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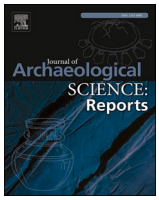

Exploring ancient Lifeways: Archaeobotanical studies at the Hill of Agios Georgios, Nicosia, Cyprus☆

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ABSTRACT

The integrated analysis of macrobotanical remains has the potential to contribute towards a more comprehensive understanding of the relationship between ancient communities and their environment both locally and regionally. This study explores the relationship between ancient communities in Cyprus and their environment from the Archaic to Hellenistic periods, focusing on agricultural practices and timber procurement strategies, and examines human-environment interactions at the Hill of Agios Georgios during this period. By analysing charred seeds and charcoal from the site, the research aims to enhance our understanding of how these communities adapted to and shaped their natural surroundings, offering insights into the broader ecological and economic practices of the time.

1. Introduction and background

The 1st millennium BCE encompasses a fascinating period for the Island of Cyprus, and is characterized by its changing political, social and cultural landscape. The Archaic and Classical periods (8th–4th centuries BCE) are characterized by the political division of the island into city-kingdoms under the influence of the near Eastern empires (Kearns, 2023). These city-kingdoms were later abolished with the establishment of Hellenistic rule in Cyprus, and the Ptolemaic kingdom (4th c. BCE). Ptolemaic rule brought administrative reforms and economic prosperity, as Cyprus's copper resources and agricultural products were integral to the kingdom's economy (Meadows, 2001). Hellenistic Cyprus also saw the flourishing of urban centres, demographic expansion, alongside shifts in settlement patterns and spatial organisation, fostered economic development but also restructured social networks, leading to the emergence of new social formations that shaped multiple aspects of daily life, not only on the island of Cyprus but in the wider region of the eastern Mediterranean (Kiely 2005 in Kearns, 2023; Papantoniou 2012; Post, 2017). The exploitation of the natural environment and resources constituted the backbone of most economic activities in combination with the commercial interaction of the island with both the east and the west. This is evident through written sources attesting to knowledge of timber properties and importance in all aspects of life, e.g. economic, cultural and social (Thirgood, 1987).

Archaeobotanical studies offer a comprehensive understanding of everyday life, agricultural regimes, dietary habits and the role of plants in ancient societies (Margaritis, 2014; 2015; 2016; 2017). Archaeobotanical research in the Archaic to Hellenistic Eastern Mediterranean has yielded valuable insights into ancient agricultural and environmental practices, yet comparable data from Cyprus remain limited. Studies from the southern Levant, such as Marston and Birney's work at Hellenistic Ashkelon, reveal a diverse crop economy including emmer wheat, pulses, grapes, and figs, reflecting market-oriented production strategies (Marston & Birney 2022). Lodwick and Rowan (2022) emphasize the interpretive value of plant remains, especially wood charcoal, in reconstructing land use, fuel practices, and ecological change. While rich datasets exist for Greece and the Levant, Cyprus lacks systematic archaeobotanical investigation for these periods.

Anthracological analysis plays a significant role, within the field of archaeobotany, in gaining an insight into not only the nature of past landscapes, land use practices, fuel consumption and economies but, also, the interactions of people with their hinterland. The island has an extensive anthracological record, from the exploitation of woodlands during the Neolithic period (Rousou et al., 2021; Rousou 2022, 2023) to the ancient copper industries of antiquity (Kassianidou et al., 2023; Sdralia et al., 2024). The anthracological studies from Cyprus's Classical

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and Hellenistic periods while limited, provide a rich understanding of how local resources were managed to sustain a thriving copper industry (see: Socratous et al., 2015). The present study investigates the exploitation of wood resources in the environs of ancient Cyprus, aiming to develop a comprehensive understanding of landscape use and management during the Archaic to Hellenistic periods, away from these industrial centres. The analysis focuses on identifying wood plant taxa, characterizing woodland management practices, and elucidating human-woodland interactions in Archaic, Classical and Hellenistic Cyprus. Additionally, the study aims at identifying the role of inland Cyprus in the transition from the Archaic and Classical to the Hellenistic periods and how the island was affected during this process. The study of both macro and anthracological provides valuable insights on the role of plants within past societies, including their socio-economic systems. While the analysis of charcoal material has significantly contributed to understanding past vegetation, woodland management practices and procurement strategies (Asouti and Austin, 2005; Kabukcu and Chabal, 2021); when combined with the analysis of charred seed remains, it provides critical insights into agricultural regimes, crop processing stages and dietary patterns.

