed on soil samples collected from each of the identified filling layers. The combination of the study of macro- and micro-remains has shown to be effective to answer questions concerning introduced food plants and agricultural practices, and native plants, including timber use. Here we wonder if a waste context can provide information about Phoenicians at Motya and their impact on the local plant communities. We found that human diet included cereals (mostly naked wheat), pulses and fruits. A focus was placed on weeds (including *Lolium temulentum* and *Phalaris* spp.) referable to different stages of crop processing. This aspect was enriched by the finding of cereal pollen, which suggests that threshing (if not even cultivation) was carried out on site. Palynology also indicates an open environment, with little to no forest cover, characterized by complex anthropogenic activities. Anthracology suggests the presence of typical Mediterranean plant taxa, including not only the shrubs *Pistacia lentiscus* and *Erica multiflora*, but also evergreen oaks. The presence of a stone pine nut and of *Pinus pinea/pinaster* in the pollen rain is noteworthy, suggesting the local occurrence of these Mediterranean pines outside their native distribution range. This represents the first such find in the central Mediterranean. Finally, the present study allows us to compare Motya's past environment with the present one. The disappearance of *Juniperus* sp. and *Erica arborea* from the present-day surroundings of the Marsala lagoon appears to be related to land-overexploitation, aridification or a combination of both processes.

Keywords

Archaeobotany, crop processing, Phoenicians, palynology, past environment

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Conflicts of interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

Introduction

"Phoenicians" is the label given by Greeks to a multifaceted culture of the coast of the Levant, which spread across the Mediterranean between the 2nd and the 1st millennium BC bringing a new socio-economic model – that of the port-city – and a revolutionary cultural tool: the alphabet. This was not the only innovative element transplanted in the Western Mediterranean (Lopez-Ruiz and Doak 2019). Epigraphy and written sources have provided a large set of data on the Phoenicians in the Western Mediterranean, however archaeology is enlarging our knowledge on their materiality and daily life in Phoenician centres. Knowledge regarding their use of plants and on the important impact they had on the ancient environment is limited to studies on Phoenician plant fossils restricted to Sardinia, Italy (e.g. Buosi et al. 2017; Ucchesu et al. 2017; Sabato et al. 2019), Southern Iberia (e.g. Buxò 2008), Tunisia (van Zeist et al. 2001), Morocco (Grau Almero 2011) and Lebanon (Badura et al. 2016; Orendi and Deckers 2018). Such studies focus on macro-remains, with pollen sometimes being introduced as a complementary tool (e.g. van Zeist et al. 2001; Sabato et al. 2015).

This study intends to substantially widen this panorama including Western Sicily, which was a main landing point for Phoenician communities during their expansion in the Mediterranean.

Although numerous archaeobotanical studies have been performed on Sicilian material (total of 32; Mercuri et al. 2015), studies on early-mid-1st millennium BC material in Sicily are scarce and only concern the sites of Rocchicella-Palikè near Mineo (Castiglioni 2008), Monte Polizzo (Salemi) and Selinunte (Stika 2004; Stika et al. 2008; Stika and Heiss 2013). Pollen records confirm a heavy environmental impact during the period of Phoenician occupation with the opening of coastal forests in both inland and coastal Sicily (Sadori and Narcisi 2001; Noti et al. 2009; Tinner et al. 2009; Calò et al. 2012; Sadori et al. 2013).

Motya (also known as San Pantaleo) is a small island (ca. 40 ha) located off the western coast of Sicily (Fig. 1a), in the Marsala Lagoon, between Trapani and Marsala (Fig. 1b). Thanks to its harbored and strategic position in the middle of the Mediterranean, as well as to the presence of fresh-water sources (Di Mauro et al. 2011), the site has been inhabited since at least the 17th century BC and was chosen by Phoenicians as a colony in the 8th century BC. Although the Phoenician-Punic occupation lasted until the siege of Motya in 397 BC, the island continued to be inhabited in the following centuries (Nigro 2007). The "Missione Archeologica a Mozia" of Sapienza University is responsible for excavations on the island since 1964, under the lead of Lorenzo Nigro starting from 2002.

These recent excavations have provided stratigraphic sequences anchored to radiocarbon dates which backdate the acquaintance of Levantine peoples with the island to the 2nd millennium BC, as described by the sequence of material cultures (Nigro 2016). Archaeobotanical analyses have so far only been performed in the area of 'Cappiddazzu', revealing information regarding the use of plants in animal sacrifices (Moricca et al. 2020b), and in the submerged street which once connected the Northern Gate of Motya to the opposite coast near the district of Birgi (Terranova et al. 2009).

The present paper is aimed at framing the Phoenician inhabitants of the small island of Motya in the landscape they have modified through centuries, cultivating and exploiting the natural resources of the territory starting from the earliest stages of the Phoenician settlement. This allows assessment of the Levantines/Phoenicians contribution to the modification of the environment and the cultural contribution given by them in terms of plant introduction and use both for nutritional and curative purposes (Moricca et al. 2020b).

This is the first systematic study of this kind for a Phoenician site in Sicily, combining the study of seeds and fruits, wood and pollen. The novelty of this study is also given by the peculiar context itself, a rich waste pit providing a photo of the daily life during two centuries (ca. 750-550 BC) of continuous occupation of the site.

Materials and methods

The archaeological site of Motya is divided in a series of areas labelled using letters. Area D lays in the south-eastern slope of the Acropolis of Motya, in the center of the island, with the highest altitude of 6 m a.s.l. (Fig 1c). Recent excavations of Sapienza University of Rome revealed that this area houses the oldest settlement stages at Motya, as already hypothesized by J. Whitaker in 1921 (Nigro et al. 2002). During the campaigns of 2004-2005, and 2016-2019, a big disposal pit, F.1112, was uncovered and excavated. This showed signs of burning and was therefore selected for archaeobotanical analysis. Apart from the archaeobotanical remains, the excavation has revealed an impressive amount of other materials, which include shells, animal bones and broken ceramics. The latter have provided a chronology ranging the first half of 8^{th}-mid of 6^{th} (this study).

Six stratigraphic units (US) – US 1112, US 2268, US 1406, US 1407, US 1492 and US 7234 – corresponding to four depositional phases, were identified in the studied deposit. These stratigraphic units spread over an area of 29 m^2 to a depth of 1.35 m (Fig. 2). They correspond to a series of events close in time, which have the most recent chronological limit in the mid-6^{th} century BC. On this date, a radical rearrangement of the area took place modifying the plan and the urban layout, and, probably, also its function. The archaeological deposit consists of a series of fills of organic and inorganic materials, dating from the mid-8^{th} to the mid-6^{th} century BC (Table 1). Four filling layers (FL) have been identified and dated, using the pottery repertoire. They correspond to four distinct human actions consequent over time and ending each time with an in-situ fire.

Macro-remains

A pilot study was carried out on preliminary samples retrieved from the pit in summer 2017. An unknown volume of material was dry sieved on a series of nested sieves of mesh size 10, 5 and 2 mm from the top of US 1112.

Systematic sampling of the pit was carried out during the excavation campaign of 2018. Samples of known volume (333 litres total; Online Resource 1) of sediment coming from each of the filling layers were processed on-site using bucket floatation. This allowed the charred material to float on the water surface and to be caught on a sieve of mesh size 250 µm. The heavy residue was water sieved using a mesh size of 1 mm in order to collect any residual remains, both charred and mineralized. Once dry, the sediments were brought to the lab and sieved on a series of nested sieves with mesh size 2, 1 and 0.5 mm (for the light fraction) or 5, 2 and 1 mm (the heavy fraction), in order to increase the efficiency of hand-picking. Archaeobotanical remains were subsequently separated from the residual sediment. Carpological remains were observed using a Leica M205C stereomicroscope (magnification between 8× and 78×). We acquired high resolution images of plant macrofossils with a Leica IC80 HD photocamera using the software Leica Application Suite, version 4.5.0.. Seeds and fruits were identified using atlases and online resources, including Jacomet (2006), Neef et al. (2012), Cappers and Bekker (2013), Nesbitt (2016), and Pignatti et al. (2017-2019). Anthracological remains >2 mm were selected for analysis using a Nomarski microscope (phase contrast microscope with differential interference contrast) and identified using atlases available for the study of Mediterranean trees and shrubs (Schweingruber 1990). Unfortunately it was not possible to use the novel approach involving High Resolution

Magnetic Resonance Imaging proposed by Capuani et al. (2020), as it is not suitable for charred wood. The botanical nomenclature follows Euro+Med for carpological remains, Schweingruber (1990) for anthracological remains, Cambini (1967) for *Quercus* taxa and Greguss (1955) for *Pinus* taxa. The findings issuing from plant remains (charcoal, seeds) and pollen were compared with the data issuing from previous literature concerning current local vascular flora (Pasta 2004; Scuderi et al. 2007 and references therein) and vegetation (Guarino and Pasta 2017 and references therein).

Pollen

Palynological analysis was performed in support of the study of macro-remains. A soil sample was collected from each filling layer, for a total of four samples. In case of filling layer I-III, comprised of US 1112 and US 2268, and filling layer IV, comprised of US 1406 and US 1407, a single sample was collected per filling layer (Table 1). The samples were chemically processed following Faegri and Iversen (1989) at the Laboratory of Archaeobotany and Palynology at Sapienza University of Rome. Sample residues were later sieved using a 10 µm nylon sieve and treated with ultrasound at the Department of Geology and Geoenvironment of the National and Kapodistrian University of Athens in order to obtain clearer slides. A known amount of *Lycopodium* spores was added to each weighted sample in order to estimate pollen and non-pollen palynomorphs concentration (NPPs; Stockmarr 1971). Pollen identification was carried out using atlases (Reille 1992–1998; Beug 2004). The features reported by Smit (1973) were used to distinguish oak pollen taxa. The identification key by Andersen (1979), readapted to glycerine as a mounting medium, was used to distinguish among cereal taxa. Pollen diagram was drawn using TILIA program (Grimm 1991).

Results

Macro-remains: carpological remains

A total of 3151 carpological remains, belonging to 78 different plant taxa, were recovered from the studied deposit (Online Resource 1; Fig. 2). These include also the remains recovered during the preliminary sampling of 2017, although these are only taken in consideration for qualitative analysis. Although most plant remains were preserved by charring, some mineralized specimens were also present. Unfortunately, due to fragmentation, the variable conservation state and intra- and inter-species variability, it was not always possible to identify specimens at the species level. The most represented taxa were *Hordeum vulgare* L. (barley, both hulled and naked), *Triticum aestivum* L./*T. durum* Desf. (naked wheat), *Vitis vinifera* L. (grape), and wild grasses such as *Phalaris* sp. and *Lolium* *temulentum* L. (darnel). Nonetheless, a wide variety of cereals including *Avena* cf. *sativa* L. – oat, *Triticum turgidum* subsp. *dicoccon* (Schrank) Thell., also known as *T. dicoccon* (Schrank) Schübl – emmer wheat, and *T. monococcum* L. – einkorn, represented also by scarce chaff remains, and pulses (*Lens culinaris* Medik. – lentil, *Pisum sativum* L. – green pea, *Vicia ervilia* (L.) Willd. – bitter vetch, *V. faba* L. – faba bean, and *Vicia/Lathyrus* was found.

Pips, undeveloped pips and pedicels of *V. vinifera* were present. *Olea europaea* L. (olive) endocarps, *Punica granatum* L. (pomegranate) pericarp fragments and *Pinus pinea* L. (stone pine) seed and scale fragments were also found. *Crataegus monogyna* Jacq. (common hawthorn), *Crataegus* sp. and *Ficus carica* L. (fig) complete the fruit assemblage. A fragment of *Linum usitatissimum* L. (linseed) seed was also retrieved.

Approximately 40% of the assemblage is constituted by weeds typically growing in cultivated crop fields and ruderal species. The most abundant taxa belonging to these categories are *Lolium temulentum*, *Phalaris* sp. and *Phalaris* cf. *minor* Retz.. However, also remains of *Calendula arvensis* (Vaill.) L., *Chenopodiastrum murale* (L.) S. Fuentes & al., *Euphorbia helioscopia* L., *Heliotropium europaeum* L., *Sherardia arvensis* L., *Silene* sp., *Urtica membranacea* Poir. and *Urtica urens* L. were found, among others.

Macro-remains: anthracological remains

The anthracological analysis concerned a total of 870 fragments of charred wood. These have been identified as belonging to 19 different taxa (Online Resource 2). Evergreen oaks (likely *Quercus ilex* L. or *Q. coccifera* L.) account for ca. 24% of the assemblage (211 fragments), followed by *Pistacia lentiscus* L. (lentisk: 14%), *Olea europaea* (olive: 12%) and *Rhamnus/Phillyrea* (10%). Some fragments were identified as *Pistacia* sp. (10%) and *Quercus* sp. (2%) due to limited size or bad preservation state. However, it is probable that they are related to respectively to lentisk or terebinth, and evergreen oaks. As for the fragments referred to *Rhamnus/Phillyrea*, although these two genera belong to two different families, i.e. Rhamnaceae and Oleaceae, their identification turns to be difficult. This is because they show a very similar wood anatomy, with diffuse-porous wood, vessels in dendritic and diagonal pattern and heterogeneous, bi- or tri-seriate rays and spiral thickenings (Schweingruber 1990). For this reason, fragments with the above described characteristics have been named as *Rhamnus/Phillyrea.* More in detail, *Phillyrea latifolia* L. occurs rather frequently in the remnant nuclei of sclerophyllous maquis in the coastal areas of western Sicily. As for *Rhamnus, R. alaternus* L. currently occurs in the Stagnone area at Isola Lunga (Di Martino and Perrone 1970), whilst *R. lycioides* L. subsp. *oleoides* (L.) Jahand. & Maire frequently grows together with *Chamaerops humilis* L. and *Quercus coccifera* L. in the low-growing sclerophyllous scrub of southwestern Sicily (Brullo et al. 2009).

Other abundant taxa are represented by *Erica arborea* type (5.5%), *E. multiflora* type (5%), *E. arborea/multiflora* (5%), *Pistacia terebinthus* (4%) and Fabaceae Faboideae (4%). Almost all Fabaceae present a strong structural variability, making identification hard. Faboideae are a subfamily of Fabaceae including shrubby brooms, whose wood is generally semi-ring porous, characterized in the transversal section by vessels arranged in an oblique to dendritic pattern with paratracheal parenchyma (Bouchaud et al. 2017). Longitudinally it presents spiral thickenings, homogenous to heterogeneous rays, of variable width (Schweingruber 1990). These features were observed in the studied fragments, which could potentially correspond to *Cytisus infestus* C. Presl, a thorny summer-deciduous shrub very common in the degraded oakwoods and garrigues of the thermomediterranean Sicilian belt, or to *Spartium junceum* L., more common on the hills of inner Sicily, especially in human-disturbed areas.

Other identified taxa include *Pinus sylvestris-montana* group (0.8%; Greguss, 1955), *Capparis spinosa* L. (0.6%), *Cupressus sempervirens* L. (0.2%), *Juniperus* sp. (0.2%), Rosaceae Maloideae (0.2%) and Rosaceae Rosoideae (0.2%).

Microremains*: *Pollen and NPPs

The total terrestrial pollen count in the studied samples ranges between 107 and 521.5 grains. Pollen preservation is variable, and concentration is in a range of 49-1790 pollen grains/g. A total of 46 taxa have been identified (Fig. 4). Pollen from trees and shrubs is scarce, belonging to the Mediterranean forest with both evergreen (*Quercus ilex*-type, including all evergreen Mediterranean oak species except *Q. suber*, and *Pinus*), and deciduous elements (deciduous and semi-deciduous oaks and the riparian *Alnus*) and maquis (Ericaceae, *Juniperus, Pistacia*). Pollen identification also evidenced locally cultivated tree taxa (*Juglans*, *Vitis*).

Most of the identified taxa correspond to herbaceous plants. Asteraceae Asteroideae, present in all samples with percentages ranging from 25 (FL I-III) to 70 (FL IV), are the most abundant pollen type, followed by Poaceae, with a maximum of 25% (FL V), and Asteraceae Cichorieae, peaking at 19% (FL VI).

Cultivated and ruderal plants are highly represented amongst the herbaceous taxa, and include cereals (*Avena/Triticum* group and *Hordeum* group), *Plantago lanceolata* type, *Plantago* undiff., *Urtica*, Brassicaceae, Fabaceae and *Rumex*. Pollen identified as *Alchemilla*, currently absent in the Sicilian flora, could correspond to *Aphanes*, which has a very similar morphology.

The non-pollen palynomorphs (NPPs) are *Glomus*, *Pseudoschizaea*, *Tecaphora*, *Turbellaria* and Rotifera eggs. The first and the second are considered indicators of erosion in lacustrine records (Sadori, 2018).

Discussion

The pit F.1112 was identified as a context with high potential for archaeobotanical analysis due to the signs of direct burning. The plant remains represent primary refuse, being accumulated and occasionally burned in order to reduce their volume (Fuller et al. 2014). The archaeological interpretation of such disposal contexts is quite complex, although extensive information regarding diet, agricultural practices, use and selection of plants, and the surrounding environment may be obtained from the analysis of archaeobotanical remains. The concentration of carpological remains in the studied sediment is quite low for this typology of context (ca. 6 remains/l), but the scarcity may have been influenced by repeated fires, possibly causing the complete combustion of numerous remains. Such burnings are also responsible for very low pollen concentrations.

Although most plant remains were preserved by charring, the most common preservation method for materials in the Mediterranean (Peña-Chocarro and Pérez-Jordà 2019), some mineralized specimens were also present. This is partly due to some taxa (e.g. *Echium plantagineum* L., *Heliotropium europaeum* L.) undergoing a process called biomineralization, due to their intrinsic properties (Van Zeist and Bakker-Heeres 1982). Another source of mineralization in this context may be organic material (human faeces, bones or other organic remains), rich of calcium phosphate (Peña-Chocarro and Pérez-Jordà 2019), which may have affected *F. carica* achenes and two *V. vinifera* seeds.

Implications for Phoenician diet and land use

A relevant portion of the assemblage is constituted by a wide variety of cereals and pulses, which provide information about the diet of local settlers. Cereals are represented, in order of abundance, by *Hordeum vulgare*, *Triticum aestivum/durum*, *T. turgidum* subsp. *dicoccon* and *T. monococcum*. The concentration of the latter is quite low, suggesting that it was not cultivated intentionally, but was a legacy of previous cultivations and eventually behaved as a weed. Unfortunately, due to fragmentation and taphonomic factors, it was not possible to identify all grains at a species level, with some being identified as *Triticum* sp. or, more broadly, as cereals. The prevalence of barley and naked wheat in the cereal assemblage can also be seen in the Early Iron Age site of Monte Polizzo and the Archaic-Corinthian site of Selinunte, both in western Sicily (Stika et al. 2008).

The finding of naked barley in the assemblage represents an aspect worth focusing on. Despite naked and hulled barley requiring similar conditions for growth, with the former being more palatable and needing less processing before human consumption, the naked variety decreases noticeably in European archaeobotanical assemblages from the Neolithic to the Iron Age/Roman period, being found only in association with hulled barley in Italy (Lister and Jones 2013). This is probably due to its higher susceptibility to insect attack and parasitic diseases, as well as the rise of naked wheat, which has a higher yield and is more suitable for making bread-like products, with barley being used only as animal fodder (Lister and Jones 2013).

Several germinated caryopses of *H. vulgare*, *T. turgidum* subsp. *dicoccon* and *T. aestivum/durum* were also retrieved from pit F.1112. This can result from processes such as damp storage or wetting while still in the field (Bouby et al. 2011).

Pulses are less numerous than cereals, but just as varied. The most abundant is *Pisum sativum*, followed by *Vicia/Lathyrus*, *Vicia faba*, *Lens culinaris* and *Vicia ervilia*. While bitter vetch and, above all, grass pea (*Lathyrus sativus*) are currently only grown as fodder due to the presence neurotoxins, it is possible that these were removed by soaking the seeds in water before cooking, as hypothesized for Byzantine Carthage (Van Zeist et al. 2001). It is, however, more probable that, while naked barley, and naked and hulled wheat were used for human consumption, hulled barley was a potential source of fodder, along with oat (*Avena* cf. *sativa*), bitter vetch, other vetches and the waste deriving from the early processing stages of all the above-mentioned cereals (Jones 1998).

Our data provide information about Phoenician agricultural practice and crop storage. The presence of numerous weed seeds in all depositional layers of F.1112, in addition to cereal grains and chaff, points towards the assemblage representing waste products, greatly correlated to different stagesof crop processing, such as winnowing. Although past studies have tried to analyse similar groups of plant remains in order to distinguish settlements of primary arable producers from those receiving the harvest, they have been criticized by Stevens (2003). He rather suggested an identification of the routine processing stages, whose waste is more likely to become charred, and depend mostly on the state in which the crops are stored. This is also because harvesting and bulk processing usually take place in a short period of time following harvest and may be carried in the field, away from the fire, resulting in a loss of the waste which distinguishes producers from consumers. In contrast, crop processing of stored crops before consumption occurred more frequently, and its waste was more likely to become charred. The Motya deposit indicates processing of stored crops before consumption. This is confirmed by the application of the ratio of small to large weed seeds, and the proportion of weed seeds to crop seeds proposed by Stevens (2003). The assemblage of F.1112 appears to fall in the area defined as "household" processed, with a weed seed to grain percentage of 54% and large weed seeds representing only 34% of the weed assemblage, suggesting that most of the processing stages were carried out on a daily basis after storage. What does not correspond to Stevens' description is the extremely low percentage of chaff. This difference is partly due to both free-threshing cereals and glume wheats being present amongst the retrieved remains, with barley (hulled and naked) and naked wheats constituting between 65 and 75% of the cereal assemblage per each stratigraphic unit. This results in most of the rachises being removed during threshing, in contrast with hulled wheats, where the rachis often remains attached to the spikelet (Stevens 2003). Jones (1990) argues that the only way to analyse mixed assemblages is a multivariate approach, calculating the grain/chaff ratio separately for each species. Applying this to the F.1112 assemblage shows in fact a great difference, with no *T. aestivum/durum* chaff, a chaff/grain ratio of 1:62 for *H. vulgare* (mostly hulled) and of 1:6 for *T. turgidum* subsp. *dicoccon*, supporting the evidence of the low chaff concentration being due to the abundance of free-threshing cereals.

Taphonomic processes are another potential factor responsible for the extremely low percentage of chaff, as chaff is more easily damaged by fire than grain, especially in oxidizing conditions (Bates et al. 2016). Archaeological evidence suggests numerous burning events in the pit F.1112 in order to reduce the volume of waste, to gain space for new material and temper bad smells, making it less likely for fragile plant parts to be found in the archaeobotanical assemblage. Additional data regarding local agricultural practices are provided by the presence of low growing species, like *Sherardia arvensis*, which suggests harvesting low down the culm (Reed 2016).Palynological evidence supports our interpretation that at least threshing (if not also cultivation) was carried on-site. Although in low concentrations, *Hordeum* group pollen was found in three out of the four investigated filling layers of pit F.1112. In addition to that, *Avena/Triticum* group pollen was identified in filling layer IV. The only filling layer in which cereal pollen was absent is filling layer VI, the oldest one. Cereals produce large pollen grains traveling over very short distances and are generally underrepresented in pollen records (Mercuri et al. 2013). It is brought into settlements along with crops and released mostly during threshing and winnowing (Montecchi and Mercuri 2018). For this reason, cereal pollen is expected to be found in this kind of context. It is more likely that the whole crop processing procedure was carried out in situ, while the remains of the first stages of processing were given to animals as fodder (Fuller et al. 2014). According to the demographic model created by Nigro (2017) by matching all available archaeological data with ethnographic resources, the estimated population of Motya between the 8^{th} and 7^{th} century was of ca. 1400 people. Despite the small size of the island, Nigro (2017) hypothesized that at least 30 ha were kept free for agriculture, animal breeding and other productive activities. Of these, 14.1 ha are thought to have been dedicated to cereal cultivation, which could explain the finding of cereal pollen in the sediment from pit F.1112.

The grain-sized *Lolium temulentum* (darnel) constituting most of the big weeds in the carpological assemblage suggests particular care in removing it from the processed crop by hand-picking. Although darnel is not poisonous itself, it is very easily attacked by the endophytic fungus *Endoconidium temulentum*, which is thought to be the source of the pyrrolizidine alkaloids (Eliáš et al. 2010). The toxicity manifests in the form of hallucinations and severe damage to the nervous system (if ingested in larger quantities) and has been known to man for millennia, being documented also in the Bible (Eliáš et al. 2010).

The second most common weed in the assemblage is *Phalaris* sp., small-sized and separated from the crop through fine sieving. According to Riehl (2010), it may represent a weed of free-threshing wheat. Although the different species are said not to be differentiated based on their caryopses (Baldini 1993), two different morphologies were identified in the assemblage: one more elongated than the other. After the comparison with pictures of modern samples present on the CISEH (2001-2018) online database of the University of Georgia and modern samples from the Herbarium of the Sapienza University of Rome (RO), the latter has been identified as *Phalaris* cf. *minor*, which grows in wastelands, fallows, edges and cultivated fields (Baldini 1993). The observed specimen of *Phalaris minor* (Walters and Southwick [date unknown]) appeared to be noticeably less elongated than the specimens of other *Phalaris* species.

Human impact on the environment

The overall weed assemblage shows similarities with the ones from the Iron Age sites of Monte Polizzo and Selinunte in Western Sicily (Stika et al. 2008). *L. temulentum/remotum* and *Phalaris* sp. predominate there as well, accompanied by other common weeds of crop fields such as *Avena* sp. and *Bromus* sp., which also grow in dry disturbed places.

Arable weeds in the F.1112 assemblage also include *Ammi majus* L., *Ranunculus* sp. and *Raphanus raphanistrum* L. (Schepers 2014). Other wild plants that are very common in sites prone to anthropogenic disturbance are *Calendula* cf. *arvensis*, *Chenopodium album* L., *Chenopodiastrum murale* (L.) S. Fuentes & al., *Echium plantagineum*, *Heliotropium europaeum*, *Malva nicaeensis* All., *Malva* sp., *Medicago* sp., *Silene* cf. *vulgaris*, *Sherardia arvensis*, *Veronica* sp. and *Portulaca oleracea* L., the latter possibly cultivated also as a vegetable (Bosi et al. 2009; Pasta et al. 2020). *Urtica membranacea* and *U. urens* are also present, being typically found on nutrient-rich and disturbed ground, but occurring also as weeds of woody crops (Van Zeist et al. 2001).

The identification of the *Calendula* cf. *arvensis* (field marigold) achene was complex, as each capitulum of this genus "can produce 2 to 6 different morphologies of achenes, and in some species, specimens presenting different combinations of achene morphs can co-exist" (Gonçalves et al. 2018). This means that different species can present achenes with the same morphology, while different morphologies may occur in the same species and on one single plant. Concerning the morphology of *Calendula* achenes, Pignatti et al. (2017-2019) state that those of *C. arvensis* are bent, sometimes locked up in a ring, with dorsal spines, which are generally absent in *C. maritima* Guss., a perennial marigold endemic to the coastal habitats of western Sicily (Pasta et al. 2017).

More surprising, although in low concentrations, was the retrieval of a variety of Cyperaceae and Polygonaceae, including *Eleocharis palustris* (L.) Roem. & Schult. and *Persicaria* cf. *amphibia* (L.) Delarbre. Their find seems to confirm the presence of humid environments with permanent freshwater or subject to extremely short periods of drying up, perhaps corresponding to the fresh-water springs found on the island (Di Mauro et al. 2011).

More data about the surrounding environment can be inferred from palynology. The dominance of non-arboreal taxa indicates an open environment, with little to no forest cover (Montecchi and Mercuri 2018). Complex anthropogenic activities are testified, among others, by Asteroideae, Cerealia, Poaceae, Ranunculaceae and *Rumex* (Mercuri et al. 2013). Other indicators of human activity are Cichorieae, indicator of mesic meadows and pastures, *Urtica*, a nitrophilous plant, and *Plantago*, which indicates trampled areas (Florenzano et al. 2015; Mercuri et al. 2013). Nonetheless, *Plantago* could refer to *P. macrorhiza* Poir., a plantain that grows on coastal salty meadows and is not linked to the presence of grazing or trampling.

NPPs also contribute to building an image of the past environment. *Glomus* is a mycorrhizal fungus that forms symbiotic relationships with plant roots and is present in all samples, with concentrations as high as 76.5% (FL I-III). *Pseudoschizaea*, presumably the schizocarp of a green alga living in the soil, also occurs in all samples. They are both considered as indicators of erosion in lacustrine records (Sadori 2018). Here they can be interpreted as evidence of soil micro-organisms. In particular, *Pseudoschizaea* is related to depositional conditions that occur in correspondence to seasonal desiccation, indicating a direct link between its presence and erosion processes (Sadori 2018). The third most abundant NPP are *Tecaphora* basidiospores that occur on higher plants (Leguminosae and Convolvulaceae; van Geel et al. 1980). Finally, *Turbellaria* are cocoons of whirl worms indicating a high concentration of nutrients (van Geel et al. 1983), while Rotifera (found only in US 1112) are near-microscopic animals, whose eggs are usually found in moist environments (van Geel 2002).

Another category widely represented in the carpological assemblage is that of fruits, which were probably the result of other activities. The most abundant is *V. vinifera* (grapevine), which was also retrieved during the preliminary survey in 2017. Grapevine holds a specific importance in the Phoenician world, as it is believed that Phoenicians, along with Greeks, were responsible for the spread of various grapevine cultivars across the Mediterranean (Ucchesu et al. 2015). It is interesting to notice the presence of *Vitis* pollen in the two bottom filling layers of F.1112, reaching a concentration of 8.3% in filling layer VI. Like seen for cereals, *Vitis* pollen grains travel over short distances (Sabato et al. 2015), suggesting local cultivation of grapevine.

Punica granatum (pomegranate), retrieved in pit F.1112 in the form of six exocarp fragments, is also believed to have been brought to the Mediterranean basin by Phoenicians (Nigro and Spagnoli 2018). Pomegranate is not very common in archaeobotanical assemblages due to seeds being eaten and the endocarp being more exposed to deterioration. From a chronological point of view, the retrieval of pomegranate at Motya represents the oldest such find in Sicily. Although in small concentrations, *P. granatum* was also found, among others, in the Iron Age sites of Concepción and Núñez Méndez in the area of Huelva (9^{th}-8^{th} centuries BC; Pérez-Jordà et al. 2017), Phoenician Tell el-Burak in Lebanon (8^{th}-4^{th} centuries BC; Orendi and Deckers 2018), Iron Age Ashkelon on Israel's southern shoreline (7^{th} century BC; Weiss and Kislev 2004) and *nuraghe* S'Urachi in Sardinia (7^{th}-6^{th} centuries BC; Pérez-Jordà et al. 2020).

Another fruit found in pit F.1112 is *Ficus carica* (fig), known to be part of the standard Mediterranean assemblage (Alonso Martinez 2005). It is amongst the oldest fruit trees cultivated in the Mediterranean, where it can also grow spontaneously (Pignatti et al. 2017-2019). Due to each "fruit" containing hundreds of achenes, as well as them being ingested and preserved in faeces through mineralization, figs are often overrepresented in archaeobotanical assemblages (Alonso Martinez 2005). Overrepresentation of fig does not take place in the F.1112 assemblage at Motya, also taking in consideration that most of the achenes retrieved were preserved by charring.

