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Fusion cuisine in the shadow of Mount Olympus: an integrated study of Middle and Late Bronze Age cooking pots¹

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Introduction

The Mycenaean civilisation which emerged in the southern part of the Greek peninsula around 1650 BC is one of the major cultural and political phenomena of the Bronze Age in Europe and the Mediterranean, its influence stretching well beyond its original geographical limits. Elements of Mycenaean material culture were widely distributed for nearly half a millennium (15th -11th century BC) throughout the Aegean and in the eastern and central Mediterranean. Multifaceted relationships developed between the polity areas of central and southern Greece and adjacent or more distant areas, involving movement of people, procurement of raw materials, circulation of artefacts and substances, transmission of technologies and practices, all in diverse forms and degrees.² The adaptation of Mycenaean cultural elements in various areas, however, appears not

¹ This research has been funded by the European Research Council (ERC), in the context of the Project PLANTCULT 'Identifying the Food Cultures of Ancient Europe', conducted under the European Union's Horizon 2020 Research and Innovation Program (Grant Agreement no. 682529), Consolidator Grant 2016–2021, and the Wellcome Trust [Grant Number 097365/Z/11/Z]. We would like to thank the personnel of the Ephorate of Antiquities of Pieria and the Directorate of the Greek Ministry of Culture responsible for issuing the necessary permits for the study, sampling and analysis of the material. We are also grateful to Dr Danai Chondrou for drafting and digitizing the vessel drawings, Dr Tasos Bekiaris for digital image processing, Themis Roustanis for preparing the map, and Dr Helen Talbot for aiding analysis of organic residues. We are also grateful to Dr Clemence Pagnoux for her feedback as regards the presence of millet in the archaeobotanical assemblage of the site. Finally, Anastasia Dimoula would like to thank Dr Evangelia Kiriati and Dr Bartek Lis for sharing their insights on LBA pottery and particularly Mycenaean cooking pots.

² Broodbank 2013: 345–347; Treuil *et al.* 2008: 359–373.

to be a linear acculturation process, but a complex reciprocal phenomenon, involving the active participation of all agents.³

In exploring these interactions one of the central foci of research is Mycenaean pottery, due to its highly standardised and distinct technological characteristics, shapes and decoration.⁴ Mycenaean pots were broadly circulating, commonly as containers of luxury substances, such as oil, perfumes or wine, or as exotic tableware, drinking sets in particular.⁵ Local productions of Mycenaean-style pottery, often associated with itinerant craftsmen, eventually outnumbered the imported vessels in some areas.⁶ Furthermore, emergent pottery types attest to the amalgamation of local and Mycenaean ceramic traditions, not to mention that Mycenaean sites adopted exogenous ceramic wares (e.g., the handmade burnished ware).⁷

This circulation of Mycenaean pottery mostly concerns tableware and storage/transportation vessels, while household pottery and especially cooking pots played a very small role. The production of the latter, in most of the interacting regions throughout the Mycenaean period, basically continues the local traditions of handmade coarse vessels with wide mouths, curved profiles and handling accessories, presumably used for various household activities.⁸ On the other hand, the Mycenaean cooking sets from central and southern Greece typically include wheel-fashioned vessels, mainly two- and one-handled jars and tripod vessels, and occasionally other shapes such as griddles or braziers.⁹ Exceptional are the handmade cooking vessels originating from the island of Aegina near Athens and widely distributed in the southern Aegean.¹⁰ Based on the available archaeological data, Mycenaean-style cooking pots are seemingly absent or extremely rare in northern Greece and the Balkans,¹¹ as well as in the central Mediterranean.¹² In contrast, they largely replace local traditional cooking vessels in Cyprus and in the Levant after c.1300 BC. Here the assemblages consist mostly of jars, with other distinctive Mycenaean forms, such as tripods, largely absent.¹³ These variations are believed to be derived from different patterns of Mycenaean influence: from simple contacts to larger-scale population movements.¹⁴ Indeed, cooking pottery, as an artefact class connected with culinary practices and food culture, is more strongly associated with social groups' identities.¹⁵

This paper explores the relations developed between Mycenaean and their northern neighbours through the study of cooking assemblages from four sites in the region of Pieria, in present-day Greek Central Macedonia. A strong connection with the Mycenaean sphere in the 13th -12th century BC has already been indicated through archaeological evidence from graves,¹⁶ but it is the first time that this connection is explored through domestic utensils. Moreover, the four sites cover chronologically the entire Middle and Late Bronze Age – i.e., a time interval corresponding to the whole of the Mycenaean period and the centuries immediately preceding it, c.2000–1100 BC – providing both wide contexts and great time depth. Through a 'longue durée' investigation of food preparation using ceramic analysis and contextual associations, we evaluate local and traditional elements of the cooking apparatus vs. new and/or exogenous ones, and identify the time of their introduction. Based on our observations we discuss cultural interaction between the Mycenaean

³ Kiriati and Andreou 2016; Gorogianni, Pavuk and Girella 2016.

⁴ Rutter 2010; Mountjoy 1993.

⁵ van Wijngaarden 2002.

⁶ Jones, Levi and Battelli 2005; Kiriati and Andreou 2016.

⁷ Jung 2003; Jung and Mehofer 2013.

⁸ Borgna and Levi 2017; Jung 2003.

⁹ Lis 2017.

¹⁰ Gauss *et al.* 2017.

¹¹ Andreou 2003: 2009; Jung 2003.

¹² Borgna and Levi 2017.

¹³ Jung 2017; Yasur Landau 2005: 2011.

¹⁴ Jung 2011.

¹⁵ See Spataro and Villing 2015.

¹⁶ Poulaki-Pantermali 2013; Andreou, Fotiadis and Kotsakis 1996.

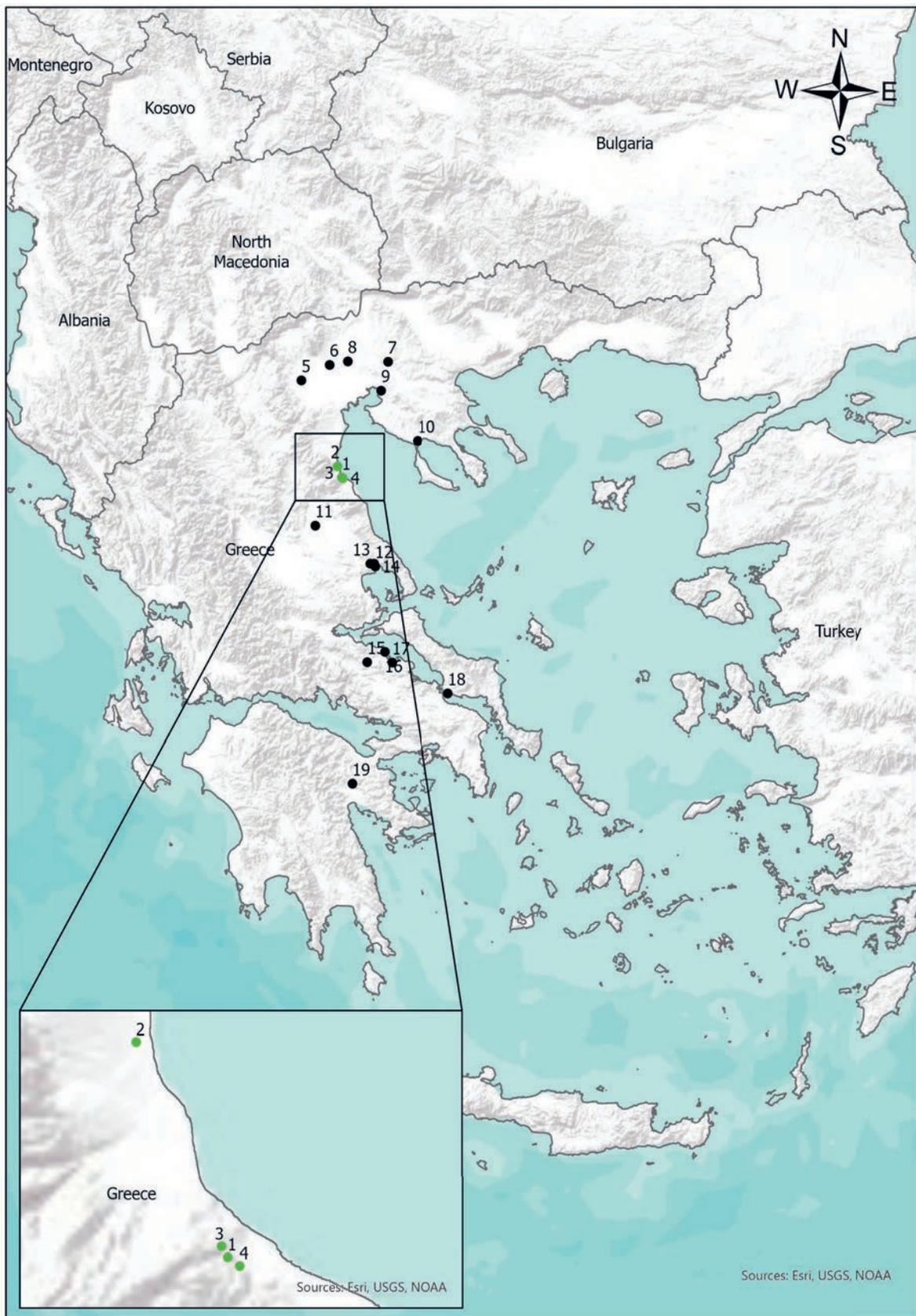


Figure 1. Map showing the sites under study (indicated with green dots) and the ones mentioned in the text (indicated with black dots): 1. Rema Xydias, 2. Valtos-Leptokarya, 3. Pigi Artemidos, 4. Trimpina, 5. Angelochori, 6. Archondiko, 7. Assiros, 8. Kastanas, 9. Toumba Thessalonikis, 10. Olynthus, 11. Argissa, 12. Pefkasia, 13. Dimini, 14. Kastro Volou, 15. Kalapodi, 16. Kynos, 17. Mitrou, 18. Lefkandi, 19. Mycenae.

and northern Greek communities as expressed through food preparation, in other words, the transformation of cooking within the specific social and historical contexts of our case studies.