2. The Hill of Agios Georgios

2.1. Archaeological history of the site

The site of the Hill of Agios Georgios is located at the heart of modern-day Nicosia, and it has a rich and complex history spanning from the Chalcolithic through to the present day, with the exception of the Bronze and early Iron Age. The excavations at the site began in 1996 as a rescue excavation and revealed an extensive part of a settlement of various chronological phases (Pilides, 2009). The Hill of Agios Georgios, situated in a region of the island characterized by significant agricultural potential and a long history of land clearance and human-induced landscape modification, offers valuable insights into how such centres interacted with, shaped, and perceived their surrounding environments. Nicosia and the site of the Hill of Agios Georgios lie along the Pedieos river in the centre of the Mesaoria Plain between the Keryneia mountains located to the north and the mountain range of Troodos to the southwest. The Mesaoria plain comprises of alluvial deposits, silt and a limestone plateau (See Fig. 1).

Excavations on the site have yielded significant evidence for a settlement established at the beginning of the Cypro-Archaic period with a sanctuary dedicated to a god and goddess of fertility and associated workshops for the production of ceramics, metal objects and textiles. Further evidence provides support for the possible identification of the excavated site with part of the city of Ledroi (Pilides and Destrooper-Georgiades, 2008, Pilides and Olivier 2008), at a time when Cyprus was divided into a number of city-states. The settlement suffered a destruction during the later stages of the Archaic period, at the time of the Ionian Revolt, probably as a result of conflict. The site was then rebuilt during the 4th century BCE and continued to house workshops and a sanctuary (Pilides, 2004; 2009). Although the olive mill was not found in situ, installations of olive oil production and storage were also recovered from the site. During the 3rd century BCE, the settlement was reorganized once again, under the hegemony of the Ptolemies, while the workshops and all other production continued under the auspices of the new Hellenistic rulers (Pilides, 2004). The site continued to flourish until the 1st century BCE, and the beginning of the Roman rule of the island, when it seems to decline (Pilides, 2004; 2009).

2.2. Locale and environmental setting

The arid Mediterranean climate of Cyprus is characterised by hot summers and cool winters. Nevertheless, the temperature is greatly influenced by the topographic characteristics of the island with the unequal heating of the sea surface and the island's interior and changes in humidity across the island (Griggs et al., 2014). The climatic and topographic conditions have a substantial influence on the flora and fauna species that evolve within them. The environment has been altered over the millennia by human exploitation, fire episodes, deforestation and the establishment of agriculture and arboriculture; these processes have resulted in the evolution of vegetation in conjunction with human activities and manipulation. Cyprus' flora is comprised of a mixture of regenerated forests, extensive areas of maquis and garigue, orchards and agricultural fields amid a landscape of villages and towns (Pons and Quézel, 1998; in Fall, 2012). Cyprus' conifer forests in the mountainous landscapes of the island (>1100 m a.s.L.) are predominated by the overlapping of two species of *Pinus* (Barbéro et al., 1998), *Pinus nigra* J.F. Arnold subsp. *pallasiana* (Black Pine) and *Pinus brutia* Ten. (Turkish Pine).

The Chaulk plateaus and the lowlands, where the site of the Hill of Agios Georgios is located, are typically unattractive to woody species due to the dry soil that do not naturally permit deep root penetration; therefore, more drought-tolerant species occupied these areas. The flora communities can be divided into two groups, maquis and garrigue. Maquis ecosystems occur primarily on the lower slopes of mountains

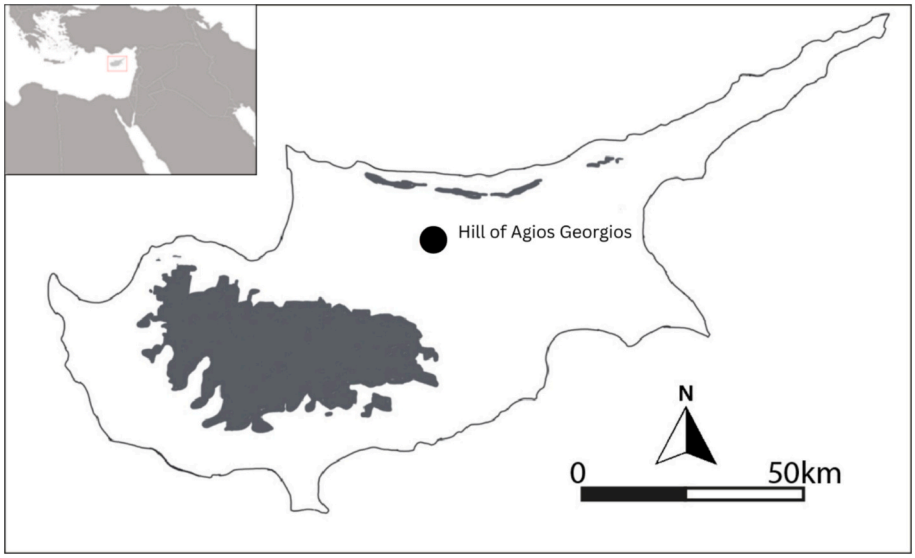

Fig. 1. Location of the Hill of Agios Georgios site.

bordering the Mediterranean Sea. Common species include *Juniperus phoenicea* L., *Pistacia lentiscus* L., *Ceratonia siliqua* L., *Olea europaea* L., *Cistus* spp. and *Salvia fruticose* Mill., with occasional *Pinus brutia* trees (Tsintides, 1998). At higher elevations in the Troodos Mountain, maquis blends into oak forests, where it is dominated by *Quercus alnifolia* Poech, *Arbutus andrachne* L., *Pistacia terebinthus* L., *Quercus coccifera* L. and *Crataegus azarolus* L. (Tsintides, 1998).