A *Pinus pinea* (Mediterranean stone pine) nutshell fragment and a bract were also found in filling layer VI. Furthermore, the *Pinus* pollen identified in the studied sediment presents the morphology of *P. pinea/pinaster*. The percentage (ca. 10% in FL I-III) achieved by this Mediterranean pine suggests a local presence. The origin and spread of the Mediterranean stone pine (*Pinus pinea*) are a subject of unresolved debates. These difficulties in assessing the origin of this plant are mostly due to its extremely low genetic variability (Pinzauti et al. 2012). *P. pinea* is considered native to the entire Mediterranean basin, with studies showing that it was present in the Iberian Peninsula for several tens of thousands of years (Martínez and Montero 2004), being found in caves inhabited by Neanderthalians (Mutke et al. 2019). It survived in Spain the LGM (last glacial maximum), being found in the Nerja Cave near Malaga during the Upper Palaeolithic dating back between c. 22,000 and 15,500 years BC (Carrión et al. 2008). It is nonetheless probable that Phoenicians played a key role in its spread (Mutke et al. 2019). *Pinus pinea/pinaster* wood was found in a Bronze Age context in Sardinia (Sabato et al. 2015), a region where native populations of *Pinus pinaster* still occur (Caudullo et al. 2017). Archaeobotanical remains of the Mediterranean stone pine have in fact been found in numerous Phoenician-Punic sites, such as Santa Giusta in Sardinia (Sabato et al. 2019), where it was believed to be added for meat preservation and spicing (Ucchesu et al. 2017), 6^{th}-5^{th} century BC layers on the Balearic Islands (Pérez-Jordà et al. 2018) and in Punic Carthage (van Zeist et al. 2001), where the find is considered as testifying the contacts with the western Mediterranean. As far as we know, the finding of Motya is the oldest Italian site, corroborating the hypothesis that Phoenicians played a major role in the spread of *Pinus pinea*. The presence of *Pinus pinea/pinaster* pollen also suggests local growing of Mediterranean coastal pines. The two Mediterranean coastal pines cannot be distinguished on the basis of pollen morphology and none of them currently grows wild in Western Sicily (Caudullo et al. 2017).

Anthracological remains make up a big part of the archaeobotanical assemblage of pit F.1112. This is to be expected in such a context, as wood was burned as fuel, producing charcoal (Fuller et al. 2014). Most of the wood taxa retrieved are typical to the Mediterranean maquis and show a correspondence with the present-day flora of the Sicilian coastline, between the infra- and the thermo-Mediterranean, referred to the *Quercetea ilicis* class and the *Pistacio-Rhamnetalia alaterni* order, with a prevalence of *Pistacia lentiscus* and *Olea europaea* (Gianguzzi et al. 2016). Despite the pollen spectra being characterized by a prevalence of non-arboreal pollen, *Pistacia* and *Quercus ilex* type are both present. What appears to be surprising is the lack of *Olea* in the palynological evidence, while it is common among anthracological remains. This is surprising as demographic studies carried out by Nigro (2017) suggested that a relevant portion of the islet was used for olive tree cultivation. Nonetheless, a study carried out by Florenzano et al. (2017) on modern pollen from olive groves in Tuscany and Basilicata shows that, while *Olea* pollen percentages from samples collected inside the groves were as high as 58%, the ones collected at a distance of 500 m or more from the grove were not higher than 1.6%. Furthermore, even some of the samples collected from inside the groves showed rather low *Olea* pollen concentrations of ca. 10%. Therefore, the lack of olive pollen does not necessarily indicate the absence of olive trees on the islet. There could have been an olive grove in Motya, possibly on the other side of the island. This is supported by the evidence from the submerged street (Terranova et al. 2009). Finally, overrepresentations of local plants in pollen assemblages coming from human settlements are common, possibly causing the *Olea* pollen concentration in the sediment from Motya to be even lower.

Nonetheless, *Olea europaea* represents a relevant part of the anthracological assemblage. While in the votive pit at Motya (Moricca et al. 2020b) it represented almost 80% of the assemblage, in pit F.1112 it does not prevail over other taxa. Considering the slow growth rate of such trees (Valamoti et al. 2018), it is rational to believe that olive timber was used scrupulously, preferring taxa with a faster growth rate. *O. europaea* is much more likely to have been cultivated for its fruits (Valamoti et al. 2018). It is interesting to notice that only two olive endocarps were retrieved from the analyzed sediment. One of the reasons may be the use of olives for oil production. Oil is present both in the soft outer part (mesocarp) and in the stone, and is obtained through pressing, requiring the application of a stronger force to extract it from the latter (Cappers et al. 2013). Olive pressing at Motya is thought to have been performed in tanks and low basins connected to food preparation (Nigro 2007). It is possible that the remains of olive pressing (pomace) were discarded near the basins, or perhaps pomace was used as a source of fuel in other areas of the site, as reported for various Mediterranean sites between 3100 BC and the 6th century AD (Rowan 2015).

Although scarce, *Chamaerops humilis* L. (Mediterranean dwarf palm) was also found. Its wood was identified using the key provided by Thomas (2013). Motya falls within the present-day natural distribution range of *C. humilis*, which covers the central and western Mediterranean (Moricca et al. 2020a). Archaeobotanical evidence of *C. humilis* is uncommon, nonetheless its macro- and micro-remains are present in records from Italy and Spain (Moricca et al. 2020a).

Overall, no significant changes were observed in the bulk of the carpological and anthracological assemblages of the different depositional layers. This may be due to the disposal pit F.1112 being used for a limited amount of time, as common for this type of archaeological feature. Nonetheless, some less abundant wood taxa, such as *Cupressus sempervirens* (cypress), *Fraxinus* sp., *Juniperus* sp., Rosaceae Maloideae and Rosoideae were present only in one or two of them. This data should not be disregarded as, e.g. *C. sempervirens* (cypress) is believed to be native to the Middle East and to has arrived to the Western Mediterranean thanks to Phoenicians and Etruscans (Pignatti et al. 2017-2019), despite some evidence showing that it may be actually native to Italy (Bagnoli et al. 2009). A mineralized remain of cypress was in fact also found in pit F.7057 in the area of the Temple of Cappiddazzu at Motya (Moricca et al. 2020b). Rosaceae Maloideae probably belong to *Pyrus* sp. or *Sorbus* sp., as *Malus* sp. prefers cooler climates and it is intolerant to drought.

Another unusual finding is represented by *Juglans* (walnut) pollen in US 1112. Its current distribution is the result of human action that favoured its spread from east to west along the Mediterranean (Pérez-Obiol and Sadori 2007). It appears in Sardinian pollen spectra since at least 5300 BP (Di Rita and Melis 2013) and its endocarps are present in the Phoenician-Punic site of Santa Giusta (Sabato et al. 2019). In Sicily, *Juglans* pollen appears in the 8^{th}– 7^{th} century BC (Sadori 2013). Furthermore, walnut charcoal is also present in the votive pit in the temple of Cappiddazzu at Motya (Moricca et al. 2020b).

Interesting is the finding of juniper in Phoenician Motya. Despite the data deriving from a single context, juniper is found both in the pollen and in the anthracological evidence. In order to assess its frequency, it would be necessary to take into consideration other contexts, gathering data from structural charcoals. Nowadays, the closest populations of *Juniperus* growing in Sicily, referred to *Juniperus turbinata* Guss., are located near Alcamo or near Siculiana, both located c. 100 km from Motya (Gianguzzi et al. 2012). Charcoals of *Juniperus* sp. have also been found in a prehistoric cave in Favignana dating ~14.2 ka cal BP (Poggiali et al. 2012). The presence of juniper in western Sicily is also confirmed by the Gorgo Basso pollen spectra, where it appears with low values and discontinuously throughout last 10,000 years (Tinner et al. 2009). Currently, we can advance two hypotheses: juniper was either present in small quantities along the coasts of the Stagnone, or it grew on the islet itself. Its complete disappearance in present-day western Sicily could be due to burning. Juniper is, in fact, less performant than other plants of the maquis, like heaths and lentisks, which easily re-sprout after fire. Similar considerations can explain the present lack of *Erica arborea*, common in the Motya assemblage, whose nearest population are nowadays located at Scorace, Angimbé and Zingaro nature reserve (i.e. at least 40 km far from Motya; Gianguzzi et al. 2012). As *E. arborea* requires a deeper, more acid and more advanced soil than *E. multiflora*, its disappearance is likely ascribable to either land over-exploitation, aridification or a combination of both.

Finally, charcoal fragments belonging to the *Pinus* sylvestris-montana group (as reported by Greguss 1955), which includes montane species of pine, were found. In fact, the only Sicilian pine sharing the same anatomical characteristics of these remains, i.e. *Pinus nigra* Arnold subsp. *laricio* Palib. ex Maire, only grows on Mount Etna, located nearly 250 km from Motya. Pine timber is known to have been used for ship-making (Giachi et al. 2003), therefore it is possible that the retrieved piece of charcoal derived from one of the ships that were built elsewhere.

Conclusions

The present multidisciplinary study provides precious information regarding the Phoenicians' daily life at Motya – their earliest colony in Sicily (Thucydides *Hist.* VI, 2, 6) – and their plant use, highlighting the importance of combining the study of macro- and micro-remains.

First, the presence of cereals, numerous weeds of different sizes and chaff made it possible to hypothesize that most of crop processing was carried out on site, after storage. The presence of cereal pollen in the studied samples supports the hypothesis that threshing was carried out next to the studied deposit, as well as the archaeological hypothesis that cultivation occurred on site.

Secondly, the study provides evidence for local human diet. Although hulled and naked wheat and barley were found, a clear preference for naked wheat and hulled barley was recorded. This is in accordance with data from other Iron Age sites in western Sicily, namely Monte Polizzo and Selinunte (Stika 2004; Stika and Heiss 2013; Stika et al. 2008). It is probable that naked wheat was used for human consumption, while hulled barley as fodder. The finding of naked barley is surprising, as it underwent a rapid decline in all Europe during the Iron Age. Other than cereals, the diet was comprised of a wide variety of pulses (including lentils, peas and faba beans) and fruits, among which grapevine prevailed.

Pollen data indicates a strongly disturbed Mediterranean landscape with little to no forest cover. Complex anthropogenic activities are testified, among others, by the presence of cultivated trees and cereals, with Asteroideae, Cichorieae, *Urtica* as the main synanthropic taxa.

Anthracological data helps to complete the local environmental picture, with findings of *Pistacia lentiscus, Olea europaea*, *Erica multiflora, Erica arborea*, *Juniperus* sp. and evergreen oaks. Only the first three currently grow on the islet, while *E. arborea* L. and *Juniperus* species grow respectively no closer than 40 km and 100 km from Motya. *Olea*, with abundant charcoals, and still cultivated on present day Motya, is surprisingly lacking in the pollen diagram. The high charcoal percentage of evergreen oaks, plants today absent on Motya and currently showing a scattered occurrence along the coast facing the Marsala Lagoon, indicates that it was a wood-type of preference. Finally, the retrieved fragments of the "montane type" of pine probably issue from imported material. Remarkably, the finding *Pinus pinea* represents the oldest one concerning this species in the Holocene in the central Mediterranean.

Based on the evidence reported in the present paper, it is possible to compare Motya's past environment with the present one. The present-day lack of *Juniper* sp. could be due to burning, as this plant is a less performant re-sprouter after fire than other woody species of the maquis, like heaths and lentisk. Similar considerations can be done for explaining the present lack of *Erica arborea*, whose disappearance is likely ascribable to either land over-exploitation, aridification or a combination of both processes.

Figure captions

Table 1. Stratigraphy of disposal pit F.1112.

Figure 1. a) The geographic location of Motya with reference to the Iron Age sites of Monte Polizzo and Selinunte, the pollen sequences of Gorgo Basso and Pergusa, and other locations mentioned in the text; b) the position of Motya within the Marsala lagoon; c) the position of Area D within the site of Motya, courtesy of Sapienza University of Rome Expedition to Motya.

Figure 2. Pit 1112 and the related stratigraphy in Area D at Motya; seen from north.

Figure 3. Selected carpological remains from pit F.1112. a) *Triticum turgidum* subsp. *dicoccon*, b) *Triticum aestivum/durum*, c) *Hordeum vulgare* (hulled); d) *H. vulgare* (hulled and sprouted); e) *H. vulgare* (rachis node); f) *Pisum sativum*; g) *Lens culinaris*; h) *Vicia/Lathyrus*; i) *Vicia ervilia*; j) *Vitis vinifera* (seed and pedicel); k) *Ficus carica*; l) *Punica granatum*; m) *Lolium temulentum*; n) *Phalaris* cf. *minor*; o) *Briza maxima*; p) *Sherardia arvensis*; q) *Silene vulgaris*.

Figure 4. Pollen percentage diagram. Total pollen concentration from the studied filling layers (FL: filling layer) are indicated in the first column.

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Figure 1

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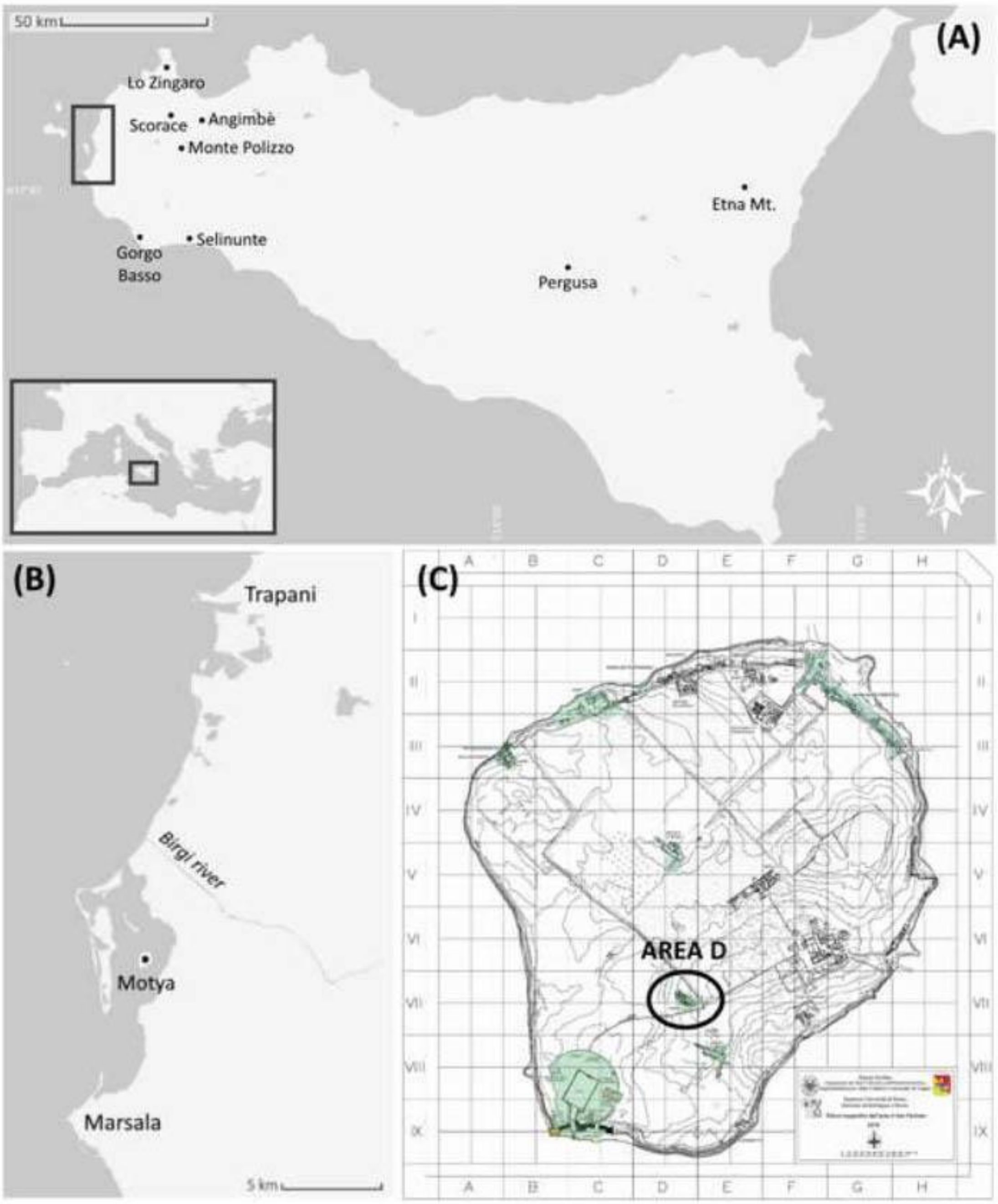

Figure 2

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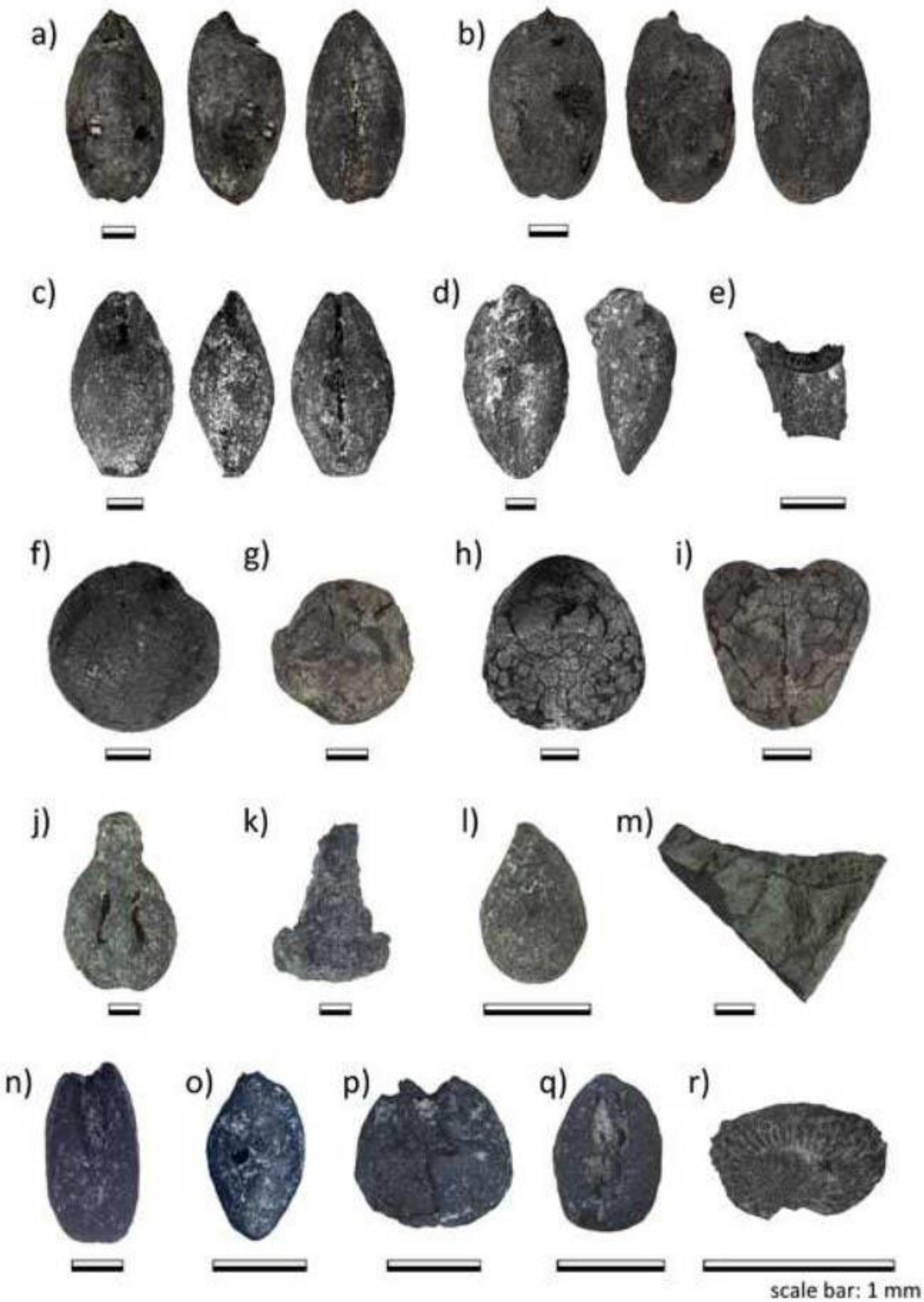
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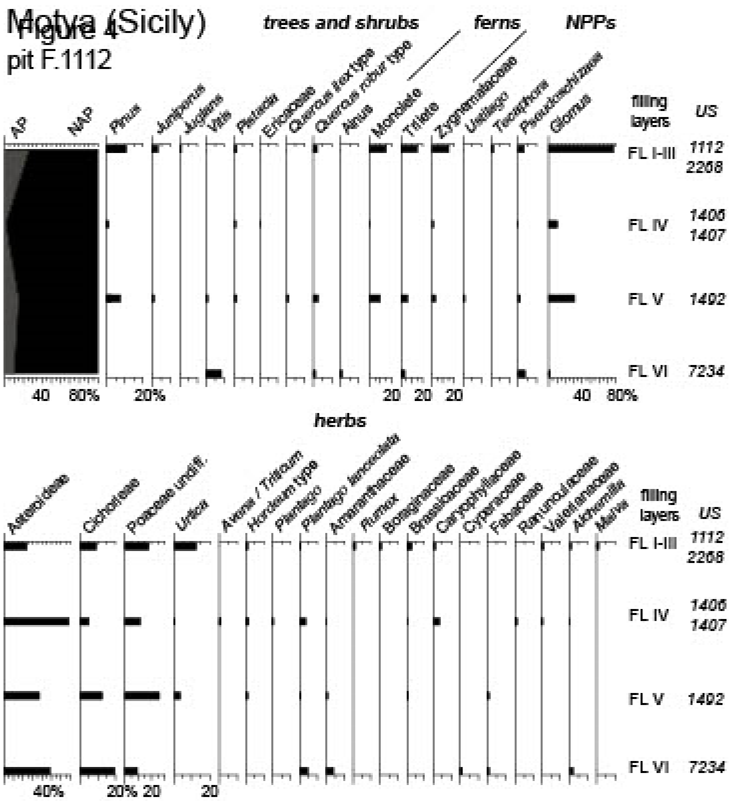
Figure 4



Motya (Sicily)
pit F.1112
trees and shrubs
ferns
NPPs
AP
NAP
Pinus
Juniperus
Juglans
Vitis
Pistacia
Ericaceae
Quercus ilex type
Quercus robur type
Alnus
Monolete
Trilete
Zygnemataceae
Ustilago
Tecaphora
Pseudoschizaea
Glomus
filling layers
US
FL I-III
1112
2268
FL IV
1406
1407
FL V
1492
FL VI
7234
40
80%
20%
20
20
20
40
80%
herbs
Asteroideae
Cichorieae
Poaceae undiff.
Urtica
Avena / Triticum
Hordeum type
Plantago
Plantago lanceolata
Amaranthaceae
Rumex
Boraginaceae
Brassicaceae
Caryophyllaceae
Cyperaceae
Fabaceae
Ranunculaceae
Valerianaceae
Alchemilla
Malva
filling layers
US
FL I-III
1112
2268
FL IV
1406
1407
FL V
1492
FL VI
7234
40%
20%
20
20

Filling layer (FL)	Stratigraphic units (US)	Date
I-III	1112 and 2268	End of 7th – mid 6th century BC
IV	1406 and 1407	Mid-7th century BC
V	1492	End of 8th – first half of the 7th century BC
VI	7234	Mid-second half of the 8th century BC

<u>Online Resource 1.</u> The carpological assemblage of pit F.1112. Counts are provided per each filling layer (FL: filling layer). C: charred; M: mineralized; numbers in brackets indicate fragments.

				1112 (*2017*)	**FL I-III**	**FL IV**	**FL V**	**FL VI**	**TOTAL**
			Volume	N/A	99	162	72	108	333
			Density (finds/L)		7.19	6.65	7.60	5.81	6.81
	Species	**Plant part**	**Preservation**						
CEREALS									
1	*Avena sativa*	fruit (fruit fr.)	C			2 (1)	1 (1)	2	5 (2)
2	*Hordeum vulgare*	floret (floret fr.)	C	21 (11)	21 (16)	36 (51)	18 (21)	42 (27)	138 (126)
		fruit (fruit fr.)	C		2 (2)	3 (6)		2 (2)	7 (10)
		fruit/floret (fruit floret fr.)	C	4	2 (2)	2 (4)	2 (3)	3 (2)	13(11)
		sprouted floret	C		2	1		2	5
		rachis node (rachis fr.)	C		0 (1)	2	1	0 (1)	3 (2)
3	*Triticum monococcum*	fruit	C	2	2 (1)	6 (1)	4 (2)	1	15 (4)
4	*Triticum aestivum/durum*	fruit	C	5	35	93	22	38	193
		sprouted fruit	C		5	12	5	7	29
5	*Triticum turgidum* subsp. *dicoccon*	fruit	C	6	31	33	11	31	112
		sprouted fruit	C	1			1		2
		glume base (glume)	C		2 (4)	4 (1)	1 (1)	1 (3)	8 (9)
		rachis fragment	C				1	1	2
6	*Triticum* sp.	fruit fragment	C	5	25	81	10	21	142
		sprouted fruit	C		1	6		8	15
		rachis fragment	C		1				1
7	Cereals indet.	fruit/floret fragment	C		54	138	70	1	263
		embryo	C		1				1
		germ of a grain kernel	C				1		1
PULSES									
8	*Lens culinaris*	seed (cotyledon)	C			0 (4)	1 (3)	1 (1)	2 (8)
9	*Pisum sativum*	seed (cotyledon)	C	6 (6)	9 (5)	14 (3)	2 (2)	2 (2)	33 (18)
10	*Vicia ervilia*	seed (cotyledon)	C	1	2 (1)	2 (1)	0 (1)		5 (3)
11	*Vicia faba*	seed (cotyledon)	C	2	2 (4)	1 (2)	1 (1)	1	7 (7)
		fruit fragment	C			1			1
12	*Vicia/Lathyrus*	seed (cotyledon)	C	1	4 (5)	2 (12)	3 (3)	4 (3)	14 (23)
13	Pulses indet.	seed fragment	C		8	20	4	9	41
FRUITS									
14	*Crataegus monogyna*	fruit	C		1				1
15	*Crataegus* sp.	fruit	C		1				1
16	*Ficus carica*		C		12	2		5	19
		fruit	M		5	2			7
17	*Olea europaea*	fruit	C			1	1		2
18	*Pinus pinea*	fruit	C					2	2
19	*Pinus* cf. *pinea*	scale fragment	C			3		2	5
20	*Punica granatum*	fruit fragment	C			6			6
21	*Vitis vinifera*		C	87 (27)	48 (43)	44 (47)	15 (15)	68 (49)	262 (181)
		seed (fr.)	M		1			1	2

		underdeveloped seed	C		1	1		2	4
		fruit fragment	C					1	1
		pedicel	C		2	1		6	9
OIL PLANTS									
22	cf. *Linum usitatissimum*	seed fr.	C			1			1
WEEDS									
23	*Ammi majus*	fruit	C		1	1	1		3
24	*Anagallis arvensis*	seed	C			2		3	5
25	*Artemisia arborescens*	seed	C		2				2
26	*Avena fatua*	fruit (fruit fr.)	C		2	7		4 (2)	13 (2)
27	*Avena* sp.	fruit fr.	C			2			2
28	*Briza maxima*	fruit	C		1	1		2	4
29	*Bromus* sp.	fruit fr.	*C*		2				2
30	*Calendula arvensis*	fruit	C					1	1
31	*Carex* sp.	fruit	C		1		2		3
32	Caryophyllaceae	seed	C		1	3	3	5	12
33	*Cerastium* cf. *glomeratum*	seed	C		3				3
34	*Chenopodiastrum murale* (L.) S. Fuentes & al.	seed	C		16				16
35	*Chenopodium album*	seed	C		5		1		6
36	*Coronilla* sp.	fruit	C				1		1
37	Cyperaceae	fruit	C			1	4	1	6
38	*Echium plantagineum*	fruit	C		1				1
			M		1				1
39	*Eleocharis palustris*	fruit	C			1	1	1	3
40	*Euphorbia helioscopia*	seed	C					1	1
41	Fabaceae	seed	C			2	1	6	9
42	*Galium* sp.	seed	C			1			1
43	*Geranium* cf. molle	seed	C		2				2
44	*Geranium/Medicago*	seed without seedcoat	C				1		1
45	*Heliotropium europaeum*	seed	M		1	2			3
46	*Hippocrepis* sp.	seed	C					3	3
47	*Hordeum murinum*	fruit (fruit fr.)	C		0 (1)		0 (1)	2 (3)	2 (5)
48	*Lolium multiflorum/perenne*	fruit	C		3	3	3	3	12
49	*Lolium temulentum*	fruit (fruit fr.)	C	1	47 (12)	198 (35)	28 (5)	45 (12)	319 (64)
50	*Malva* cf. *sylvestris*	seed	C			1	1		2
51	*Malva* cf. *nicaeensis*	seed	C		1				1
52	*Malva* sp.	seed fr.	C		2				2
53	*Medicago* sp.	fruit	C		3				3
54	cf. *Medicago*	seed	C		1				1
55	*Microrrhinum minus* (L.) Fourr.	seed	C		1				1
56	*Misopates* sp.	seed	C		1		1		2
57	*Persicaria amphibia* (L.) Delarbre	fruit	C				3		3
58	*Phalaris* cf. *minor*	fruit	C		33	7	37	21	98
59	*Phalaris* sp.	fruit (fruit fr.)	C		48 (71)	21 (31)	61 (93)	66 (29)	196 (224)
60	Plantaginaceae	seed	C			1			1

61	Poaceae	fruit (fruit fr.)	C		9 (19)	1 (47)	3 (45)		13 (111)
62	*Polygonum* sp.	fruit	C		2				2
63	Polygonaceae	fragment	C		2	1		1	4
64	*Portulaca oleracea*	seed	C		3	1			4
65	*Potentilla* sp.	seed	C				1		1
66	*Ranunculus* sp.	seed	C					1	1
			M		1				1
67	*Raphanus raphanistrum*	fruit fr.	C	1	1				2
68	*Rumex* sp.	fruit	C				4		4
69	*Scirpoides holoschoenus*	fruit	C				1		1
70	*Sherardia arvensis*	seed	C		7	5		1	13
71	*Silene* cf. *vulgaris*	seed	C		7	2	3	2	14
72	cf. *Silene* sp.	seed	C		1	1			2
73	cf. *Spergula arvensis*	seed	C			1			1
74	*Urtica membranacea*	seed	C				7		7
75	*Urtica urens*	seed	C		2	16			18
76	*Urtica* sp.	seed	C		1				1
77	*Veronica* sp.	seed	C		1				1
78	*Vulpia* sp.	fruit	C		2		3		5
	indet	seed	C		27	30	4	58	119
	TOTAL			187	712	1078	547	627	3151

<u>Online Resource 2</u>. The anthracological assemblage of pit F.1112 (FL: filling layer).

Taxon	**FL I-III**	**FL IV**	**FL V**	**FL VI**	**Total**
Capparis spinosa	3		1	1	5
Cupressus sempervirens		1			1
cf. *Cupressus sempervirens*		1			1
Erica arborea type	19	14	12	3	48
Erica multiflora type	19	7	12	4	42
Erica arborea/muiltiflora	22	11	6	5	44
Faboideae	12	12	10	2	36
Fraxinus sp.				1	1
Juniperus sp.		1		1	2
Maloideae		2			2
Olea europaea	49	18	12	27	106
Chamaerops humilis	1		1	5	7
Pinus sylvestris-montana group	4			1	5
Pinus cf. sylvestris-montana group		1	1		2
Pistacia lentiscus	30	36	43	15	124
Pistacia terebinthus	11	13	9	1	34
Pistacia sp.	25	34	22	10	91
Quercus evergreen	61	36	64	50	211
Quercus sp.	1	9	5	4	19
Rhamnus/Phillyrea	27	22	7	31	87
Rosoideae	1	1			2
Total	285	219	205	161	870

SECTION 2

Morphometry: the statistical analysis of form and its (co)variation

CHAPTER 3

Grapes and vines of the Phoenicians: morphometric analyses of pips from modern varieties and Phoenician archaeological sites in the Western Mediterranean

Moricca C., Bouby L., Bonhomme V., Pérez-Jordà G., Nigro L., Spagnoli F., Peña-Chocarro L., van Dommelen P., Sadori L.