Materials and Methods

The sites

The ceramic cooking assemblages discussed in this paper derive from domestic contexts of four sites located on the east foothills of Mount Olympus, at the narrow stretch of land inserted between the massif and the western shores of the Thermaic Gulf (Figure 1). The area comprises diverse environments, both coastal and inland, lowland and upland, with abundant fresh water sources. Moreover, it controls the passage on the coastal route that connects Macedonia and the Balkans to the north, and Thessaly and central Greece to the south.

The main body of the cooking pottery assemblage examined is from the site of Rema Xydias (Figure 2), where excavations revealed a domestic building complex with two construction phases and part of a cemetery, dated to the 15th-12th century BC; mobile finds from all spaces are characterised by the high occurrence of Mycenaean types, including kitchenware.¹⁷ However, in the scope of exploring the regional characteristics of cooking pottery before and during the broad permeation of Mycenaean cultural traits in the area, cooking pots from three neighbouring sites were also studied as comparative material (Table 1). The site of Pigi Artemidos (Figure 3) initially formed a cemetery, in the area of which residential structures were later built, during a period quite contemporary to that of Rema Xydias.¹⁸ In the site of Trimpina (Figure 4), habitation preceded the use of a Mycenaean cemetery, which sets a *terminus ante quem* in 1400 BC.¹⁹ Both these sites also comprise many



Figure 2. Rema Xydias, aerial view of the building complex (© Ephorate of Antiquities of Pieria).

¹⁷ Koulidou *et al.* 2014.

¹⁸ Koulidou 2010.

¹⁹ Koulidou *et al.* 2012.

Site	Studied specimens and their contexts	Chronological period (with parallels to phases of S Greece)	Dates
Rema Xydias	16; Interior-exterior of building complex	LBA, parallel to LHIIIA-LHIIIC early (relative)	1489-1296 BC (radiocarbon)
Pigi Artemidos	3; Open-air hearth and indeterminate architectural remains	LBA, parallel to LHIIIA-LHIIIC late	1390-1100 BC (relative)
Trimpina	5; pits 12 and 15	LBA, parallel to LHI-LHII	1600-1400 BC (relative)
Valtos-Leptokarya	7; Interior-exterior of building	MBA, parallel to MHI-III (relative)	1930-1695 BC (radiocarbon)

Table 1. The ceramic assemblages under study.



Figure 3. Pigi Artemidos, stone built open-air structure (© Ephorate of Antiquities of Pieria).

Mycenaean features in their assemblages. Finally, Valtos-Leptokarya (Figure 5) is dated to the MBA (20th-17th century BC), i.e., prior to the emergence of the Mycenaean civilisation, and has both residential and funerary remains.²⁰

The vessels and their context

For each site, we studied macroscopically all the vessels of presumed cooking function that were complete, almost complete or large fragments that preserved sufficient information to reconstruct vessel shape; fragments of indeterminate shape or from other functional categories (tableware, storage or transportation) were excluded. The overall number of specimens might change in the future, as the search for refitting sherds will progress in the different sites. An examination of the presently available smaller fragments has suggested though that, concerning cooking vessels, no other types were represented beyond those discussed here.

²⁰ Poulaki-Pantermali *et al.* 2007.



Figure 4. Trimpina, general view of the excavation (© Ephorate of Antiquities of Pieria).



Figure 5. Valtos-Leprokarya, view of the building (© Ephorate of Antiquities of Pieria).

Rema Xydias provided sixteen specimens in total. Two complete jars were found along the back wall of an apsidal building built with mud bricks on stone foundations, while a third jar, containing a small cup and a dipper (non-cooking), and fragments of a tripod vessel, were found at a short distance near the semi-circular central clay-built hearth (Figure 6). Fragments of another tripod cooking pot were found among the charred remains of a possible wooden cist in the southwest corner of the room. Scattered in the same area more than thirty almost complete vessels of non-

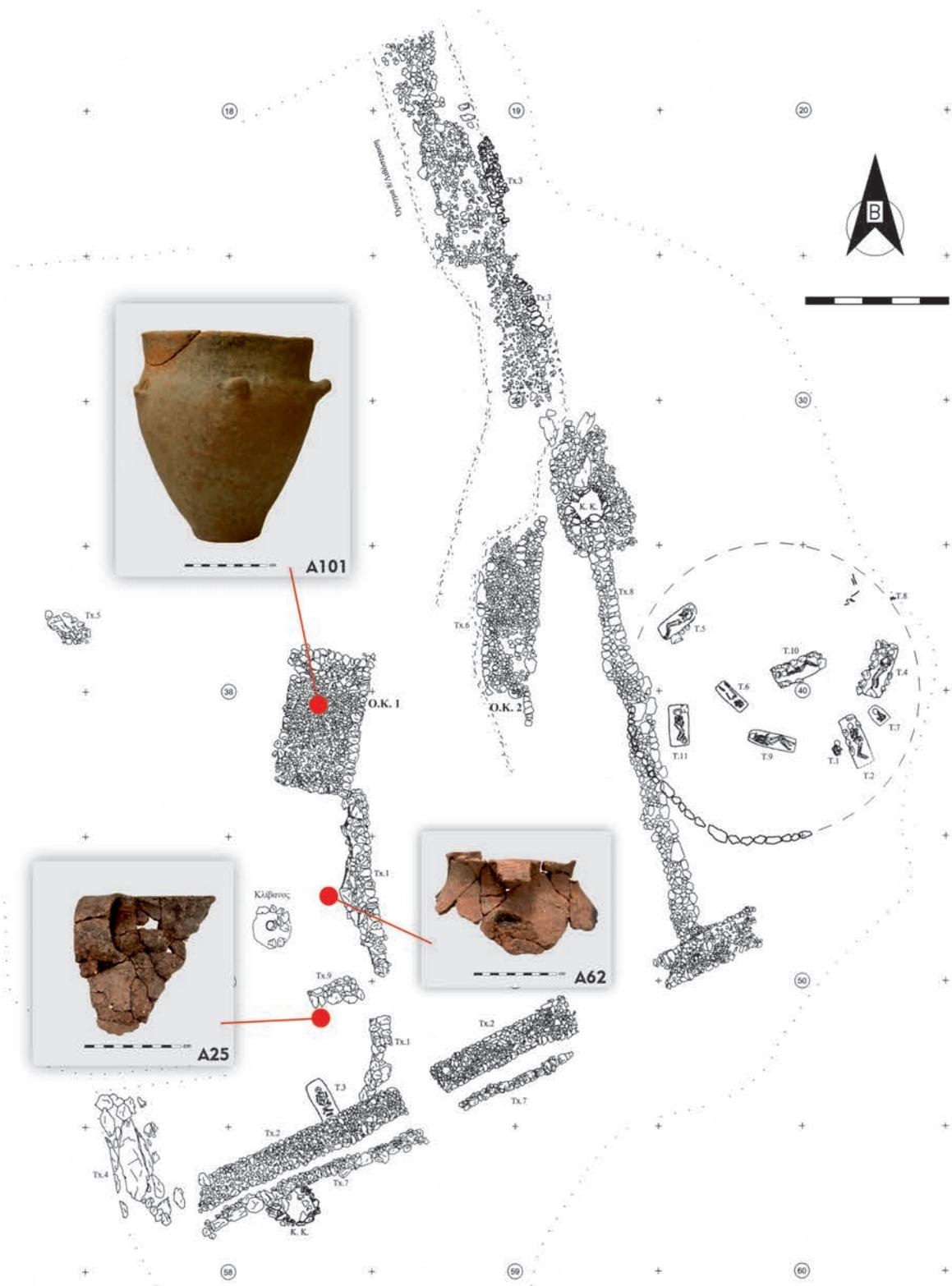


Figure 7. Pigi Artemidos, plan of the architectural remains with the finding spots of the cooking vessels under study (© plan: Ephorate of Antiquities of Pieria; photos: PlantCult Project, A. Dimoula).