2.3. Forestry History, woodland management and role of wood in antiquity

The flora of Cyprus, like that of the broader Eastern Mediterranean region, is typified by fairly high biodiversity, with numerous endemic species (Tsintides, 1998). In spite of the environmental alterations mentioned above, the natural flora of the island is still persists largely unchanged in its remainder woodlands and refugial pockets of natural vegetation.

The exploitation and use of the natural resources formed the economic base of the wider ancient Greek world (Post, 2017), and timber, in particular, served as a valuable commodity not only in constructing and shipbuilding but also as a source of fuel. Literary sources from the 1st millennium BCE document the distinct use of different wood taxa for various uses and activities and are further supported by anthracological studies conducted across the region of the eastern Mediterranean (Allevato et al., 2010; Moser et al., 2018). This attests to the knowledge and understanding of the properties of wood and the evident selection strategies and criteria related to each timber type. Through the historical record, it is evident that the island of Cyprus was once heavily forested and a centre of shipbuilding (Thirgood, 1987). The importance of forests in Cyprus is first cited by Theophrastus (370–287 BCE), who mentions the use and suitability of pine trees (*Pinus brutia* and *Pinus nigra*) in shipbuilding (Hadjigeorgiou,2017).

Woodlands and forests were valued sources for building materials, energy and food in the ancient world. While the existing literary evidence principally concerns Greece, and most notably Athens, this could be extrapolated for the majority of the ancient Greek world, including Cyprus. During the 1st millennium BCE the region experienced a significant rise in population, which respectively resulted in the increasing need of resources, goods and materials hence increasing the clearing of wooded landscapes (Thommen, 2012). This forest clearing activity and woodland exploitation was one of the most distinct human interventions on nature by the ancient Greeks; and the consequences of this became clear from the Archaic period. Plato (427–347 BCE) later discussed the negative effects of deforestation on the landscape (Thommen, 2012), and Aristotle in his work “Politics” (sections 1321b & 1331b) mentions several magistrate positions such as ‘Custodians of Forests’ and ‘Wardens of the Woods’ indicating the importance of forestry in ancient Greece and the efforts of the state to control and maintain the valuable resources provided by the natural environment.

3. Materials and Method

3.1. Sampling procedures

The charcoal material presented in the study were recovered from the site during the excavations of the Department of Antiquities from 1996 to 2010. The samples were collected from the field during the excavation process using two distinct methods, handpicked or through flotation. The first involves the collection of charcoal materials, visible with the naked eye, straight from the excavation, while the second requires the treatment of soil samples through a flotation device. Bulk sediment samples (of approximately 10–15 L) were recovered during excavation and processed by flotation using 1 and 0.25 mm mesh sieves to recover the coarse and fine fractions. Sample volumes ranged between 12 and 14 L.

Upon completion of the flotation process, the light fraction was studied under a stereomicroscope (Leica EZ4 E). For the recovery of the anthracological remains, the residues were dry-sieved through a 2 mm mesh, and charred wood remains were then separated. Anthracological analysis was performed on material larger than the 2 mm threshold, as suggested by Kabukcu and Chabal (2021). Overall, the sampling process resulted in the analysis of 43 samples, originating from all chronological phases, and the examination and identification of a total number of 882 charcoal fragments.

The archaeological contexts sampled, as detailed in Table 1, represent a range of deposits associated with floors, hearths, structural remains, and fills, spanning the Archaic to Hellenistic periods. These deposits offer valuable insights into site use and spatial organization. Floor surfaces and hearths were common. Contexts related to structural features, such as rubble beneath walls, areas adjacent to major walls, and under plaster floors. Some samples were drawn from pits and platforms, expanding the functional range of the dataset. Overall, the sampled material derives from diverse contexts, capturing a spectrum of domestic and architectural activity. These deposits contribute significantly to understanding the site’s long-term occupation and the dynamic interaction between people and their built environment.