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Grapes and vines of the Phoenicians: morphometric analyses of pips from modern varieties and Phoenician archaeological sites in the Western Mediterranean

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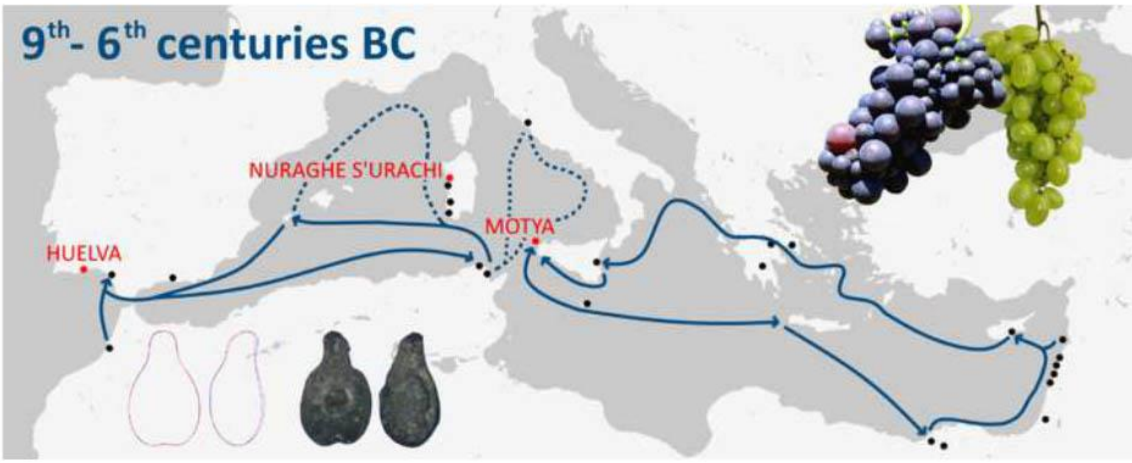
	Peter Van Dommelen
	Laura Sadori
Abstract:	The present study aims to contribute to the investigation of the role of Phoenicians in the spread and trade of grapevine through the morphometric analysis of grape pips. Waterlogged and charred samples were selected from three Western Mediterranean sites: Motya (Sicily, Italy), Nuraghe S'Urachi (Sardinia, Italy) and Huelva (Andalusia, Spain). While only Motya is a Phoenician foundation, all three were nevertheless associated with Phoenician expansion and cultural interaction. Ten cultivars from the "Vivaio Federico Paulsen" in Marsala (western Sicily) were chosen as modern reference material. The key challenge was the comparison of archaeological pips preserved through different fossilization processes, which was overcome using two reference datasets of the same modern cultivars, one uncharred and one charred. Statistical analyses of pip outlines show that archaeological material from these sites is morphologically comparable to that of modern varieties, suggesting that the archaeological finds may be described as "strongly domesticated". PCA analyses allowed an inter-site comparison, showing that samples from the three sites are clearly distinguishable based on their morphology. This indicates the use of different varieties which may be due to different factors. Our analysis represents a first step, which could be enriched by the addition of pips deriving from more contexts and more sites, compared against a wider selection of modern cultivars.

Highlights

- Morphometric analysis of grape pips from Western Mediterranean Iron Age sites
- Indirect comparison of waterlogged and charred grape seeds through morphometry
- "Strongly domesticated" morphology of pips at all sites
- Different grape varieties in different sites
- Phoenician viticulture probably based on local grape varieties


9th- 6th centuries BC
NURAGHE S'URACHI
MOTYA
HUELVA

Grapes and vines of the Phoenicians: morphometric analyses of pips from modern varieties and Phoenician archaeological sites in the Western Mediterranean

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Abstract

The present study aims to contribute to the investigation of the role of Phoenicians in the spread and trade of grapevine through the morphometric analysis of grape pips. Waterlogged and charred samples were selected from three Western Mediterranean sites: Motya (Sicily, Italy), Nuraghe S'Urachi (Sardinia, Italy) and Huelva (Andalusia, Spain). While only Motya is a Phoenician foundation, all three were nevertheless associated with Phoenician expansion and cultural interaction. Ten cultivars from the "Vivaio Federico Paulsen" in Marsala (western Sicily) were chosen as modern reference material.

The key challenge was the comparison of archaeological pips preserved through different fossilization processes, which was overcome using two reference datasets of the same modern cultivars, one uncharred and one charred.

Statistical analyses of pip outlines show that archaeological material from these sites is morphologically comparable to that of modern varieties, suggesting that the archaeological finds may be described as "strongly domesticated".

PCA analyses allowed an inter-site comparison, showing that samples from the three sites are clearly distinguishable based on their morphology. This indicates the use of different varieties which may be due to different factors.

Our analysis represents a first step, which could be enriched by the addition of pips deriving from more contexts and more sites, compared against a wider selection of modern cultivars.

Keywords: Phoenicians, viticulture, morphometry, Western Mediterranean, experimental charring

1. Introduction

This study aims at better understanding the role of Phoenicians in the spread and trade of grapevine through the morphometric analysis of grape pips.

Grapevine (*Vitis vinifera* L.) is one of the most important fruit crops of the past and present world, both economically and culturally. The wild and cultivated forms, respectively *Vitis vinifera* L. subsp. *sylvestris* (C.C. Gmel.) Hegi and *V. vinifera* L. subsp. *vinifera*, differ by an array of traits, including their reproductive biology. Wild grapevine is dioecious and is cross-pollinated, while domesticated grapes are in most cases hermaphrodite and capable of self-pollination (This et al., 2006). Domestication has also resulted in an increase in berry size and sugar content, which are both factors that play a key role in fermentation (Bouby et al., 2013). Differences can moreover be observed in the shape of its seeds, with wild pips being "small, robust, with a rounded outline, or cordate, with short stalks […] almost flat ventrally with sharp angles and a strongly developed chalaza", in contrast with cultivated ones that are large, elongated, oval or pyriform, with a longer stalk, more rounded ventrally and less sharply sculptured (Mangafa & Kotsakis, 1996, p. 409; Levadoux, 1956; Jacquat and Martinoli, 1999).

The origins of wine production have been traced back to the Caucasus in the 7^{th}-6^{th} millennia (McGovern et al., 2017). It is unknown if these first wines were made from wild or cultivated grapes (Bouby et al., accepted). In any case all the evidence points to an origin of domesticated grapes (e.g. Myles et al., 2011). Grapevine was cultivated, and probably domesticated, in South West Asia by at least the 4th millennium BC (e.g. Miller, 2008; Fuller and Stevens, 2019). Grassi et al. (2003), Imazio et al. (2004), Arroyo-García et al. (2006) and more recently Riaz et al. (2008) have performed simple sequence repeats (SSR) analyses on wild and cultivated grapevines. Their results suggest the presence of at least two separate grape domestication events: one in Transcaucasia and another in Western Europe, particularly in Spain and Sardinia. Scienza (2008) and Forni (2012) describe several centers of "accumulation", areas located on major commercial routes near ports, where many varieties were gathered over the centuries due to frequent/intensive contacts between populations. Some of these have been identified as the main centers of diversity. Distinct groups of cultivated grapevines were proposed by Negrul, who identified three *proles*: a *proles pontica* between Georgia and Asia Minor and in Eastern Europe, a *proles occidentalis* in Italy, France, the Iberian Peninsula, and Germany, and a *proles orientalis* in Central Asia, Persia, Armenia and Afganistan (Dalmasso, 1961).

Riaz et al. (2018) suggest that cultivars from the *proles pontica* where introduced to Western Europe by people. Today, domesticated grape diversity is the results of millennia of human selection and diffusion. Ancient civilizations such as the Assyrians, Phoenicians, Greeks, Etruscans and Romans, spread viticulture first along the Mediterranean basin, and later also into more temperate regions (McGovern, 2003). In the Western Mediterranean there is an increasingly clear link between the Phoenician presence and the development of viticulture (Botto, 2013), as may be seen from both the archaeobotanical record (Buxó 2008; Pérez-Jordà et al., 2017; Ucchesu et al., 2015), and other elements in the archaeological record such as the wine presses (Gómez Bellard et al., 1993) or evidence of cultivation (Vera & Echevarria 2013). Evidence of *Vitis vinifera* in Phoenician sites is also found in association to animal bones (e.g. Moricca et al., in press; Portas et al., 2015), as it is believed that the waste from winemaking was used by Phoenicians for meat preservation thanks to the antioxidant capacity of grapes (Sabato et al., 2019).

Morphometry, the statistical analysis of form and its (co)variation (Rohlf and Bookstein, 1990), has played a key role in the study of grape pips from archaeological contexts since the early 20th century to distinguish between wild and domesticated seeds (Stummer, 1911; Mangafa & Kotsakis, 1996). The approach was initially mainly based on measuring the length and breadth of the whole pip but it has developed to include multiple parameters, such as the length of the stalk or position of the chalaza (Rivera Núñez et al., 2007); more recently, it has embraced geometric morphometrics and, in particular, outline analysis (Terral et al., 2010). Although only genetic analyses can demonstrate a direct connection between modern cultivars and archaeobotanical specimens (Guasch-Jané, 2019), geometric morphometric analyses are useful in archaeobotany, where shape is often the only remaining datum (Portillo et al., 2020). Since most of the surviving plant remains are usually seeds, outline analyses that do not require landmarks are particularly suitable and have been successfully used in numerous studies (eg. Ekhvaia & Akhalkatsi, 2010; Terral et al., 2010; Orrù et al., 2013; Ros et al., 2014; Pagnoux et al., 2015; Sabato et al., 2015a; Bonhomme et al., 2017; Bourgeon et al., 2018; Boso et al., 2020). Desiccated remains, whose shape was not modified by (sub)fossilization, have proven to be the most suitable material for morphometric analysis, followed by waterlogged ones (Bouby et al., 2013). An additional advantage that these categories carry is the possibility to perform DNA analyses, which can serve as a complementary tool (Bacilieri et al., 2017). The study of charred grape pips is more challenging, as this (sub)fossilization results in a notable degree of deformation, in particular a swelling of the seed, which mostly occurs on the ventral side and which is best observed on the lateral outline (Smith and Jones, 1990; Bouby et al., 2018).

Despite the distortion of charred botanical remains, differences in seed shape may remain informative. Attempts to perform morphometric analyses on charred grape pips have been recently undertaken by Ucchesu et al. (2016) and Bouby et al. (2018), who both concluded that it is possible to distinguish between wild and domesticated pips, even if they are charred.

Bouby et al. (2018) have moreover shown that if charring occurred at a temperature of 250°C or lower, wild and domesticated pips may not only be correctly distinguished from each other, but it is also possible to identify correctly a high percentage of domesticated pips. Charring at higher temperatures increases the classification error, which means that cultivar classification may only use pips charred at lower temperatures (Bouby et al., 2018).

This paper compares, for the first time, grape pips collected in different sites with Phoenician connections to explore the interaction of Phoenicians with plants and food, including commercial routes and trade goods. Were Phoenicians responsible for the spread of viticulture to the western Mediterranean? Or did they exploit and possibly domesticate wild grapes? Are modern cultivars a result of Phoenician influence?

1.1. Study sites

The present study focuses on the analysis of materials originating from three sites related to the Phoenician-Punic diaspora: Motya, Huelva and Nuraghe S'Urachi, which are respectively situated in Sicily (Italy), Spain and Sardinia (Italy; Fig. 1).

Phoenicians and their material culture traveled the length and breadth of the Mediterranean between the end of the 2nd and the first half of the 1st millennium BC (Aubet Semmler, 2001; López-Ruiz and Doak, 2019). Their expansion from the coastal Levant in modern Lebanon towards the Western Mediterranean involved the major islands and many mainland coastal areas of the Mediterranean, such as Crete, Sicily, Sardinia, and Andalusia. In all these areas, commercial and agricultural settlements were newly established or created in association with existing indigenous ones, and the relations between Phoenicians and local communities became a key aspect of the economic and social transformation of these regions.

While only one of the three sites studied is a Phoenician foundation, all three were nevertheless undoubtedly associated with Phoenician expansion and cultural interaction.

Motya is a small island of just 45 ha off Western Sicily in the Central Mediterranean. It is located in a sheltered lagoon, where it had offered an ideal stopping point on trade routes since the second millennium BC. It was settled by Phoenicians from the 8th century BC (Nigro and Spagnoli, 2017; Nigro, 2019). Situated at the westernmost point of Sicily, it represented the last stop before reaching Sardinia. Intensified interactions between Sicily, Sardinia and Iberia during the Late Bronze Age and the Early Iron Age are attested by archaeological evidence (Bernabale et al., 2019; Nigro et al., 2020).

Nuraghe S'Urachi is situated on the central west coast of Sardinia, on the northern shores of the Gulf of Oristano. The nuraghe itself was first built sometime in the Middle Bronze Age or mid-2nd millennium BC, and remained continuously occupied well into the 1st millennium BC. From around the turn of the 8th-7th century, Phoenician material culture was imported in increasingly abundant quantities and subsequently locally produced, suggesting a stable presence of Phoenicians (Van Dommelen et al., 2020).

Situated in the coastal wetlands created by two rivers flowing into the Atlantic, the site of Huelva was likewise an indigenous settlement, where Phoenician material culture was imported as early as the 9th century BC. It offered access to an important mining district in the interior, which enabled its inhabitants to establish connections across both the Atlantic and the Mediterranean (Ruiz-Gálvez Priego 1986; 2014). A small number of Sardinian pottery amidst a rich variety of Phoenician and other imports shows the involvement of both indigenous communities in Phoenician commercial networks Gonzales de Canales et al., 2006).

[Figure 1 near here]

2. Materials and Methods

2.1. Modern material

Ten cultivars collected from the "Vivaio Federico Paulsen: Centro Regionale per la Conservazione della Biodiversità Agraria" in Marsala (TP, western Sicily) were selected as modern reference material (http://vivaiopaulsen.it). The choice of cultivars was based on their geographic origin, with three cultivars regarded as native to Georgia ("Chichvi", "Ogialesci" and "Zerdagi"), five to Sicily ("Albanello", "Catarratto", "Inzolia", "Perricone" and "Vitrarolo") and one to mainland Italy ("Coda di Volpe" - Tab. 1; Ansaldi et al., 2014, Galet, 2000). The origin of "Zibibbo", also known as "Muscat of Alexandria", is debated. It has nevertheless a long history of cultivation in Sicily, presumably starting with the Arabic domination of the Island (ca. 9th century AD) but being first described as a cultivar by Francesco Cupani in 1696 (De Lorenzis et al., 2015). Although, many cultivars have both black and white mutants (e.g. "Pinot"), we have maintained a balance in our sample between black and white grapes. 30 grape pips of each cultivar have been sampled for the present study, and each pip was given a unique identification code in order to compare its morphology before and after charring.

[Table 1 near here]

2.2. Charring conditions

Experimental charring was performed on the selected pips in order to train identification models with pips representative of well-preserved archaeobotanical material. Charring conditions were established following the studies realized by Ucchesu et al. (2016) and Bouby et al. (2018), which evaluated the most suitable conditions of experimental charring for morphometric studies. They respectively defined temperature ranges of 240-310°C and 250-450°C, below which charring resulted in heterogeneous carbonization and above which the pips disintegrated. Oxygen availability and duration of heating had a smaller impact on pip deformation, although it seemed slightly more accentuated under oxidizing conditions. Complete charring of the reference assemblages occurred already after 20 minutes. Bouby et al. (2018) concluded that only pips charred at a low temperature should be used for identification at the cultivar level, as charring at 250°C allowed not only to distinguish correctly between wild and domesticated pips, but also to identify accurately specific varieties.

Each of the selected pips, which had previously been given a unique identification code, was wrapped in two layers of aluminum foil in order to re-create reducing conditions, and to simulate the taphonomic factors which resulted in the creation of the archaeological assemblage. The pips were placed in a Thermolyne 48000 furnace at ambient temperature, the temperature was set at 250°C and the furnace was turned on. After 90 minutes the sample tray was removed from the oven. In order to reduce the uncertainty correlated to the charring temperature (high or low), only very well-preserved pips were retained, filtering out the ones with a more inflated aspect, as these can only be considered for a wild/domesticated distinction (Bouby et al., 2018).

2.3. Archaeological material

Archaeological grape pips were collected from the western Mediterranean sites of Motya, Nuraghe S'Urachi and Huelva. The archaeological material from Motya consisted of 189 grape pips collected from a 8^{th}-6^{th} century BC refuse pit, which had been preserved by carbonization and collected using the bucket floatation technique. The grape seeds come from six stratigraphic units interpreted as four depositional events (Moricca et al., submitted). Few pedicels were found in comparison to the number of grape seeds, indicating that these are more likely to originate from food consumption than to represent wine making refuse (Margaritis and Jones, 2006).

The material from the sites of S'Urachi and Huelva was by contrast preserved by waterlogging. The 179 grape pips from S'Urachi come from the fill of a trench that was backfilled with rubbish from the early 7^{th} century BC onwards, along with other fruits, cereals as well as large quantities of animal bones and pottery (Pérez-Jordà et al., 2020).

The 253 pips from Huelva were recovered at a fill context that possibly represents waste dumped in a port area. The sediment was extracted mechanically, but associated radiometric dates and archaeological evidence allow us to place it in the 9^{th}-8^{th} century BC (Pérez-Jordà et al., 2017).

2.4. Morphometric analysis

Modern (both pre- and post-charring) and archaeological grape pips were positioned on a blue background and photographed in dorsal and lateral position (Fig. 2) at a fixed magnification using an Olympus SZ-ET stereomicroscope and an Olympus DP 12 camera. These images were then processed in order to obtain black masks on a white surface. Outlines coordinates (x; y) were extracted and 360 points, equally spaced along the curvilinear abscissa were sampled.

Normalization of the outlines was carried out by centering, scaling them using their centroid size, and by defining the first point right above the centroid (Bouby et al., 2018). Elliptic Fourier transform (EFT) approach (Kuhl and Giardina, 1982), subsequently enabled us to turn the shape into multivariate coefficients. EFT consists of a decomposition x- and y- coordinates as two harmonic sums of trigonometric functions (Bonhomme et al., 2014). The two views were treated separately, and their coefficients were later combined. In our case, seven harmonics were chosen for the two views, enough to gather 99% of the total harmonic power. Each harmonic corresponds to four coefficients, so EFT resulted in 56 coefficients (2 views × 7 harmonics × 4 coefficients per harmonic) further treated as quantitative variables. Morphometric used the Momocs package (Bonhomme et al., 2014; version 1.3.2 available at https://github.com/MomX/Momocs) and all analyses were performed in the R environment, version 4.0.2 (R Core Team, 2020).

[Figure 2 near here]

2.5. Statistical analyses

Shape variability of the modern charred and uncharred pips and the archeological seeds was assessed and compared at different levels using Principal Component Analyses (PCA).
Preliminary analyses were conducted to quantify error related to the positioning of pips for photographic documentation and their graphical elaboration. A PCA_{geo} (Fig. 3) on the matrices of the EFT coefficients of modern uncharred pips was first calculated to characterize the seed shape variability at the cultivar level. A mean score was represented for each variety. The first two principal components (PC 1 and PC 2) are shown in Figure 3, along with the corresponding morphological space that illustrates the shape components captured by these PCs. Secondly, charred samples were projected as supplementary observations in PCA_{geo}, to visualize the effects of charring on pip shape (PCA_{exper} ; Fig. 4). Here again, only average scores per variety were represented. Mean shapes for modern pips were also calculated to visualize these changes (Fig. 5). Regarding the archaeological pips, a PCA_{archeo} (Fig. 6) was carried out in order to compare the pips from the sites of Motya, Nuraghe S'Urachi and Huelva. We used the first 12 PCs, that gather 95% of the total variance in a permutational MANOVA using the package vegan (Oksanen et al., 2019), to test for differences between assemblages. We then carried out two PCAs (PCA_{water} and PCA_{char} ; Fig. 7 and 8) on modern material (uncharred and charred) that we overlaid with the waterlogged and charred archaeological pips from respectively Huelva and S'Urachi and Motya as additional observations.

3. Results

The first two principal components (PCs) of the PCA performed on uncharred modern samples (PCA_{geo}) explain 59.2% of the total variance (Fig. 3). PC1 (38.2%) distinguishes between roundish pips with a short stalk, characterizing shapes close to the wild morphotype, and more elongated pips with a longer stalk, typically associated with cultivated grapes. PC2 (21.0%) mostly captures the straightness/curviness of the pip outline in lateral view.

3.1. Provenance of cultivars

The application of PCA_{geo} to modern materials makes it possible to highlight the differences in seed shape between cultivars, which can be compared to the geographical origin of each cultivar (Fig. 3).

[Figure 3 near here]

The center of the plot is occupied by the Sicilian cultivars, while the Georgian ones are shifted towards the righthand side of the graph. Pips of the Georgian cultivars are broader and more laterally curved than the Sicilian ones, which present a shape closer to that of wild plants. "Coda di Volpe", which is the only cultivar from the Italian mainland in the analysis, presents by contrast pips that are on average more elongated and straighter in the lateral outline.

3.2. Charring effect

PCA on reference materials has enabled us to describe the effects of experimental charring in terms of changes in pip shape (PCA_{exper}; Fig. 4). This is reflected in a general inflation of the pip bodies, resulting in an overall plumpness (PC1) and a straightening of the lateral outline (PC2). All cultivars follow a similar pattern.

[Figure 4 near here]

The calculated mean shapes associated with the charring conditions (Fig. 5) show that charring mostly affects the lateral section, particularly on the ventral side with an inflation of the body and a change in inclination of the beak. The changes in the dorsal view are nevertheless much lower.

[Figure 5 near here]

3.3. Comparison of archaeological samples

A PCA of all the archaeological samples was also carried out (PCA_{archeo}; Fig. 6). In PCA_{archeo}, the first two PCs explain 59.6% of the total variance. PC1 (40.9% of variance) distinguished pips based on their elongation (or roundness), while PC2 (18.7% of variance) is correlated with the curvature of the lateral outline.

While some differences can be seen along PC1, with pips from Motya's stratigraphic units 1112, 1406 and 2268 being rounder than the others, most differences can be observed along PC2. Waterlogged pips, particularly from S'Urachi are characterized by a more curved lateral outline, while pips from the Motya deposit have a straighter lateral outline. This is coherent with the results of the previous analyses, as PC2 is mostly explained by charring. Pips from Huelva and Motya's US 1407 are very similar, as they are the most elongated ones among the studied pips; they also have a similar curvature in the lateral outline. While looking specifically at the waterlogged assemblages, it is possible to see that pips from S'Urachi are the broadest. This analysis does not, however, take into consideration the effect of charring, which our experiments have shown to cause an inflation of the pip body.

[Figure 6 near here]

Archaeological waterlogged samples were projected on PCA_{geo}, previously obtained for modern uncharred pips (Fig. 7). PCA_{water} allows to compare the morphology of the pips from Huelva and S'Urachi with modern cultivars. Although the pips from S'Urachi are closest to those of "Albanello", they do not match the modern cultivars. This is also the case with the ones from Huelva.
The permutational MANOVA carried out to test differences between assemblages was comprised of a pairwise comparison of modern varieties (both charred and uncharred) and archaeological samples. In pairwise comparisons p-values lower than 0.05, which indicate differences in the pairwise comparison, were seen for: "Albanello" and Huelva; "Coda di Volpe" and Motya US2268; "Ogialesci", S'Urachi and Motya US1407; "Perricone", Motya US1407 and US2268; "Zerdagi", Motya US1492 and US2268.

[Figure 7 near here]

Finally, average scores for samples from Motya were plotted on the PCA previously obtained for the experimentally charred modern cultivars (Fig. 8). This shows that the samples from Motya are relatively distant from modern cultivars. Even so, the pips from US 1407 and US 7234 are most similar to "Perricone", while the mean score for US 1492 falls between "Perricone" and "Catarratto", US 2268 is closest to "Zibibbo", and the pips from US 1112 and US 1406 are finally closest to "Chichvi".

[Figure 8 near here]

4. Discussion

The present study represents a first attempt to evaluate differences in assemblages of grape pips from Phoenician sites and sites that underwent Phoenician influence. Here we show that: a) there is a correlation between the geographical origin of modern cultivars and the shape of their pips; b) the results of the charring experiments are coherent with the existing literature; c) a comparison between modern and archaeological pips allows the identification of the sites with the most and least "domesticated" pips; d) no direct match with modern cultivars was found yet, similarities can be pointed out.
In the first place, we have found a correlation between the pip shape of modern cultivars with their geographical origin, despite a slight overlap of the Sicilian and the Georgian clusters. This correlation has previously been observed, just as it has also been noted that considering a higher number of varieties results in less clear-cut differences between geographical groups (Pagnoux et al., 2015).
The results concerning the deformation of pips by charring are consistent with the experiments conducted by Smith and Jones (1990) and Bouby et al. (2018) and show that the grapevine seeds become rounder when charred. The stalk is less affected by deformations, at least in its length. Charring also affects the lateral side by decreasing its curvature.

PCA_{archeo} carried out on archaeological pips allows a first comparison of their morphology. Although slight differences were seen in the roundness of the pips, with those from Huelva and Motya's US 1407 being the slimmest, and those from three stratigraphic units in Motya being the roundest, most differences concerned the straightness of the lateral outline and may be ascribed to charring.

A more appropriate comparison of archaeobotanical samples was carried out indirectly, by projecting waterlogged pips on PCA_{geo} and charred ones on PCA_{exper}.

The comparison between waterlogged seeds from Huelva and S'Urachi highlighted differences rather than similarities. On average, pips from the former site were slimmer and their lateral outline was less curved, in comparison to the ones coming from the Sardinian excavation. In the nearby site of Sa Osa, *Vitis vinifera* remains are found in levels dating 1300 years BC (Orrù et al., 2013), suggesting an earlier tradition. This could have been maintained on the island in the following centuries, as suggested by the high concentrations of *Vitis* pollen in the adjacent Mistras lagoon at the transition from the middle Bronze Age to the Punic Period (approx. from 3500 to 2500 cal BP; Di Rita and Melis, 2013). In contrast, in the Huelva area grape pips are not present before the 9th-8th centuries.

Comparison with modern varieties was not as straightforward. Even if pips from S'Urachi share some features with the modern ones of "Albanello", "Chichvi", "Vitrarolo" and "Zibibbo" grapes, no clear correspondence was evident. Even if this lack of conformity could be due to the limited size of the reference collection, we should consider that these are modern varieties, that quite likely were introduced later in history. How closely related can modern and ancient varieties be in a given region? Since grapevines are commonly managed through vegetative propagation it is possible for varieties to remain genetically unchanged for centuries. Nonetheless, new cultivars can be created through sexual crosses or somatic mutations. Ancient DNA studies that may help to trace kinship with modern varieties have been undertaken on archaeological pips from several archaeological sites in France (Ramos-Madrigal et al., 2019). Although a clear match ("Savagnin blanc") was only found at a medieval site, several pips from Roman sites show first-degree relationships with modern French and Swiss cultivars. This suggests that at least some varieties remain virtually unchanged since Roman times, and possibly for a longer time.

Misidentification can, nonetheless, be influenced by taphonomic factors, including the fact that remains may become slightly swollen because of waterlogging (Pagnoux et al., 2015).

The samples from Motya, which have been preserved through charring, differ mostly by their roundness. Pips from the most recent stratigraphic units (US 1112 and US 2268), which make up a single depositional phase, are the wider ones, with their shape appearing to be of a "least domesticated" type. This may be related to the fact that these stratigraphic units also included prehistoric materials (such as pottery and other objects). The "least domesticated" pips could have therefore been deposited along with the latter. Pips of units 1407, 1492 and 7234 (respectively from the mid-7th century BC, end of 8th-first half of the 7th century BC, and mid-8th century BC) seem by contrast more elongated and with longer stalks. It is surprising, therefore, that pips from stratigraphic units 1406 and 1407, which also belong to the same depositional layer, differ quite substantially in shape. This may however be due to the small sample size obtained from US 1407. There exists in fact overlap between the datasets, if we examine the values obtained for single pips. The differences may be explained by the presence of different grape varieties within the same depositional layer. A second explanation could be uneven charring in the archaeological context. The context of retrieval is a disposal pit that is several meters wide (Moricca et al., submitted). This would allow for the possibility that higher temperatures were achieved in US 1406 than US 1407, found on the opposite sides of the same filling layer. Charring at higher temperatures has been proven to cause an inflation of the pip bodies (Bouby et al., 2018). Nonetheless, this explanation seems less likely. Such reasoning may also apply to the samples from US 1112 and 2268, even if the values are not as contrasting.

In terms of their correspondence to modern cultivars, the outlines of pips from units 1112 and 1406 best resemble pips from "Chichvi" grapes, while the seeds from the other samples present shapes noticeably different from the modern reference cultivars. It is interesting in this regard to consider the results of the genetic study carried out by Riaz et al. (2018), who analyzed 1378 cultivated and wild grape samples. While most Italian cultivars clustered with those from France, Spain and Pakistan – Turkmenistan, a small subset was associated with wild and cultivated grapevines from Georgia. This suggests that the first domesticated cultivars in Central Asia and Caucasus (the *proles pontica*) somehow did leave a genetic footprint in the Western European *proles occidentalis*.

"Zerdagi" is the modern variety with the broader seeds and least elongated stalks, and which is therefore most like wild grapes, but there are no subfossil equivalents in either the waterlogged or charred assemblages. The same holds for the "Coda di Volpe" variety, which has the slimmest pips and the shortest stalks. These observations may suggest a certain level of domestication of the vine from all the sites studied.

The results of PCA_{water} and PCA_{char}, evidence that archaeological material from the three sites is, morphologically, broadly comparable to the modern varieties, which similarly suggests that the archaeological finds may be described as "strongly domesticated". If we take into consideration the effects of charring, we note that the "slimmest" pips come from three stratigraphic units at Motya, which may suggest the presence, or perhaps cultivation, of "more strongly domesticated" varieties at or near the Sicilian site.

A diversity of cultivated grapes in the studied sites can be observed. This may be caused by local adaptation. One hypothesis could be introgression with local grapevines, as suggested by Forni (2012). Another option to take into consideration is that the pips of Motya could be related to the *proles pontica*, which is believed to have left a genetic footprint in the *proles occidentalis* in the Western Mediterranean (Riaz et al., 2018). This might explain differences between the samples from Motya and those from the indigenous sites of S'Urachi and Huelva.

Sicilian viticulture is structured in a group of varieties of regional interest, and a bigger group of minor varieties present with a certain frequency only in specific viticultural areas or at the level of a few strains, also called "reliquia", that include "Inzolia" and "Vitrarolo" (Scienza and Failla, 2016). Genetic studies have identified the variety "Sangiovese", as the progenitor of numerous

Sicilian cultivars, amongst which "Perricone". Furthermore, multivariate statistical analyses carried out on 11 SSR loci of 46 Sicilian varieties have shown a clear distinction between varieties based on their geographical origin, with Eastern Sicilian cultivars ("Nerello mascalese", "Nerello cappuccino", "Frappato", "Perricone" and "Carricante") clustering on one side, and those typical of western Sicily ("Inzolia", "Catarratto", "Grecanico", "Nero d'Avola") on the other (De Lorenzis et al., 2014).

A correspondence between our morphometric results and the ampelographic history of Sicily is however not straightforward. Even so, pips from S'Urachi find morphological similarities with those of "Albanello", while three samples from Motya are plotted in the space between "Catarratto" and "Perricone". It is however unclear how we may interpret such associations.

The substantial intra-site diversity in pip morphology at Motya should also be noted, as the sample would seem to cover a range of different varieties. Taphonomic factors, such as differential charring, may however have affected pip morphology. At all the sites the morphology of the pips suggests fully domesticated grapes. The clear differences between pip morphology at the three sites points is against the theory that Phoenicians favoured the spread of grape varieties. It appears more probable that they based their viticulture on local grape varieties, depending on the site where they settled.

The first evidence of viticulture in the Western Mediterranean comes from Sardinia, and has been dated to the last third of the 2nd millennium BC (Sabato et al., 2015b). There is little or no evidence to assess the continuity, scale and prominence of viticulture in the western Mediterranean during the later 2nd millennium, but that changed by the beginning of the 1st millennium with new finds from Tunisia, Sicily, Sardinia and the Iberian Peninsula, which may be associated to a Phoenician presence. The rapid growth of vine cultivation and wine production in the first half of the new millennium generated increasingly frequent exchanges wine amphorae across the Western Mediterranean (Ramón Torres, 1995). Vine cultivation and wine production also became widespread in indigenous areas, where amphora production and wine presses have been found (Pérez-Jordà et al., 2013). Thanks to the Orientalizing influence, which includes not only Phoenicians, but also Greeks and Etruscans, wine soon became a very successful and widely distributed product with substantial agricultural, economic and cultural impact and significance (Botto, 2013). This underscores the interest of trying to define in precise terms the history, distribution, expansion and cultural appreciation of this crop. The varieties that were introduced and/or created in each of the areas are an essential element of this historical process, which indicates the relevance of the line of research that is opened with this work.