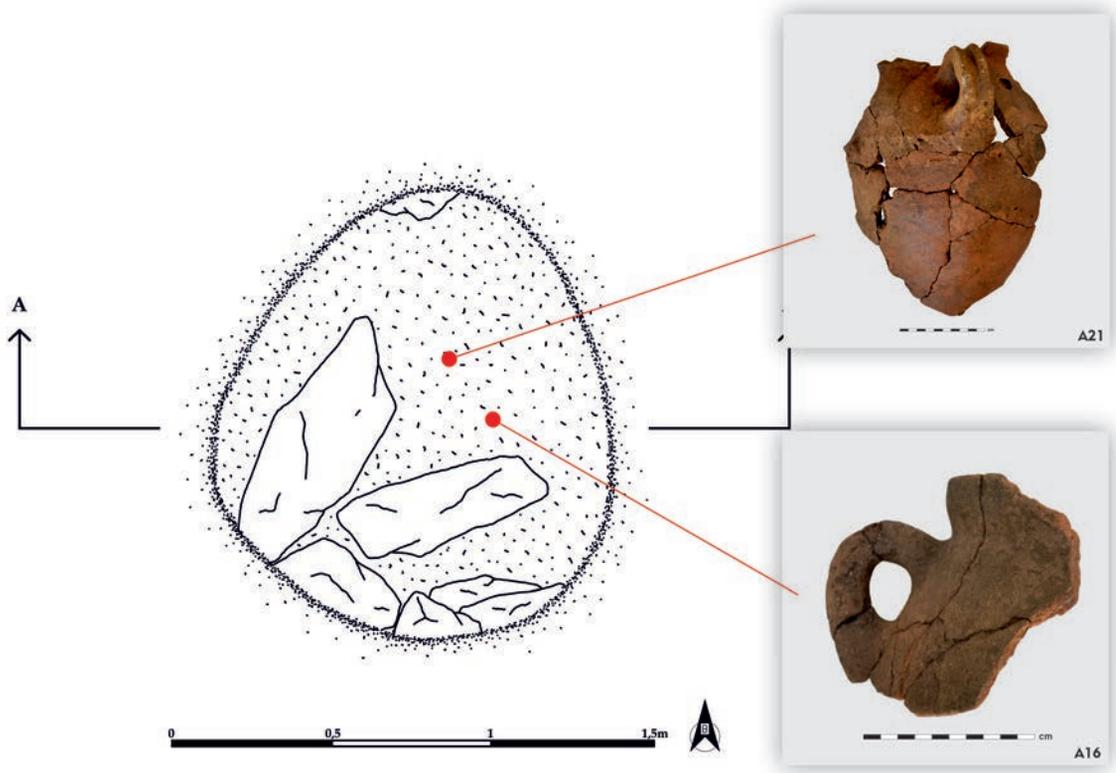


Figure 8. Trimpina, pit 12 with the cooking vessels found within (© plan: Ephorate of Antiquities of Pieria; photos: PlantCult Project, A. Dimoula).

vessels, the other two are probably tripod jars, found among the architectural remains (Figure 7). However, it should be mentioned that among the sherd material, fragments of pyraunoi pedestals were identified, as well as jar rims with impressed decoration. These were not included in this study as their high degree of fragmentation did not allow for the reconstruction of their shape.

In Trimpina (Figure 4), the domestic remains also include extended cobbled areas, fragmentary walls and pits of various sizes.²⁴ Almost complete cooking pots were found in two of them (pit 12 and pit 15, the latter proved to be the pit of a cist grave), each containing pyraunoi and jars; five of them were studied (Figure 8).

Finally, seven restorable cooking pots from Valtos-Leptokarya come from an extended destruction layer scattered across the site, dated to the earlier MBA phase of the settlement.²⁵ Four of them are associated with a two-roomed building (Figure 5 and Figure 9) with stone foundations and mud brick walls.

Analytical methods

The study of the cooking assemblages followed a comprehensive contextual, technological and functional approach, using macroscopic, microscopic and chemical methods. Contextual study attempted to explore the original operation of the vessels and their affiliation with other classes of features or artefacts, as well as the taphonomic processes affecting their current preservation. The macroscopic study focused on the morphological and technological characteristics, use wear and traces of content, in order to establish typological correlations and make inferences on functional

²⁴ Koulidou *et al.* 2012.

²⁵ Poulaki-Pantermali *et al.* 2007.

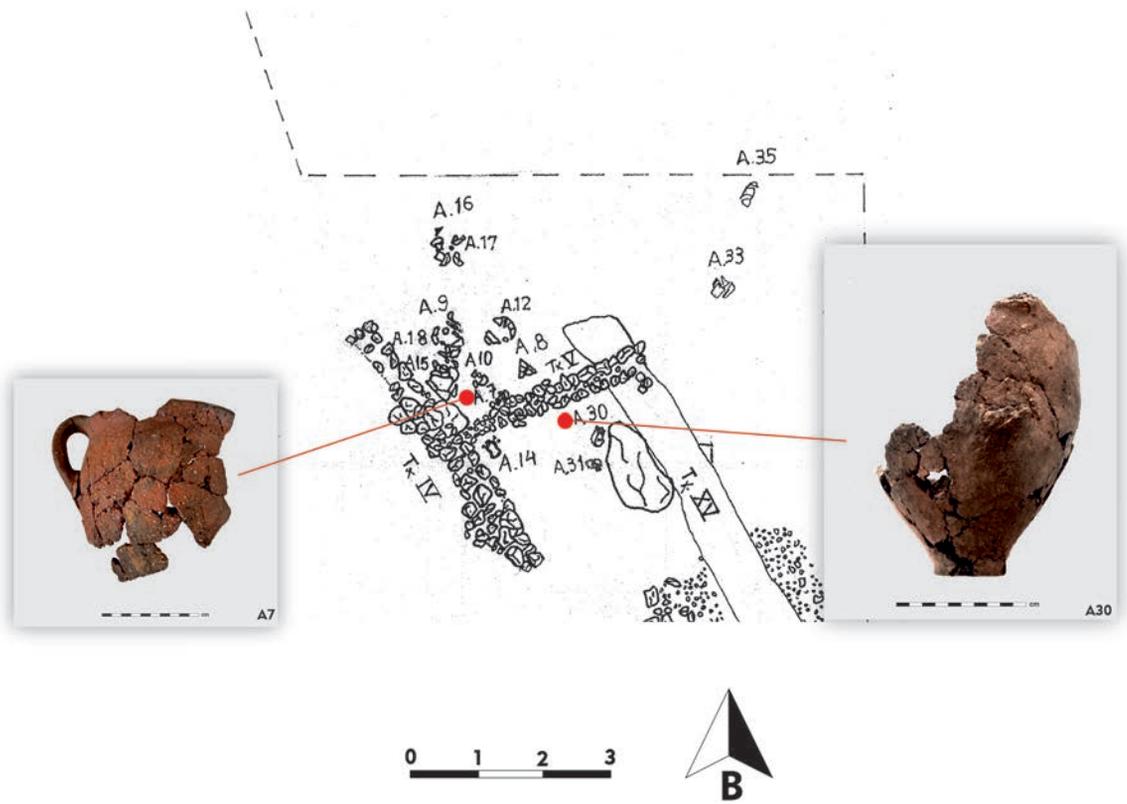


Figure 9. Valtos-Leptokarya, plan of the building with the finding spots of the cooking vessels under study (© plan: Ephorate of Antiquities of Pieria; photos: PlantCult Project, A. Dimoula).

aspects and actual uses.²⁶ As such, all the morphological attributes of the 31 vessels from the four sites were recorded and measured (overall shape, shape of the base and rim, shape and position of handles/lugs), together with technological evidence on forming techniques, surface finishing and firing,²⁷ as well as apparent fire/carbonisation and abrasion/attrition traces.²⁸ Moreover, in the cases of sufficient information on shape and dimensions, the capacity of the vessels was calculated.²⁹

The techno-functional study was complemented by petrographic³⁰ and organic residue analysis (ORA) of twenty cooking vessel samples, selected as representatives of their site, context, type, shape and macroscopic fabric (Tables 4–5).³¹ The aim of petrographic analysis was to elucidate issues of provenance, to follow the technological choices made in each manufacturing stage, and to acquire refined data on pottery function and use.³² Molecular and isotopic analysis of ceramic-absorbed organic residues was undertaken to further elucidate the use of each vessel,³³ providing contextual evidence of the role of ceramics, in culinary practices, at the four sites investigated. Samples of ceramic powder were subjected to acidified methanol (n= 20) and solvent (n= 15) extraction methodologies. The extracts were analysed by gas chromatography – mass spectrometry

²⁶ See Lis 2015.

²⁷ See Rice 1987.

²⁸ See Skibo 2013.

²⁹ Vessel capacity was calculated with the use of the software Pot Utility, which was created by Jean Paul Thalmann in the ARCANÉ Project (<http://www.arcane.uni-tuebingen.de>).

³⁰ Thin sections were prepared in the Geology Department, Aristotle university of Thessaloniki, by N. Kipouros supervised by Prof. L Papadopoulou. Petrographic examination was conducted by A. Dimoula, in the PlantCult laboratory in CIRI-AUTH, using a Leica DM2700P polarizing microscope. Images were taken with a Leica MC190 HD microscope camera and using the LAS V4.12 software. Description and characterisation of the fabric groups follow the system proposed by Whitbread 1995.

³¹ The prefix OL was used in sample numbering referring to the area of Olympus.

³² See Quinn 2013.

³³ Evershed 2008.

(GC-MS) and gas chromatography – combustion – isotope ratio mass spectrometry GC-C-IRMS (see Supplementary material).

Results

Shapes inventory

Three concise type groups have been identified, based on the overall shape and size of the vessels, each including different variants on the basis of their morphological details (Tables 2 and 3, Groups A–C). The types are well represented in the building complex of Rema Xydias, but are also present in the contemporary structures of Pigi Artemidos and in the earlier pits of Trimpina. In contrast, the earlier assemblage of Valtos-Leptokarya dated to the MBA appears to include quite different cooking pot types (Tables 2 and 3, Groups 1–4).

Late Bronze Age types

The first group (Type Group A, Tables 2 and 3) is well represented in Rema Xydias, present in contemporary Pigi Artemidos, and in very fragmentary form in Trimpina. It comprises handmade medium to large jars (height (h) 21–33cm, rim diameter (rd) 21–24cm, wall thickness (wth) 0.5–1cm) with narrow bases, convex or disc shaped. These vessels are open, with elliptical or circular in plan mouth and simple flat on top rim. Two thick vertical handles, elliptical in section, are attached below the rim and on the shoulder. In addition to the simple type (Type A), two variants are discerned: one with a high concave neck (Type A1, see vessel A55), and one with a concave neck, a wider flat base and two mastoid lugs alternating with the handles (Type A2, see vessel A101).