3.2. Archaeobotanical identification and analysis

The identification process of the archaeobotanical remains was conducted at the Archaeobotany Lab in Science and Technology in Archaeology and Culture Research Centre (STARC), of the Cyprus Institute. The identification of plant macro remains was performed under a binocular stereo microscope (Leica EZ4 E) at magnifications between 10× and 50×. After sorting the samples into morpho-typologically consistent groups, taxonomical identification was achieved by using comparative material, published atlases and reference collections (Cappers et al., 2009, 2012; Cappers and Bekker, 2013; Cappers and Neef, 2021). The anthracological identification process involves the use of a reflected light microscope (Zeiss AxioImager) at magnifications ranging between 40x and 500×. The anatomic characteristics, across all three anatomical planes – transverse, radial and tangential, of every specific charcoal fragment were defined in accordance with the system suggested by the International Association of Wood Anatomists (IAWA) list of microscopic characteristics for the identification of both angiosperm (Richter et al., 2004) and gymnosperm species (Wheeler, 1989). Taxonomic identification was realized following the methodology proposed for charcoal identification in the eastern Mediterranean region (Ntinou, 2019). Online databases (Wheeler, 2011) as well as published atlases (Crivellaro and Schweingruber, 2013; Schweingruber, 1990) were used to validate and refine the identification of the wood charcoal samples.

Carbonised wood data was summarised in assemblages expressing the relative frequencies of the wood taxa, and analysis was grouped in accordance with the phytosociological units proposed by Meikle (1977); linking each taxa with the ecological group(s) in which they are prevalent. The rates of each vegetation zone were achieved by compounding the frequencies of plant taxa correlated to each zone. Several methods to evaluate biodiversity and assemblage allocation were employed to assess species diversity and evenness of species across all chronological phases. These include Margalef’s Diversity Index, Simpson’s diversity index (Branch, 2005), Shannon diversity and equitability index and Pielou’s evenness index (Pielou, 1966). The above indices allow for the quantification of species richness, diversity and the better understanding of ecological balance and potential anthropogenic influence. The representativity of the anthracological assemblages in the deposits were assessed through the use of accumulation curves (Asouti and Austin, 2005). Gini-Lorenz index was also applied to measure the ecological representativity of each assemblage. The chosen indices offer complementary and comprehensive measures of the structure, diversity, and representativity of anthracological assemblages. The statistical analyses and graphic representations of the results were done using Microsoft

Table 1
Hill of Agios Georgios charcoal sample by chronological order.

	Area	Square	Layer	Date	Description	Total Fragments examined
Hellenistic	I	A7		26/06/1996	Under plaster floor	270
	II	Θ1-I1		15/07/1996	Rubble under wall	
	II	Θ1-I1		10/07/1996		
	II	Θ1-I1		17/07/1996	Outside E-W wall	
	II	A7		05/09/1997	Charcoal from lower wall	
	X	AB14/AA14				
	X	AB15			Hearth area	
	X	AΓ14			Floor	
	X	AA9	Layer 2.5	23/09/2009	Depression in Floor 1	
	X	AB14/AB13			North of wall 10	
	X	AB8	Layer 3.1		Northeastern corner	
	XV	Θ16		06/11/2003	Floor 1	
	XV	H17		04/11/2003	Road 9 Fill of sewage channel	
	XV	Θ17		24/10/2002	Ashy layer south of wall 184	
	XIV	P14	Layer 1	04/06/2002		
	XIV	O14/Ξ14	Layer 1			
	V	T11	Layer 2	05/05/1998	Burnt area	
	V	I2		16/09/1997	Yellowish floor	
	XI	AA7	Layer 2.4		Below floor 1, Hearth 80	
Classical	Plot 1221	Box I1			East extension	371
	Plot 1221	Box I1			East extension	
	Plot 1221	Box I1			East extension	
	Plot 1221	Box I1			East extension	
	Plot 1221	AΥ23		10/10/2006	South of Pit 1	
	Plot 1221	AT24/AT25		19/10/2006	Hearth 8	
	Plot 1221	AT24/AT25	Layer 2.2	19/10/2006	Hearth 8	
	X	AB9	Layer 3.3		Hearth 83	
	X	AA14			Ashy layer	
	XI	AA7/AB7	Layer 2.4	24/07/07		
	XVI	K6	Layer 2.4		South	
	XVII	Ψ6/Ψ7	Layer 2.3	15/06/2006	Area of Ashlar platform (49A)	
Archaic	II	Θ1		10/07/1996	Pit 2	241
	II	Θ1-I1			Pit 2	
	V	Y14		30/09/1997	Pit in bedrock	
	V	T10/T11	Layer 2	19/05/1998		
	V	Σ13	Layer 2	22/09/1997	Charcoal and burnt sherds	
	III	O1		16/07/1996	Above pit	
	III	O1		18/07/1996		
	VII	Δ1		29/03/2000	Pit 1	
	X	AE9			Hearth 87	
	X	AE9	Layer 2.5		Hearth 86	
	XIII	O7		22/07/2002	Between walls 60&61	
	Plot 1221	AY26	Layer 2.1	02/10/2006	Black Lustrous ash sample	

Excel and TiliaGraph (Grimm 1992).