5. Conclusions

The present study has first of all allowed us to characterize the pip morphology of grapes cultivated by Phoenicians and connected indigenous communities in the West Mediterranean and to assess the similarities and difference between these ancient seeds and modern varieties using geometric morphometry. Taking in consideration the effects of charring on pip shape, pips from three stratigraphic units at Motya (1407, 1492 and 1407) appear to have the "most domesticated" morphology. More specifically, pips from stratigraphic unit 1407 are the most elongated, closely followed by those from units 1492 and 7234. Although it was not possible to associate them with any specific modern variety, they resemble the Sicilian cultivars "Perricone" and "Catarratto". In terms of elongation, these are closely followed by pips from Huelva, that do not find a resemblance in the reference cultivars. The remaining pips from S'Urachi and Motya (US 2268, 1406 and 1112) are rounder.

None of the investigate pips resembles those of the Georgian cultivar "Zerdagi", which has the roundest pips amongst the selected modern cultivars.

The key challenge for the present study was the comparison of archaeological pips preserved through different fossilization processes (waterlogging and charring). Although it is impossible to undo the charring conditions that created the archaeobotanical assemblage, experimental charring has been used to obtain material that may be compared to well-preserved archaeobotanical material. The use of two reference datasets of the same modern cultivars, one uncharred and one charred, has enabled us to tackle the complications of differential preservation.

Our analysis represents a first step, we are in fact aware of the fact that the number of reference cultivars, which could not adequately represent the diversity of modern grapevine cultivars, could represent a limit. Even so, our selection still offers a general impression of modern similarities with the archaeological samples suggesting that local(s) cultivation and selection could have produced important? changes.

Future studies could be carried out with a larger number of modern reference cultivars that better represent contemporary biological diversity. An additional focus could be placed on modern Sardinian and Iberian cultivars. If the number of samples from each archaeological site could also be increased, we would also gain a better understanding of grape diversity at each site. Even so, finds from other sites would likely be necessary to take a broader view and evaluate the role of Phoenicians in the diffusion of the grapevine across the western Mediterranean.

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Figures and tables

Figure 1. Map of the Mediterranean with the sites of Motya (37°52’05”N, 12°28’10”E), S’Urachi (40°00’56”N, 8°34’57”E), and Huelva (37°14’53”N, 6°56’58”W) along the Phoenician trade routes.

Figure 2. Pip #4 from stratigraphic unit US 1492 (Motya) in dorsal and lateral views.

Figure 3. PCA on reference cultivars in association with their geographical origin (PCA_{geo}).

Figure 4. PCA describing the effects of charring on modern cultivars (PCA_{exper}).

Figure 5. Mean shapes of all pips, Chichvi pips and Zerdagi, dorsal (left) and lateral (right) outlines. Blue line for uncharred pips, red for charred ones.

Figure 6. PCA of archaeological samples (PCA_{archeo}).

Figure 7. PCA of waterlogged archaeological seeds and modern uncharred cultivars (PCA_{water}).

Figure 8. PCA of charred grape pips from Motya and modern reference cultivars experimentally charred (PCA_{char}).

Table 1. Modern cultivars selected for the reference collection

Figure 1

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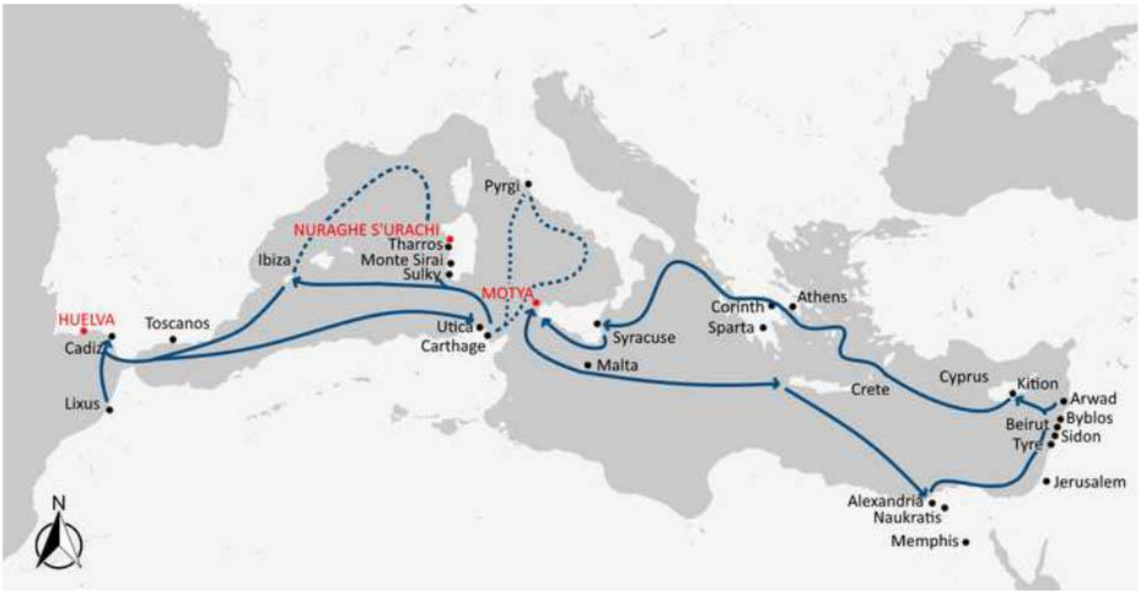


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Figure 3

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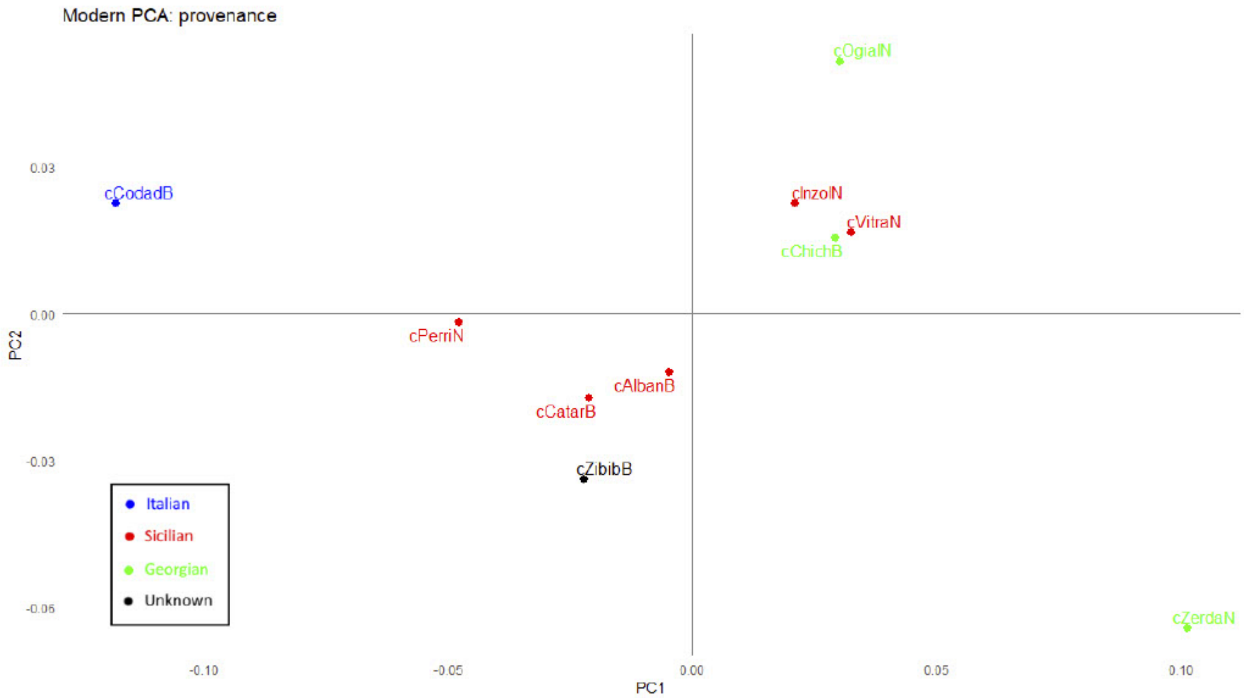

Figure 4

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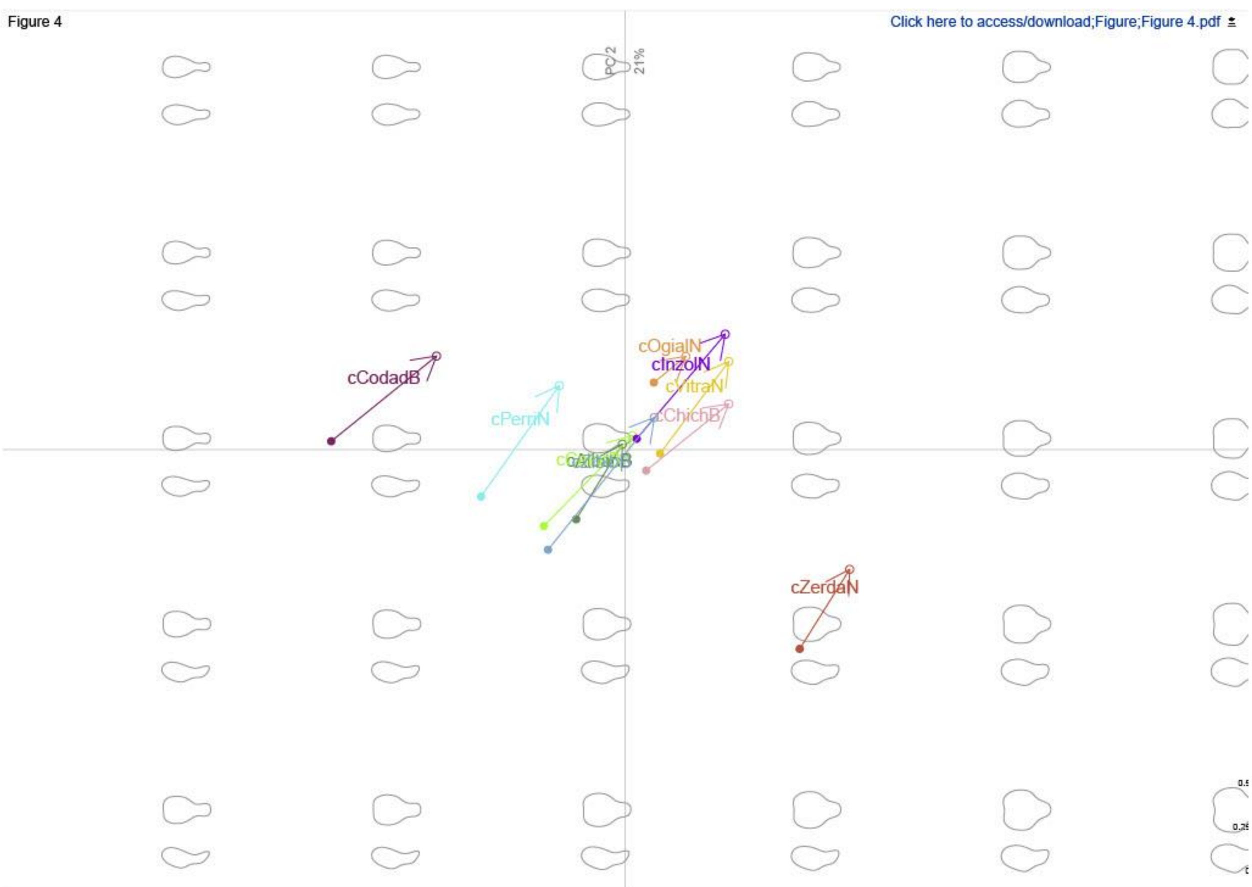


Figure 5

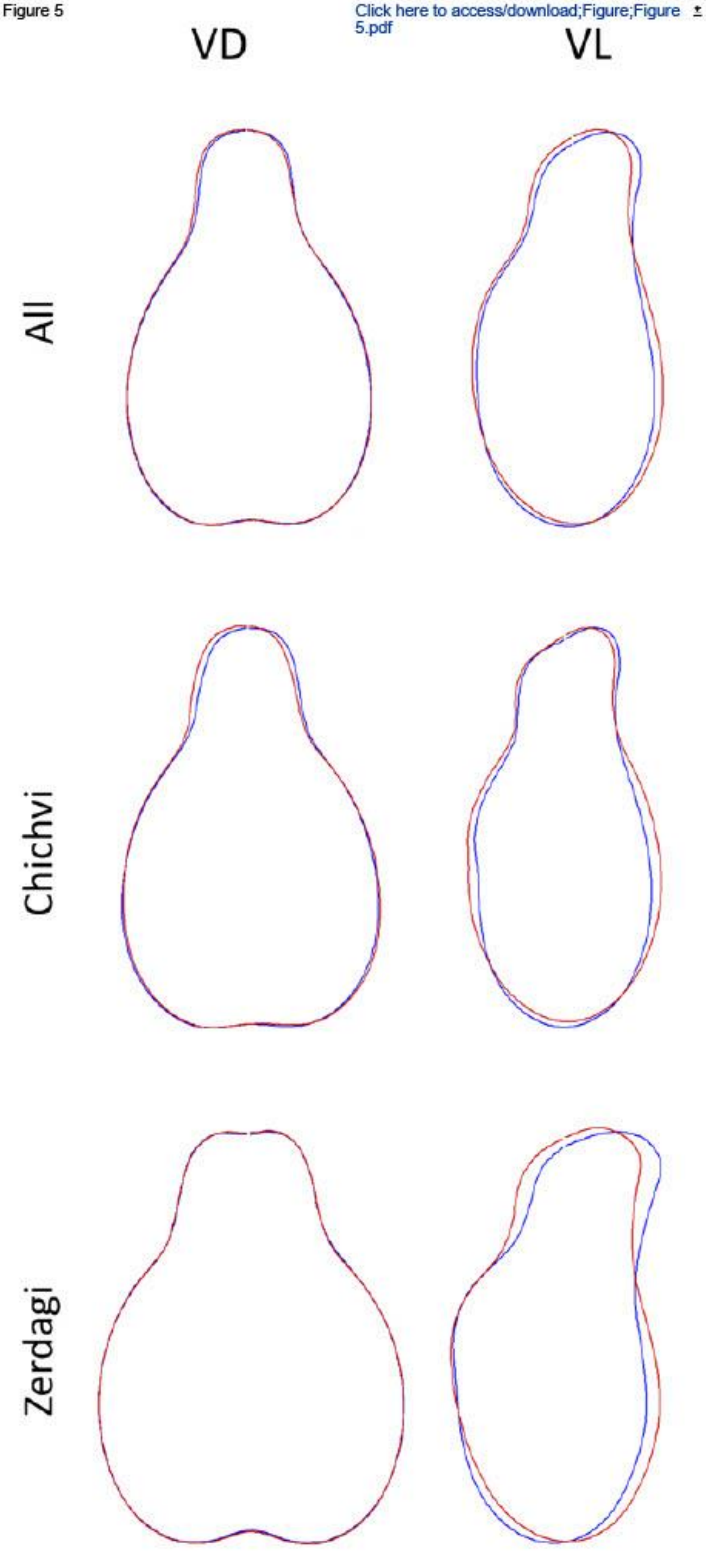


Figure 6 [Click here to access/download;Figure;Figure 6.pdf]

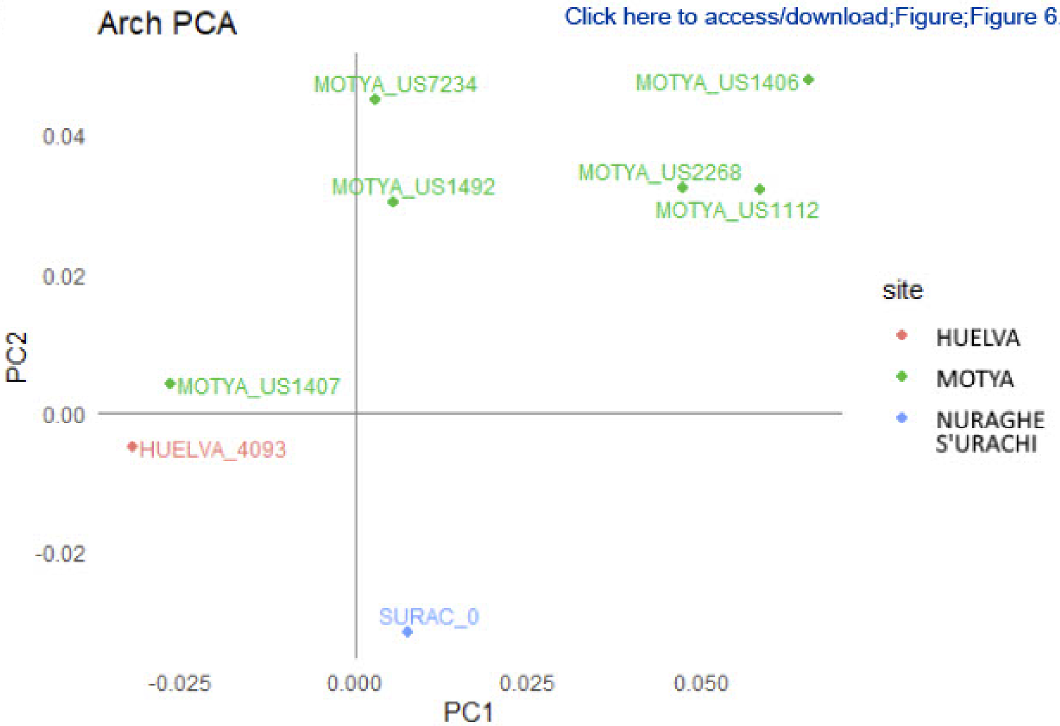


Figure 7 [Click here to access/download;Figure;Figure 7.pdf]

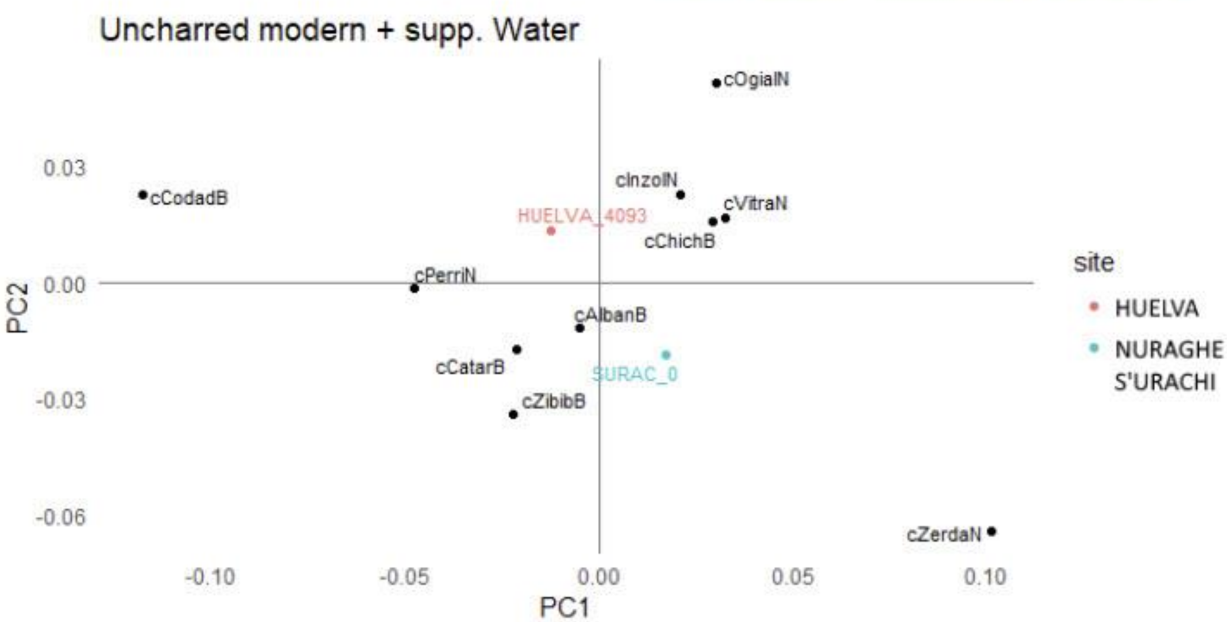
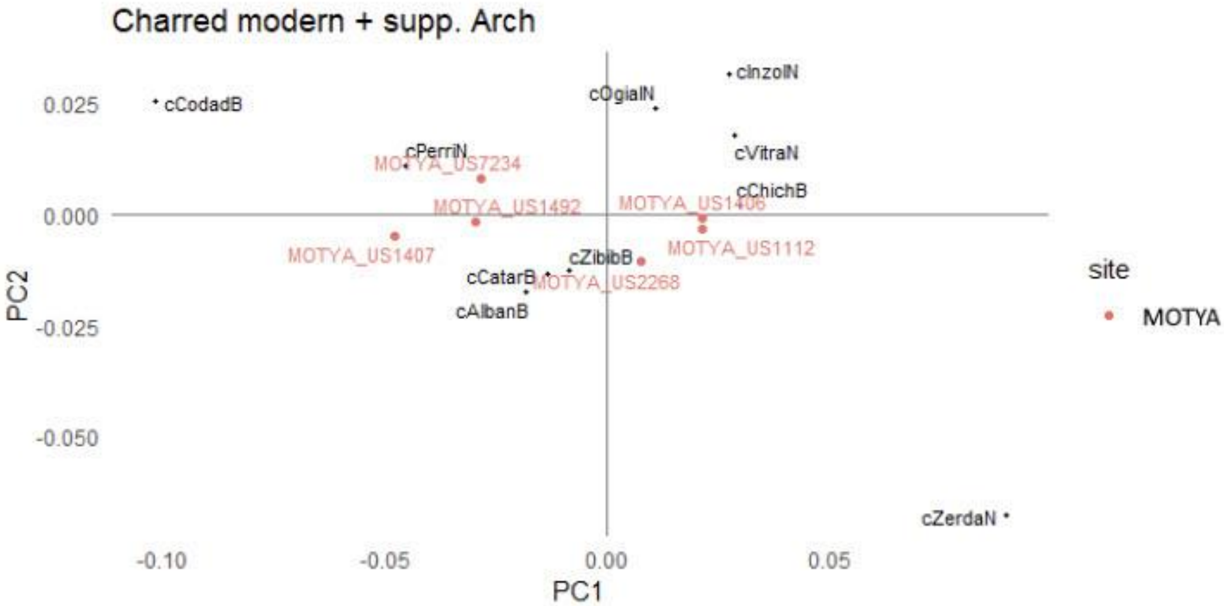


Figure 8


Charred modern + supp. Arch
cInzolN
cCodadB
cOgialN
cVitraN
cPerriN
MOTYA_US7234
cChichB
MOTYA_US1492
MOTYA_US1406
MOTYA_US1407
MOTYA_US1112
cZibibB
cCatarB
MOTYA_US2268
cAlbanB
cZerdaN
0.025
0.000
-0.025
-0.050
PC2
-0.10
-0.05
0.00
0.05
PC1
site
MOTYA

Abbreviation	Cultivar	Origin	Berry color	Number of pips
Alban	"Albanello"	Sicily	White	30
Catar	"Catarratto"	Sicily	White	30
Chicv	"Chichvi"	Georgia	White	30
Codad	"Coda di Volpe"	Italy	White	30
Inzol	"Inzolia"	Sicily	Black	30
Ogial	"Ogialesci"	Georgia	Black	30
Perri	"Perricone"	Sicily	Black	30
Vitra	"Vitrarolo"	Sicily	Black	30
Zerda	"Zerdagi"	Georgia	Black	30
Zibib	"Zibibbo"	Uncertain	White	30

CONCLUSIONS

In spite of the Phoenicians having expanded and settled along the coasts of the Mediterranean basin, from the Levant towards the west, surpassing the Strait of Gibraltar, they have not yet been thoroughly investigated from an archaeobotanical point of view. Phoenician plant records are, in fact, still fragmented. For this reason, this PhD dissertation constitutes a fundamental contribution to the understanding of human-environment interactions of this set of populations.

The study presented in this PhD thesis represents the first systematic archaeobotanical study performed at the Phoenician site of Motya (Sicily, Italy). The published/submitted papers here illustrated are the result of different processing stages of the archaebotanical record, starting from sampling and on-site processing, through separation, identification and photographic documentation of the plant remains, which I performed from scratch in the duration of my PhD project.

This dissertation highlights the potential of multidisciplinary archaeobotanical analyses. Different aspects of daily life were inferred through the analysis of different closed contexts: a votive *favissa* next to the Temple of Melqart/Herakles (SECTION 1, Chapter 1; Moricca et al., 2020. *Environmental Archaeology*) and a disposal pit in Area D (SECTION 1, Chapter 2; Moricca et al., accepted. *Vegetation History and Archaeobotany*), both datable to the 8^{th}-6^{th} century BC. A complete picture was only possible thanks to the combination of the study of macro- and micro-remains.

The conclusions presented here are based on the combination of the data obtained in SECTION 1, Chapter 1 (Moricca et al., 2020. *Environmental Archaeology*), Chapter 2 (Moricca et al., accepted. *Vegetation History and Archaeobotany*) and SECTION 2, Chapter 3 (Moricca et al., under review. *Journal of Archaeological Science: Reports*).

Human diet of the Phoenicians of Motya resulted in being comprised of cereals (mostly naked wheats), pulses and fruits. As suggested by pollen evidence and previous demographic studies, cereals were likely cultivated on-site. Remains of different sized weeds and chaff in the carpological assemblage, as well as their amount in relation to grains, suggests that processing was carried out daily after storage.

Anthracological remains from both the studied contexts give indications on the choice of timber, showing a preference for local taxa. While in the disposal pit evergreen oaks represent the prevalent taxon, *Olea europaea*, characterized by a slow growth rate, was preferred in the sacred context. Nonetheless, more rare taxa are also attested. These include walnut, characterized by high quality timber, which was introduced to Sicily from the East in the 7^{th}-6^{th} century BC, possibly thanks to the Phoenician influence and trade. Furthermore, mountain pine, which grows in Sicily only on Mount Etna, could have been brought from there, or imported from the Balkans or the Phoenician territories in Cyprus, northern Africa or the southern coast of Spain.

Concerning the ritual sphere, the carpological remains of cereals, grapes and figs have allowed the confirmation of the archaeological hypothesis that ritual meals accompanied animal sacrifices. Archaeobotany also attests to the offering of flowers, ornamental and prestigious plants. A high concentration of plants with medicinal properties may be linked to Melqart/Herakles, the titular deity of the studied temple. In Motya, Melqart also includes some salvific aspects of Eshmun, another major Phoenician healer.

An interesting aspect is given by the presence of numerous taxa toxic to livestock. The find of such plants possibly indicates an intentional poisoning, aimed at sedating the animals before sacrificing them.

Past environment is inferred by anthracological and palynological evidence. Palynology allows for the depiction of a strongly anthropized Mediterranean landscape, with little to no forest cover. Complex anthropogenic activities are testified by, among others, the presence of cultivated trees and cereals, with Asteroideae, Cichorioideae and *Urtica* as the main synanthropic taxa. Anthracology helps to complete the local environmental picture, with findings of *Pistacia lentiscus*, *Olea europaea*, *Erica multiflora* type, *Erica arborea* type, *Juniperus* sp. and evergreen oaks.

A particularly interesting aspect is indicated by the presence of juniper and *Erica arborea* in the anthracological and/or fossil records. These species are, in fact, absent in the present-day flora of the Marsala lagoon. The complete disappearance of juniper in present-day western Sicily could be due to burning. Juniper is, in fact, less performant than other plants of the macchia, like ericaceans and lentisk, after a fire. These easily sprout again after the passage of a fire. Similar considerations can be made for explaining the present lack of *Erica arborea*, which requires a deeper and more advanced soil than *E. multiflora*. Its disappearance is likely due to soil erosion caused by desertification affecting western Sicily, ascribable to aridification and/or over-exploitation of land.

Morphometric analyses have proven to be a useful tool to further investigate the relationship between Phoenicians and plants. Placing the focus on the grapevine has allowed us to gather information concerning the role of Phoenicians in the spread of viticulture. Based on the results obtained in this PhD research project, it is possible to ascertain that domesticated grapevines of more than one cultivar were consumed at Motya. Although no apparent clear correspondence to modern cultivars was found, pips from selected stratigraphic units resemble the Sicilian cultivars “Albanello”, “Catarratto” and “Perricone”.

Morphometry allowed for the extension of the area of research of the present thesis to the Western Mediterranean, taking in consideration waterlogged samples from the Iron Age sites of Nuraghe S’Urachi and Huelva, which are associated with Phoenician expansion and cultural interaction. Pips from these sites also present a “domesticated” morphology. Furthermore, samples from the three sites are clearly distinguishable based on their morphology. This indicates the use of different cultivars, contradicting the theory that Phoenicians favoured the spread of grape varieties. It appears more probable that they based their viticulture on local grapevines, depending on the site where they settled.

While the present PhD thesis has allowed the investigation of many key aspects of the human-plant relationship of Phoenicians at Motya, a lot can still be unraveled. Future studies could focus on the analysis and comparison of plant assemblages from different contexts which have not yet been brought to light, allowing researchers to gather a broader view on the investigated issue. The potential of pollen records should not be discarded, as they have been proven to provide information complementary to those obtained through the study of macro-remains. Furthermore, the analysis of a continuous stratigraphic sequence would allow researchers to obtain an image of the environment changing through the course of time.

Another interesting aspect to be developed concerns the biomineralization processes which affect numerous taxa of the Boraginaceae family, present in high concentrations in the sacred context. While this type of mineralization is acknowledged in literature, in depth studies have only been performed on a few selected taxa.

Finally, morphometric analyses have the potential to answer further questions regarding the role of Phoenicians in the spread of viticulture in the Western Mediterranean and their impact on modern grapevine diversity. Such analyses could be extended to cover materials from different

contexts at Motya, different Phoenician sites and a wider variety of modern cultivars. In cases of waterlogged materials, DNA analyses could be an additional tool.
In conclusion, the present PhD research project has facilitated the successful description of the interactions of Phoenicians and plants at the site of Motya during the Iron Age, also depicting an image of the past environment. This has greatly contributed to filling a gap in the knowledge of this enigmatic set of populations, providing new perspectives for future studies.

Paper contributions

Archaeobotany at Motya

1. **Moricca C.**, Nigro L., Spagnoli F., Sabatini S., & Sadori L. 2020. Plant assemblage of the Phoenician sacrificial pit by the Temple of Melqart/Herakles (Motya, Sicily, Italy). *Environmental Archaeology*, 1-13. https://doi.org/10.1080/14614103.2020.1852757

The manuscript was conceived and written by the candidate, who was responsible for data production, management and interpretation in collaboration with all the authors. She also elaborated all the figures.

2. **Moricca C.**, Nigro L., Masci L., Pasta S., Cappella F., Spagnoli F., & Sadori L. (accepted). Cultural landscape and plant use at the Phoenician Motya (Western Sicily, Italy) inferred by a disposal pit. *Vegetation History and Archaeobotany*.

The manuscript was mostly written by the candidate with the collaboration of other authors. She was responsible for the production of data deriving from plant macro-remains and took part in the treatment of samples for palynological analysis. She was also responsible for data management and interpretation together with the co-authors. Most of the figures were elaborated by the candidate.

3. **Moricca C.**, Bouby L., Bonhomme V., Ivorra S., Pérez-Jordà G., Nigro L., Spagnoli F., Peña-Chocarro L., van Dommelen P., & Sadori L. (in review). Grapes and vines of the Phoenicians: morphometric analyses of pips from modern varieties and Phoenician archaeological sites in the Western Mediterranean. *Journal of Archaeological Science: Reports*.

The candidate wrote the manuscript in collaboration with the co-authors. She was responsible for data acquisition and collaborated to its elaboration. She interpreted the data along with the other authors. Figures were partially drawn by the candidate.

Archaeobotany at Jericho

4. **Moricca C.**, Nigro L., Gallo E., & Sadori L. 2020. The dwarf palm tree of the king: a *Nannorrhops ritchiana* in the 24^{th}-23^{rd} century BC palace of Jericho. *Plant Biosystems*, 1-10. https://doi.org/10.1080/11263504.2020.1785967

The manuscript was conceived and written by the candidate, who was responsible for data production, management and interpretation in collaboration with all the authors. She also elaborated most of the figures.

Archaeobotany at Santi Quattro Coronati

5. **Moricca C.**, Alhaique F., Barelli L., Masi A., Morretta S., Pugliese R., & Sadori L. 2018. Early arrival of New World species enriching the biological assemblage of the Santi Quattro Coronati Complex (Rome, Italy). *Interdiscipinaria Archaeologica Natural Sciences in Archaeology*, *9*, 83-93.

