



DOI: 10.5281/zenodo.581717

ORGANIC COMPOUNDS AND CULTURAL CONTINUITY: THE PENN MUSEUM LATE MINOAN IIIC STIRRUP JAR FROM TOURLOTI

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Received: 06/04/2017

Accepted: 02/05/2017

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ABSTRACT

The turn of the 12th century B.C. traditionally has been cast as a period of turmoil and upheaval in the eastern Mediterranean. Although recent scholarship qualifies “the Collapse,” the dominant narrative continues to be one of disruption, regression, and isolation. East Crete has been painted with a similar brush. Yet the century that followed the final demise of Bronze Age Knossos remains generally understudied, despite scholarly recognition of the region’s importance for the reconstruction of both local Cretan and pan-Mediterranean histories at the end of the Late Bronze Age. As a small contribution to this discourse, we present here an interdisciplinary analysis of a noteworthy Late Minoan IIIC Early (ca. 1175 B.C.) stirrup jar from the western Siteia foothills of East Crete. Organic residue analysis utilizing gas chromatography has allowed us not only to identify the value-added product contained within the jar, a perfumed oil, but also to consider its individual ingredients in light of known craft practices and agricultural activity from the earlier Neopalatial period. Our results reveal surprising evidence of specialized craft continuity in East Crete at the conclusion of the Bronze Age, which suggests a historical picture more complex than traditionally imagined. This will be the first in a series of OpenARCHEM studies of legacy objects employing both traditional and scientific methods.

KEYWORDS: organic residue analysis (ORA), OpenARCHEM, phytochemistry, perfumed oils, Bronze Age collapse, East Crete, Close Style Octopus stirrup jar, Minoan-Mycenaean.

1. INTRODUCTION

"We seem to be back in the Neolithic Period with its life of terror" Pendlebury 1939, 303

The turn of the 12th century B.C. in Crete, as well as the broader eastern Mediterranean, traditionally has been cast as a period of displacement, turmoil, and decline (Boyd 1901, 130; Hogarth 1901, 145; Bosanquet et al. 1903, 289; Pendlebury 1939, 303; Day 1997, 404; Nowicki 2000, 223-247; Watrous 2012, 65-66). Although recent scholarship has moved beyond Pendlebury's dramatic description of the era to qualify "the Collapse" (Dickinson 2010, 483; Cline 2014; Knapp and Manning 2016), the dominant narrative of the century encompassing the transitional Late Minoan (LM) IIIB-C period continues to be one of isolation and regression. East Crete is no exception, having been memorably deemed "the wild country east of Dikte" in light of its perceived detachment from the rest of Crete after LM IB (Bennett 1987; cf. Tsipopoulou 1997, 247).

Despite such a sweeping characterization, the century that followed the final demise of Knossos and contemporary LM III urban centers (such as Palaikastro) in fact remains generally understudied and not fully understood. Recent studies of East Crete have led to a growing scholarly recognition of the region's importance for the reconstruction of local histories (e.g. the emergence of Eteocretans) and pan-Mediterranean narratives (e.g. the Sea Peoples phenomenon) at the end of the Late Bronze Age (e.g. Kanta 1980; Hallager and Hallager 1997; Whitley 1999; Nowicki 2004; D'Agata and Moody 2005; Haggis 2005; Soles 2008; Smith 2010; Brogan and Smith 2011; Perna 2011; Watrous 2012, 67; Gaignerot-Driessen 2016; cf. Kotsonas 2008). Yet few early Postpalatial (ca. 1300-1175 B.C.) settlements in East Crete have been excavated. This lacuna is due in part to general prospection biases on Crete (Koh and Clinton 2015) coupled with a preferential interest in the "palatial" periods at the expense of subsequent ones. Given the restricted nature of the data, synthetic studies of the period, particularly those that treat the larger Mediterranean, have by default tended towards Knosso-centric perspectives, even when such extrapolation may not be appropriate for all parts of the island.

For East Crete, therefore, we must rely heavily on finds recovered from cemeteries to expand our knowledge of the pivotal LM IIIB-C transition and the decades leading up to it. Fortunately, the funer-

ary landscape in the western Siteia foothills offers a rich material record of the period, although few sites have been published fully. Under such conditions, every object has a story to tell. As Harmanşah notes, "Materials and objects are imbued 'with positive and auspicious characteristics' not only because of their scarcity...but also because they carry the rich associations with the places they come from, their complex processes of acquisition, bodies of skilled knowledge they embody in their materiality, and the human relations behind their making" (2008, 125). The brief study that follows offers an interdisciplinary analysis of a noteworthy LM IIIC Early (ca. 1175 B.C.) stirrup jar from a tomb in the western Siteia foothills of East Crete, using organic residue analysis (ORA) to reveal its original value-added contents. The results show surprising evidence of specialized craft continuity in East Crete at the conclusion of the Bronze Age, which suggests a historical picture more complex than traditionally imagined. This will be the first in a series of OpenARCHEM¹ studies on legacy objects employing both traditional and scientific methods, harnessing these approaches to move, as Harmanşah describes, beyond artifacts and their contents to unveil a more nuanced picture of the economic, natural, and cultural landscapes that produced them.