4. Results

From the anthracological analysis, a total of 882 charcoal fragments were examined, of which 822 were anatomically identified at different taxonomic levels. The charcoal assemblage exhibits a high degree of taxonomic resolution, with the majority of fragments successfully identified despite the majority measuring under 5 mm in size. This suggests favorable preservation conditions and the presence of diagnostic anatomical features even in highly fragmented material, allowing for reliable identification and robust interpretation of the wood charcoal record. Fragments lacking sufficient anatomical features—often as a result of extensive fragmentation or distortion—did not allow for confident taxonomic identification under microscopic analysis and thus remained as "unidentified".

The anthracological assemblage from the Hill of Agios Georgios identified eleven distinct plant taxa, comprising of eight Angiosperm species and three Gymnosperm species. In the case where individual charcoal fragments presented an insufficient number of observable characteristics for precise taxonomic identification, the charred woods remain were identified only to the genus level, for example, *Pistacia* sp. and *Quercus* sp. (type Evergreen) (See Table 2).

The initial phase of the Cypro-Archaic period (750–475 BCE) features 9 different plant taxa, with an overall dominance of *Olea europaea* (42.7 %), *Pinus brutia/halepensis* (22.4 %) and *Quercus* sp. (type Evergreen) (13.7 %), representing the vegetation of the Maquis. *Pistacia* sp., *Myrtus communis* L., *Platanus orientalis* L., *Pinus nigra/sylvestris* are also presented in lower proportions of <10 %. The degree of diversity in this assemblage is rather stable with a Shannon's diversity index score of H

Table 2
Total fragment counts of each charcoal species identified per chronological period.

Chronological Period	Archaic Period				Classical Period				Hellenistic Period			
	Fragmentcount	Ubiquity	% Count	% Ubiquity	Fragmentcount	Ubiquity	% Count	% Ubiquity	Fragmentcount	Ubiquity	% Count	% Ubiquity
Taxa												
Myrtus communis	8	3	3.3	25	–	–	–	–	8	5	3.0	26
Olea europaea	103	10	42.7	83	216	10	58.2	83	106	11	39.3	58
Pistacia lentiscus	–	–	–	–	1	3	0.3	25	–	–	–	–
Pistacia terebinthus	–	–	–	–	10	4	2.7	33	–	–	–	–
Pistacia sp.	18	6	7.5	50	46	6	12.4	50	20	3	7.4	16
Platanus orientalis	7	4	2.9	33	13	4	3.5	33	8	2	3.0	11
Quercus sp. (type Evergreen)	33	3	13.7	25	50	3	13.5	25	20	3	7.4	16
Rhamnus lycioides	–	–	–	–	3	1	0.8	8	–	–	–	–
Cupressus sempervirens	–	–	–	–	–	–	–	–	2	1	0.7	5
Pinus brutia/ halepensis	54	4	22.4	33	6	1	1.6	8	82	7	30.4	37
Pinus nigra/ sylvestris	3	1	1.2	8	–	–	–	–	5	2	1.9	11
Unidentified	15	–	6.2	–	26	–	7.0	–	19	–	7.0	–
Total	**241**	**(N = 12)**	**100**		**371**	**(N = 12)**	**100**		**270**	**(N = 19)**	**100**	

= 1.62.

The following chronological phase of the Cypro-Classical (475–325 BCE) is represented by a total of 9 plant taxa, of which one is an unidentified species. The assemblage is characterized by the dominance of *Olea europaea* (58 %), *Quercus* sp. (type Evergreen) (13.4 %) and *Pistacia* sp. (12.4 %). During this period there is a clear increase in the contribution from the Maquis vegetation and a distinct decrease of the Brutia Pine Zone, mainly due to the increased proportions of *Olea europaea* and the clear decrease of *Pinus brutia/halepensis* compared to the earlier chronological phase. Shannon's diversity index indicates a lower diversification compared to the previous phase (H = 1.36).

The ultimate chronological phase under investigation, the Hellenistic period (325–30 BCE) is represented by 10 different plant taxa, of which two are unidentified species. The Hellenistic assemblage is characterized by the dominance of *Olea europaea* (39.2 %) and *Pinus brutia/halepensis* (30.4 %). *Pistacia* sp., *Quercus* sp. (type Evergreen), *Myrtus communis*, *Platanus orientalis*, *Cupressus sempervirens* and *Pinus nigra/sylvestris* at proportions lower that 10 %. This period can be characterized by a higher diversification as highlighted by the slightly higher result of the Shannon's diversity index (H = 1.66).

The distribution of charcoal fragments across different context types and chronological phases (Table 3) reveals notable patterns in potential wood-use activities. During the Archaic period, pits yielded the highest number of taxa and fragment counts, followed by hearths, suggesting a concentration of charcoal-rich refuse in these features. In contrast, the Classical period shows a more balanced representation across hearths, pits, and structural remains, indicating broader spatial dispersal of charred material. The Hellenistic period is marked by a pronounced shift, with floors and structural remains producing the majority of identifiable fragments, reflecting either intensified architectural use of wood or better preservation in these contexts. *Olea europaea* dominates all periods and contexts, but particularly structural remains in the Hellenistic phase. The presence and frequency of taxa such as *Pinus brutia/halepensis*, *Pinus nigra/sylvestris* and *Cupressus sempervirens* in structural remains further suggest selective use of specific taxa for construction purposes over time.