The manuscript was written the candidate in collaboration with other authors. She was responsible for the production of data deriving from plant remains, their management and interpretation in collaboration with all the authors. She also elaborated most of the figures.

6. Alhaique F., **Moricca C.**, Barelli L., Masi A., Pugliese R., Sadori L., Romagnoli G., Piermartini L., Brancazi L., Gabbianelli F., Chillemi G., & Valentini A. 2021. Elite food between the late Middle Ages and Renaissance: some case studies from Latium. *Environmental Archaeology*. https://doi.org/10.1080/14614103.2020.1867038

The candidate was responsible for the production, elaboration and interpretation of archaeobotanical data. She elaborated two of the figures present in the manuscript.

7. Kosňovská J., Beneš J., Skružná J., Speleers L., Brinkkemper O., Castillo C., **Moricca C.**, Wiethold J. (in preparation). Explaining American useful species in the early modern Prague: contextual analysis of the post-columbian archaeobotanical and historical evidence in Europe. *Economic Botany*.

The candidate contributed to the collection of bibliographic data regarding the archaeobotanical evidence of Native American taxa in Europe, being responsible for data deriving from Italian contexts. She also collected data regarding iconography of the studied taxa.

Other products

During my PhD project, when downtimes occurred between excavation seasons, I have had the opportunity to follow two extra lines of research in the field of archaeobotany, focusing on different archaeological sites.

The first one concerned the analysis of charred archaeobotanical remains from the archaeological site of Jericho, excavated by Sapienza University of Rome under the supervision of Prof. Lorenzo Nigro. The initial purpose of the analysis was the characterization of the remains before ^{14}C dating. However, amongst the remains, one captured my attention. An in-depth analysis using classical archaeobotanical techniques and computed tomography scans allowed to characterize it as a fruit of *Nannorrhops ritchiana* Griff. (Aitch.), a dwarf palm which does not currently grow in the area of Jericho. Its retrieval in archaeological layers, possibly associated to the cult of the sacred tree, allows to hypothesize contacts with the southern Arabian Peninsula earlier than has been previously suggested, providing a new perspective on Middle Eastern trade routes. This study resulted in a publication titled "The dwarf palm tree of the king: a *Nannorrhops ritchiana* in the 24th-23rd century BC palace of Jericho", authored by Claudia Moricca, Lorenzo Nigro, Elisabetta Gallo and Laura Sadori and published in Plant Biosystems (**Appendix A**).

The second line of research regarded the publication of my Master's thesis concerning the analysis of archeobotanical remains from an Early Modern Age pit in the Santi Quattro Coronati complex in Rome. Here, among other plants, I identified the seeds of *Cucurbita pepo* and *Cucurbita maxima/moschata*, pumpkins native to the New World. They represent one of the oldest retrievals of such species, if not the oldest, in Europe. These early introductions could be justified by the fact that the Cardinal's palace, a very prestigious and wealthy landmark, was one of the first stops along the trading routes that emanated from the New World, leading to the rapid availability of new plant and animal species. This study, authored by Claudia Moricca, Francesca Alhaique, Lia Barelli, Alessia Masi, Simona Morretta, Raffaele Pugliese and Laura Sadori, was published under the title "Early Arrival of New World Species Enriching the Biological Assemblage of the Santi Quattro Coronati Complex (Rome, Italy)" in Interdisciplinaria Archaeologica: Natural Sciences in Archaeology (**Appendix B**).

Two collaborations were born from this line of research: an article concerning high status foods in Medieval/Early Modern Age Latium (**Appendix C**) and a review of New World archaeobotanical findings in Europe (Kosňovská et al., in preparation).

Appendix A

The dwarf palm tree of the king: a *Nannorrhops ritchiana* in the 24th-23rd century BC palace of Jericho

Moricca C., Nigro L., Gallo E., Sadori L.

Taylor & Francis

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The dwarf palm tree of the king: a *Nannorrhops ritchiana* in the 24th-23rd century BC palace of Jericho

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ABSTRACT

Charred botanical finds from the excavation of the Early Bronze Age city of Jericho (Tell es-Sultan), one of the earliest urban centers of 3rd millennium BC Palestine, were collected during the 2015-2017 excavation seasons carried out by Sapienza University of Rome and the Palestinian MoTA-DACH. Among other plant macro-remains, a round fruit was found in the subsidiary room behind the throne room of Royal Palace G, next to a vase, in the burnt filling overlying the platform. It was identified as a drupe of a dwarf palm, through classical archaeobotanical techniques and computed tomography scan. Two dwarf palms were taken into consideration: the Mediterranean dwarf palm (*Chamaerops humilis* L.) and the Mazari palm (*Nannorrhops ritchiana* (Griff.) Aitch. native to the Saharo-Indian region), both with small, round/oval fruits, none of which currently grows in the area of Jericho. A detailed analysis of iconography, archaeobotanical literature and herbarium samples of both species stored in Rome (RO), Florence (FIAF) and Edinburgh (E), has allowed to identify the charred drupe as *Nannorrhops ritchiana*. Its presence in the palace suggests the existence of an overland commercial track to the south-east, across the desert of Saudi Arabia, which only recent excavations and other finds have revealed.

ARTICLE HISTORY
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KEYWORDS
Jericho; *Nannorrhops ritchiana*; sacred tree; archaeobotany; iconography; Early Bronze Age

Introduction

Tell es-Sultan is located in the Jericho Oasis (Figure 1), 3 km from the centre of the present town of Ariha, in Palestine, at an altitude of 220 meters below sea level (Barkai and Liran 2008; Nigro 2014a). The climate of the area is classified as arid, with hot summers and warm winters with very rare frost incidents (Mimi and Jamous 2010). The present-day vegetation has been described as a Sudano-Deccanian enclave, constituted mostly of a *Ziziphus spina-christi* (L.) Desf. (Christ's thorn jujube) - *Balanites aegyptiaca* Delile (desert date) association. Other species include *Acacia tortilis* (Forssk.) Hayne, *Calotropis procera* Aiton and *Solanum incanum* L. (Zohary 1947). *Ceratonia siliqua* L. and *Cupressus sempervirens* L. are among the plants that have been adapted in the area of Jericho (Ighbareyeh 2019).

The Archaeological Expedition to Jericho of the Sapienza University of Rome and the Palestinian MoTA-DACH (Ministry of Tourism and Antiquities, Department of Antiquities and Cultural Heritage) has been committed in the excavation of the Early Bronze Age city of Tell es-Sultan, one of the earliest urban centers of 3rd millennium BC Palestine (Nigro and Taha 2009; Nigro et al. 2011; 2015; Nigro 2016; Nigro 2020a). Excavations unearthed a monumental fortification system (Areas B; F, L), the northern dwelling quarter (Area F), and royal Palace G, the major administrative center of the city.

A severe earthquake led to a sudden end of the life of the earliest fortified city of the Early Bronze (EB) II (Sultan IIIb Period) towards the end of the 28th century BC (Nigro 2014b). The city was immediately rebuilt (2700-2500 BC, EB IIIA, Sultan IIIc1 Period), as the life resources of the city were not swept away by the upheaval. The reconstruction of the city, thus, became an opportunity to strengthen the defensive system, with the erection of a new double city-wall with rectangular towers and blind rooms in between the outer and inner city-walls (Sellin and Watzinger 1913; Garstang 1930; Garsta 1931; Kenyon 1981; Marchetti and Nigro 1998; Nigro 2016). A major enterprise of this second urban stage was the reconstruction and enlargement of the palace on the eastern flank of the "Spring Hill" overlooking the spring and the oasis (Sellin and Watzinger 1913; Garstang 1932; Kenyon 1981; Nigro et al. 2011; Nigro 2016; Nigro 2017; Nigro 2020b). The palace was subdivided into three wings each on a different terrace descending down to the spring. The main entrance of the palace was on its southern side and opened onto a square in the main street which climbed the Spring Hill in a northerly direction. It led to the middle terrace, where a porch opened onto a hall with a raised podium on its north side, a reception suite, flanked by a small subsidiary room (Figure 2). Some stairs led to the upper storeys which presumably hosted the royal apartments.

The upper terrace was accessible directly from the main street, through a door in the western perimeter wall of the palace. It hosted industrial installations, with rooms for food preparation and other workshops (perhaps also a smith).

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A third entrance to the palace was located on the eastern lower terrace and connected directly with the spring area and the market just inside the city gate. This door gave access to the administrative and storage wing of the building, and to a corner tower which possibly also served to control the access to the main street from the market area.

Several finds from the palace may illustrate multiple functions of this building. A copper axe and a dagger (with the preserved part of the handle) were found in the courtyard of the lower wing (Kenyon 1981; Nigro 2016; Nigro 2020b), while a basalt potter's wheel (Dorrell 1983) and several stone tools, including grinding stones, pestles, polishing pebbles and flints were found in the upper western wing. In the central wing, big jars and pithoi belonged to the furnishings of the royal apartments (Nigro et al. 2011; Nigro 2020a).

The focus of this article is on a small subsidiary room behind the throne room of the palace, where a round stone platform was found abutting from a wall with two symmetrical high benches or niches. This installations was interpreted as a cultic one, because of the retrieval of the bull-shaped spout of a cultic vessel (Nigro et al. 2011; Nigro 2016) The vase, possibly a *kernos*, was used for libation in front of a sacred image or plant, as often depicted in the art of the ancient Near East (see below).

The palace was destroyed by a fire that took place in ca. 2350 BC (Nigro 2017; Nigro 2020b).

Materials and methods

Botanical finds from the contexts referable to the final destruction of the city (ca. 2350/2300 BC, EB IIIB, Sultan IIIc2 Period), were collected by hand-picking during the 2015-2017 seasons in order to be AMS radiocarbon dated (Nigro et al. 2019).

Among the finds, a round fruit preserved by charring was found in the subsidiary room behind the throne room of the royal Palace G, next to a vase, in the burnt filling overlying the platform. The peculiar archaeobotanical remain was observed under a Leica M205C stereomicroscope at the Laboratory of Archaeobotany and Palynology in the Department of Environmental Biology of Sapienza University of Rome. High resolution images were acquired using the Leica IC80 HD photo camera and to the program Leica Application Suite, version 4.5.0. These were later processed using Helicon Focus, version 6.6.1 Pro, which allows to blend together shots of the same sample taken at different focus. The precise measures of the fruit's diameter were obtained using the ImageJ 1.51j8 software.

In order to assess the nature of the remain, a computed tomography scan was performed at the Radiology Department of the "Policlinico Umberto I" of the Sapienza University of Rome. Identification was carried out through the consultation of atlases (Neef et al. 2012), digitized herbarium samples from the Royal Botanic Garden of Edinburgh (2018) and from the Museum Herbarium of the Sapienza University of Rome, as well as fresh samples from the Botanical Garden of the Sapienza University of Rome.

Results

The observations under the stereomicroscope allowed to describe the fruit as globose, having a smooth and uniform surface without longitudinal grooves (Figure 3).

The specimen presents a stigma scar on its base and a pedicel scar on its apex. The measured diameter is of 12 mm. The computed tomography scan allowed to determine the presence of one endocarp, having a different density than the rest of the fruit, leading the specimen to be classified as a drupe (Figure 4), a fruit containing a stone seed.

The described features closely correspond to palm fruits. While five Arecaceae genera are currently found in the Mediterranean basin and the Near and Middle East (*Chamaerops*, *Hyphaene*, *Medemia*, *Nannorrhops* and *Phoenix*; Dransfield et al. 2014), only the fruits of *Chamaerops humilis* L. (Mediterranean dwarf palm) and *Nannorrhops ritchiana* (Griff.) Aitch (Mazari palm or dwarf palm) correspond to the description. The two species are very similar to each-other and none of them currently grows in the Levant.

The Mazari palm (Figure 5) is a small gregarious perennial palm, with grayish green leaves, which is able to reach a height of approximately 5 meters in optimal conditions. Native to the deserts of the Saharo-Indian region, it is known as one of the most robust and versatile palms, being able to tolerate temperatures as low as −12°C, but also extreme heat, insufficiency of water and harsh winds (Mahmood et al. 2017; Naseem et al. 2005). *N. ritchiana*'s fruits are described by Malik (2011 as globose or ovoid drupes of variable size in the range of 6-18 mm. Khodashenas et al. (2016) narrow the size range down to 10-13 mm.

Chamaerops humilis, the Mediterranean dwarf palm (Figure 6), the only palm native to Europe, closely resembles *N. ritchiana*. On average, it grows between 1 to 1.5 meters in mean height, but in protected areas it can reach a height of 10 meters (Benmehdi et al. 2012). *C. humilis*'s underground rhizome produces shoots with palmate, sclerophyllous leaves. Like the Mazari palm, the Mediterranean fan palm is very tolerant to disturbance, being able to survive deforestation, fires, pasturing and cold temperatures (as low as −9°C; Bannister 2007; Herrera 1989). *C. humilis* fruits closely resemble the description of the charred specimen, being classified by Pignatti (1982) as subspherical and ovoid with size comprised between 1-3 cm. Herrera (1989) adds that they are dully yellow to brown when ripe and contain a single, stony seed. Likewise, Morales et al. (2016) describe them as globular reddish-brown drupe, oblong or ovoid, measuring 1-4 cm.

Among the two, the analyzed remain fits more closely the description of *N. ritchiana* for the quasi-spherical shape, while size is not a discriminating feature.

Although in literature the drupes of the two species are described as being very similar, herbarium samples show otherwise. While *N. ritchiana* fruits (Figure 5) are proven to be round, *C. humilis* fruits are clearly more elongated (Figure 6). This points towards an identification of the charred remain as a Mazari palm fruit.

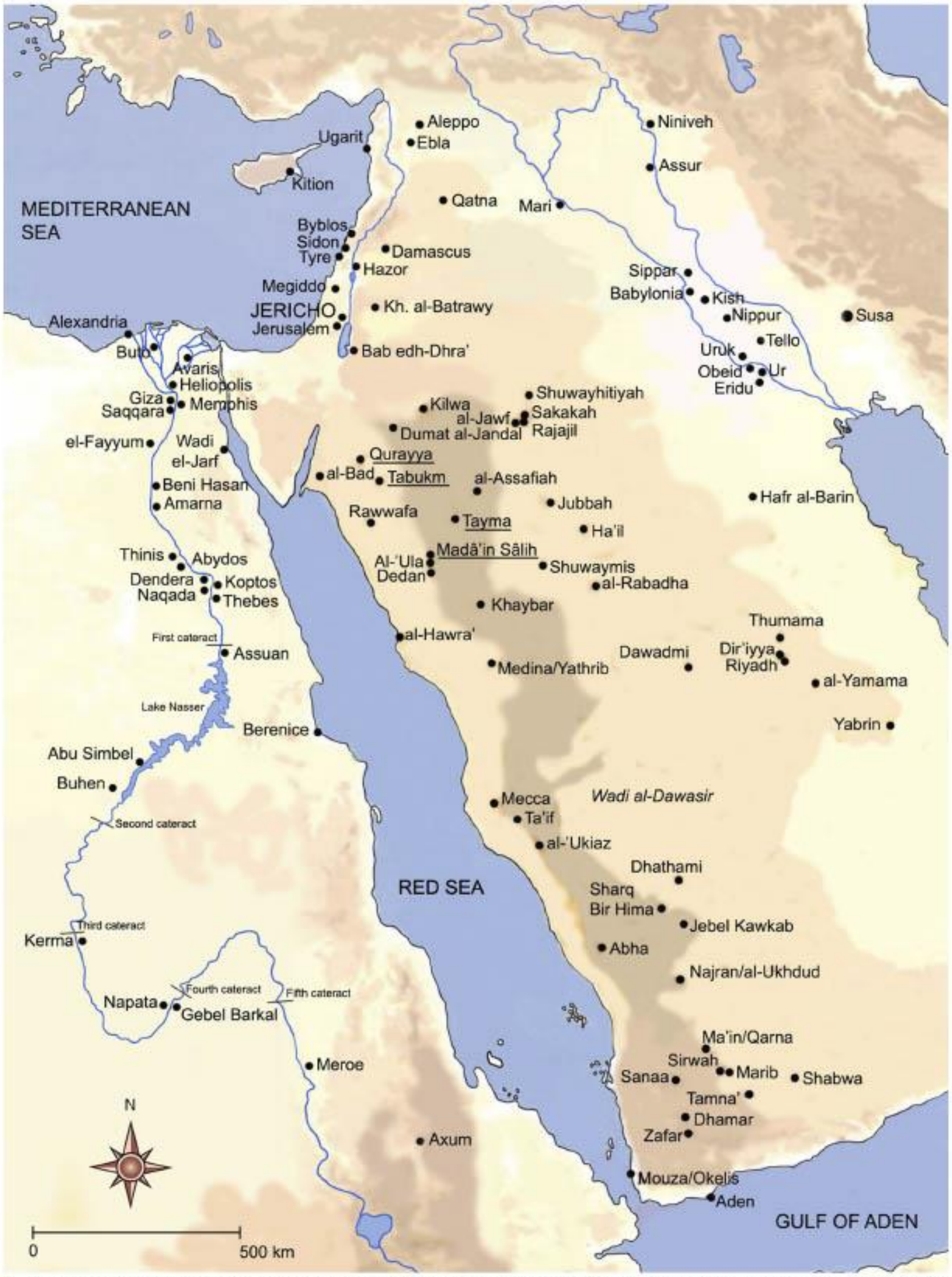

Figure 1. General map of the Near East, Egypt and Saudi Arabia Peninsula. Main archaeological sites are reported. The underlined names refer to sites quoted in the text.

Figure 2. View of the subsidiary room L.1160 with platform L.1168 and light well L.1162 to the north brought to light in the middle terrace of EB III Palace G, from the east. © Sapienza University of Rome ROSEPAJ.

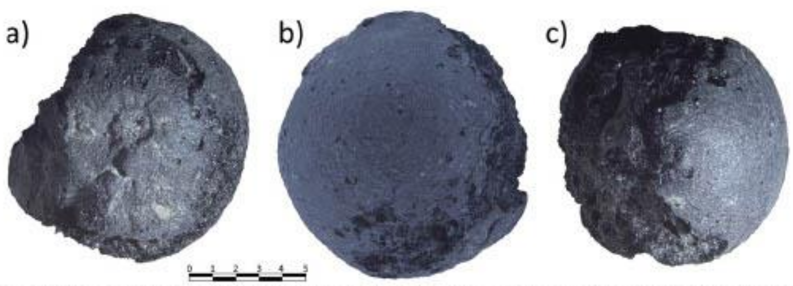

Figure 3. Charred round fruit found in the archaeological site of Tell es-Sultan; a) top view, pedicel scar is visible; b) lateral view; c) bottom view, stigma scar is visible.

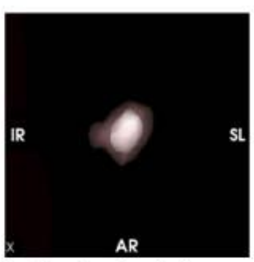

Figure 4. The investigated specimen showing the presence of only one seed inside (CT scan image).

Discussion

Despite of both the fruits of *Chamaerops humilis* and *Nannorrhops ritchiana* roughly fitting the description, being ovoid and having a diameter of ca. 1 cm, we are confident in identifying the specimen from Tell es-Sultan as *Nannorrhops ritchiana*. This is motivated by Mazari palm fruits being more round than the ones of the Mediterranean dwarf palm, as can be observed by comparing the specimen of *C. humilis* from two Italian *herbaria*, *Herbarium Cesatianum* stored at the Sapienza University of Rome Herbarium (RO; Figure 5; Millozza and Giovi 2008) and *Herbarium Universitatis Florentinae* in Florence, with the digitized herbarium sample of *N. ritchiana* from the Royal Botanic Garden of Edinburg (E; Figure 6).

The find of a drupe of dwarf palm proves to be of great interest in the site of Tell es-Sultan, as it represents the first such archaeobotanical record in the area. The peculiarity is enhanced by the fact that no dwarf species currently grows in the area of Jericho. The present geographical distribution of *Nannorrhops ritchiana* is currently represented by the semi-desert areas of the Middle East (Iran, Afghanistan, Pakistan and Saudi Arabia; Kubitzki 1998; Gratzfeld and Khan

Figure 5. (a) Nannorrhops ritchiana (Griff) Aitch. specimen from the Royal Botanical Gardens of Edinburgh Herbarium (E; Miller 1984); (b) close-up of the Nannorrhops ritchiana fruits.

2015; Figure 7). In contrast, *Chamaerops humilis* covers the central and western Mediterranean, including both the European side (S Portugal, S and E Spain, SE France, W Italy and Malta) and African countries (Morocco, N Algeria and N Tunisia; Garcia-Castano et al. 2014; Guzmán et al. 2017).

Ethnobotanical and medicinal studies of the Mazari palm have attributed it many uses and properties, which may have influenced its importation to Jericho. Leaves are used for basket and rope making, the dried plant can be used as fuel, the ash as a coloring material. The principles extracted from the leaves have proven to be successful for the treatment of diarrhea and dysentery. They are also used as a purgative in veterinary practice (Marwat et al. 2011; Zabihullah et al. 2006). Inflorescences and fruits are used as food (Johnson 1987). In particular, fruits are, in contrast with leaves, consumed for their laxative and purgative properties (Hussain et al. 2018). Finally, seeds are used as beads, in India they are chosen specifically for rosaries (Khan and Shaukat 2006).

Archaeobotanical evidence of dwarf palms

Some considerations may be done on the geographical distribution of archaeobotanical and historical attestations of *Nannorrhops ritchiana* and *Chamaerops humilis*. Most records of the Mazari palm are restricted to sites in Pakistan, where they are found in the form of seeds and fruits. Endocarps or fragments of endocarps were found in the 4th-2nd millennium BC sites of Miri Qalat and Shahi-Tump in the Kech valley (Tengberg 1999; Besenval et al. 2005). Fruits of *N. ritchiana* were found in samples from Period III (ca. 2700-2400 BC) in Sohr Damb, a prehistoric site in Central Balochistan, Pakistan (Neef et al. 2012). The possibility of such plant being cultivated is taken in consideration, although gathering from the wild is not excluded (Benecke and Neef 2003). Additionally, phytolith studies have allowed to identify *N. ritchiana* as the plant used for making a protohistoric net, preserved by charring in the site of Shahi-Tump (Baluchistan, Pakistan) after a fire partly destroyed a 4th millennium BC building (Thomas et al. 2012). These sites are all located within a radius of less than 500 km from each other, but 3000 km away from Madâ'in Sâlih (in Saudi Arabia), where charred stems of the Mazari palm, identified based on the anatomy of the fibrous vascular bundles, have been found in domestic contexts (Bouchaud et al. 2011). Although more recent (2nd century BC - 7th century AD) than the find from Tell es-Sultan, this advances the idea of *N. ritchiana* being exchanged through commercial routes with the Middle East since earlier on.

The archaeobotanical and historical attestations of *Chamaerops humilis* reflect its present distribution, being restricted to the coasts of the Western Mediterranean. Stones of the Mediterranean dwarf palm were found in the Iberian Peninsula in the Iron Age site of Huelva (Pérez-Jordà et al. 2017), in the 6th millennium BCE site of Cova de les Cendres (Alicante) and in Morocco (Peña-Chocarro et al. 2015). Remains of the Mediterranean dwarf palm were also found in Early Neolithic sites of São Pedro de Canaferrim and Lapiás das Lameiras in Sintra, Portugal (López-Dóriga 2018). Charcoal fragments dating to the 1st century AD were retrieved in a garden of a rich domus in the ancient Roman town of Privernum, in southern Latium (Sadori et al. 2010). The Mediterranean dwarf palm is also mentioned by the Roman author Pliny the Elder in his *Naturalis Historia* (Gleason 2019). *C. humilis* pollen also represents an evidence

Figure 6. (a) Chamaerops humilis L. sample from the Herbarium Cesatianum held at the Museum Herbarium of the Sapienza University of Rome: (i) whole specimen, (ii) detail of the fruits; (b) Chamaerops humilis L. sample from the Herbarium Universitatis Florentinae: (i) whole specimen, (ii) detail of the fruits.

worth of notice, being found in the Mid- to Late-Holocene site of Sierra de Gàdor in Southern Spain (Carrión et al. 2003), in Holocene sediments from Gorgo Basso (Tinner et al. 2009) and of Biviere di Gela, both lakes on the southern coast of Sicily (Noti et al. 2009). The only find of the Mediterranean dwarf palm which falls outside its present distribution area is represented by ropes from the 9th century AD Bozburun Byzantine shipwreck, Turkey, identified as being made of *C. humilis* fibers based on the diagnostic cell patterns of the epidermal tissue retrieved (Gorham and Bryant 2001). Such location is set at roughly 900 km from the site of Tell es-Sultan. However, it should be considered that the find dates to the 9th century AD, much more recent than the find from Jericho. Additionally, *C. humilis* is there found in the form of fibers used in rope making, therefore not testifying the use of its fruits or of the whole plant.

The iconography of the sacred tree in the near east

The retrieval of a palm fruit in the small room behind the throne room of the EBA palace of Jericho also proves to be of great interest from an archaeological perspective. The first depictions of palm-like objects in art date back to the 6th – 5th millennia BC, before the beginning of literacy, being engraved on bones from the sites of Neve-Yam and Hagoshrim in Northern Israel, and interpreted as the portrayal of a tree goddess (Orrelle and Horwitz 2016). More

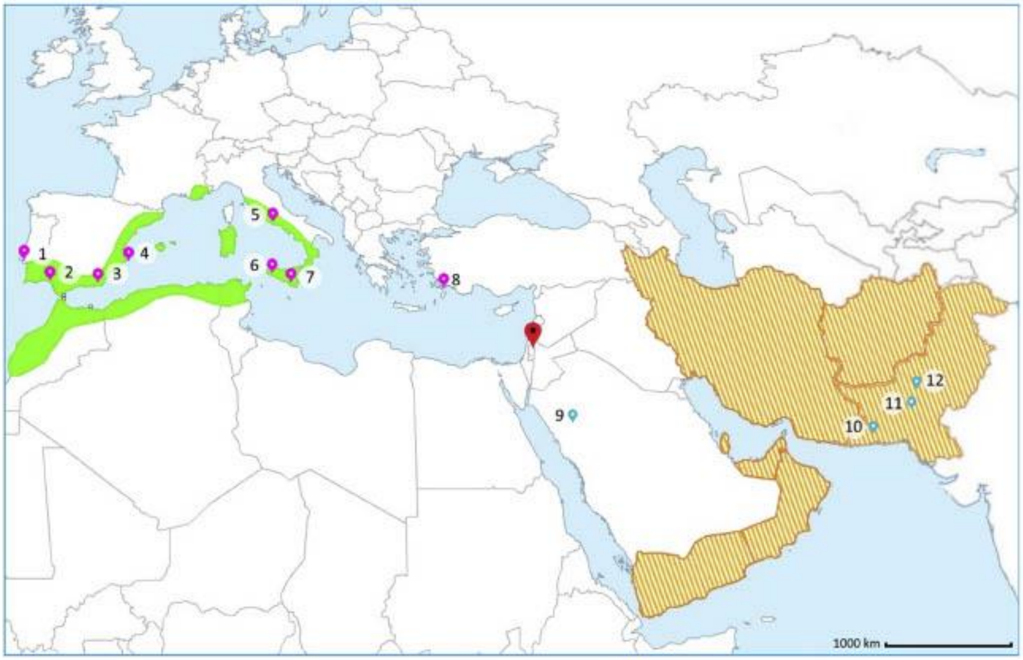

Figure 7. Present distribution map of Chamaerops humilis (green; from Garcia-Castano et al. 2014) and Nannorrhops ritchiana (striped orange; from Palmweb 2019). A proper distribution map was not available for the latter, therefore whole countries where the palm is found have been highlighted. The red pin indicates the archaeological site of Tell es-Sultan (Jericho). Pink pins indicate the archaeobotanical findings of C. humilis: 1. São Pedro de Canaferrim and Lapiás das Lameiras in Sintra (charcoal); 2. Huelva (stones); 3. Sierra de Gàdor (pollen); 4. Cova de les Cendres (stones); 5. Priverno (charcoal); 6. Gorgo Basso (pollen); 7. Biviere di Gela (pollen); 8. Bozburun (fibres). Blue pins indicate the archaeological sites where N. ritchiana remains were found: 9. Madâ'in Sâlih (charcoal); 10. Shahi-Tump (endocarps, phytoliths); 11. Sohr Damb (fruits); 12. Miri Qalat (endocarps).

frequent iconographic representations of a sacred palm-like tree date back to as early as 3000 BC, when Sumerians are supposed to have started date palm cultivation (Nixon 1951), and include depictions on a bronze axe found in Byblos (Nigro 2003). Sacred plants worshipped by priests, kings and even hemi-mythic beings are known from Mesopotamian art (in glyptic of Akkadian, Old-Babylonian, Kassite, Assyrian), and there is evidence in several palaces (from Kish to Mari) of the presence of trees and plants for ornament or symbolic functions. The motif continues to be seen until the end of the first millennium, with a great degree of individual variability. Despite of this, it can be summarized as featuring a series of peculiar characteristics. These consist of "a trunk with a palmette crown standing on the stone base and surrounded by a network of horizontal or intersecting lines fringed with palmettes, pinecones, or pomegranates" (Parpola 1993).

Due to the absence of cuneiform sources expressly mentioning the tree species, scholars have developed several interpretations, without reaching a consensus on its iconography. There are three main interpretations: a) that it represents the "tree of life"; b) a date palm; c) a constructed cult object (Giovino 2007).

Although the date palm theory appears to have overpowered the other two, Giovino (2007) believes that the interpretation as a constructed cult object is much more promising. Langdon (1919), observing the Assyrian Sacred Tree (AST) against other Near Eastern examples, noticed that the image of worshippers before the AST was mirrored in their depiction in front of human-form or aniconic representations of gods, such as a spade and wedge, using the same gesture of worship in both cases.

Interestingly, the recovered charred fruit belongs to a different palm species than the one corresponding to the most widely accepted interpretation of iconography. It is possible that the adoration was not directed specifically to the date palm tree, but rather to a general tree or tree-like object, such as the 8th century BC "artificial tree" evidence found in Neo-Assyrian royal city of Khorsabad during mid-19th century excavations (Giovino 2007). Such evidence is constituted by large pieces of bronze sheathing embossed with the design of palm tree trunk scales or imbrications which had once been nailed to a shaft of cedar 9 m long and 0.5 thick, resulting in a metal encased pole. For this reason, a dwarf palm would have served as a perfect substitute. The small dimensions of *Nannorrhops ritchiana* made it more suitable for cultivation inside the palace or in sacred buildings. An additional prestige might have been given by the fact that the Mazari palm has medical properties and that it must have been imported from further areas. The latter fact also suggests the existence of an overland commercial track to the south-east, across the desert of Saudi Arabia, which only recent excavations and other finds have revealed.

Conclusions

The presence of *Nannorrhops ritchiana* in the area of Jericho represents a novelty as this species does not grow in the area and has not been attested there in the past. It is therefore believed that the fruit could have arrived from the desert areas of either the Southern Arabian Peninsula or the Middle East through a commercial network. The Mazari palm, and in particular its fruits, could have been traded due to its widely attested medical properties. However, the context of retrieval, the room adjacent to the throne room, along with Near Easter iconography, rather suggests a sacred use of *N. ritchiana*.

This helps to backdate the possible use of the dwarf palm as a religious symbol/cult object. Recent finds in the north-western Arabian oases of Qurraya and Tabukm, may antedate direct contacts between the Southern Levant and the Arabian Peninsula to the Early Bronze Age. Connections between Tayma and the Levant are demonstrated for the final stage of the period (Early Bronze Age IVB) and in the following Middle Bronze Age, and accentuated during the Late Bronze Age (LBA), when political and commercial contacts extended to Egypt, the Mediterranean, Assyria and Babylonia (Liu et al. 2015). The establishment of actual trade routes between the southern Arabian Peninsula and the Levant is dated to the LBA, involving the trade of incense and copper (Liu et al. 2015), enriched during the Early Iron Age with the trade of iron (Renzi et al. 2016). Although the cited studies refer to more recent archaeological periods, it is evident that this geographical area represented a fundamental junction point between Mesopotamia and the Eastern Mediterranean. Through the presentation of few, but significant data, the present study allows to hypothesize contacts with the southern Arabian Peninsula earlier than has been previously suggested, providing a new perspective on Middle Eastern trade routes.