Late Bronze Age types			Middle Bronze Age types
Type Group A			
Type A (Jar)	Type A1	Type A2	Type 1 (Bowl)
Handmade, medium-large, open, narrow base, simple flat rim, two vertical elliptical handles	High concave neck	High concave neck, flat base, mastoid lugs	Handmade, medium-large, open, globular, short neck, outward rim, large raised tongue lugs
Type Group B			Type 2 (Jar)
Type B (Legged jar)	Type B1	Type B2	Handmade, medium, open, globular, low neck, outward flat rim, two vertical strap handles, double mastoid lugs
Handmade, small-medium, open, globular, simple flat rim, two vertical strap handles, leg attachment points on the belly	Acute concave neck	Wheel thrown, collared rim, cylindrical handles	
Type Group C			Type 3 (Jug)
Type C (Pyraunos)	Type C1	Type C2	Handmade, medium, ovoid, outward rim, flat base, vertical elliptical handle
Handmade, large, open, globular, narrow base, high concave neck, simple flat rim, vertical elliptical handles, integral pedestal attached on the belly	Ovoid, pointed base, pedestal attached below handles	Incurving, low neck, grooved handles, pedestal attached below handles	

Table 2. Summary of the morphological characteristics of the cooking pot types.

Type Group A			Type Group B			Type Group C		
Rema Xydias	Rema Xydias	Trimpina	Pigi Artemidos	Valtos-Leptokarya				
Type A A41 (House interior)	Type B1 A52 (House interior)	Type C1 A289 (House exterior)	Type BA25 (indeterminate architectural remains)	A7 (House interior)	A42 (House interior)	Type B2 A16 (Pit 12)	A30 (House interior)	Type C2 A21 (Pit 15)
Type Group B			Type Group C					

Table 3. Drawings of the cooking pot types; vessel inventory numbers and finding spots are indicated.

The second group (Type Group B, Tables 2 and 3) is represented in all sites under study. It includes handmade small to medium jars (estimated h 15–20cm, rd 18–20cm, wth 0.3–0.6cm). Based on the occasional preservation of leg attachment points on their belly and below the handles (see vessels A310 and A25) and the fact that the walls get thinner towards the lower part, which is commonly destroyed by fire, we deduce that the vessels most probably belonged to tripods.³⁴ On the other hand, for the examples not preserving leg attachments, we cannot exclude the possibility of them being simply flat-based.³⁵ The vessels have a globular body and vertical elliptical strap handles attached to the outward flat rim and shoulder. A first variant is characterised by an acute concave neck (Type B1, see vessel A52), while quite different is the earlier in date handled jar from Trimpina (Type B2, see vessel A16), which is the only wheel-made example in all assemblages (see below). It has a collared outward rim (rd 23cm) and vertical cylindrical handles attached below the rim and on the shoulder.

The third group (Type Group C, Tables 2 and 3) comprises the so-called ‘pyraunoi’, attested in Rema Xydias and earlier Trimpina, but also in Pigi Artemidos though in a very fragmented state. These handmade pots consist of a large open vessel (h 29–32cm, rd 18–25cm, wth 0.5–1cm), globular, supported by an integral cylindrical pedestal with openings for air circulation and fuel addition, attached at the mid height of the vessel body (Type C, see vessel A231). Their bases are narrow, convex, the rims are concave and flat on top, while they have vertical elliptical handles on their upper part, joining the rim with the shoulder. There are two more variants: the first (Type C1, see vessel A289) has an ovoid vessel with two elliptical handles attached below the rim; the base is pointed disc-shaped, while the cylindrical pedestal is attached below the handles and surrounds the body, with holes for air circulation at intervals created with the index finger. The second variant (Type C2, see vessel A21), slightly earlier in date, from Trimpina, has an incurving profile with low neck; the pedestal is applied below the handles, which are attached on the shoulder and have grooves on the upper side.

Middle Bronze Age types

The cooking pot types from Valtos-Leptokarya have completely different characteristics from those of the LBA sites described above; the definition of the types is based on the five well-preserved specimens and further sustained by smaller fragments (Tables 2 and 3). The first one (Type 1, see A42) corresponds to an open bowl with globular body, short neck with outward rim, and large raised tongue lugs placed on the shoulder (preserved h 11cm, rd 26cm, wth 0.5–0.7cm). The second type (Type 2, see A7) corresponds to a globular jar with low neck and outward flat rim, two strap handles joining the rim and shoulder, where they alternate with double mastoid lugs (preserved h 20cm, rd 20cm, wth 0.7cm); the base is not preserved, but we believe that it would have been flat. The third type (Type 3, see A30) comprises a jug with a tall ovoid body, outward rim, narrow flat and thick base, and a vertical long handle, elliptical in section, attached below the rim and on the belly (pres. h 20cm, rd 12cm, wth 0.5–0.8cm).

Raw materials and manufacture, Middle and Late Bronze Age

The cooking pots under study are characterised by a relative homogeneity in the technological choices followed during their production throughout the Middle and Late Bronze Ages. The results of the petrographic analysis demonstrate that the majority of the cooking pots from the four sites are characterised by a single clay fabric group, consistent in composition and texture (Table 4, Fabric Group 1a, b). It is coarse grained and characterised by the use of low iron content clays,³⁶ containing high grade metamorphic (gneiss, schist, serpentinite) and less igneous rock

³⁴ Marabea 2019: 494, 505.

³⁵ Lis, Rückl and Choleva 2015: 67.

³⁶ Quinn 2013: 44.

	Fabric Group 1a	Fabric Group 1b	Isolated sample 1	Isolated sample 2
Samples¹ (with vessel inv. no)	OL1 (A41), 2 (A43) , 5 (A55) , 10 (A89) – Rema Xydias, OL13 (A70) – Trimpina, OL19 (A31), 20 (A42) – Valtos-Leptokarya	OL3 (A289), 4 (A231), 6 (A52), 7 (A112), 8 (A158), 9 (A310) – Rema Xydias, OL11 (A21), 14 (A23) – Trimpina, OL15 (A25) – Pigi Artemidos, OL17 (A7) – Valtos-Leptokarya	OL16 (A62) – Pigi Artemidos	OL12 (A16) Trimpina
Shapes	LBA Type A, MBA Types 1 and 3	LBA Types B and C, MBA Type 2	LBA Type B	LBA Type B
Inclusions Frequency²	Coarse	Coarse	Coarse	Coarse
Inclusions Sorting/³ Bimodality	Poor Bimodal	Poor Bimodal	Poor Bimodal	Poor Bimodal
Clay composition	Coarse, low iron content	Medium-fine, low iron content	Medium-fine, calcareous	Medium, micaceous, high iron content
Common Inclusions	High grade metamorphic rock fragments, gneiss, mica schist, serpentinite, quartzite, quartz, feldspar, pyroxenes, amphiboles	As Fabric Group 1a, with organic material	Quartz and feldspar, often perthitic, quartzite, very few phyllite fragments	Biotite schist fragments
Inclusions Size/ Pores	>5 mm, average 0.3–0.5 mm Frequent	>5 mm, average 0.3–0.4 mm Common	>4 mm, average 0.2–0.3 mm Common	>4 mm, average 0.2–0.3 mm Common
Orientation of elongated inclusions and voids	Random or parallel to vessel walls	Random or parallel to vessel walls, OL 15 circular arrangement	Parallel to vessel walls	Diagonal to vessel walls
Optical Activity/ Colour⁴	Inactive Dark brown	Active Brownish yellow	Active Yellowish Brown	Inactive Dark red
Surface finish	No slip	No slip	No slip	No slip

¹ Sample OL18 was destroyed during the thin section preparation, due to its very small size, thus it is not included here

² Estimations on the frequency of inclusions are based on the comparative charts by Mathew, Woods and Oliver 1991.

³ Estimations on the sorting of inclusions are based on the comparative charts by Bullock *et al.* 1985: 27, fig. 27.

⁴ Colour characterisations are according to Munsell Soil Color Charts 1975

Table 4. Summary of the results of petrographic analysis.

fragments (Figure 10). This composition is compatible with the geological formations developing in the east piedmont of Mount Olympus, overlying the carbonate massif, which consists mainly of metamorphosed sediments and ophiolitic rocks.³⁷ Thus, the raw materials used in the cooking pottery production of the Olympus sites presented here, appear to have been acquired from the surroundings of the sites.

³⁷ Smith *et al.* 1997: 2006.

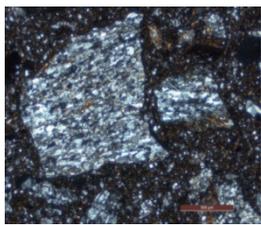
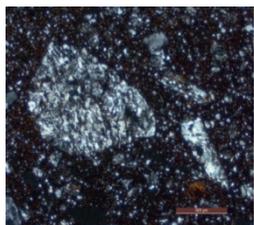
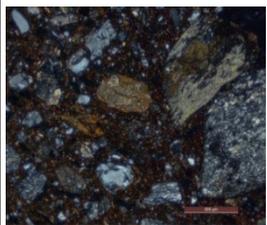
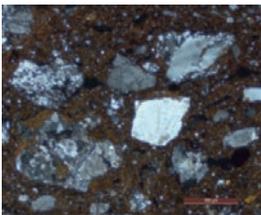
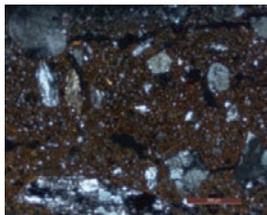
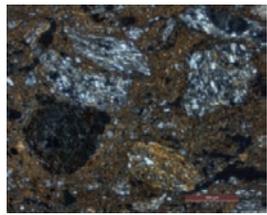
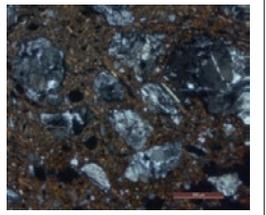
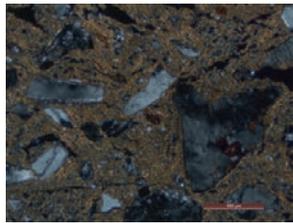
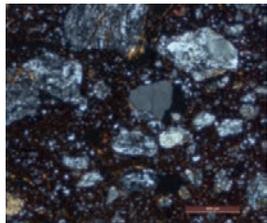
Rema Xydias	Pigi Artemidos	Trimpina	Valtos-Leptokarya
LBA Type A – Fabric Group 1a			MBA Type 1
			
OL5 (A55)		OL13 (A70)	OL20 (A42)
LBA Types B and C – Fabric Group 1b			MBA Type 2
			
OL3 (A289)	OL15 (A25)	OL11 (A 21)	OL17 (A 7)
LBA Imports – Isolated samples 1 and 2			
			
	OL16 (A 62)	OL12 (A 16)	

Figure 10. Microphotographs of thin section samples under crossed polars (© PlantCult Project, A. Dimoula).