Table 3
Toral fragment counts of each species identified per type of context, for all chronological phases.

Chronological Period	Archaic Period				Classical Period				Hellenistic Period			
Context	Floors	Hearths	Pits	Structural Remains	Floors	Hearths	Pits	Structural Remains	Floors	Hearths	Pits	Structural Remains
Taxa	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Myrtus communis	–	–	8	–	–	–	–	–	4	–	3	1
Olea europaea	20	42	37	4	7	74	66	69	37	9	2	58
Pistacia lentiscus	–	–	–	–	–	–	–	1	–	–	–	–
Pistacia terebinthus	–	–	–	–	–	1	1	8	–	–	–	–
Pistacia sp.	4	9	5	–	3	17	21	5	14	6	–	–
Platanus orientalis	–	3	4	–	–	9	–	4	–	1	–	7
Quercus sp. (type Evergreen)	–	1	32	–	–	8	2	40	16	4	–	–
Rhamnus lycioides	–	–	–	–	–	–	–	3	–	–	–	–
Cupressus sempervirens	–	–	–	–	–	–	–	–	–	2	–	–
Pinus brutia/halepensis	–	12	22	10	–	–	–	6	5	4	–	73
Pinus nigra/sylvestris	–	–	–	3	–	–	–	–	–	–	–	5
Unidentified	2	10	3	–	3	6	9	8	4	12	–	3
Total	**26**	**77**	**111**	**17**	**13**	**115**	**99**	**144**	**80**	**38**	**5**	**147**

In addition to the wood charcoal remains, the archaeobotanical macro-assemblage from the site includes seeds and other plant parts, such as cereals, legumes, fruits, nuts, and some wild flora. The material was recovered primarily through flotation, as was the case for some of the wood remains.

The Archaic period assemblage, derived from two pits (Pit 60 and Pit 61), features hulled barley (*Hordeum vulgare* ssp. *vulgare*), free-threshing wheat (*Triticum aestivum* ssp. *aestivum* / *Triticum aestivum* ssp. *durum*), and other cereals classified as Cereal sp. due to their fragmentation and poor preservation, likely caused by exposure to high temperatures. Pulses include chickpeas (*Cicer arietinum*), lentils (*Lens culinaris*), and smaller legumes identified as Leguminosae sp. Fruits are represented by grape (*Vitis vinifera* ssp. *vinifera*), olive (*Olea europaea*), fig (*Ficus carica*), and blackberry (*Rubus* sp.). Wild taxa include *Lolium* sp. and small *Poaceae*.

These assemblages from the pits likely represent residues from food preparation and cooking, as well as by-products of fuel use at the site.

A particularly intriguing find comes from an area near a hearth, situated a short distance from an olive oil storage area within a large adjacent building of the 4th century BCE This deposit includes complete olive stones as well as hundreds of fragmented olive stone pieces. Notably, the fragmentation appears to have occurred in antiquity rather than as a result of post-depositional processes. Experimental work (Margaritis and Jones 2008) suggests that these fragmented olive stones are residues from olive oil production, later repurposed as fuel (See Fig. 2).

5. Discussion

The anthracological assemblage from the Hill of Agios Georgios consists of 11 different plant taxa, corresponding to a diversity of vegetational zones across the island of Cyprus. These zones include the pine forests of the Troodos Mountain range, the *Brutia* pine woodlands found across the whole of the island and the mostly dry (xeric) shrublands of the lowlands. The presence of these vegetation zones suggests the exploitation of timber from a rich assortment of environmental settings, indicative of both the local and regional natural environment of the site. Paleoenvironmental analyses of randomly sampled anthropogenic assemblages from historical settlements can provide valuable insights into past ecological conditions (e.g., Asouti and Austin, 2005; Théry-Parisot et al., 2010; Kabukcu and Chabal, 2021). The anthracological analysis of the site indicates that the site of the Hill of Agios Georgios from the Cypro-Archaic to the Hellenistic periods obtained the necessary timber from various vegetational zones across the island of Cyprus, from the nearby locale up to the higher peaks of the island's mountain ranges. The vegetation zones present within the anthracological assemblage are consistent with the present-day vegetation cover of the island as described by Meikle (1977) and Tsintides (1998) (See Fig. 3.).

Fig. 2. Complete carbonised grape pips.