The find of further archaeobotanical remains (charcoals, pollen, phytoliths) could help in defining whether the Mazari palm was locally grown or, as appears to be more probable, was just found at Jericho as a result of commercial exchanges. Archaeological issues at the site of Tell es-Sultan could help to shed some light on the issue.

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Appendix B

Early Arrival of New World Species Enriching the Biological Assemblage of the Santi Quattro Coronati Complex (Rome, Italy)

Moricca C., Alhaique F., Barelli L., Masi A., Morretta S., Pugliese R., Sadori L.

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Early Arrival of New World Species Enriching the Biological Assemblage of the Santi Quattro Coronati Complex (Rome, Italy)

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Rome

ABSTRACT

This paper reports the archaeobotanical and archaeozoological data from a disposal pit, whose use started after the partial closure of a staircase, and from a mortar surface within a former porch in the Santi Quattro Coronati complex in Rome, Italy. The two contexts were in use in the Early Modern Age, when the complex served as a cardinal seat. The element that distinguishes the Santi Quattro Coronati from other contemporaneous contexts is the presence of New World species, until now only hypothesized based on a letter sent by the first resident bishop in Santo Domingo to Lorenzo Pucci, then cardinal with the titulus of the Santi Quattro Coronati. Pumpkin seeds (*Cucurbita pepo* and *C. maxima/moschata*) were found in the pit, while a pelvis of guinea pig (*Cavia porcellus*) was found in a former porch. Numerous archaeobotanical remains preserved by mummification, identified mostly as food, and many archaeozoological specimens were found in the pit. Based on the data, it is hypothesized that the pit was used mainly as a deposit for table waste. The results as a whole help towards the investigation of the eating customs and daily habits of a Renaissance high-status clerical community.

1. Introduction

The discovery of the New World by Columbus in 1492 caused a series of revolutions, among which the arrival of new vegetal and animal edible species that were gradually introduced in the diet and habits of Europeans and soon became a substantial part of it. The plants include *Capsicum* spp. (pepper and hot chili), *Cucurbita* spp. (gourds and pumpkins), *Helianthus* spp. (sunflower), *Phaselous* spp. (beans), *Solanum lycopersicum* L. (tomato), *Solanum tuberosum* L. (potato), *Theobroma cacao* L. (cocoa), *Zea mays* L. (corn), and the not edible, but quite important plant from an economic point of view, *Nicotiana* spp. (tobacco). Domestic animal species, in contrast, are much fewer: *Meleagris gallopavo* L. (turkey), *Cavia porcellus* Pallas (guinea pig), and *Cairina moschata* L. (Muscovy duck). Their introduction occurred at different times and rates as can be highlighted by iconographic pieces of evidence, ancient texts and recipes, as well as rare archaeobotanical and archaeozoological findings (Moffet, 1992; Karg, 2010; Benes *et al.*, 2012).

In the reconstruction of the spread of new species, written sources play a key role. The first indications come from Columbus himself who, for instance, in a letter dated November 13th, 1493, described maize as a type of millet. The following year, 1494, some *Zea mays* caryopses were delivered from Mesoamerica by Peter Martyr to Cardinal Ascanio Maria Sforza Visconti in Rome, favouring its distribution not only in Italy, but also in Spain, Portugal and Turkey (Janick, 2011). The fast spread of this plant is

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also attested by the first depictions of maize in Rome in the festoons of the Loggia of Cupid and Psyche painted by Raphael (1515–1518). The fresco shows also *Phaselous vulgaris*, *Cucurbita maxima* and *C. pepo* (Caneva, 1992). The latter, however, had already been represented a decade before in the 1503–1508 *Grandes Heures d'Anne de Bretagne*, a prayer book compiled and illustrated in Touraine, France (Paris *et al.*, 2006). The earliest finding of *Cucurbita moschata*/*C. maxima* appears to derive from a 15th–16th century cesspit in a Renaissance monastery in Argenta, Northern Italy (Mercuri *et al.*, 1999); again in Northern Italy, between 16th and 17th century, we find *Cucurbita* seeds in kitchen trash of the Guerrieri Gonzaga Palace in Volta Mantovana (Bosi, Buldrini and Rinaldi, 2015). Since the 16th century it appeared widespread in central Europe (Teppner, 2000).

Capsicum spp. appears to have been immediately accepted by Europeans because of its pungent taste, reminiscent of the black pepper that Columbus was originally looking for (Janick, 2011). The first European illustrations of chili pepper are dated to 1540 (*Codex Amphibiorum*) and, along with other Renaissance images, indicate that hot chili was the first variety of *Capsicum* to be introduced. *C. annuum* seeds are attested in Europe since the 16th–17th century in the Dutch site of Hertogenbosch (Hallavant and Ruas, 2014), in early modern sites in Northern Poland (Karg, 2010) and in a 17th–18th brick cesspit belonging to the college of the Theatine order in Prague, Czech Republic (Čulíková, 2014).

Helianthus annuus L. (sunflower) is also part of the vast heritage acquired after the discovery of the New World. Its first European depiction dates to 1568 and is found in *Florum et Coronariarum* by the Flemish botanist Dodoens. Archaeobotanical findings of sunflower in the Old World were found between the 15th and the 18th centuries in south-western Germany, where also *Z. mays* is attested (Rösch, 1998).

The arrival of potato to Europe is attributed to Francis Drake in association with the rescue of Roanoke colonists (Janick, 2012). The delay in the introduction of potato and tomato was partly due to their land of domestication, respectively the Inca Empire, conquered by Francisco Pizarro in 1531–1536 and the Aztec Empire, whose conquest occurred in 1521 (Daunay, Laterrot and Janick, 2006). Potato is first mentioned in herbals, where an illustration is also found, by Gerarde in 1597. Tomato is first mentioned in a 1544 chapter on mandrake by P. A. Matthioli (Daunay, Laterrot and Janick, 2006). The first illustration appears in Fuchs' unpublished *Vienna Codex*, painted by A. Meyer between 1542 and 1565 (Daunay, Laterrot and Janick, 2006). Much scepticism surrounded the consumption of both tomato and potato due to their similarity to the poisonous mandrake fruits and roots respectively (Janick, 2011). However, they both soon became substantial parts of the Mediterranean diet.

Among the animals, the most important is the turkey. This bird was likely imported to Spain in 1511 and from there it rapidly spread all over Europe (De Grossi Mazzorin and Epifani, 2015 and references therein). As far as Italy is concerned, the earliest possible evidence are the stuccoes in the Vatican Loggias made by Giovanni da Udine and Perin del Vaga between the end of 1517 and the beginning of 1519, but their identification as turkeys or peacocks is debated. Other clearer images are found in the paintings of Palazzo Madama by Giovanni da Udine dated to 1522–23. Although in the beginning turkeys were only considered as exotic animals to be exhibited by wealthy people, within a few decades they became popular as high-status food as evidenced, for example, by recipes in the *Singolare dottrina* by Domenico Romoli (1560) and the *Opera* by Bartolomeo Scappi (1570). Turkey bone remains are much rarer and less securely dated (De Grossi Mazzorin and Epifani, 2015): the earliest identified specimen having been found in a silo at Muro Leccese referred to the end of the 16th–beginning of 17th century; other remains referred to the 16th–17th century are from the Prösels/Presule castle in Alto Adige and from the Gonzaga Palace at Volta Mantovana in Lombardy. In Rome turkey remains were recovered at Caput Africae (17th–18th century) and at the Crypta Balbi (18th century); other specimens dated to the 17th and 18th cent. were identified in the Nuovo Mercato di Testaccio (Rome), possibly indicating that by this time the species was no longer only the prerogative of the high classes.

Relevant for our site and for its relations with the Americas is a letter, dated to 1519 or 1520 (Oliva, 1993) by Alessandro Geraldini, first resident bishop in Santo Domingo, to Lorenzo Pucci (Arrighi, 2016), then cardinal with the titulus of the Santi Quattro Coronati and supervisor for the Church of the Indies in the Consistory, in which turkeys, referred to as a *gallus* and a white *gallina* from the "*sub Aequinoctiali plaga*", were mentioned as a gift sent to the cardinal together with parrots (*psittacos*) and some gods worshipped by local indigenous populations.

The analysis of archaeobotanical and archaeozoological data is fundamental for the reconstruction of the history and the introduction of New World species in the European context. These complement written sources and illustrations in terms of the identification of the geographical spread of American flora and fauna in the Old World, also taking into consideration factors such as climate and social status. To this purpose the chance to study bioarchaeological samples from Early Modern age confined contexts of the Santi Quattro Coronati in Rome is of great importance.

2. The investigated site

The Santi Quattro Coronati is an architectural complex comprised of several blocks constructed between the 4th century AD and modern times. It is located in Rome (Italy) on the Caelian Hill between the Lateran and the Colosseum (Figure 1). Starting from 1138 AD and for the following four centuries, the history of the monastery was strictly correlated to that of the Umbrian Abbey of Sassovivo, of which it represented the most important filiation, as it was the seat of the attorney of the Roman diocesan administration and

Figure 1. Rome, Italy. Location map of Santi Quattro Coronati (circled in white), between the Colosseum and the Lateran Basilica.

the temporary residence of the Pope's guests (Barelli and Pugliese, 2012). In the 13th century, a portion of the complex became part of a vast palace, meant to host the cardinal titular of the basilica. In 1564 the complex was assigned to host the Conservatory of the Orphan Girls, run by Augustinian Nuns, who still guard the complex.

The complex was subjected to a series of restorations that, through different archaeological campaigns, have brought to light structures attributable to the Renaissance. These include a closed staircase, used as a discard pit and some layers excavated within a former arched porch (Barelli and Pugliese, 2012).

3. Materials and methods

For the current research, two specific contexts of this large complex have been taken into consideration (Figure 2). One is a discard pit excavated in 1996, under the supervision of the architects Lia Barelli and Monica Morbidelli and the archaeologist Raffaele Pugliese. The pit occupied the bottom part of the staircase of the façade-tower of a vast titular complex rebuilt under Pope Leo IV (847–855). The closure of a door on the ground floor of the tower is attributed to the restoration works ordered by Cardinal Carrillo (cardinal between 1424 and 1434). This allowed for the stairwell to be filled by waste of a varied nature in the following decades. Such use, as highlighted by ceramics, appears to be dated towards the end of the 15th century. The closure of the pit is dated at the middle of the following century, possibly in concomitance with the settlement of the Augustinian nuns in 1564.

The entire fill of the bell tower has been collected and preserved. For the current study the stratigraphic units US 3 and US 4 have been selected. Archaeobotanical remains were separated through dry sieving, using a series of three sieves with 5-, 2- and 1-mm meshes. A total of 28 l of material was sieved. Each fraction was then hand-picked. Macro-remains were counted, observed under a Leica M205C stereo microscope (magnification up to 100×) and photographed using a Leica IC80 HD camera. Combined pictures and 3D models were obtained using Helicon Focus (version 6.6.1 Pro). Morphological identification was performed by comparing the samples against several atlases (Cappers, Neef and Bekker, 2009; Neef *et al.*, 2012; Cappers and Bekker, 2013) and modern reference samples.

The second context was investigated during the most recent excavations, carried out in 2011–2012 (Barelli and Pugliese, 2012; Masi, Sadori and Pugliese, 2012) in a former porch (Asciutti, 2012) located in the west side of the garden of the complex. Among the investigated layers, a surface made of mortar (US 521) referenced to the beginning of the 17th century mixed with ceramic materials dated to the end of the 16th century, yielded a small faunal assemblage whose content is relevant for the present research. Traditionally, in archaeozoological analyses the volume of the excavated material is unknown; the remains were therefore simply picked out from the entire filling of each layer.

The faunal assemblage – separated from the same buckets as the plant materials as well as another small sample handpicked during the excavation from the same discard pit, but lacking precise stratigraphic provenience – have been analysed. Furthermore, as mentioned before, US 521 from the 2011–12 excavations of the former porch has also been

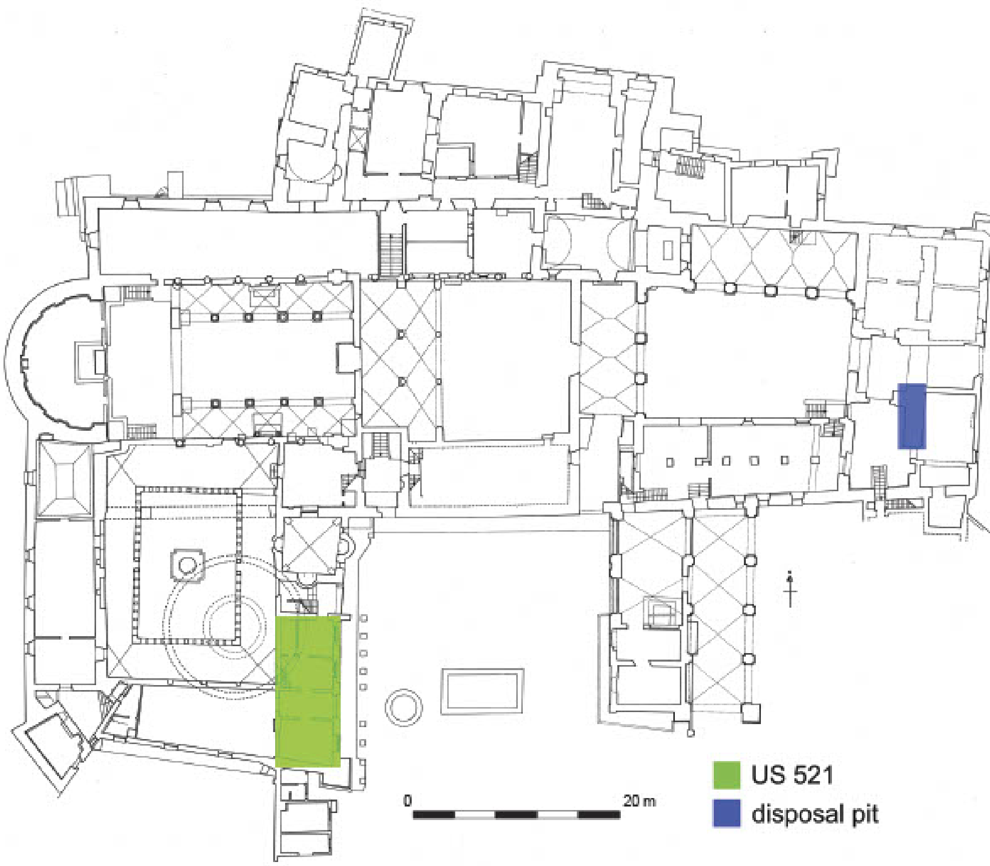

Figure 2. Plan of the architectural complex of Santi Quattro Coronati. The two contexts of retrieval are highlighted.

investigated. Although the specimens are very fragmented, the preservation condition of bone surfaces is good and has allowed the observation and identification of human, animal and other natural traces; all specimens, including the unidentifiable ones, were inspected for any such modifications. The age of single individuals of domestic species was calculated based on the archaeozoological literature (Silver, 1969; Payne, 1973; Barone, 1981; Bull and Payne, 1982; Grigson, 1982; Barone, 1995). Given the fragmented state of the bone specimens, it was possible to estimate only the withers height of a horse (May, 1985).

4. Results

The infill of the discard pit from US 3 and US 4 is mostly constituted of hay, which represents the bulk of the finding in which the carpological and zoological remains were dispersed. Approximately 6,000 well-preserved fragments of seeds and fruits, belonging to 35 taxa, mostly identified at species level and attributed to 18 different plant families were identified (Table 1, Figure 3). Scientific nomenclature follows Flora d'Italia (Pignatti, 1982) and Mabberley's Plant Book (Mabberley, 2008). The favourable thermo-hygrometric conditions present in the pit allowed the mummification of plant remains by desiccation, although few wood remains were found charred. Even the most fragile mummified parts of plants, such as lemmas and paleas of spikelets are preserved.

Besides the few wild and ornamental plants, the botanical assemblages included food remains. For this study, these will be classified as cereals, pulses, fruit plants and vegetables/spices. Cereals include oat (*Avena fatua/sterilis*), broomcorn millet (*Panicum miliaceum*) and bread wheat (*Triticum* cf. *aestivum*). Concerning barley (*Hordeum vulgare*), only rachises were found. In terms of pulses, faba (or broad) bean (*Vicia faba* major) is the most numerous finding, although pea (*Pisum sativum*) is also present. Remains of faba beans are

Table 1. List of identified plant and the number of remains retrieved in the pit of Santi Quattro Coronati, where * represents the fruits estimated based on the number of retrieved fragments.

Carpological remains		US 3		US 4	
		N	%	N	%
Allium cepa L.	tunic	3	*0.13*	3	*0.09*
Allium cepa/sativum	basal plate	10	*0.44*	22	*0.67*
Allium sativum L.	tunic	25	*1.09*	8	*0.24*
Avena fatua/sterilis	spikelet	0	*0*	10	*0.30*
Cannabis sativa L.	achene	2	*0.09*	12	*0.36*
Castanea sativa Mill.	pericarp	63	*2.75*	130	*3.93*
Citrus sp.	pericarp	14	*0.61*	26	*0.79*
Coriandrum sativum L.	mericarp	6	*0.26*	1	*0.03*
Corylus avellana L.	pericarp	5*	*0.22*	5*	*0.15*
Cucumis melo L.	seed	41	*1.79*	76	*2.30*
Cucurbita maxima/moschata	seed	8	*0.35*	27	*0.82*
Cucurbita pepo L.	seed	2	*0.09*	6	*0.18*
Cupressus sempervirens L.	cone	1	*0.04*	0	*0*
Ficus carica L.	achene	4	*0.17*	0	*0*
Foeniculum vulgare Mill.	mericarp	3	*0.13*	14	*0.42*
Hordeum vulgare L.	rachis	19	*0.83*	9	*0.27*
Juglans regia L.	pericarp	10*	*0.44*	17*	*0.51*
Lagenaria siceraria Standl	seed	5	*0.22*	0	*0*
Malus sp.	seed	1	*0.04*	1	*0.03*
Medicago sp.	legume	49	*2.14*	177	*5.36*
Olea europea L.	endocarp	54	*2.35*	96	*2.90*
Panicum miliaceum L.	floret	17	*0.74*	33	*1.00*
Panicum sp.	floret	44	*1.92*	188	*5.69*
	caryopsis	0	*0*	1	*0.03*
Pastinaca sativa L.	mericarp	380	*16.56*	526	*15.92*
Piper nigrum L.	drupe	8	*0.35*	4	*0.12*
Pisum sativum L.	seed	5	*0.22*	11	*0.33*
Prunus avium/cerasus	endocarp	28	*1.22*	47	*1.42*
Prunus domestica L.	endocarp	26	*1.13*	14	*0.42*
Prunus persica (L.) Batsch	endocarp	3	*0.13*	5	*0.15*
Punica granatum L.	seed	26	*1.13*	83	*2.51*
	exocarp	13	*0.57*	15	*0.45*
Ranunculus repens L.	achene	4	*0.17*	21	*0.64*
Rubus fruticosus aggr.	endocarp	1	*0.04*	3	*0.09*
Torilis arvensis (Huds) Link	mericarp	0	*0*	4	*0.12*
Triticum cf. *aestivum* L.	caryopsis	2	*0.09*	0	*0*
	rachis	425	*18.53*	623	*18.85*
Vicia faba L. major	seedcoat	385	*16.78*	63	*1.91*
Vitis vinifera L.	pip	187	*8.15*	377	*11.41*
	pedicel	389	*16.96*	617	*18.67*
	tendril	22	*0.96*	20	*0.61*
Apiaceae undiff.	mericarp	4	*0.17*	10	*0.30*
Total		**2294**	***100***	**3305**	***100***

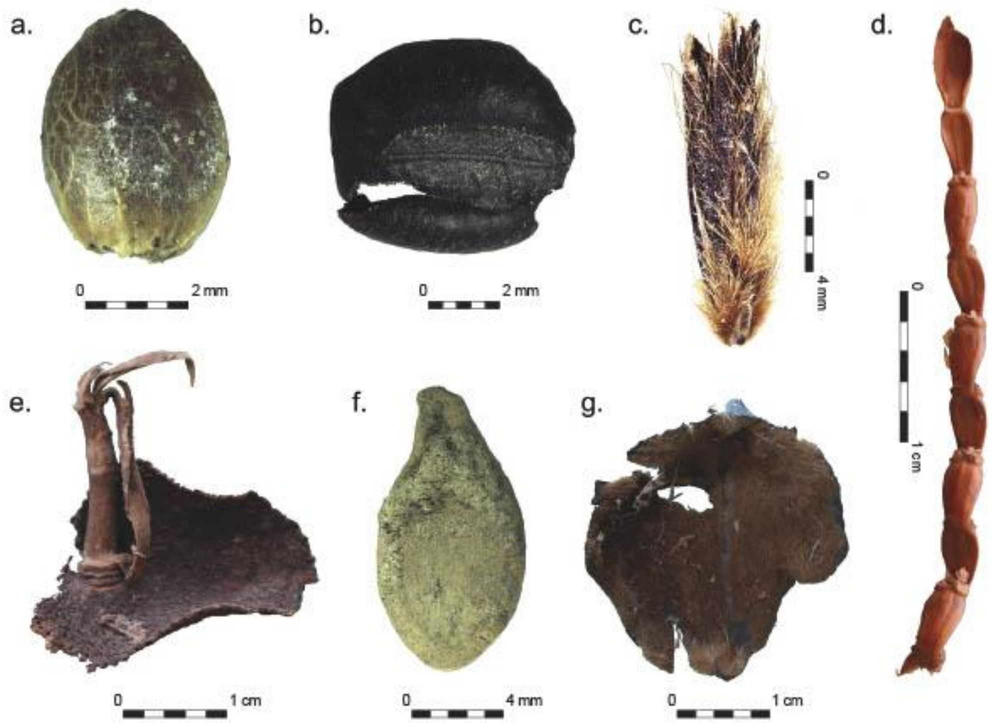

Figure 3. Santi Quattro Coronati (Rome): plant macro remains. a. *Cannabis sativa*, fruit; b. *Vicia faba*, seedcoat with hilum; c. *Avena fatua/sterilis*, spikelet; d. *Triticum* cf. *aestivum*, rachis; e. *Citrus* sp., pericarp; f. *Cucurbita pepo*, seed; g. *Castanea sativa*, pericarp.

present only in the form of teguments. A wide variety of fruit plants, used also as vegetables, was retrieved. These include olives (*Olea europaea*), cherries (*Prunus avium/cerasus*), plums (*Prunus domestica*), peaches (*Prunus persica*), blackberries, *Rubus fruticosus*, grapes (*Vitis vinifera*), pomegranate (*Punica granatum*), citrus fruits (*Citrus* sp.), pumpkins (*Cucurbita maxima/moschata* and *C. pepo*), melon (*Cucumis melo*), calabash (*Lagenaria siceraria*), apples (*Malus* sp.), figs (*Ficus carica*), hazelnuts (*Corylus avellana*), chestnuts (*Castanea sativa*) and walnuts (*Juglans regia*). Finally, also various plants used as vegetables or spices were attested in the examined sediments. These include parsnip (*Pastinaca sativa*), garlic (*Allium sativum*), onion (*Allium cepa*), coriander (*Coriandrum sativum*), fennel (*Foeniculum vulgare*), black pepper (*Piper nigrum*) and hemp (*Cannabis sativa*). Additionally, the weeds spreading hedgeparsley (*Torilis arvensis*), creeping buttercup (*Ranunculus repens*) and alfalfa (*Medicago* sp.) were found. Cypress (*Cupressus sempervirens*), an ornamental species, was also attested (with a cone) in the Santi Quattro Coronati pit.

Cucurbita seeds are very similar among species, but they also present a vast range of intraspecific variations. However, *C. maxima* is more distinctive (Moffett, 1995). Unfortunately, due both to the conservation state of Apiaceae seeds and the similarities among different species, it was not possible to identify all Apiaceae remains. For this reason, the presence of other Apiaceae, such as dill and parsley cannot be excluded.

The faunal assemblage from the discard pit includes a total of 582 specimens mostly from US 3 and US 4 (Table 2). Land gastropods consist mainly of Helicidae, especially the chocolate-band snail (*Eobania vermiculata*) and the garden snail (*Cornu aspersum*). Marine bivalves are represented mostly by the wedge clam (*Donax trunculus*) and a few remains of common cockle (*Cerastoderma edule*). Fragments of crustacean exoskeleton were recovered in both layers and fish remains, still under study, are very common.

Among the birds, only chicken (*Gallus gallus*) and pigeon (*Columba livia/oenas*) have been surely identified; in addition, eggshell fragments have also been recovered.

In the microfauna there are mainly remains of rodents (*e.g. Rattus rattus*) as well as some small reptiles (Lacertilia). Besides the bone specimens reported in Table 2, two mummified "rats" were recovered in US 3.

Table 2. Faunal remains recovered in the discard pit (NISP=Number of Identified Specimens; for taxa with * "1" indicates just presence; N/A materials from the pit lacking precise US information).

Species	US 3		US 4		N/A		TOTAL	
	NISP	%	NISP	%	NISP	%	NISP	%
Land gastropods	16	*6.8*	14	*4.5*	4	*11.1*	34	*5.8*
Marine bivalves	26	*11.0*	31	*10.0*	2	*5.6*	59	*10.1*
Crustacea*	1	*0.4*	1	*0.3*			2	*0.3*
Pisces	41	*17.3*	44	*14.2*			85	*14.6*
Aves	18	*7.6*	15	*4.9*			33	*5.7*
Aves eggshell*	1	*0.4*			1	*2.8*	2	*0.3*
Gallus gallus L.	6	*2.5*			2	*5.6*	8	*1.4*
Columba livia/oenas			1	*0.3*			1	*0.2*
Microfauna	15	*6.3*	16	*5.2*	1	*2.8*	32	*5.5*
Lagomorpha					1	*2.8*	1	*0.2*
Felis catus L.	1	*0.4*					1	*0.2*
Equus caballus L.					1	*2.8*	1	*0.2*
Sus domesticus Erxleben	8	*3.4*	18	*5.8*	15	*41.7*	41	*7.0*
Ovis vel Capra	12	*5.1*	16	*5.2*	6	*16.7*	34	*5.8*
Bos taurus L.	1	*0.4*			3	*8.3*	4	*0.7*
Small mammal	1	*0.4*					1	*0.2*
Medium mammal	23	*9.7*	42	*13.6*			65	*11.2*
Large mammal	3	*1.3*	9	*2.9*			12	*2.1*
Unidentifiable	64	*27.0*	102	*33.0*			166	*28.5*
Total	**237**	***100***	**309**	***100***	**36**	***100***	**582**	***100***

Lagomorphs are represented by a mandible fragment belonging to a young individual. A single *Felis catus* phalanx was recovered in US 3, but the same layer also yielded the complete mummy of a cat. The only horse remains is a complete left metatarsal belonging to an individual about 149 cm tall at the withers.

Among the three main domestic mammals the domestic pig *Sus domesticus* is the dominant species with a minimum number of 10 individuals ranging from very young ones (0–6 months) to over 4 years old, but more than half of them are less than 18 months old. There are at least two males and two females. Ovicaprines are the second domestic *taxon* as number of specimens, referable to a minimum of 9 individuals most of them adult and even senile. Cattle is very rare, represented by a minimum of 3 individuals, one of them 6–12 months old while the other two are adults.

The proportions of skeletal fragments attributed to size groups reflects the abundance in the identified species. In this research "small mammal" would comprise lagomorphs, cat, and other animals of similar size; sheep, goat, and pig, are considered "medium-sized mammal"; cattle and horse, are "large mammal". All the rest of the specimens were completely unidentifiable.

The faunal assemblage from US 521 (Table 3) includes many intrusive small gastropods (*e.g. Pomatia elegans*, *Rumina decollata*) and very few Helicidae which may have the same origin, although their exploitation as food cannot be excluded. The domestic species recognized are mainly pig and ovicaprines, each represented by a single prime adult individual; because of fragmentation, it has been possible to assign larger animals only to size group and not to species. A single cat calcaneum attests to the presence of this feline.

Table 3. Faunal remains recovered in US 521 (NISP=Number of Identified Specimens).

Species	US 521	
	NISP	%
Land gastropods	23	21.1
Pisces	1	0.9
Aves	1	0.9
Cavia porcellus Pallas	1	0.9
Felis catus L.	1	0.9
Sus domesticus Erxleben	7	6.4
Ovis vel Capra	4	3.7
Medium mammal	19	17.4
Large mammal	3	2.8
Unidentifiable	49	45.0
Total	109	100

Finally, the assemblage included also an almost complete left pelvis (Figure 4) attributed to guinea pig (*Cavia porcellus*).

Figure 4. Santi Quattro Coronati (Rome): the *Cavia porcellus* pelvis from US 521.

The specimen was identified on the basis of morphology, presenting among the other features a characteristic notch on the neck of the ischium, (Ijzereef, 1978; Pigiére *et al.*, 2012). Measurements too (SH 4.3 mm, LAR 6.0 mm, following von den Driesch, 1976) are comparable to data from archaeological and reference specimens (Pigiére *et al.*, 2012; Van Neer, pers. comm.)

5. Discussion

Archaeobotanical and archaeozoological studies of Late Medieval/Early Modern Age contexts are quite rare in central Italy. A great help in the survey of plant remains is provided by BRAIN (Botanical Records of Archaeobotany Italian Network: https://brainplants.unimore.it/; Mercuri *et al.*, 2015), an interactive database including archaeological sites with microscopic and macroscopic remains, which allowed the authors to gain awareness of five Medieval-Renaissance sites in central Italy where carpological analyses were performed.

In the studied pit, without considering the hay, the plant and animal remains (seeds, fruits, eggs, shells, teeth, and bones) mostly consist of a series of edible species, likely belonging to the diet of the inhabitants of the Santi Quattro Coronati complex. Ornamental and wild plants, such as cypress and alfalfa, are present as well. The plant and animal assemblages provide an overview of the eating habits in a cardinal's residence of the 16th century in Rome.

The archaeobotanical remains did not present prominent differences in qualitative or quantitative terms. Only five species (*Torilis arvensis*, *Lagenaria siceraria*, *Cupressus sempervirens*, *Avena fatua/sterilis* and *Ficus carica*) were found in one depositional layer but were absent in the other.

The number of refuse items of cereals and pulses is higher than in many other contemporaneous deposits (*e.g.* Moffet, 1992; Bandini Mazzanti *et al.*, 2005; Bosi *et al.*, 2009) (Table 1). This richness deserves particular attention. A noticeable part of the Poaceae remains is from the hay and consists of non-edible parts (Table 1) such as rachises, leaves, and culms. Hay could have been used either as *palliasse* (bedding material) or to dampen bad odours and preserve foods (Barelli and Pugliese, 1996). Nonetheless, the hay assemblage provides information regarding the food plants available in the area. A clear example is provided by barley, for which only rachises are present. It is worth mentioning that two main clusters of millets were found in the pit. One, characterised by a rounder shape, was identified as *Panicum miliaceum*. The other one, which included more elongated florets was not identified at a species level and will be the subject of further studies.

Parsnip mericarps represent the main finding of the present study. The presence of fruit remains for a plant whose roots are eaten, finds an easy explanation. Parsnip roots were in fact used as a cooked vegetable and as animal fodder starting from Roman times (Zohary, Hopf and Weiss, 2012). They are usually harvested after a frost, which results in an increase in sweetness (Cain *et al.*, 2010). As with carrots, parsnip roots are harvested and often stored along with their stem and leaves (Gray, Steckel and Ward, 1985). The presence of the fruit (ripening in autumn) is evidence of a late harvest. This factor allows for the documentation of a plant which could have otherwise been neglected.

The Fabaceae assemblage represents ca. 16% of the botanical carpological remains, including also alfalfa, a plant not directly related to food consumption. It was either part of the hay or represents the remains of fodder. Faba beans and peas were also abundant. Seed coats of the former (Figure 3b) represent a significant finding: also in terms of dietary habits. Being sourer than the rest of the seed, it appears as if they were being discarded on purpose, as it is also commonly done in modern times. The "Mirror Pit" in northern Italy (Bandini Mazzanti *et al.*, 2005) has registered the presence, even if very low, of both legumes.