Only two cooking pots have raw materials that appear not to derive from the local geological environment. The first is a Type B jar from Pigi Artemidos, probably tripod (Figure 7: vessel A62). Its fabric is coarse grained, characterised by the use of medium-fine calcareous clay tempered with silicates and very few phyllite fragments (Table 4: Isolated sample 1, Sample OL16, Figure 10). This composition is very characteristic of the crystalline-schist formations developed both in the eastern verges of the plain of Thessaly and coastal parts of the Pagasetic Gulf and has been identified in an array of Neolithic pottery samples, e.g., from Argissa and Sesklo;³⁸ unfortunately, there are so far no data from petrographic analyses of Bronze Age samples in this area. The second sample belongs to the wheel-made jar from Trimpina (Figure 8 and Table 3: vessel A16). The fabric is again coarse grained, but characterised by the use of micaceous clay tempered with biotite schist fragments (Table 4: Isolated sample 2, Sample OL12, Figure 10). Although this composition matches the local geological setting, its difference from the dominant fabric group could tentatively point to a different origin.

With the exception of this last vessel, all other vessels are built with the coiling technique, as indicated by both macroscopic and petrographic evidence. In thin section, the elongated inclusions

³⁸ Dimoula 2017: 211–215.

of Sample OL12 (Table 3: vessel A16, Table 4: Isolated sample 2) show an arrangement diagonal to the vessel walls, characteristic of the use of Rotative Kinetic Energy.³⁹ The surface of all vessels is smoothed, with the interior better smoothed than the exterior; only in the case of pyraunoi, the interior of the pedestal, along with the part of the vessel covered by it, is left unprocessed, rough. No use of slips was observed. Decoration is also absent, with the exception of large grooves on some pyraunos handles. A single jar (Figure 7: vessel A62, Table 4: Isolated sample 1), features two shallow parallel horizontal incisions on the upper part of the handle: such incisions are, however, usually interpreted as potter's marks rather than decoration (see below, Discussion).

Finally, all evidence points to rather homogeneous oxidising firing conditions, but in different firing temperatures, judging from the optical activity of the groundmass in thin sections.⁴⁰ Thus, large-sized jars of Type Group A, whose fabrics are characterised by mineral temper added in a coarse-grained groundmass resulting in a porous paste, are fired in temperatures exceeding 800–850°C (Table 4, Fabric Group 1a, Figure 10). On the other hand, smaller (tripod) jars and pyraunoi (Type Groups B and C), whose fabrics are characterised by mineral and organic temper added in a medium/fine-grained groundmass, are fired in temperatures below 800–850°C (Table 4, Fabric Group 1b, Figure 10). One would expect to have the coarse large jars fired in lower temperatures, in order to avoid breakage. Moreover, it has been suggested that low temperature firing offers advantages regarding the thermal behaviour of cooking vessels.⁴¹ However, the use of vessels as storage containers is perhaps unlikely, given charring on the external surface of ceramics and the presence of diverse and, in some instances, significant accumulations of lipids in ceramic fabrics that indicate a range of different cooking activities.

Use traces and capacities

The cooking vessels examined have been affected by depositional factors, namely destruction by fire, degrading and altering original use traces. However, macroscopic, petrographic, and molecular evidence is preserved, enabling observations and inference of function.⁴²

All acidified methanol (AM) extracted samples produced low but appreciable lipid yields, i.e., > 5µg g⁻¹ (Table 5), corresponding to generally low yields observed at other sites in the region.⁴³ Only two solvent extracted samples produced appreciable lipid yields, which contained a limited range of compounds, likely demonstrating extensive degradation of residues. Substantial quantities of palmitic and stearic acid were present in all but one AM extracted sample (OL15), enabling compound specific carbon isotope analysis. Despite thorough investigation, using selected ion monitoring (see Supplementary Material), neither miliacin, isoprenoid fatty acids, nor C₂₀ ω-(o-alkylphenyl) alkanolic acids (APAAs), were identified in any of the samples. The absence of characteristic compounds, perhaps due to poor preservation, precludes specific and conclusive identification of processed products. Therefore, the discussion of ORA data is focused on the interpretation of compound specific carbon isotope data.

All the LBA large-sized jars (Type Group A) have convex or very narrow bases, suggesting their use on a pedestal or placed above a fire. On the other hand, the bases of these vessels are oxidised, while sooting clouds developed along their wall (Figure 11a), indicating that the base was actually placed inside the fire or fuel and the flames and smoke licked the sides of the vessels.⁴⁴ Sooting or carbonisation traces were completely absent from their interior. In one jar from the house at Rema

³⁹ Roux and Courty 1998: 753–755.

⁴⁰ Whitbread 1995: 390–391; Quinn 2013: 188–200.

⁴¹ Hein, Müller and Kilikoglou 2009.

⁴² Skibo 2013; Roffet-Salque *et al.* 2017.

⁴³ Whelton *et al.* 2018.

⁴⁴ See Dimoula *et al.* 2020.

Sample	Site	Type Group	Fabric Group	Yield $\mu\text{g g}^{-1}$	$\delta^{13}\text{C}_{16:0}$	$\delta^{13}\text{C}_{18:0}$	$\Delta^{13}\text{C}$
OL 01	RX	A	1A	20	-28.2	-29.4	-1.2
OL 02	RX	A	1A	25	-28.7	-29.3	-0.6
OL 03	RX	C	1B	48	-27.6	-27.3	0.3
OL 04	RX	C	1B	38	-27.3	-29.0	-1.8
OL 05	RX	A	1A	25	-28.2	-28.8	-0.7
OL 06	RX	B	1B	83	-26.2	-25.4	0.9
OL 07	RX	B	1B	31	-27.6	-29.2	-1.6
OL 08	RX	C	1B	25	-27.9	-30.6	-2.7
OL 09	RX	B	1B	34	-26.9	-27.6	-0.7
OL 10	RX	A	1A	47	-22.1	-21.0	1.1
OL 11	Tr	C	1B	13	-27.6	-28.9	-1.3
OL 12	Tr	B	12	19	-27.7	-27.4	0.3
OL 13	Tr	A	1A	17	-28.5	-29.2	-0.7
OL 14	Tr	A	1B	13	-27.5	-29.2	-1.7
OL 15	PA	B	1B	13	-	-	-
OL 16	PA	B	11	16	-27.0	-26.2	0.8
OL 17	VL	MBA2	1B	34	-28.9	-29.3	-0.4
OL 18	VL	MBA3		12	-27.3	-31.6	-4.3
OL 19	VL	MBA3	1A	16	-25.6	-28.2	-2.6
OL 20	VL	MBA1	1A	18	-27.6	-27.4	0.2

Table 5. Results of ORA (GC-MS and GC-C-IRMS) using AM extraction.

Xydias (Table 3: vessel A41, Table 4: sample OL1), extended attrition traces, in the form of flaking, were observed on the interior wall (Figure 11g).

Type Group A residues are predominantly comprised of lipids from either C_3 plants, ruminant adipose, or mixtures thereof, except for one sample (OL10), that is enriched in ^{13}C and overlaps with the reference range of marine products (Figure 12). This residue may derive from the processing of either C_4 plant, C_4 -fed animal, or marine products. Broomcorn millet (*Panicum miliaceum*) is the only extensively exploited C_4 plant present in this region during the LBA,⁴⁵ yet it is rare in the archaeobotanical assemblage of Rema Xydias⁴⁶ and miliacin was not identified in this residue. Therefore, it is perhaps unlikely that ^{13}C enrichment in OL10 is derived either directly or indirectly from *P. miliaceum*. However, the degradation of miliacin and processing of products from terrestrial animals that grazed on wild C_4 plants must also be considered in the interpretation of this residue. The processing of marine products is the most obvious source of ^{13}C enrichment, given the proximity of Rema Xydias to the coast, yet the absence of aquatic biomarkers (isoprenoid fatty acids and C_{20+} APAAs) complicates such an interpretation. Further molecular and isotopic

⁴⁵ Valamoti 2016.

⁴⁶ Pagnoux personal communication.



Figure 11. Use-wear traces on vessels. (© PlantCult Project, A. Dimoula)

analysis, supplemented by archaeobotanical and zooarchaeological investigations, are necessary to determine the extent and source of ^{13}C enrichment in this material type and at Rema Xydias.

The tripod jars (Type Group B) have sooting clouds developed on the belly, handle and the periphery of the rim, often alternating with oxidised areas, while the thin lower wall is commonly burnt (Figure 11d). This indicates that the lower part and base was in direct contact with fire. Their interior is generally clean of any fire or attrition traces.