Anthracological analysis of the site inidicates no major changes in the palaeoenvironment of the island of Cyprus between the Cypro-Archaic and Hellenistic periods. Previous paleoenvironmental studies conducted in the region of the eastern Mediterranean suggest the prevalence of arid conditions during a major part of the 1st millennium BCE in the region, with this coming to an end at around 2100–2000 yrs BP (Roberts et al., 2001, 2008; Wick et al., 2003; Finne et al., 2011). Studies have also indicated that this shift towards drier conditions has been coupled with the expansion of *Olea europaea* pollen and evergreen shrubland (Vignola et al., 2022). The presence of arid conditions in the region is reflected in the anthracological study of the site, as there is a clear increase in the thermophylous zone (Maquis) during the Cypro-Classical period, coupled with a distinct decrease of *Pinus brutia/halepensis* counts and a significant increase of evergreen flora (e.g. *Quercus*) and *Olea europaea*.

The diverse assortment of species of the site assemblage displays the wide range of wood taxa utilised by the ancient communities at the site of the Hill of Agios Georgios. The plant taxa present in the anthracological record represent several habitats found within the island of Cyprus, from the xerophilous plains to the upper mountainous regions, thus revealing a clear interaction of the site with its hinterland. The high proportions of plain and open woodland taxa (Maquis and Brutia Pine zones) are indicative of the strategies and capabilities of the site towards timber procurement, suggesting a preference towards the low to mid-altitude and open woodland landscapes surrounding the settlement. Results displayed a preference towards specific types of timber or firewood such as *Pinus brutia/halepensis* and *Olea europaea* which represented more than half of the assemblage across the majority of the periods. The appearance of shrubs such as myrtle (*Myrtus communis*) and Mediterranean buckthorn (*Rhamnus lycioides*) points to the probable use of their small branches for kindling purposes. The presence of plant taxa characteristic of the island's higher elevations suggests a strong link between the settlement at the Hill of Agios Georgios and other areas of the island. Furthermore, the presence of hydrophilic species such as *Myrtus communis* and *Platanus orientalis*, which are typically associated with rivers, streams, and other moisture-rich environments, can likely be attributed to the settlement's close proximity to the Pedieos River. This connection may indicate a deliberate timber procurement strategy that encompassed both the local environment and, to a lesser extent, more distant regions, reflecting a high degree of organizational development during the periods under investigation.

Land use, including woodland management (which can be for exploitation but also protection), results in the creation of anthropogenic environments. These arise from an array of distinct practices such as selective removal of species or trees, coppicing or clearance of the original woodland. Clearance is perhaps the most evident transformation in land use, often involving the burning of original woodlands, followed by continuous maintenance through the suppression of tree seedlings or grazing to prevent regrowth (Asouti and Kabukcu, 2014). The large quantity of olive remains, and charcoal recovered from the site, suggests the use of olive wood from orchard maintenance (pruning residues) and is indicative of the importance of olive trees in the settlement. Olive tree pomace serves as valuable fuel, burning slowly and reaching high temperatures with minimal smoke, making it ideal for indoor use. The production of residual biomass deriving from pruning a mature modern olive tree orchard can be as much as 2.1 t ha-1 (Velázquez-Martí et al., 2011) and further attests to the importance of olive in both cultural and economic spheres in the ancient world. The use of leftover from tree maintenance as well as the presence of olive seed and olive presses at the site, further attests to the importance of the olive in both cultural and economic spheres. The tree was closely linked