Grape represents one of the main findings analogous to other contemporaneous pits in Italy (*e.g.* Ferrara-Emilia Romagna: Bandini Mazzanti *et al.*, 2005; Bandini Mazzanti and Bosi, 2007; Bosi *et al.*, 2009; Latium: Clark *et al.*, 2009) and in England (*e.g.* London: Giorgi, 1997). Fresh fruit consumption is hypothesised for the find in Rome, where more pedicels than pips were found. A similar consideration can be made for the olive endocarps, which are found intact and do not show signs of pressing, suggesting their use as table food.

The very low concentration of fig achenes and of blackberry stones, generally among the most numerous findings in contemporaneous deposits (Giorgi, 1997; Bandini Mazzanti *et al.*, 2005; Bandini Mazzanti and Bosi, 2007; Karg, 2007; Bosi, Mercuri and Bandini Mazzanti, 2009; Sadori *et al.*, 2013; Mariotti Lippi *et al.*, 2015), finds a parallel in the "Ducal Pit" (Bosi *et al.*, 2009), characterised as a deposit of table waste, rather than a latrine. Analogously to most pits contemporaneous (Giorgi, 1997) to the current case study, Rosaceae remains are a finding worthy of note in the Santi Quattro Coronati pit, with a prevalence of the genus *Prunus*, represented mostly by plums, sour or sweet cherries, together with peaches. Remains of apples here are few (Table 1), while these were found to be more common at other sites (Bandini Mazzanti *et al.*, 2005; Bosi *et al.*, 2009; Badura *et al.*, 2015).

Melon seeds were also found in the Roman complex. These constituted a common finding in the pits of the Ferrara area in Italy (Bandini Mazzanti *et al.*, 2005; Bosi *et al.*, 2009) and were also retrieved in two Early Modern cesspits in Prague (Beneš *et al.*, 2012), representing an exception for central European sites. The use of melon in Sardinia, Italy, has been documented since the Late Bronze Age (Sabato *et al.*, 2017).

Remains of Rutaceae peels were also found but were identifiable only to the genus level. *Citrus* remains were rare in other contemporaneous deposits, being retrieved in the form of seeds and a leaf in the 16th–17th century infilling of the Vladislav Hall of Prague Castle, where they appear to be clearly associated to social status (Beneš *et al.*, 2012). *Citrus* seeds were also found in deposits in early modern London on rare occasions (Giorgi, 1997). The peels found in the Santi Quattro Coronati pit represent a unique find, as such parts usually undergo a fast process of degradation. *Citrus* remains are in fact generally scarce and consist mostly of seeds. Furthermore, *Citrus* taxa are hard to distinguish among each other due to a sexual compatibility within the members of the genus, which favours natural hybridisation (Pagnoux *et al.*, 2013).

The finding of pomegranate at the Santi Quattro Coronati complex is relevant and it is constituted by both seeds and exocarps. Access to luxury foods and exotics can be key elements to the identification of the social status of the inhabitants of the complex, being found only in middle to upper-class deposits (Bandini Mazzanti and Bosi, 2007; Bosi *et al.*, 2009).

Nuts represent a significant finding in the Santi Quattro Coronati pit. Walnuts, chestnuts and hazelnuts represent a large part of the dietary remains. Among these, the most striking finds are represented by chestnut (Figure 3g), with an exceptional preservation of the hairy episperm.

Walnuts and chestnuts were found in most Late Medieval/Renaissance pits of Emilia Romagna (Bandini Mazzanti and Bosi, 2007). Hazelnuts, probably collected from the wild, were also found in England (Moffet, 1992; Giorgi, 1997).

The extensive use of garlic dates back to ancient Roman times, when this plant was used in a wide number of food preparations and for healing purposes (Tattelman, 2005). Charlemagne ordered the cultivation of garlic and onions in all royal gardens (Castelletti, Castiglioni and Rottoli, 2001).

The assemblage of Apiaceae, used mostly as food flavourings, corresponds to that of other parallel cases. Fennel and coriander were found in Ferrara (Bandini Mazzanti *et al.*, 2005; Bosi *et al.* 2009), in the Hanseatic towns of northern Europe (Karg, 2007) and in Dudley, England (Moffet, 1992). Fennel could have been collected wild, although it is possible that it was cultivated for convenience. In contrast, coriander was necessarily cultivated (Moffet, 1992).

Despite its usual association to textile production, the presence of hemp is most probably correlated to its use in Late Medieval and Early modern recipes (Korber-Grohne, 1987; Beneš *et al.*, 2002). Hemp seeds are still used in many recipes nowadays, but also because of their excellent content of omega-3 and omega-6 fatty acids (Rodriguez-Leyva and Pierce, 2010). Hemp has been retrieved in other pits in Ferrara (Bandini Mazzanti *et al.*, 2005; Bosi *et al.*, 2009), in England (Moffet, 1992), in a wooden sewage Renaissance tunnel in Prague (Beneš *et al.*, 2012) and in several Middle Age and Early modern drains and drainage channels, ditches, pits and wells in Denmark (Karg, 2007).

The composition of the faunal assemblage of the two layers (US 3 and US 4) in the discard pit is very similar. Land gastropods, including mainly Helicidae, may represent either intrusive species or items of food refuse, but even in the latter case they were not a significant part of the diet. Fish is abundant as would be expected in a religious context, although in Rome alimentary rules also affected lay people (D'Amelia, 1975); crustaceans, as well as marine molluscs, are probably part of the same meatless diet. The remains of birds together with eggshell fragments, indicate the exploitation of this class of animals as well as of their products.

The microfauna, small rodents and reptiles, can be considered as intrusive elements or pests discarded in the pit together with the other waste products. The cat was often used not just as a pet, but mainly for pest control and, apparently, after death its carcass was considered as "common" garbage.

The horse specimen shows some scrape marks along the shaft, possibly traces from manufacturing, suggesting that craftwork activities were also performed at the site. Many of the domestic mammals show cuts and chop marks indicating, as expected, that they represent food debris. Only a few remains are burnt, but such modification appears accidental and not directly related to cooking activities because the combustion is not localized, but present over the whole specimen. This may suggest that boiling or stewing rather than roasting were probably the main cooking procedures. Carnivore traces on the bones are more abundant than anthropic modifications and were produced mainly by small predators, such as cats, suggesting a close relationship between humans and felines.

The faunal assemblage from the discard pit represents a mixture of food debris and other waste (*e.g.* cats and rats) and does not show peculiarities in the taxonomic composition and/or any identified modifications which may clearly suggest a high-status residence (*e.g.* presence of more abundant or peculiar wild species or of many very young individuals for most domestic *taxa*). This is in contrast to the indication provided by the plant remains; however, the faunal assemblage may give some hints about the diet not only of the cardinal and his entourage, but also of the servants working in the palace.

Other Italian late medieval-early modern contexts, such as the Castello di Manzano (Cherasco, Cuneo – Bedini, 1995), Castello di Rafenstein (San Genesio, Bolzano – Eccher and Tecchiati, 2014), Palazzo Vitelleschi (Tarquinia, Viterbo – Clark *et al.*, 1989), Castello di Santa Severa (Santa Marinella, Roma – Cerilli Fatucci, 2016), Castello Baglioni (Graffignano, Viterbo – Alhaique *et al.*, in press), and the Palazzo del Principe (Muro Leccese, Lecce – De Grossi Mazzorin and Nocera, 2005), show more clear evidence for luxury elements also in the fauna, possibly because such contexts are not strictly related to religious communities.

Except for the presence of the guinea pig, the faunal sample retrieved in US 521 does not show peculiarities and includes both food debris and intrusive elements such as small land gastropods. Chop and cut marks were detected on the remains of the main domestic animals, as well as on specimens attributed only to one size group. Very few remains are burnt or display traces of carnivore activity.

5.1 New World species at the Santi Quattro Coronati complex

The Santi Quattro Coronati complex is characterised by the presence of New World species, both in terms of flora (*Cucurbita* sp.) and fauna (*Cavia porcellus*).

As far as plant species are concerned, the genus *Cucurbita*, native of South America and imported to Europe only after the discovery of America in 1492 (Teppner, 2004), was retrieved. They got so well established in the Old World, that it was not until the 20th century that botanists realised that they were in fact original of the New World (Whitaker, 1947).

The genus *Cucurbita* includes five cultivated species: *Cucurbita ficifolia* Bouchè, *C. maxima* Duchesne, *C. moschata* Duchesne, *C. argyrospema* Huber and *C. pepo* L. (Moffett, 1995). In the pit, seeds of *C. maxima/moschata* and *C. pepo*, the most popular in Europe, were found. Many doubts are placed regarding the route through which these species reached Europe during the 16th century. It was thought that *C. pepo* was introduced to Asia before arriving in Europe (Moffett, 1995), although both iconographical and archaeobotanical evidence seems to reveal otherwise. The plant iconography of a prayer book traces back the introduction of *Cucurbita* species in Europe to at least 1503–1508 (Paris *et al.*, 2006). Most archaeobotanical studies carried out on *Cucurbita* were performed on American material (Smith, 1968). Seeds constitute the most common type of macro-remains found and they are usually preserved through desiccation, charring or waterlogging (*e.g.* Decker and Newsom, 1988; Smith, 1997; Lema, Capparelli and Pochettino, 2008). In terms of micro-remains, phytoliths prevail (*e.g.* Piperno, Andres and Stothert, 2000; Hart, Thompson and Brumbach, 2003; Piperno and Stothert, 2003; Hart, Brumbach and Lusteck, R., 2007).

The archaeobotanical evidence is, however, quite limited and presents a wide dispersion in area over Europe and northern Africa starting from the 16th century. The Santi Quattro Coronati find helps to confirm such an early introduction to Italy, heretofore hypothesized only looking at the festoons of the Loggia of Cupid and Psyche in Rome (Caneva, 1992). *Cucurbita* seeds have been retrieved mostly in post-Medieval castles and urban sites, not necessarily associated with high status (Moffett, 1995). Despite being exotic, they soon became particularly valuable to people who did not have access to a wide variety of fresh food (Parkinson, 1904), due to their good preservation qualities. The earliest finds of *Cucurbita moschata*/*C. maxima* in northern Italy appear in Argenta (15th–16th century – Barbi *et al.*, 1998) and in Volta Mantovana (16th–17th century – Bosi, Buldrini and Rinaldi, 2015). The presence of *Cucurbita* sp. was attested in the 17th century in Libya at the ancient town of Garama (Pelling, 2003). Seeds of *C. pepo* were retrieved in Germany in a pit from the 16th–17th century in Lüneburg (Wiethold, 2003) and in a deposit in Rhineland (Knörzer and Pflanzenspuren, 1999), and in Belgium in a 17th century cesspit at the Arme Klaren site (Speleer and Van der Valk, 2017). In the Czech Republic, in Prague, *C. pepo* seeds were found in the infill of the vault of Prague Castle's Vladislav Hall, which is dated between the 16th and 17th century, and in two cesspits framed within the same period (Beneš *et al.*, 2012). One seed and a half of *C. pepo* were also retrieved from a pit in Dudley Castle, central England, which was used between 1642 and 1647 (Moffet, 1992). Other European findings of the same species include 17th century latrine deposits from Amsterdam in the Netherlands (Paap, 1984), Bratislava in Slovakia (Hajnalová, 1985) and Arnstadt, Germany (Lappe, 1978).

Among the animal remains from the discard pit of the tower, no New World species were recovered, but the faunal sample from US 521 in the excavations of the former porch yielded a pelvis attributed to *Cavia porcellus*. The whole specimen appears slightly burnt, but given its uniform distribution over the bone surface, such modification is probably not related to cooking. Although no cut marks were detected on the specimen, it is not possible to exclude *a priori* that this animal was used as food because coeval recipes using this species are known (*e.g.* Scappi, 1570).

The guinea pig was likely imported to Europe within the first half of the 16th century. The Swiss naturalist Conrad Gessner describes and depicts this species, calling it *Cuniculo vel Porcello Indico,* in his *Historia Animalium* published between 1551 and 1558, based on individuals he received as gifts from France and from Germany. Depictions of this animal appear in early 17th century paintings such as the Garden of Eden and the Entry of Animals into Noah's Ark by the Flemish artist Jan Brueghel the Elder. Skeletal remains of this species are very rare in archaeological sites and early specimens have so far been identified only in England in a manor at Hill Hall (Essex) within a context dated to 1574–75 (Hamilton-Dyer, 2009), in a middle-class residence referable to the late 16th–early 17th century at

Mons in Belgium (Pigiére *et al.*, 2012), and in a farmstead at Middleburg (Netherlands) from layers of the late 17th–early 18th century (Van Dijk and Silkens, 2012). In Europe, guinea pigs were initially considered only as prestigious exotic pets, but relatively soon they also became part of the human diet, as suggested by recipes in the *Opera* by Bartolomeo Scappi (1570), where he also mentions that, although the best season to eat the *coniglio d'India* was between October and February, it was available in Rome and in other places in Italy all year round.

6. Conclusion

The botanical and faunal assemblage of the disposal pit has allowed much information to be gathered regarding the diet and daily habits of the inhabitants of the Santi Quattro Coronati complex during the Early Modern period. The bulk of the biological remains were made up of hay and the plant assemblage, and poor in remains that are indicators of latrines, such as fig achenes and blackberry endocarps, allowing us to characterise the pit as a disposal for residues of food preparation and meals. The table and kitchen waste comprised remains of cereals, legumes, vegetables, fruits, nuts, spices, molluscs, fish, birds, and mammals.

Three New World species, two pumpkins from the pit, and the guinea pig from the former porch, complement the Old World species assemblage.

The *C. pepo* and *C. maxima/moschata* seeds found in the pit of Santi Quattro Coronati represent one of the oldest retrievals of such species, if not the oldest, in Europe. While *C. pepo* represents the oldest find, *C. moschata/maxima* has also been found in Northern Italy in a cesspit ascribed to the 15th–16th century (Barbi *et al.*, 1998). In the absence of a more precise dating it is not possible to ascertain which one would be the oldest find.

The guinea pig specimen, referable to the end of the 16th or beginning of the 17th century, represents the first evidence of this species in Italy and one of the earliest in Europe.

These early introductions could be justified by the fact that the Cardinal's palace, a very prestigious and wealthy landmark, was one of the first stops along the trading routes that emanated from the New World, leading to the rapid availability of new plant and animal species. This may possibly also be related to the role of Cardinal Lorenzo Pucci, titular of the Santi Quattro between 1513 and 1524, as supervisor for the Church of the Indies in the Consistory. The high social status of the inhabitants of the complex can be further affirmed by the presence of pomegranate remains, associated with fertility, hope for immortality, and resurrection.

The Santi Quattro Coronati complex represents a unique case study in the context of Early Modern archaeobotany and archaeozoology, and even more so due to the outstanding state of conservation of the mummified remains. It allows another piece of the puzzle to be added to the picture of New World species being imported to Europe.

The present study also demonstrates the wide potential of scientific research in relation to the Modern Age, a historical period to which it has yet to be applied for this specific context. Furthermore, it represents a work carried out in full harmony between the Academy, involving different areas of study and specialization, and the Superintendence, the national body officially in charge for the conservation of cultural heritage, obtaining relevant results in a common framework and the shared goal of scientific research.

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Appendix C

Elite food between the late Middle Ages and Renaissance: some case studies from Latium

Alhaique F., Moricca C., Barelli L., Masi A., Pugliese R., Sadori L., Romagnoli G., Piermartini L., Brancazi L., Gabbianelli F., Chillemi G., Valentini A.

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Elite Food Between the Late Middle Ages and Renaissance: Some Case Studies from Latium

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ABSTRACT
The study of plant and animal remains from archaeological sites provides important evidence about past human diets and habits: this includes species selection, food preparation, consumption and disposal practices. Furthermore, such information may also provide inferences about social status. Data from refuse disposal features identified in some elite contexts in central Italy – a high-status residence in Celleno Vecchio (Viterbo) and the Baglioni-Santacroce castle in Graffignano (Viterbo), both in northern Latium, as well as the Santi Quattro Coronati ecclesiastical complex in Rome – allow to explore, using archaeobotanical, archaeozoological and genetic data, some of the different ways in which people expressed wealth by means of food during a period between the late Middle Ages and Renaissance.

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Introduction

The study of ancient food remains to investigate differences in social status is a topic that has received increasing attention over the last few decades and has been applied to different time periods and geographic regions (for an overview see, for example, Twiss 2012, 2019; Veen van der 2003a). The emerging pattern is that there are differences between cultures in what can be considered as evidence for elite consumption, but also that, within a culture, the same food item may change its status through time. In general, when expressing status there seems to be an emphasis on quantity in more egalitarian groups, while food quality (in addition to quantity, in some cases) becomes more important in complex, more stratified societies. However, although food quality may, in most cases, be indicated by archaeological data, the identification of 'quantity' is usually more difficult and therefore such evidence may be 'invisible'.

Certainly, food and foodways may be a reflection not only of social status, but also of ethnicity, gender, religion, etc. as well as the interplay between them. Furthermore, although the research focus is often only on specific aspects of food, all the steps from production/acquisition to refuse disposal should be considered for a meaningful interpretation of archaeological data. However, biological and ecological factors should also be considered as a baseline (Twiss 2012), as well as all other contextual information.

Several authors (e.g. Curet and Pestle 2010; deFrance 2009; Ervynck et al. 2003; Twiss 2012; Veen van der 2003b) have suggested criteria for identifying elite and luxury food in archaeological contexts (e.g. rarity, quality, quantity, diversity, animal age, size, body elements, preparation techniques, restrictive rights), but it is also necessary to evaluate such criteria within the contextual framework of each period and region using ethnographic data and, when available, historical written sources. In fact, what may be considered as tasty and desirable, and therefore a luxury item, is culture dependent and may sometimes contradict modern common sense.

To complicate the interpretation of the data further, there may be biases intrinsic to the archaeological assemblages: for example, plant remains are often not preserved and recovery methods may negatively affect smaller species. Furthermore, servants living with their employers and using the same refuse disposal features may mask the 'elite signature' in the samples. Moreover, the garbage pits may be used not only for food debris, but also for disposing of pests and pets, or weeds, together with other materials. This creates the need to reliably assess, with an open mind as to what is edible or not, which species, or parts of them, were actually used as food. For animal

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remains, taphonomic data (e.g. presence of butchery marks, completeness of the skeleton) may, in many cases, be a useful diagnostic criterion.

The evidence regarding the diet of lower classes, generally richer in vegetables, may be less visible archaeologically and therefore be under-represented for comparative purposes. Moreover, the refuse disposal places used by lower classes are probably less well defined than in wealthy contexts and, not being rich in terms of the evidence they offer, surely less likely to be investigated. In a broader anthropological perspective, food should be considered not only as a mere physiological need, but as an active mean to underline and maintain social differences. Such differences were sometimes even reinforced in medical treaties (e.g. Pisanelli 1583), which reported strict relationships between certain kinds of food and social status. Luxury foods may also include elements that do not follow an optimal foraging rule and, as compensation for the expenditure, allow the maintenance of the social status (Ervynck et al. 2003). The first step in the analysis and subsequent interpretation of food should be the milieu of the findings, although it may be difficult to identify *a priori* elite contexts, especially in prehistoric and early historical sites.

Materials and methods

In this paper we shall consider published (Alhaique, Piermartini, and Romagnoli 2018; Gabbianelli et al. 2020; Moricca et al. 2018; Romagnoli et al. 2019) and unpublished data on faunal and plant assemblages from high-status residences in central Italy dated to the late Middle Ages and Renaissance with the aim of investigating, by means of several proxies, how food has been used in these contexts to express social status. The social background in these cases is quite clear and contemporary recipe books and medical treaties (e.g. Maestro Martino, in Bemporat 2001; Platina 1475; Savonarola 1515; Romoli 1560; Scappi 1570; Pisanelli 1583; Messisbugo 1549) are available to help to place the findings within the tastes of the period. Each analysed context was accumulated within a relatively short time span and then closed, providing no or minimal evidence for later intrusive materials.

Archaeological Contexts and Materials

The faunal assemblages from northern Latium were collected from refuse pits in high-status residences in towns located along the Tiber valley in the Viterbo province. The earliest context is in Celleno Vecchio (Romagnoli 2019) and was originally an underground cistern reused during the Middle Ages for dumping refuse, a common practice for the period (e.g. De Minicis 2003). Ceramic material is dated to a period between the fourteenth and mid-fifteenth centuries and includes tin-glazed pottery and common ware. The richness in the number of shapes and decorations reflects the affluence of the inhabitants of the palace and indicates the provenance of the pottery from workshops in Viterbo and Orvieto (Umbria).

Two other underground refuse dumps, previously used as cisterns or silos, also containing animal remains have been discovered within the Baglioni-Santacroce castle in Graffignano (Alhaique, Piermartini, and Romagnoli 2018; Romagnoli et al. 2019). The typology and decoration of the ceramic content (tin-glazed and lead-glazed pottery, common ware) date a first pit (Pit 1) to the first half of the fifteenth century, while the rich pottery assemblage (i.e. complete serving sets as well as cooking pots, containers for preparing or preserving food and for other domestic uses) from a second pit (Pit 2) may be dated to a period between the second half of the fifteenth and the beginning of the sixteenth century. These ceramics were produced in workshops not only in Viterbo and Orvieto, but also in the renowned centre of Deruta (Umbria). The pottery from Pit 1, although originally of high quality, shows wear and signs of repairs, possibly evidence for reuse by the servants in the castle, and therefore the faunal remains may also reflect a lower status. In contrast, the well-preserved complete sets of fine decorated tableware, as well as other domestic containers, from Pit 2 indicate an 'elite dump'.

The faunal materials from all these northern Latium contexts were hand-picked, but the collection was fairly careful as evidenced by the high frequencies of elements of small animals and the presence of bones of very young individuals of larger taxa. The whole faunal assemblage from these dumps was analysed.

The Santi Quattro Coronati ecclesiastical complex (Barelli 2009; Barelli and Pugliese 2012), located in Rome on the Caelian Hill, provided two other assemblages, dated to a period between the end of the fifteenth and the beginning of the seventeenth century. The complex was built from the fourth century AD on top of pre-existing Roman structures and part of it became a large palace that hosted the cardinal titular of the basilica during the thirteenth century. In 1564, the complex was assigned to the Augustinian nuns who still live in the monastery. The first context of the Santi Quattro Coronati is a dump at the bottom of the staircase of the façade-tower that was used to discard refuse from the end of the fifteenth century until the mid-sixteenth century, when the stairway was no longer in use. The peculiar micro-environmental conditions allowed for the preservation of many botanical remains by desiccation, even very fragile parts such as lemmas and paleae of spikelets, as well as the mummified carcasses of two rats and a cat, besides bones, teeth and shells of different taxa. Plant and animal remains from selected stratigraphic units in the 'tower dump' were separated by dry sieving 28 litres of materials, using a series of three sieves with 5-, 2- and 1-mm meshes and then hand-picked (for details on the sampling strategy see Morricca et al. 2018).

The second context of the Santi Quattro complex, relevant in this paper for its faunal content, is a layer (SU 521) excavated within a former arched porch (Barelli and Pugliese 2012; Masi, Sadori, and Pugliese 2012; Asciutti 2012). This layer is a mortar surface stratigraphically dated to the beginning of the seventeenth century and containing ceramic materials that date to the end of the sixteenth century. A small faunal assemblage from this level was hand-picked during the excavations and analysed. The 'tower dump' and its content are related to the palace of the cardinal and therefore may reflect more clearly luxury foodways; while the second context (SU 521) is within the Benedictine monastery where the monks followed strict alimentary rules more in conformity with the poverty vows. Nevertheless, contamination between the two adjacent institutions is possible.

Methods

The preservation conditions of all the faunal assemblages considered in this paper are fairly good, and human, animal and other natural modifications were identified on bone surfaces. All fragments, including unidentifiable ones, were inspected for such modifications and recorded. Microscopic observations were carried out using a stereo-microscope (Nikon SMZ 1000). The age of domestic species was assessed on the basis of archaeozoological literature (Silver 1969; Payne 1973; Barone 1981; Bull and Payne 1982; Grigson 1982; Barone 1995). Measurements of the specimens were taken following Driesch von den (1976) and, in the few possible cases, withers height was calculated using indexes published by May (1985) for equids, Teichert (1969) for pigs, Matolcsi (1970) for cattle, Teichert (1975) for sheep. Meat yield of the main taxa was based on Flannery (1969). Plant macro-remains from the 'tower dump' were counted, identified under a stereo-microscope (LeicaM205C; magnification up to 100×) and photographed using a Leica IC80 HD camera. Combined pictures and 3D models were obtained using Helicon Focus (version 6.6.1 Pro). Morphological identification was based on several atlases (Cappers, Neef, and Bekker 2009; Neef et al. 2012; Cappers and Bekker 2013) as well as on modern reference samples.

Results

Northern Latium Sites

The size of the faunal samples from the earliest and the latest northern Latium pits is comparable (Celleno N = 1538; Graffignano Pit 2 N = 1502), while Graffignano Pit 1 yielded only 54 specimens, therefore comparisons with the latter assemblage should be considered with caution (Figure 1 and Table 1).

As expected, the species range is wider in the larger samples, which also display some general similarities in composition: prevalence of sheep/goat (*Ovis vel Capra*) over pig (*Sus domesticus*), with cattle (*Bos taurus*) in third place among the mammals, and a relatively high frequency of birds, especially chicken (*Gallus gallus*). However, in Celleno there are also several tortoises (*Testudo hermanni*) and cervids (*Cervus elaphus* and *Capreolus capreolus*), while such taxa are absent in Graffignano Pit 2, except for two roe deer antler fragments. In contrast, in Graffignano Pit 1 cattle are the most abundant mammal, while pigs and sheep/goats follow in similar proportions, a tortoise plastron portion, an eggshell fragment, and a freshwater mollusk are also present. The two larger assemblages indicate that the diet was supplemented by minor species such as pine marten (*Martes martes*), as documented by the position of the cut marks identified on the shaft of the femur and the tibia (Figure 2) which are not compatible with the 'simple' recovery of the pelt, as well as lagomorphs (*Lepus* sp., *Oryctolagus cuniculus*), fish, crustaceans, and mollusks. The latter also includes tusk-shell (*Dentalium* sp.), a non-edible species, which may have been used as decoration, or even for medical purposes and/or as an amulet (e.g. Bellucci 1881). These same pits yielded also remains of pets (dogs, *Canis familiaris*, cats *Felis catus*) and pests (rats, *Rattus rattus*), as well as other species (horse, *Equus caballus*) or body parts (antler) that were probably not part of the diet. Unexpectedly, at Celleno a dog ulna shows butchery marks (Figure 3) possibly related to consumption, and similarly fox (*Vulpes vulpes*) remains (chopped vertebrae, Figure 4, disarticulation marks on a distal humerus) from the same site indicate the occasional exploitation of this species as food. Nevertheless, the positive association

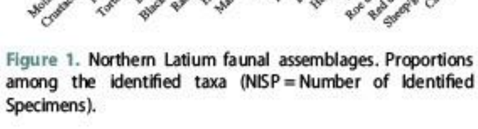

Figure 1. Northern Latium faunal assemblages. Proportions among the identified taxa (NISP = Number of Identified Specimens).

Table 1. The faunal assemblages from northern Latium (N = Number of remains; MNI = Minimum Number of Individuals).

	Celleno				Graffignano Pit 1				Graffignano Pit 2			
Species	N	N%	MNI	MNI%	N	N%	MNI	MNI%	N	N%	MNI	MNI%
Cerastoderma edule/glaucus									1	0.1	1	0.8
Dentalium sp.	3	0.2	3	3.7					1	0.1	1	0.8
Unio sp.					2	3.7	1	9.1				
Crustacea	1	0.1	1	1.2					1	0.1	1	0.8
Pisces									2	0.1	1	0.8
Testudo hermanni	25	1.6	4	4.9	1	1.9	1	9.1				
Anseriformes									2	0.1	1	0.8
Columba livia/oenas	2	0.1	1	1.2								
Columba palumbus	5	0.3	1	1.2								
Columbiformes									1	0.1	1	0.8
Gallus gallus	153	9.9	19	23.5					233	15.5	40	30.5
Perdix perdix	2	0.1	1	1.2								
Passeriformes									3	0.2	1	0.8
Aves	27	1.8							13	0.9		
Aves (egg)					1	1.9	1	9.1				
Microfauna					1	1.9	1	9.1				
Rattus rattus	8	0.5	3	3.7					7	0.5	2	1.5
Oryctolagus cuniculus									19	1.3	3	2.3
Lepus sp.	3	0.2	1	1.2					1	0.1	1	0.8
Martes martes									3	0.2	1	0.8
Felis catus	10	0.7	2	2.5					45	3.0	1	0.8
Vulpes vulpes	13	0.8	3	3.7					1	0.1	1	0.8
Canis familiaris	2	0.1	1	1.2					19	1.3	2	1.5
Equus caballus									2	0.1	1	0.8
Sus domesticus	273	17.8	15	18.5	12	22.2	3	27.3	332	22.1	28	21.4
Capreolus capreolus	10	0.7	2	2.5					2	0.1	1	0.8
Cervus elaphus	93	6.0	3	3.7								
Capra hircus	1	0.1	13	16.0					5	0.3	34	26.0
Ovis aries	29	1.9							20	1.3		
Ovis vel Capra	389	25.3			11	20.4	2	18.2	487	32.4		
Bos taurus	112	7.3	8	9.9	18	33.3	2	18.2	119	7.9	9	6.9
Small mammal	6	0.4							2	0.1		
Medium mammal	301	19.6			5	9.3			117	7.8		
Large mammal	58	3.8			3	5.6			47	3.1		
Unidentifiable	12	0.8							17	1.1		
TOTAL	**1538**	**100**	**81**	**100**	**54**	**100**	**11**	**100**	**1502**	**100**	**131**	**100**

of these canids with elite consumption is not confirmed, and we should consider that foxes are still eaten in some rural areas in Italy.

Human modifications related to butchery are also present on all the main species in high frequencies (ranging from 49% in Graffignano Pit 1 to almost 30% in Graffignano Pit 2). Most of the marks were produced by heavy implements rather than by small blades and all stages of carcass processing, from skinning to meat removal, are represented. In some cases, the cranium was opened to obtain the brain. The proportions of traces appear to be strictly related to the size of the animals, with larger taxa presenting a higher number of marks. Burning is less common in all of the assemblages (between 1.7% in Graffignano Pit 2 and 9% in Graffignano Pit 1), and it was usually not very intense, suggesting that roasting was not a widely used cooking method.

The skeletal element representation of the main domestic taxa (Table 2) indicates that completeness is influenced by the size of the animals, with smaller taxa usually being acquired as whole carcasses. This is more visible in the two largest assemblages, while the size of the Graffignano Pit 1 sample is too small to be informative.

Given the general fragmentation of the northern Latium assemblages, it was only possible to calculate withers height on a few specimens. The adult pigs from Pit 2 in Graffignano are relatively large in size (80–82 cm at the shoulder), but the skeletal elements from Pit 1 and Celleno also indicate large individuals. This, coupled with cranial morphologies similar to wild boar, suggests possible crossbreeding with local wild boar, confirmed by aDNA results in the case of Graffignano Pit 2 (Gabbianelli et al. 2020), and most likely also indicates free-range herding. The occurrence of domestic pig together with crossbreeds with wild boar complicates the identification of suid remains. Furthermore, the presence of 'pure' wild boar remains cannot be completely ruled out, especially in the case of Celleno, where the contribution of hunted wild taxa to the diet is more relevant. The sheep from Celleno and Graffignano Pit 2 have a similar size, 66 and 68 cm respectively, while the one from Graffignano Pit 1 is smaller (59 cm at the shoulder). A cow from Celleno is smaller (ca. 120 cm) than the one from Graffignano Pit 2 (127 cm).