Type Group B residues comprise an increased contribution of non-ruminant lipids, relative to Type Group A residues, although processing of ruminant products is evident in one sample, OL7, that has a $\Delta^{13}\text{C}$ value of -1.6‰ and is in the range of ruminant adipose products (Figure 12). The ^{13}C enrichment observed in Type Group B residues may derive from several sources, including porcine products and those discussed above for OL10. However, as no biomarkers were observed, further investigation, in line with OL10, is necessary to determine the source of isotopic enrichment.

In the case of pyraunoi (Type Group C), the interior of the pedestal and the part of the vessel covered bear dense and extensive sooting clouds, as fuel is placed under the pedestal and fire and smoke are trapped there (Figure 11c). On the other hand, the lower part and bases are commonly oxidised, indicating that they were in contact with the fuel (Figure 11b). Sooting clouds are also developed on the upper part of the vessels and specifically concentrated above the pedestal ventilation holes, through which smoke passed (Figure 11b). Internal carbonisation has not been observed, however sooting clouds appear to have developed on the internal upper wall, above content level (Figure 11e). In one case, abrasion traces were recorded in the vessel bottom, in the form of scraping, pointing to the use of a pointed stirring tool (Figure 11f).

Type Group C residues primarily comprise ruminant adipose lipids. However, the residue of sample OL3 (Table 4: vessel A289, Figure 11b, e-f) derives primarily from non-ruminant products ($\Delta^{13}\text{C}$ value of 0.3‰).

Finally, the earlier MBA cooking pots from Valtos-Leptokarya, jars, jugs and bowls, are generally characterised by oxidised bases and sooting clouds developed on the belly, handles and rims. Their

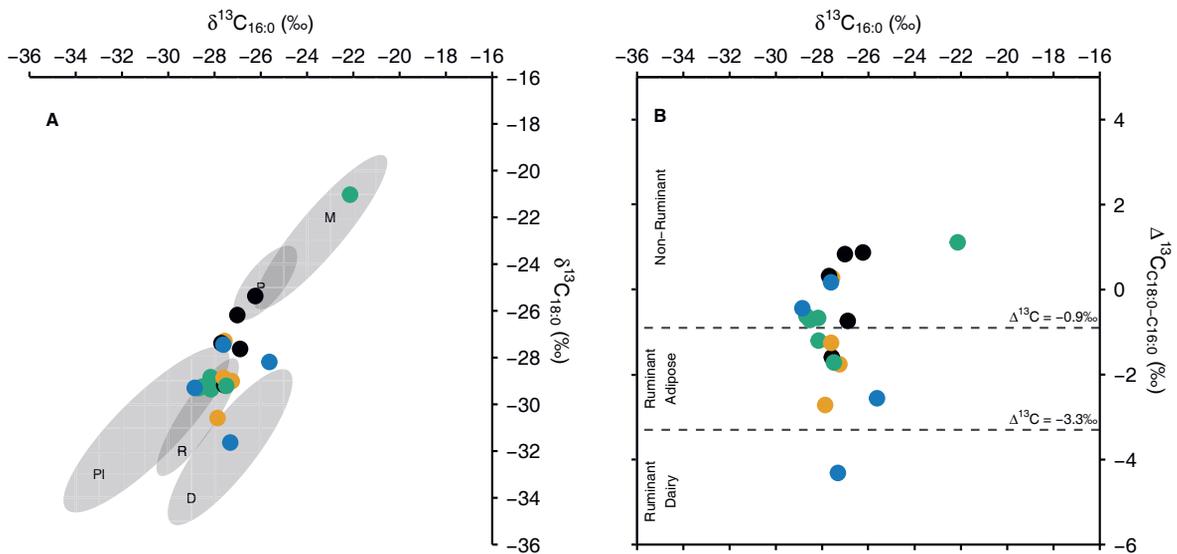


Figure 12. **A** Compound specific $\delta^{13}\text{C}$ values of $\text{C}_{16:0}$ and $\text{C}_{18:0}$ fatty acids (Table 5) plotted against 1σ confidence ellipses of modern-carbon adjusted reference materials, including marine (M), porcine (P), C_3 plant (PI), ruminant adipose (R), and ruminant dairy (D) products (Supplementary Table #2). **B** Compound specific $\delta^{13}\text{C}_{16:0}$ value and difference in $\delta^{13}\text{C}$ values ($\Delta^{13}\text{C}$) of $\text{C}_{18:0}$ and $\text{C}_{16:0}$ fatty acids (Supplementary Table #1). Analysed compounds in organic residues extracted from Type Group A (green), Type Group B (black), Type Group C (yellow), and MBA (blue) ceramic vessels.

interior has extensive burning traces on the belly and towards the rim, accompanied by cracks, possible due also to their destruction by fire.

The residues of MBA vessels are derived from multiple sources (Figure 12). Sample OL18 produced a $\Delta^{13}\text{C}$ value of -4.3‰, indicative of dairy lipids. Sample OL19 produced a low $\Delta^{13}\text{C}$ value (-2.6‰) that could derive from dairy lipids but is perhaps most likely indicative of either wild or domesticated ruminant carcass fats.⁴⁷ Residues of samples OL17 (Table 4: vessel A7, Figure 9) and OL20 (Table 4: vessel A42) are primarily formed of non-ruminant lipids.

Furthermore, the majority of the samples examined in thin section exhibit dark interior margins, representing the penetration of carbonised particles in the wall surface. This has been considered as a result of the practice of wet cooking, i.e., with liquid participation.⁴⁸ More specifically, in moist conditions, food particles penetrate the unslipped and porous surface of the pot and carbonise after continuous use, particularly during simmering or the preparation of thick dishes, when liquid is left to evaporate. Consequently, the majority of the cooking pots under study appear to have been used for wet cooking, e.g., stews, soups or porridges.

Finally, in terms of capacities, jars of Type A have maximum capacities ranging from 3–4 l (Table 3: vessels A41, A101) to 11–13 l (A55), while Type C pyraunoi range from 5 l (Table 3: A289) to 11–15 l (Table 3: A21, A231). Type B tripod jars could range from 3 l (Table 3: A310, A16) to 6 l (Table 3: A25). Thus, the first two types do exist in several formats, allowing people to cook larger or smaller quantities of food, whereas tripod jars would only be used for smaller quantities. MBA cooking pots are even smaller, with capacities ranging from 1.5 l (Table 3: A30) to 2–3 l (Table 3: A42, A7).

Discussion

Cooking sets over time: continuity and change during the MBA and LBA

The results of this interdisciplinary study suggest that there are substantial changes between the MBA and the LBA cooking pot assemblages in the Olympus area. More particularly, the MBA (20th – 17th BC) cooking set under study includes various locally produced vessel types used within the house, namely bowls, jugs and jars, for wet cooking of rather small quantities. The vessels were probably placed on simple hearths among embers, guaranteeing a slow, low temperature cooking. The ORA data demonstrate diverse cooking practices for this period, incorporating dairy products and ruminant and non-ruminant meat processed in various vessel types. However, a larger sample size is necessary to understand how these products were processed, what they were processed with, and whether different vessel types were used for specific purposes.

In the LBA, cooking bowls and jugs are no longer attested, while the medium handled jar is replaced by a more elaborate form, perhaps supported by legs. A noteworthy example of such a vessel from the early stages of the LBA (1600-1400 BC) is wheel-made and most probably imported. At the same time, larger jars and pyraunoi are also present, although their very fragmentary state does not allow for exact shape reconstruction. The study of traces indicate that all types are used again for wet cooking, but the quantities can now also be greater. More importantly, all types appear to have been used in an elevated position, with fuel and fire placed below their base; in this way higher cooking temperatures and quicker boiling could be achieved.⁴⁹ The new set (narrow based jar, medium-sized jar with legs, pyraunos) is therefore morphologically and functionally different from its predecessor (medium-sized jar, bowl, jug).

⁴⁷ Craig *et al.* 2012.

⁴⁸ Skibo 2013: 96–98.

⁴⁹ Dimoula *et al.* 2020; Morrison *et al.* 2015.

In the late periods of the LBA (15th–11th century BC), the locally produced pyraunos is fully in use, preferably in open-air spaces, together with local large handled cooking jars, used both in interior and exterior spaces; both vessel types can contain large quantities of liquid food. In parallel, the smaller in capacity handled jar with legs becomes more popular: it is now handmade and locally produced with one exception seemingly imported from Thessaly (see below). Interestingly, the fabrics of all vessels with integral pedestals or legs from all periods and sites under study, either pyraunoi or tripods, involve the application of a different ceramic recipe in comparison to larger jars, perhaps pointing to different potting traditions.

Concerning contents, contrary to the MBA data, there is no clear evidence for the processing of dairy products in the LBA vessels analysed, although they may have been processed in mixed use vessels. Ruminant meat and non-ruminant products appear to be dominant in this period, yet further sampling is necessary to distinguish products that were processed, specifically whether marine resources were exploited. There are subtle differences observed in the isotopic data of each Type Group that may indicate a preference for processing certain products in specific vessel types, e.g., non-ruminant products in Type B vessels and ruminant meat in Type C vessels. However, the sample size assessed in this study is too small for statistical analysis and reliable conclusions to be made, necessitating further research. Nonetheless, these data do demonstrate a varied approach to cuisine and subsistence that has not previously been extensively explored in this region, by ORA techniques, specifically in the Bronze Age.

Coexistence or fusion of different traditions

The study of Olympus LBA cooking vessels shows that, in terms of shape, they belong to types or incorporate characteristics that derive from different neighbouring areas, either north or south.