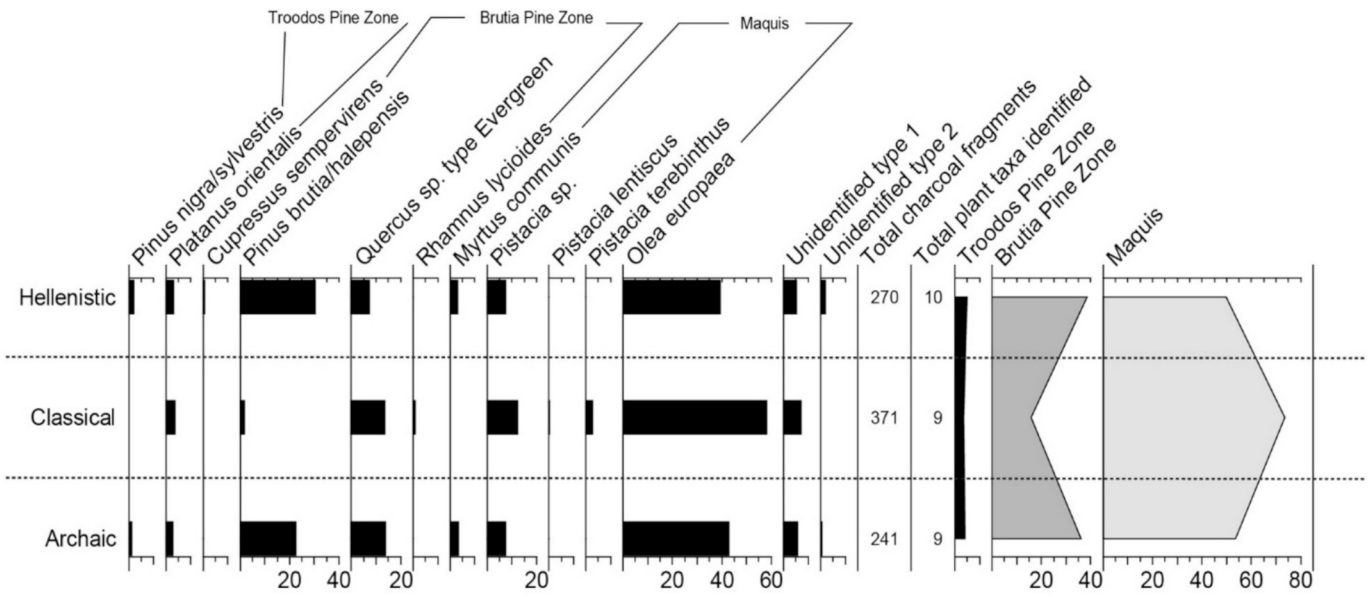

Fig. 3. Anthracological diagram of the Hill of Agios Georgios by chronological phase.

to the gods, valued for its crops, and for oil and wood production (Voyiatzi et al., 1999). Considering the broader spectrum of archaeobotanical remains, the Hill of Agios Georgios has provided substantial evidence for the presence and importance of the olive for the ancient community on the island. In the case of the high proportions of *Pinus brutia/halepensis* charcoal fragments present in the assemblage from the site, especially during the Hellenistic period, could be attributed to management and indirect forest management encouraging pine forest growth for the copper industry. Socratous et al. (2015) conducted a comprehensive study of charcoal remains from slag heaps dating to the Classical and Hellenistic periods on the island. Their analysis showed that *Pinus brutia* (pine) was the predominant wood species used for copper smelting during these periods. Pine's dominance as a fuel source reflects both its abundance in on the island and its suitability for sustaining high temperatures required in copper smelting. This selective use underscores a continuity in fuel choice that persisted from earlier periods, showing an adaptive strategy tailored to local resources. Cyprus's forests assumed strategic importance for the Ptolemies (Papantoniou, 2013), reportedly as the sole wooded region within their territorial holdings. The island subsequently developed into a crucial centre for Ptolemaic shipbuilding, especially amid the period's naval arms race that prioritized the construction of warships. This industry sustained its economic importance into the Roman era of Cyprus (Leonard 2005).

The results of the charred wood analysis from samples deriving from the structural remains suggest the use of *Pinus nigra/sylvestris*,and, *Platanus orientalis* and *Quercus* sp. (Evergreen) as construction materials. Anthracological studies from the early Roman period at Herculaneum have shown that the timber from *Pinus nigra/sylvestris* was used for planks, while *Olea europaea L.* was used as squared joists and treenails (Moser et al., 2018). The higher proportions of species such as *Platanus orientalis* and *Quercus* sp. (Evergreen), in the destruction contexts, shows that the use of such timber was also sought after for construction, and possibly softwood and hardwood were used for different parts of the structures. The complex use of specific timber for specific construction elements suggests a sophisticated network of wood procurement practices in the craftmanship during the studied period. The acquisition of these specific timbers from nearby vegetations and the wider region attests to the knowledge that these societies had about the technical properties of the wood and a selection strategy related to such properties (Moser et al., 2018).

6. Conclusion

The analysis of plant macro-remains and the anthracological assemblage from the Hill of Agios Georgios revealed a rich and diverse interaction between the inhabitants and their environment, thus highlighting key aspects of both agriculture and arboriculture. The presence of cereals, legumes, fruits and nuts represent a diverse suite of plants used for consumption; whole and crushed olive remnants indicate an advanced level of cultivation and olive oil production, further supported by the possible presence of an olive mill at the site. In addition, the various plant taxa identified within the anthracological assemblage of the site are indicative of the procurement of timber from various vegetational zones across the island, including the pine forests of the Troodos Mountain range, the open Pinus Brutia woodlands and the xeric shrublands of the lowlands. This wide range of species indicates the community's strategic timber collection practices, particularly from mid-altitude and open woodland areas, and points to a clear exploitation of their surrounding environment. Considering the broader spectrum of archaeobotanical remains, the Hill of Agios Georgios has provided substantial evidence for the presence and importance of the olive for the ancient community on the island. This selective use underscores a continuity in fuel choice that persisted from earlier periods, showing an adaptive strategy tailored to local resources.

CRediT authorship contribution statement

Panagiotis Koullouros: Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation, Conceptualization. **Despina Pilides:** Writing – review & editing, Project administration, Data curation, Conceptualization. **Evi Margaritis:** Writing – review & editing, Supervision.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jasrep.2025.105398.

Data availability

Data will be made available on request.

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