An assessment of the age at death of the animals from the three pits indicates that there is a high frequency of young and very young individuals for sheep/goat, pig (Figure 5) and even chicken in Graffignano Pit 2, while at Celleno (Figure 6) older adult and senile individualsof the main domestic mammals were also relatively abundant and adult chickens are

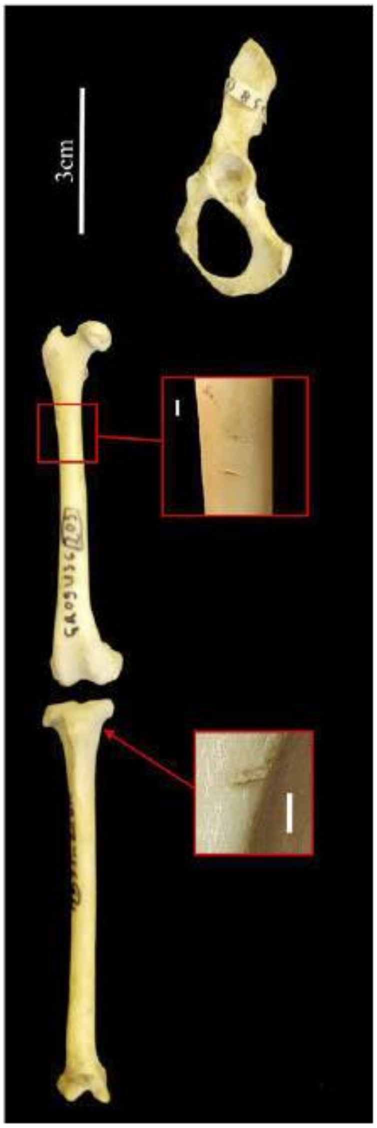

Figure 2. Graffignano Pit 2: pine marten remains with location of cut marks and details (the bar in the detail pictures is 1 mm).

prevalent (Figure 7). The few individuals from Graffignano Pit 1 are generally older than those from the other pit of the same site.

Unexpectedly, genetic analyses (Gabbianelli et al. 2020) evidence that most of the pigs from Pit 2, including young and very young ones, were females. The marked prevalence of hens over cocks and capons in all contexts is instead more in line with expectations and may simply indicate local poultry rearing.

Figure 3. Celleno: dog ulna with location of cut marks and detail.

The data on meat yield for the main food species from the northern Latium pits (Figure 8) indicates that cattle were the main source of meat followed by pigs, while sheep/goats fall in third place in the two Graffignano pits, but are fourth in Celleno where cervids (roe and red deer) provided slightly higher amounts of food. Even when represented by high numbers of individuals, chickens contributed little to the diet; however, these figures should be read with caution since they do not take into account the age of the animals and the actual body portions recovered.

The Santi Quattro Coronati Ecclesiastical Complex

Luckily, the refuse pit of the tower staircase at the Santi Quattro Coronati complex in Rome provided data from both plant and animal remains. As far the

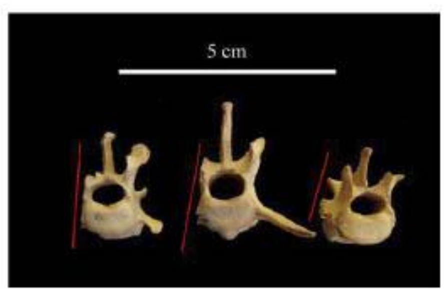

Figure 4. Celleno: chopped fox vertebrae.

Table 2. Skeletal element representation for the main domestic taxa of the northern Latium assemblages (NISP = Number of Identified Specimens; MNE = Minimum Number of Elements; MAU = Minimum Animal Units).

	Celleno									Graffignano Pit 1									Graffignano Pit 2								
	Sus domesticus			*Ovis vel Capra*			*Bos taurus*			*Sus domesticus*			*Ovis vel Capra*			*Bos taurus*			*Sus domesticus*			*Ovis vel Capra*			*Bos taurus*		
Element	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU
Horn				4	2	1.0																3	3	1.5	2	2	1.0
Cranium 1/2	13	5	2.5	23	6	3.0	9	5	2.5							2	2	1.0	50	9	4.5	16	5	2.5	13	3	1.5
Maxilla 1/2	8	8	4.0	8	7	3.5										2	1	0.5	11	11	5.5	9	9	4.5	2	2	1.0
Mandible 1/2	22	11	5.5	33	17	8.5	9	4	2.0	2	1	0.5	1	1	0.5	1	1	0.5	25	15	7.5	34	27	13.5			
Upper teeth	5	5	0.2	8	8	0.7	2	2	0.2							2	2	0.2	1	1	0.05	1	1	0.1			
Lower teeth	11	11	0.5	8	8	0.4	2	2	0.1										6	6	0.3						
Teeth				1	1	0.03	1	1	0.03										1	1		1	1	0.03			
Hyoid				2	1	0.5	4	2	1.0																1	1	0.5
Atlas	3	2	2.0	4	2	2.0	1	1	1.0										2	2	2.0	2	2	2.0			
Axis	2	2	2.0				1	1	1.0										1	1	1.0	3	3	3.0			
Cervical Vert.	5	4	0.8	17	9	1.8	7	4	0.8				1	1	0.2							11	9	1.8	7	4	0.8
Thoracic Vert.	14	8	0.6	24	11	0.8	5	4	0.3	2	2	0.1							8	7	0.5	22	11	0.8	13	9	0.7
Lumbar Vert.	7	4	0.6	22	8	1.1	6	2	0.3										2	2	0.3	13	6	0.9	7	4	0.6
Sacral Vert.	1	1	0.3	2	2	0.5													1	1	0.3	1	1	0.3	2	2	0.5
Caudal Vert.				3	3	0.2																					
Vertebrae				4	1	0.03	1	1	0.03							1	1	0.03							1	1	0.03
Ribs	79	35	1.2	72	35	1.3	20	5	0.2	2	2	0.1							72	32	1.1	214	92	3.5	20	5	0.2
Sternum				5	2	0.3	1	1	0.2													1	1	0.2			
Scapula	7	5	2.5	18	8	4.0	3	2	1.0	1	1	0.5				2	1	0.5	13	10	5.0	18	7	3.5	1	1	0.5
Humerus	14	9	4.5	16	9	4.5	4	3	1.5	1	1	0.5				2	1	0.5	15	11	5.5	16	12	6.0	3	2	1.0
Radius	11	6	3.0	19	11	5.5	3	3	1.5				2	2	1.0	3	2	1.0	7	6	3.0	22	11	5.5	1	1	0.5
Ulna	4	4	2.0	9	7	3.5	4	3	1.5	1	1	0.5				3	2	1.0	8	8	4.0	12	6	3.0	1	1	0.5
Pelvis	7	5	2.5	17	11	5.5	4	2	1.0										8	7	3.5	20	12	6.0	6	3	1.5
Femur	11	6	3.0	22	10	5.0													22	16	8.0	22	12	6.0	5	2	1.0
Patella							1	1	0.5																		
Tibia	14	8	4.0	25	13	6.5	1	1	0.5	1	1	0.5							17	13	6.5	32	15	7.5	9	3	1.5
Malleolus/Fibula	3	1	0.5				1	1	0.5										12	9	4.5				1	1	0.5
Carpals	1	1	0.1	2	2	0.2	3	3	0.3				1	1	0.1	1	1	0.1	1	1	0.1	1	1	0.1			
Astragalus	3	3	1.5	3	3	1.5	2	2	1.0										2	2	1.0				1	1	0.5
Calcaneus	2	2	1.0	6	5	2.5	2	2	1.0										4	3	1.5	2	2	1.0	3	3	1.5
Other Tarsals	2	2	0.2	1	1	0.2	2	2	0.3										2	2	0.2						
Metacarpus	8	8	1.0	8	6	3.0	3	3	1.5				4	4	2.0				13	13	1.6	16	13	6.5	2	2	1.0
Metatarsus	3	3	0.4	22	15	7.5	2	2	1.0	1	1	0.1	2	2	1.0				13	12	1.5	12	9	4.5	2	2	1.0
Metapodial	4	4	0.4	1	1	0.3	4	3	0.8										6	6	0.6	2	1	0.3	2	1	0.3
Sesamoid																									2	2	
Phalanx 1	6	6	0.4	9	9	1.1	3	3	0.4										8	7	0.4	4	4	0.5	5	5	0.6
Phalanx 2	1	1	0.1	1	1	0.1	1	1	0.1										1	1	0.1	2	2	0.3	3	3	0.4
Phalanx 3	2	2	0.1																						4	4	0.5
Total	**273**	**172**		**419**	**235**		**112**	**72**		**11**	**10**		**11**	**11**		**19**	**14**		**332**	**215**		**512**	**278**		**119**	**70**	

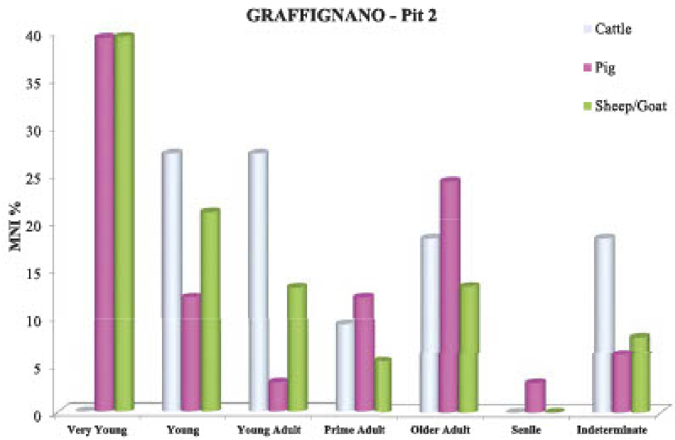

Figure 5. Graffignano – Pit 2: proportion among age classes for the main domestic mammals (MNI = Minimum Number of Individuals).

plants are concerned, besides hay, which represents most of the plant matter, the assemblage includes almost 6,000 remains of seeds and fruits, belonging to 35 plant taxa, referable to 18 families (Figure 9). Most of the specimens belong to fruit plants, mainly grapes (*Vitis vinifera*), but also olives (*Olea europaea*), cherries (*Prunus avium/cerasus*), plums (*Prunus domestica*), peaches (*Prunus persica*), blackberries (*Rubus fruticosus*), citrus fruits (*Citrus* sp.), melon (*Cucumis melo*), calabash (*Lagenaria siceraria*), apples (*Malus* sp.), figs (*Ficus carica*), hazelnuts (*Corylus avellana*), chestnuts (*Castanea sativa*), and walnuts (*Juglans regia*). Particularly interesting in this group is the presence of pomegranates (*Punica granatum*) and pumpkins (*Cucurbita maxima/moschata* and *C. pepo*), the latter native to the New World. Cereals are the second most abundant group, dominated by wheat (*Triticum aestivum/durum*) and millet (*Panicum* sp.). Faba beans (*Vicia faba* major) and peas (*Pisum sativum*) are the most frequent pulses. Other food herbs and spices are also present in the assemblage: mainly parsnip (*Pastinaca sativa*), but also garlic (*Allium sativum*), onion (*Allium cepa*), coriander (*Coriandrum sativum*), fennel (*Foeniculum vulgare*), black pepper (*Piper nigrum*), and hemp (*Cannabis sativa*). Among the weeds, alfalfa (*Medicago* sp.) is the most frequent, while ornamental plants are indicated by the cypress (*Cupressus sempervirens*).

The faunal assemblage from the 'tower dump' is much smaller (582 specimens) than the plant one (Figure 10 and Table 3). Pigs (*Sus domesticus*) are the most frequent mammal species, represented by a minimum number of 10 individuals, more than half of them less than 18 months old. Sheep/goats (*Ovis*

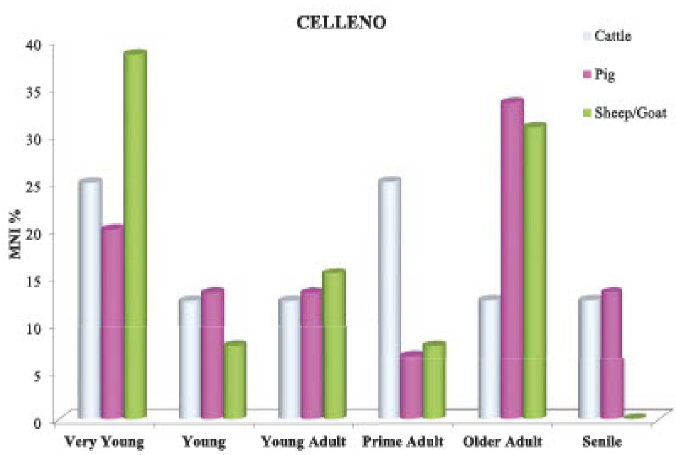

Figure 6. Celleno: proportion among age classes for the main domestic mammals (MNI = Minimum Number of Individuals).

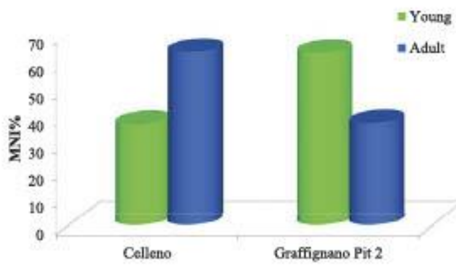

Figure 7. Comparison in the proportion of young and adult chicken individuals at Celleno and Graffignano Pit 2 (MNI = Minimum Number of Individuals).

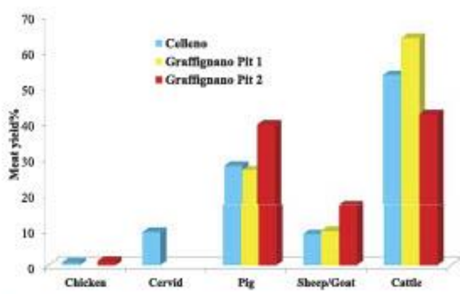

Figure 8. Northern Latium faunal assemblages. Proportions as meat yield among the main taxa.

vel Capra) are the second taxon in terms of the number of remains and are referable to a minimum of 9 individuals; in this case, most of the animals are adult, even senile. Cattle (*Bos taurus*) are rare and represented by three individuals, one of them young. The diet was supplemented by lagomorphs, birds, mainly chicken (*Gallus gallus*), but also pigeon (*Columba livia/oenas*), and eggs, as well as by aquatic resources such as fish, crustaceans and marine mollusks (*Donax trunculus, Cerastoderma edule*). Some of the land gastropods, belonging to edible species (chocolate-band snail *Eobania vermiculata* and garden snail *Cornu aspersum*), may have also been part of the diet. Finally, the sample includes intrusive microfauna (rats and small reptiles) and animals probably not used as food, such as a complete left metatarsal belonging to a horse (*Equus caballus*) about 149 cm tall at the shoulder and the complete mummy of a cat.

The very small faunal assemblage (N = 109; Figure 10 and Table 3) from SU 521, in the former arched porch, contains mainly intrusive small gastropods (*Pomatias elegans, Rumina decollata*) and a few remains of Helicidae, whose presence, considering the association with the other more abundant land mollusks, is probably also accidental. Among the main domestic mammals, pig and sheep/goat have been identified, each one represented by a single prime-aged individual, while larger taxa are documented only by fragments not attributable to species. The cat was recognised from a single calcaneum. The most

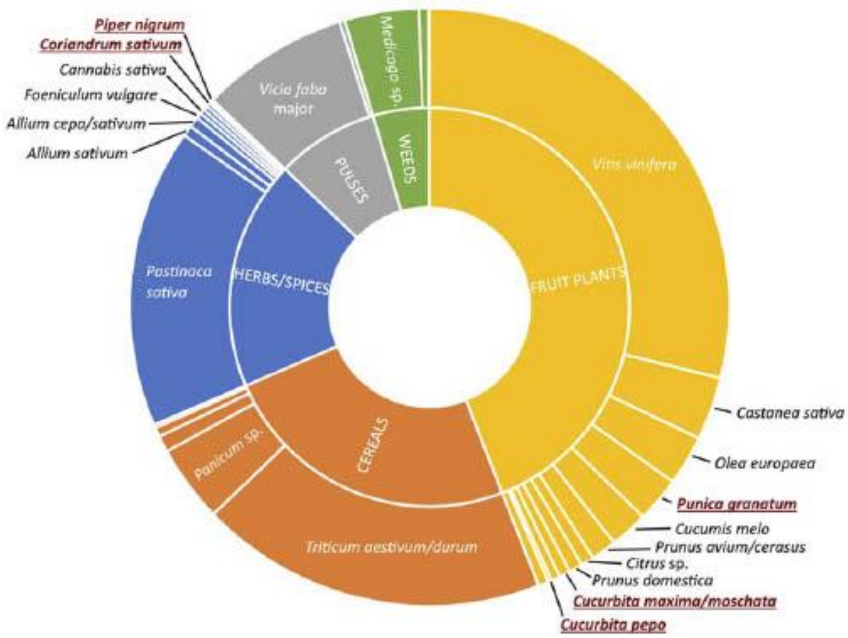

Figure 9 Santi Quattro Coronati (Rome). Proportions among plant taxa (luxury species are underlined).

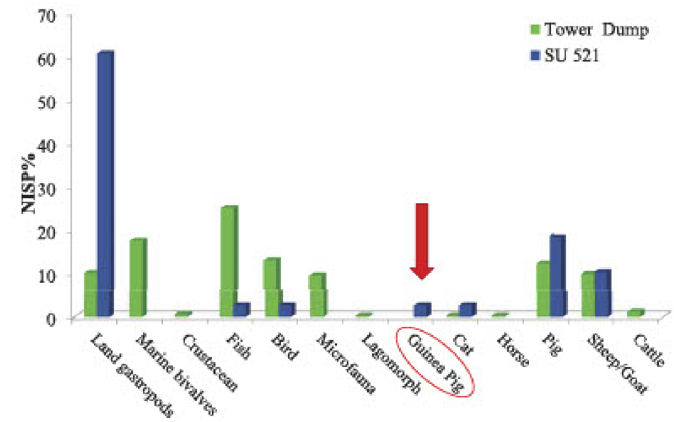

Figure 10. Santi Quattro Coronati (Rome). Proportions among the identified taxa (NISP = Number of Identified Specimens).

interesting find of this sample, which is otherwise quite 'normal', is a pelvis of guinea pig (*Cavia porcellus*). Butchery marks have been identified on the main food species, although in lower percentages compared to the northern Latium assemblages (almost 20% in the 'tower dump' and 9% in SU 521). Combustion appears much more frequent in SU 521 (9%) than in the 'tower dump' (0.03%) suggesting that the two faunal samples were influenced by different cooking methods and/or disposal practices. The small size of the faunal assemblages from the Santi Quattro does not allow a meaningful analysis of the body part representation for the main domestic taxa (Table 4); however, the general expected pattern of a more complete carcass for the smaller species seems to be supported by the available data.

Discussion

The analysis of these late medieval to early modern assemblages provides interesting data for discussing how people used food as a way to display wealth (Table 5). In our case, the location of the contexts is the first indicator of status, but the support of the ceramic information allowed to interpret the faunal and botanical data with greater confidence.

Table 3. The faunal assemblages from Santi Quattro Coronati (N = Number of remains; MNI = Minimum Number of Individuals).

	Santi Quattro Tower Dump				Santi Quattro SU 521			
Species	N	N%	MNI	MNI%	N	N%	MNI	MNI%
Cerastoderma edule	2	0.3	1	1.3				
Donax trunuculus	57	9.8	25	31.6				
Rumina decollata					9	8.3	9	32.1
Pomatias elegans					8	7.3	8	28.6
Eobania vermiculata	2	0.3	2	2.5				
Cornu aspersum	1	0.2	1	1.3				
Helicidae	30	5.2	20	25.3	3	2.8	2	7.1
Small Gastropoda	1	0.2	1	1.3	3	2.8	3	10.7
Crustacea	2	0.3	1	1.3				
Pisces	85	14.6			1	0.9	1	3.6
Columba livia/oenas	1	0.2	1	1.3				
Gallus gallus	8	1.4	1	1.3				
Aves	33	5.7			1	0.9	1	3.6
Aves (egg)	2	0.3						
Microfauna	31	5.3						
Rattus rattus	1	0.2	1	1.3				
Cavia porcellus					1	0.9	1	3.6
Lagomorpha	1	0.2	1	1.3				
Felis catus	1	0.2	1	1.3	1	0.9	1	3.6
Equus caballus	1	0.2	1	1.3				
Sus domesticus	41	7.0	10	12.7	7	6.4	1	3.6
Ovis vel Capra	34	5.8	9	11.4	4	3.7	1	3.6
Bos taurus	4	0.7	3	3.8				
Small mammal	1	0.2						
Medium mammal	65	11.2			19	17.4		
Large mammal	12	2.1			3	2.8		
Unidentifiable	166	28.5			49	45.0		
TOTAL	**582**	**100**	**79**	**100**	**109**	**100**	**28**	**100**

Table 4. Skeletal element representation for the main domestic taxa of the Santi Quattro assemblages (NISP = Number of Identified Specimens; MNE = Minimum Number of Elements; MAU = Minimum Animal Units).

	Santi Quattro – Tower Pit									Santi Quattro – SU 521					
	Sus domesticus			*Ovis vel Capra*			*Bos taurus*			*Sus domesticus*			*Ovis vel Capra*		
Element	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU
Horn															
Cranium 1/2	2	1	0.5	5	1	0.5				1	1	0.5			
Maxilla 1/2	8	4	2.0	1	1	0.5				1	1	0.5			
Mandible 1/2	5	3	1.5	1	1	0.5									
Upper teeth	5	5	0.2	2	2	0.2									
Lower teeth	6	6	0.3	3	3	0.2	1	1	0.1	2	2	0.1			
Teeth				1	1	0.03									
Hyoid															
Atlas															
Axis															
Cervical Vert.	1	1	0.2	3	2	0.4									
Thoracic Vert.	1	1	0.1	3	3	0.2				1	1	0.1			
Lumbar Vert.	2	1	0.1	2	1	0.1	1	1	0.1						
Sacral Vert.															
Caudal Vert.				1	1	0.1									
Vertebrae															
Ribs				3	1	0.04									
Sternum															
Scapula	3	2	1												
Humerus				1	1	0.5									
Radius				2	2	1.0				1	1	0.5			
Ulna				1	1	0.5									
Pelvis	1	1	0.5										1	1	0.5
Femur				1	1	0.5	1	1	0.5						
Patella															
Tibia															
Malleolus/Fibula	1	1	0.5												
Carpals													1	1	0.1
Astragalus				2	2	1.0									
Calcaneus	2	2	1.0	2	2	1.0				1	1	0.5	1	1	0.5
Other Tarsals															
Metacarpus															
Metatarsus	1	1	0.1												
Metapodial	1	1	0.1				1	1	0.3						
Sesamoid															
Phalanx 1	1	1	0.1										1	1	0.1
Phalanx 2	1	1	0.1												
Phalanx 3															
Total	**41**	**32**		**34**	**26**		**4**	**4**		**7**	**7**		**4**	**4**	

At Celleno, the affluence of the palace inhabitants is indicated by the relatively high percentage of wild taxa (roe and red deer) and the abundance of very young individuals of the main mammal species. It is not clear whether the occasional use of fox and dog as a source of meat, as indicated by butchery marks, is part of the high-status diet or if they had been eaten only by the servants working in the residence.

In Graffignano Pit 1, the small faunal assemblage suggests a lower status for those who used the dump, as indicated by the older age of the animals and possibly the smaller size of the sheep compared to the other northern Latium contexts. This hypothesis is also supported by ceramic material that appears worn and with signs of repair.

The food refuse from Graffignano Pit 2 reflects more clearly the wealth of the Baglioni family, not so much in the range and type of species exploited, but in the young and very young age of pigs and sheep/goats, which suggests the selection of more tender meat. Furthermore, the prevalence of female pigs among the young individuals contrasts the economic expectations: in fact, medieval agronomists (e.g. Crescientio 1519) and classical sources (e.g. Columella, Varro and Palladio) recommended people to keep reproductive females alive until they reached full adult age, while culling surplus young males. Therefore, this evidence may be a further indicator of prosperity since the lords of the castle could afford to contradict this advice, foregoing an optimal return strategy and spoiling a source of future economic gain. The prevalence of young animals is also evident for chickens and is a supplementary indication of affluence, as inferable from contemporary sources: '*I pulcinelli quando saran grossi come quaglie o li presso … son molto nobili & al proposito per ghiotti*' (When the chicks are the size of a quail, or close to it … they are very noble and good for gourmands – Romoli 1560, book 2, ch. 22).

In the 'tower dump' of the Santi Quattro Coronati, only the plant remains (Figure 11) show clear evidence of wealth: there is a wide range of food species, proof of a rich diet, presence of taxa considered as luxury items such as pomegranate (Figure 11(a); Bandini Mazzanti et al. 2005; Bruni et al. 2011), prestigious spices like coriander (Figure 11(b); Bosi et al. 2009)

Table 5. Summary data for the analysed contexts.

Site	Type	Chronology	Pottery	Plant evidence	Animal evidence	Peculiarities	Status
Celleno	High status Residence	fourteenth–mid-fifteenth century	High quality	N/A	• Cervids ca. 10% meat yield • Many young individuals for the main domestic mammals	Fox and dog also used as food (not necessarily high status)	High
Graffinano Pit 1	Castle	first half fifteenth century	High quality, but signs of repair and wear	N/A	• Mainly adult and old animals • Small sized sheep (?)		Low
Graffinano Pit 2	Castle	second half fifteenth –beginning sixteenth century	High quality	N/A	• Many young individuals for pig, sheep/goat and chicken • Prevalence of females also among young pigs	Marten used as food	High
Santi Quattro Coronati – ' Tower Dump'	High status ecclesiastic residence	end fifteenth–mid-sixteenth century	High quality	• Wide variety of food plants • New World species • 'Luxury' taxa	• 'Normal' meat consumption pattern		High
Santi Quattro Coronati – SU 521	Ecclesiastic residence	end sixteenth–beginning seventeenth century	High quality	N/A	• New World species		Low + High?

and possibly black pepper (Figure 11(e); Hallavant and Ruas 2014), and, more importantly, two species of pumpkin from the New World (Figure 11(c,d)). In contrast, the faunal assemblage shows a relatively 'normal' pattern, with a restricted range of species, mostly adult sheep/goats, young and adult pigs, and a relatively high frequency of aquatic resources (fish, mollusks, crustaceans) consistent with the dietary rules of a religious context. The small faunal sample from SU 521 is not particularly significant, except for the presence of the guinea pig, the first one documented so far in Italy, which accords with the occurrence of the New World plants in the 'tower dump'. The use of this small animal as food at the Santi Quattro Coronati cannot be positively ascertained because of the lack of butchery marks on the specimen, and therefore this animal may represent 'only' a luxury pet since it was common for wealthy people to own exotic animals. In fact, the first couple of turkeys that we know about from written sources (Oliva 1993) in Italy was sent as a gift, together with some parrots and other items, to the Cardinal Lorenzo Pucci, titular of the Santi Quattro Basilica (1513–1524) and supervisor for the Church of the Indies in the Consistory, by Alessandro Geraldini, first resident bishop in Hispaniola, as reported in a letter he wrote in 1519–20. However, within a few decades both these exotic animals were included in the diet and started to appear in recipe books (Romoli 1560 for the turkey and Scappi 1570 for the guinea pig). Of course, at the beginning the consumption of such exotic species was the prerogative of the elite, but they then became more common and even in the sixteenth century, Scappi (1570) stated that guinea pigs were available all year round in the main Italian towns. Although the use of guinea pigs as food declined in Italy, they were still eaten in Sicily in the 1960s (Mineo, pers. communication).

Conclusion

In summary, sheep/goat and pig are the main species in terms of the number of remains and individuals in most of the contexts included in this research, while cattle is dominant only in Graffignano Pit 1, where it appears to be associated with lower status. However, in all cases, the highest meat yield was provided by cattle. Chicken is only considered important at some sites and probably both meat and eggs were exploited. Besides the main domestic taxa, the diet was supplemented by aquatic resources, which were particularly relevant in the religious context of the Santi Quattro 'tower dump'. Tortoise was also occasionally exploited, possibly as a non-meat food for abstinence days. The use of the latter species is well documented in contemporary recipe books as well as in other archaeological contexts in the same region (Colonnelli

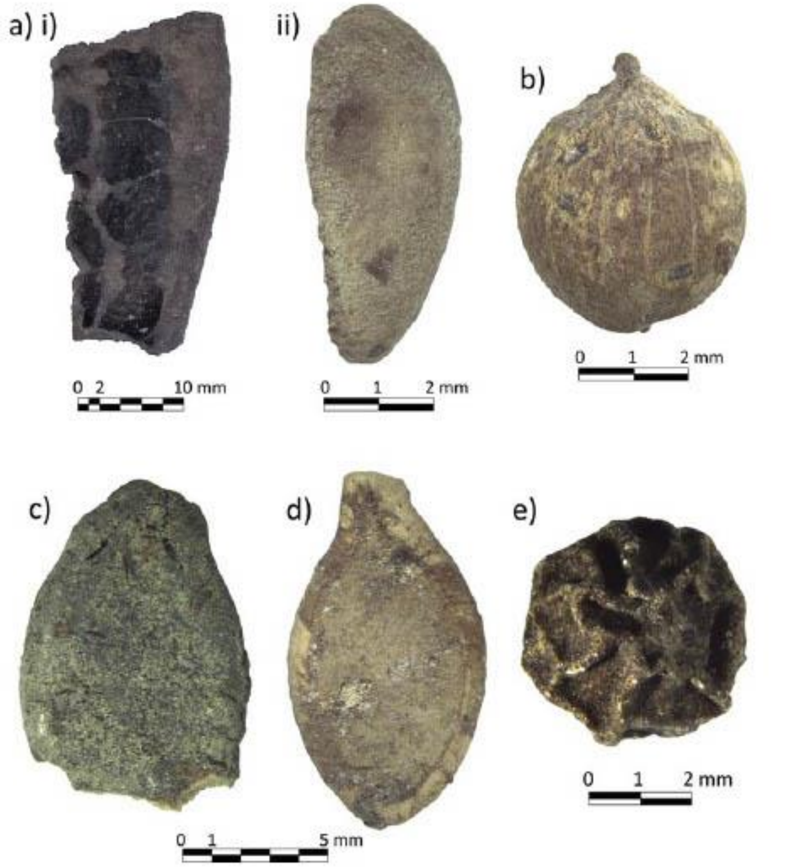

Figure 11. Santi Quattro Coronati (Rome). Luxury food plants at Santi Quattro Coronati: (a) *Punica granatum* (i) exocarp, (ii) seed; (b) *Coriandrum sativum* mericarp (c) *Cucurbita maxima/moschata* seed fragment; (d) *Cucurbita pepo* seed; (e) *Piper nigrum* drupe.

and De Grossi Mazzorin 2000; Romagnoli, Brancazi, and Piermartini 2017; Wilkens 1991).

As already mentioned, it is necessary to consider status within the framework of coeval thinking: for example, animal parts that we now consider mostly of low quality (e.g. offal, ears, eyes, feet, heads) and evidence of low status, were instead considered as delicacies, when properly prepared, during the late Middle Ages and Renaissance, as indicated by recipe books (e.g. Romoli 1560; Scappi 1570). Furthermore, the same cooking manuals also provide indications on how to prepare delicacies with the meat of older animals, therefore in some cases these may also indicate high status. In contrast, food that is now highly valuable, such as the *Cinta senese* pig breed, was considered at Graffignano just as any other pig breed and its 'pureness' was not a priority, as documented, on the basis of genetic analyses (Gabbianelli et al. 2020), by crosses both with other domestic breeds and with wild boar.

The evidence presented here suggests that there is no single way to use food to display status and of course the signatures highlighted are not the only possibilities. Furthermore, this research indicates once again how it is important to use an interdisciplinary approach drawing upon different types of proxies. Besides the more traditional criteria suggested by other authors (e.g. Curet and Pestle 2010; deFrance 2009; Ervynck et al. 2003; Twiss 2012; Veen van der 2003b) to identify elite foodways, the study of the Graffignano assemblages in particular indicates that forthcoming developments to assess what may be considered as elite or luxury food or not, may be provided by genetic analyses (e.g. identification of the sex of young animals, use of particular breeds). Direct isotopic data on plants and animals may in the future give information that would otherwise remain invisible with more traditional approaches (e.g. long distance import of common species).

By adding a further piece of evidence to our knowledge of Latium elite contexts, the data show that people always exploited a wide range of animal and plant resources, but there was variability even within a restricted region and over a time span of few centuries (fourteenth to early seventeenth century) in the way affluence was displayed. Although such variability may be the result of changes through time (e.g. of course New World species were not available before 1492) or local environmental conditions (e.g. presence of woods in the surroundings of the settlement allowed easier access to wild resources), it nonetheless indicates the will to use food as a mean to underline social differences, adapting behaviour according to the situation.

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