As such, pyraunoi comprise typical cooking vessels in northern Greece and the Balkans. Presumably introduced from the Danube and the Carpathian basin, they appear in northern Greece in the Middle Bronze Age and by the Late Bronze Age they become integral parts of cooking sets across the region, but are not attested further south;⁵⁰ the exceptions being one vessel from Lefkandi in Euboea and one from the Menelaion in the Peloponnese.⁵¹ The most widespread are types C1 and C2, attested also in many other LBA northern Greek sites.⁵² Thus, their presence in the Olympus area indicates common traditions with these northern neighbouring sites. Type C from Rema Xydias looks quite different though, as it combines the general concept of the pyraunos shape with morphological details encountered in the Mycenaean type handled (tripod) jars (Type B), such as the globular body and the concave neck with outward rim. It is a good example of the kind of fusion performed in the area during this period.

On the other hand, the morphological characteristics of the large jars from Rema Xydias and Pigi Artemidos find closer parallels to the southern neighbouring area of Thessaly. It is indeed in the sites of Thessaly and central Greece that the particular morphological details are common, such as the narrow bases and the concave necks in combination with strap handles.⁵³ Particularly the jar from Pigi Artemidos (Table 3: vessel A101, Figure 7) finds typological parallels even further south in the Peloponnese.⁵⁴ Late Bronze Age jars in Macedonia have either open ovoid or hole-mouthed globular shape and two vertical handles, but more frequently with a large flat base.⁵⁵

⁵⁰ Horejs 2005; Gimatzidis 2017; Krapf 2014.

⁵¹ Lefkandi: Popham, Schofield and Sherratt 2006: 212; Menelaion: Catling *et al.* 2009: 382.

⁵² E.g., Kastanas: Hochstetter 1984: 155–165; Olynthus: Horejs 2007: 148–153; Toumba Thessalonikis: Kiriati 2000:168–171; Assiros: Wardle, Halstead and Jones 1980: 249–250; Archontiko: Deliopoulos 2014: 248–252; Angelochori: Dimoula *et al.* 2022.

⁵³ E.g., Dimini: Adrymi-Sismani 2014: 378; Pefkakia: Batziou-Efstathiou 2015: 64–65; Kastro Volou: Batziou-Efstathiou 2003: 259; Kalapodi: Jacob-Felsch 1996: Taf. 35; Kynos Dakoronia 2003: 43; Mitrou: Lis 2017b: 41.

⁵⁴ Filippa-Touchais 2000: 430.

⁵⁵ E.g., Kastanas: Hochstetter 1984: 113–142; Olynthus: Horejs 2007: 126–146; Assiros: Wardle, Halstead and Jones 1980: 249–250; Archondiko: Deliopoulos 2014: 240–248; Toumba Thessalonikis: Kiriati 2000: 168–171.

Finally, the handled tripod jars are of an exclusively southern and particularly Mycenaean tradition. Tripods appear in southern Greece in the Middle Helladic and mainly the early Mycenaean period (LHI-LHIIIA2 early), regarded as an influence from Crete.⁵⁶ They are absent from northern Greece, with the exception of a complete pot from Olynthus.⁵⁷ In the Olympus assemblages, a new wheel-made handled jar, possibly a tripod, is introduced as an import in Trimpina before LHIII (Table 3: vessel A16). This shape is adjusted to a handmade locally produced form, legged, and is used in the sites of Rema Xidias and Pigi Artemidos throughout the LHIII. The tripod jars identified at the Olympus sites find general typological parallels (globular shape, outward rim, strap handles) in sites of Thessaly and central Greece,⁵⁸ however they comprise local handmade productions with rather roughly formed morphological details, in comparison to the original Mycenaean (i.e., southern Greek) tripods. More refined, in terms of shape and surface finishing, is the ‘carinated’ type (Table 3: vessel A52), which is considered as chronologically later, related to the LHIIIC early period, also found in Thessaly and central Greece.⁵⁹

Therefore, LBA cooking assemblages in the Olympus area appear as an ‘idiosyncratic’, selective mix of elements that have their roots in different geographical areas and are introduced in the course of the LBA. This mixing of traditions seems to go back to the MBA period, since already at Valtos-Leptokarya we have: a) no jar of the typical ‘local’ cooking pot type in the coeval sites of Macedonia (flat based handled pithoid jar, see above), b) three other shapes, whose best parallels are found, again, in the contemporary ceramic assemblages of Thessaly.⁶⁰ We can deduce that the Olympus area is more closely affiliated with the region of Thessaly already from the MBA period, at least in terms of cooking pottery, though without alienating itself from northern areas.⁶¹

The Mycenaean connection and the role of Thessaly

The production of cooking pottery in the area under study follows the general pattern of Mycenaean-style decorated pottery production, observed in many of the regions interacting with the Mycenaeans.⁶² Thus, the limited imports of Mycenaean painted pottery in the early Mycenaean phases are followed by the local production of Mycenaean-style painted vessels, often borrowing morphological details from local types. However, cooking pots usually continue to follow the local regional traditions.⁶³ The Olympus case is different in that Mycenaean influence affects cooking pottery production as well, resulting in the introduction and use of tripods, a typical Mycenaean cooking pot.

On the other hand, the Olympus case cannot be considered as similar to that in contemporary Cyprus, where Mycenaean-type handled jars appear to dominate local cooking pot production.⁶⁴ In Olympus, close relations with Thessaly are evidenced already by the MBA cooking types and the subsequent shift to the LBA large jars. In this scheme, the tripod pots are added, present in contemporary Thessalian sites, which are considered part of the Mycenaean world, according to architectural and epigraphical evidence.⁶⁵ Thus, during the Mycenaean period the Olympus area appears to be a crucible of different traditions, northern Greek and Thessalian, with Thessaly possibly serving as the intermediate zone for connecting the region with the southern Greek areas.

⁵⁶ Filippa-Touchais 2000: 427–432.

⁵⁷ Horejs 2007: 146.

⁵⁸ E.g., Dimini: Adrymi-Sismani 2014: 378–380, 448–450, 557–558; Pefkakia: Batziou-Efstathiou 2015: 68; Lefkandi: Popham *et al.* 2006: 140–141, 148, 207–210; Mitrou: Lis 2017: 194–204.

⁵⁹ Marabea 2019: 465.

⁶⁰ Pefkakia: Maran 1992: Beilagen 3, 5–9; Argissa: Hanschman 1981.

⁶¹ For other pottery classes see Poulaki-Pantermali 2013; Poulaki- Pantermali *et al.* 2007; Koulidou 2010, 2021; Koulidou *et al.* 2012, 2014.

⁶² Kiriatzi and Andreou 2016.

⁶³ Jung 2003; Borgna and Levi 2017.

⁶⁴ Jung 2017.

⁶⁵ E.g., Dimini: Adrymi-Sismani 2014; Pefkakia: Batziou-Efstathiou 2015.

At this point a special mention should be made of the tripod pot from Pigi Artemidos (vessel A 62, Figure 7, Tables 4–5: sample OL16) featuring potmarks on the handle, a typical practice of potters from the island of Aegina in Attica. Aeginetan kitchenware is widely distributed in mainland southern Greece during the late Mycenaean period (LHIIIB-LHIIIC early), reaching as far north as Dimini in Thessaly.⁶⁶ However, it has been observed that, in some cases, although typological and technological details resemble Aeginetan pots, the clay composition is different (e.g., Mitrou, Pefkakia). This has been interpreted as a result of mobility patterns including not only pots but also potters, especially after the fall of the Mycenaean palaces at the end of the 13th century BC.⁶⁷ The typological characteristics of the Olympus tripods bear similarities with the Aeginetan ones: they are coil built, with smoothed surfaces, and vertical handles attached to outward rims, later carinated. On the other hand, they bear significant differences: the handles are not circular in section, but elliptical, while the rims are commonly flat on the top. Such details are met on contemporary cooking pots from Thessaly.⁶⁸ We believe indeed, based also on evidence from the petrographic analysis, that the Olympus tripods are placed in the wider tradition of Thessaly, which has encompassed elements of the Aeginetan cooking pottery tradition.

Cooking practices and cultural identities

The Olympus cooking pottery study shows how Mycenaean elements penetrate local food preparation traditions, which is not observed in other areas of northern Greece.⁶⁹ Yet, our detailed consideration of the cooking vessels from these sites allows a more nuanced approach of cooking equipment and cooking practices in general. The MBA cooking pots under study are coarse, mineral tempered, flat-based, with rather small capacity (1.5–3l), used for the wet processing of ruminant, non-ruminant, and dairy products. In the LBA cooking pot fabrics generally follow the above tradition, but different shapes appear to be related to different ceramic recipes. Moreover, vessels appear to be used in an elevated position and their capacities vary from small to large (3–6 to 11–15l). They are again used for the wet processing of various terrestrial foodstuffs, potentially excluding dairy but perhaps including marine products. Thus, a shift is observed in ceramic and cooking technology, indicating more intricate culinary contexts and practices.

While broomcorn millet is observed in the archaeobotanical assemblage of the site,⁷⁰ and ¹³C enrichment is observed in human remains,⁷¹ molecular evidence for the cereal, i.e., miliacin,⁷² was not observed. One may have expected to detect the cereal in ceramic-absorbed residues, given evidence for its prominence in Northern Greece during the LBA.⁷³ The absence of molecular evidence for this species may demonstrate either miliacin degradation or other uses of the cereal, including animal fodder, aceramic processing, and processing in different ceramic vessels to those investigated in this study. The latter possibility could indicate a difference in either the context or people that consumed this cereal, than are investigated in this study, warranting further investigation. However, it is necessary to determine the source of ¹³C enrichment in ceramic-absorbed residues and human remains and further explore the extent of archaeobotanical and molecular evidence for *P. miliaceum* at this site before the economic, culinary, and cultural role of this cereal may be understood.