2. BACKGROUND TO THE POSTPALATIAL WESTERN SITEIA FOOTHILLS

The LM III (ca. 1400-1050 B.C.) cemetery known by the toponym "Plakalona" is located one km north of the modern village of Tourloti, which straddles the national highway in the northern foothills of the western Siteia Mountains² of East Crete (Fig. 1). Archaeologist Richard B. Seager initiated excavations at the site in 1905-1906 (Seager 1909, 286; Betancourt 1983, 52; Tsipopoulou 1999, 123) after conducting exploratory investigations in the area while working at Vasilike. Although he never published his results,³ he did choose a group of select objects from Tourloti and nearby sites for the Candia Museum to donate to the University of Pennsylvania Museum of Archaeology and Anthropology (Becker and Betancourt 1997, 66). They arrived in Philadelphia on March 1907 and were gifted, in part, to help secure funding for Seager's next project at Pseira (Becker and Betancourt 1997, 71-72).

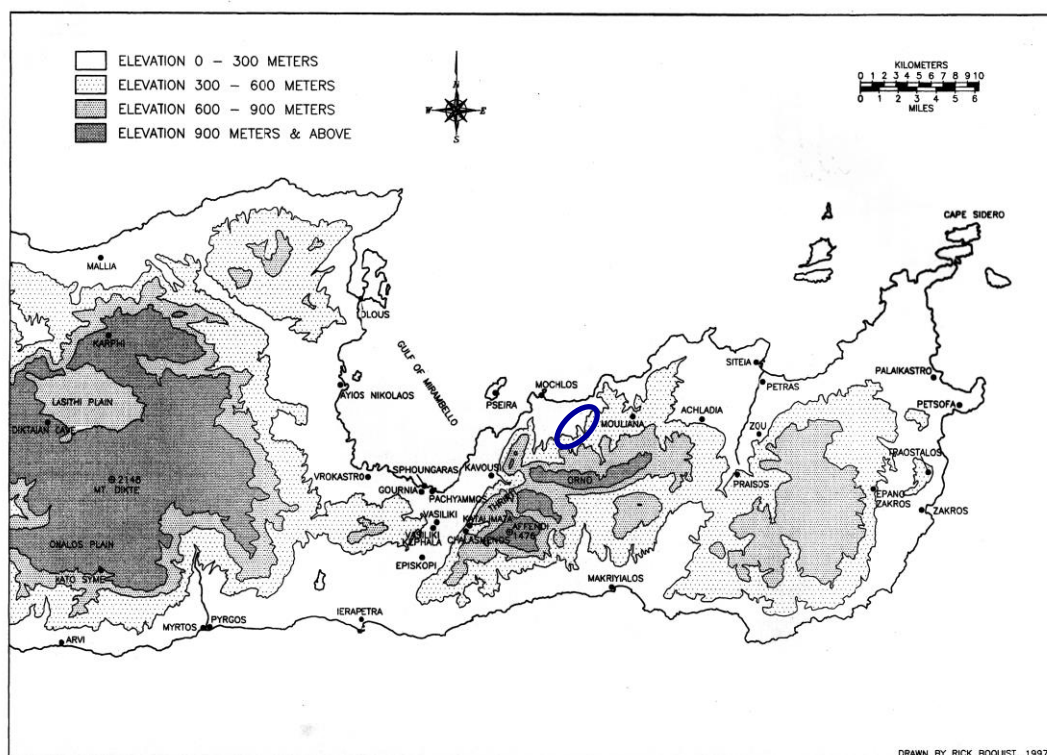


Figure 1. A Map of East Crete with Turloti Region Highlighted (Map by R. Boquist. Courtesy of J. G. Younger.)

In 1959, archaeologist Nikolaos Platon located a few additional chamber tombs in Turloti (Platon 1959, 388-389), but never excavated them, instead electing to unearth the palatial complex at Kato Zakros.⁴ Since that time, a series of rescue excavations have been carried out by the Greek archaeological service in the area (Papadakis 1983, 128-129; Tsipopoulou 1995, 177-188; Paschalidis 2009, 4).⁵ These rescue projects have offered a tantalizing glimpse of a considerable, if not exceedingly wealthy, cemetery that bears a resemblance to the neighboring site of Myrsini Aspropilia (Smith 2002). The precise extent of the cemetery at Plakalona is unclear, but the position of the known chamber tombs in relation to the topography and geology of the area suggests that it was sizeable indeed, and potentially ranged between 10-15 hectares, indicating Plakalona was an important area during LM III. Relatively little is known, however, about the LM III inhabitants of the western Siteia foothills attached to the cemetery (Koh and Clinton 2015).