⁶⁶ Lindblom 2001: 44; Gauss and Kiriati 2011; Lis 2012.

⁶⁷ Lis, Rückl and Choleva 2015: 71.

⁶⁸ Lis, Kiriati and Batziou in preparation.

⁶⁹ The study of skeletal remains from funerary contexts of the four sites under study has also indicated diverse mortuary practices from the MBA and during the LBA, related to Mycenaean stimuli, Tritsaroli 2021; Tritsaroli and Koulidou 2018.

⁷⁰ Pagnoux personal communication.

⁷¹ Tritsaroli personal communication.

⁷² Heron *et al.* 2016.

⁷³ Valamoti 2016.

Conclusion

This regional study of cooking pots has revealed in microscale how local practices are influenced by cultural interaction, how novel types are introduced, and how transferred elements are filtered and adjusted to local parameters. With regard to cooking practices, it appears that the region of southern Pieria had formed, already from the MBA, a local tradition that incorporated elements of both northern Greece and southern Thessaly. In the course of the LBA, Mycenaean elements are integrated with local technologies and materials, forming a 'fusion' cooking set comprising local and exogenous types. This is accompanied by the application of more specialised ceramic recipes in cooking pot manufacture, by the processing of a variety of animal and plant ingredients, and by the multi-scaled production of food. Whether this is associated with different social forms of food consumption rather than with a more sophisticated cuisine remains open to future research. At present, it appears that societies in the shadow of Olympus altered their culinary apparatus as a result of their contact with Mycenaean lifestyles, but at the same time they accentuated their local traditions, maintaining their local identity in the cosmopolitan environment of the late 2nd millennium BC. Future research should be directed to the study of more cooking pot assemblages from the area, including the ones from burial contexts, and the analyses of a greater number of samples. All the above, along with the results of isotopic analyses of skeletal remains, will further contribute towards the understanding of food and identity during the Late Bronze Age in the Aegean.

Supplementary material: organic residue analysis materials and methods

Sampling

Samples of ceramics were obtained in a powdered form by using a model drill. The sampled area of each ceramic sherd was cleaned, using the drill, by removing the top surface layer of the sherd. A clean drill bit was used to obtain the sample. Samples of archaeological sherds were obtained from an approximately 2 x 2 cm area on the internal surface, up to a depth of 0.5 cm. Around 2 g of ceramic powder was obtained from most samples, although the size of five sherds restricted sample mass.

Residue extraction

Acidified methanol: Simultaneous extraction and derivatisation of lipids was achieved using an adapted acid methanol methodology.⁷⁴ Methanol was added to homogenised samples of ceramic powders (4 mL to 1 g). Mixtures were ultrasonicated for 15 minutes, before adding 800 μ L concentrated (98%) sulphuric acid (H_2SO_4), and heating, at 70°C, for four hours. Following centrifugation of mixtures, at 3000 rpm for five minutes, the supernatant was transferred to a separate vial. Lipids were extracted from the acidified mixture using *n*-hexane (3 x 2 mL) and dried under a gentle stream of nitrogen. Samples were resuspended in 100 μ L of *n*-hexane and transferred to a conical insert, in a GC vial, with 10 μ L of a C₃₆ alkane standard. A C_{16:0} and C_{18:0} fatty acid standard was processed with each batch of 10 samples, in addition to a method blank.

Solvent: Lipids were extracted from ceramic samples, by ultrasonication for 15 minutes, with a 2:1 mixture of DCM:MeOH (3 x 2 mL). The supernatant was separated from the ceramic powder between each sonication stage, by centrifugation at 3000 rpm for 5 minutes, and transferred to a secondary vial. Extracts were dried under a gentle stream of nitrogen before derivitisation. Immediately before analysis, samples were silylated, requiring the heating of extracts for one hour, at 70°C, with 100 μ L of N,O-bis(trimethylsilyl)trifluoroacetamide (BSTFA) with 1% trimethylchlorosilane (TMCS).

Gas Chromatography – Mass Spectrometry

GC-MS analysis was undertaken using an Agilent 7890A Series Gas Chromatograph coupled to an Agilent 5977B Mass-selective detector equipped with a quadrupole mass analyser (Agilent technologies, Cheadle, Cheshire, UK). A split/splitless injector, operated in splitless mode, was maintained at 300°C and a DB-5MS column was used (PN 122-5532; 30 m x 250 µm x 0.25 µm; J&W Scientific technologies, Folsom, CA, USA). Helium was the carrier gas (2 mL min⁻¹). For acid methanol extracts, the oven temperature was set to 50°C for 2 minutes, then increased at 10°C min⁻¹ to 200°C before increasing at 4°C min⁻¹ to 320°C and held for 5 minutes. For solvent extracts, the oven temperature was set to 50°C for 2 minutes, then increased at 10°C min⁻¹ to 325°C and held for 15 minutes. The ionisation energy of the mass spectrometer was 70 eV and spectra were obtained in scanning mode between m/z 50 and 800.

Selective ion monitoring (SIM) of solvent extracts was undertaken using an Agilent 7890A Series Gas Chromatograph coupled to an Agilent 5977B Mass-selective detector equipped with a quadrupole mass analyser (Agilent Technologies, Cheadle, Cheshire, UK). A split/splitless injector, operated in splitless mode, was maintained at 300°C and a (50%-cyanopropyl)-methylpolysiloxane DB-23 column was used (PN 122-2362; 60 m x 250 µm x 0.25 µm; J&W Scientific technologies, Folsom, CA, USA). Helium was the carrier gas (1.5 mL min⁻¹). The oven was set to 50°C for 2 minutes, increased at 10°C min⁻¹ to 100°C, increased at 4°C min⁻¹ to 140°C, increased at 0.5°C min⁻¹ to 160°C, then increased at 20°C min⁻¹ to 250°C and held for 10 minutes. SIM mode was used in order to target the specific markers of aquatic resources using characteristic ion groups: m/z 74, 87, 213, 270 for 4,8,12-trimethyltridecanoic acid (TMTD), m/z 74, 88, 101, 312 for pristanic acid, m/z 74, 101, 171, 326 for phytanic acid, and m/z 74, 105, 262, 290, 318, 346 for the detection of ω-(o-alkylphenyl) alkanolic acids of carbon lengths C16 to C22 (APAA₁₆₋₂₂).

MassHunter software (Agilent Technologies) and NIST 17 (mass spectra database) was used for quantitative and qualitative analysis of extracts.

Gas Chromatography – Combustion – Isotope Ratio Mass Spectrometry

Compound specific isotope (GC-C-IRMS) analysis of methyl palmitate and methyl stearate was undertaken, for AM extracts, using an Isoprime 100 (Isoprime, Cheadle, UK) IRMS detector coupled to an Agilent 7890B Series Gas Chromatograph with an Isoprime GC5 interface. An 5975C inert XL mass-selective detector (MSD) equipped with a quadrupole mass analyser was also coupled to the GC. A split/splitless injector, operated in splitless mode, was maintained at 300°C and a DB-5MS UI column was used (PN 122-5562UI; 60 m x 250 µm x 0.25 µm; J&W Scientific technologies, Folsom, CA, USA). Helium (ultra-high purity grade) was the carrier gas (2 mL min⁻¹). The oven temperature was set to 50°C for 0.5 minutes, increased at 25°C min⁻¹ to 175°C, then increased at 8°C min⁻¹ to 325°C and held for 20 minutes. Gases eluted from the column were split into two streams, that entered the MSD and GC5 interface. The ionisation energy of the mass spectrometer was 70 eV and spectra were obtained in scanning mode between m/z 50 and 800. The GC5 furnace tube (CuO) was maintained at 850°C to oxidise carbon species to CO₂. Clear resolution and baseline separation of analysed peaks was achieved. Products eluted from the furnace were ionised in the IRMS by electron impact. Ion intensities of m/z 44, 45 and 46 were recorded for automatic computing of the ¹³C/¹²C ratio of each peak in the extracts.

Computation was made with IonVantage and IonOSsoftwares (Isoprime, Cheadle, UK). The results of the analysis were expressed in per mill (‰) relative to an international standard, V-PDB. The accuracy and precision of the instrument was determined on *n*-alkanoic acid ester standards of known isotopic composition (Indiana standard F8-3). The mean ± S.D. values of these were -29.96 ± 0.08‰ and -23.27 ± 0.07‰ for the methyl ester of C_{16:0} (reported mean value vs. VPDB -29.90 ±

0.03‰) and $C_{18:0}$ (reported mean value vs. VPDB $-23.24 \pm 0.01\%$) respectively. Each sample was measured in duplicate (mean of S.D. 0.13‰ for $C_{16:0}$ and 0.10‰ for $C_{18:0}$). Values were also corrected subsequent to analysis to account for the methylation of the carboxyl group that occurs during acid extraction. Corrections were based on comparisons with a standard mixture of $C_{16:0}$ and $C_{18:0}$ fatty acids of known isotopic composition processed in each batch under identical conditions. The results from the analysis are reported in parts per mil (‰) relative to an international standard (V-PDB). Each batch of samples was calibrated using a calibration curve (average $R^2 = 0.999 \pm 0.011$ in 1 batch) based on expected vs. measured $\delta^{13}C$ values of *n*-alkanes and *n*-alkanoic acid esters international standards (Indiana A6 and F8-3 mixture). More precisely, the accuracy of the instrument was determined on *n*-alkanoic acid ester standards of known isotopic composition (Indiana standard F8-3, 4 measurements).

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