In the absence of excavated contemporary settlements, cemeteries such as Turloti-Plakalona are key to any reconstruction of the economic and cultural narrative of East Crete in the wake of palatial “collapse” (Tsipopoulou 1995, 188; Kanta in Nowicki 2001, 40; Nowicki 2001, 40; Nowicki 2004, 276). Given the dearth of systematically excavated and published tombs from Plakalona, efforts to understand the nature of the area during LM III have centered

upon targeted studies of individual objects (Tsipopoulou and Vagnetti 1999) and relatively modest assemblages from at least three chamber tombs (Papadakis 1984, 306; Tsipopoulou 1995, 186).⁶

Although we know little about Seager’s activities at Turloti, we are fortunate to have an LM III Early stirrup jar that he excavated from the site (MS4494, Fig. 2). This vessel constitutes the only vessel from Turloti he opted to include as a part of his handpicked 1906 donation to the Penn Museum.



Figure 2. LM III Early stirrup jar from Turloti, Crete (MS4494)

3. MS4494 - THE TOURLOTI STIRRUP JAR

Seager's choice pick from Tourloti, originally published by Betancourt (1983, 52, fig. 14, pl. 12 - no. 137),⁷ is a small LM IIC Early globular stirrup jar, Furumark Shape 176 (FS 176; Furumark 1941, 29, 33, 83, 565 ff.), complete with the exception of a missing handle and broken spout, with a capacity of roughly 350 ml.⁸ The vessel was produced in a fine pink (7.5YR 7/4-5YR 7/4) fabric with small phyllite inclusions, slipped reddish brown (5YR 5/3-5YR 3/2) and wiped with water. The jar was decorated with two groups of three thin horizontal bands, the first situated just below the midsection of the vessel and the latter around the lower part of the body, with a fourth band around the edge of the low, articulated base. The handles, false neck, and spout are encircled by a single undulating line, unevenly rendered.

The body of the jar is decorated with a stylized octopus, Furumark Motif 21 (FM 21; Furumark 1941, 302-306), in the Close Style (Kardara 1977, 9), which occupies its entire decorative register. Linear ornament (concentric arcs and chevrons) fills the intervening spaces. The octopus has four arms, two on each side, and stares out through eyes rendered in a series of three concentric circles, the pupils of which are solid. Vertical lines of fringe radiate upwards along the octopus' upper arms and meet across its brow. These uppermost arms extend around the sides of the vessel, each finishing in a single coil just behind the handles. The upper right tentacle is solidly slipped, and flanked on its upper and lower edge by a thin band, leaving a negative 'relief' line between them. The upper left tentacle also may have been solidly slipped, but only a series of arced bands are preserved, pointing to the original presence of white paint atop the dark slip.⁹ The lower tentacles continue around to the opposite side of the vessel and finish in single coils, mimicking the placement of the eyes. A third coil or spiral - this one coiling upwards, rather than downwards - is set between the upper and lower tentacles on the left side. This may suggest a third arm or a filler spiral.

Although the octopus is not a rare motif on LM IIC Close Style stirrup jars (Kanta 1980, 255-256; MacDonald 1986, 136, 138) and larnakes (Tsipopoulou and Vagnetti 1997, 474-476), certain decorative details have been associated with particular regional workshops (Kanta 1980, 255-256, 292; Paschalidis 2009, 14, 23, 30-31, 34). The fringe that appears across the upper edge of the octopus on MS4494 is one such trait (Tsipopoulou and Vagnetti 1997, 474-475; Paschalidis 2009, 14, 30-31, 34), and has been attributed to an as yet unidentified production center in the Tourloti/Myrsini/Mouliana region of East Crete (Kanta 1980, 163-176; Tsipopoulou 1995, 189-192;

Tsipopoulou 1997, 243; Tsipopoulou in MacGillivray 1997, 206-207; Smith 2002, 162; Paschalidis 2009, 7-8, 27-28).

4. MATERIALS AND METHODS: ORA OF MS4494

Ancient organic compounds pose a challenge to the archaeological scientist in that even under ideal conditions organic compounds are prone to volatilization, degradation, and decomposition over time. One must additionally reckon with the fact that samples are also susceptible to anthropogenic or environmental contamination. Collectively these processes can obscure chemical signatures or render them considerably weaker than in comparable modern samples. The trace amounts involved, therefore, demand analytical instruments of high sensitivity, which allow researchers to separate and characterize organic compounds both qualitatively and quantitatively. As such, instruments of choice have been chromatographic, especially liquid (LC-MS) or gas chromatography (GC-MS) coupled with mass spectrometry (Mills and White 1999; Colombini et al. 2009; Koh in press).

The contents of MS4494 have been identified via ORA by GC-MS instrumentation. With a permit from the Penn Museum Scientific Testing Committee and employing the ARCHEM extraction protocol (Koh and Betancourt 2010; Koh et al. 2014), a series of samples were isolated from the vessel in the museum's Conservation Department. Generally, the best results from this procedure are obtained from sherds carefully selected from ongoing or recent excavations (Koh and Betancourt 2010; Koh et al. 2014; Koh et al. 2015; Koh in press), although significant results have been achieved from legacy objects, such as MS4494, with the proper consideration of object parameters and biographies (Gerhardt et al. 1990; Evershed 1993; Biers et al. 1994; Koschel 1996; Mills and White 1999; Colombini et al. 2009).

The jar is almost completely intact and enclosed (i.e. it has not been handled extensively or cleaned for exhibition) making it an ideal candidate for ORA despite its relatively early excavation date. To account for the build-up of dust and other intrusive elements inside the vessel and allow for the chemical release of ancient organic residues trapped within the matrix of the ceramic fabric (Goldenberg et al. 2014), three separate extractions were executed in sequence, resulting in three filtered, solution samples (ARCHEM samples 4426-4428). The extractions utilized absolute, analytical-grade ethanol that was heated to just below boiling and pipetted directly into the jar through its small mouth and immediately "swished" within the object. The resulting solution was then poured into filter paper for direct col-

lection into a 20 ml scintillation master vial, in accordance with established ARCHEM project protocols (Koh and Betancourt 2010; Koh et al. 2014; Koh in press).

These solution samples were transported back to the Brandeis University Department of Chemistry and processed the following day for immediate analysis. First, ~2 ml subsamples were concentrated to solid by rotary evaporator and redissolved in uninhibited tetrahydrofuran (THF) to produce ~300 µl GC-MS analytes, which supplied 5 µl for auto injec-

tion into an Agilent 7890A GC with a HP-5MS column and a 5975C VL MSD Triple Axis Detector. The pulsed split injector and interface were both set to 250°C. The initial oven temperature was set to 100°C and held for two minutes before reaching 250°C at a rate of 10°C/minute, at which time it was held for an additional 11 minutes, giving the total program time of 28 minutes/sample. Solvent blanks were utilized before and after each sample to verify that no contaminants existed from previous runs and that no components were lost in the column.

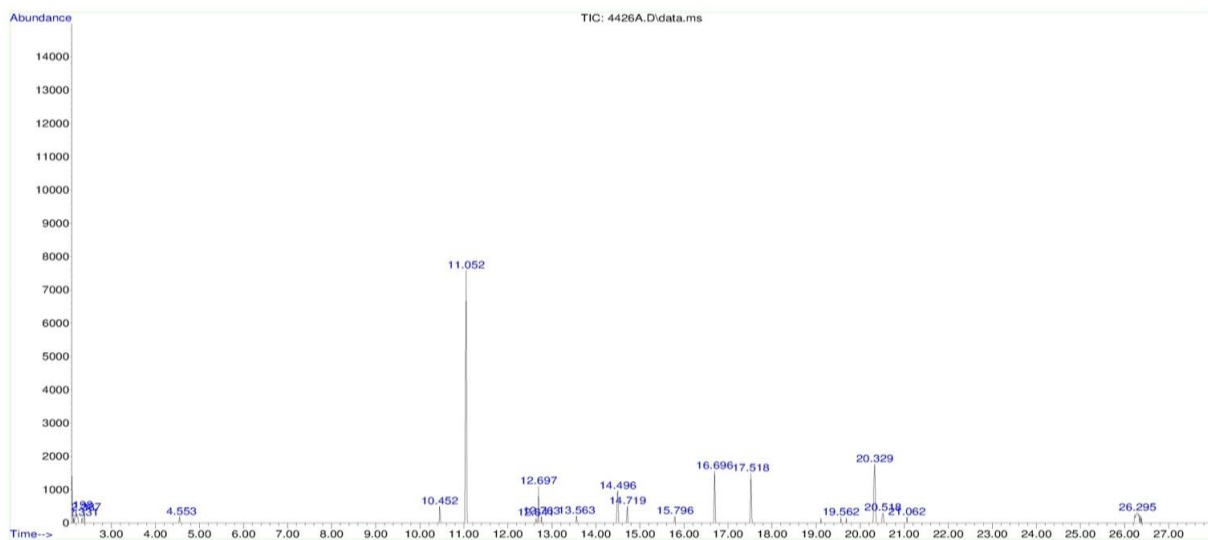


Figure 3. Total ion chromatogram from first extraction of MS4494

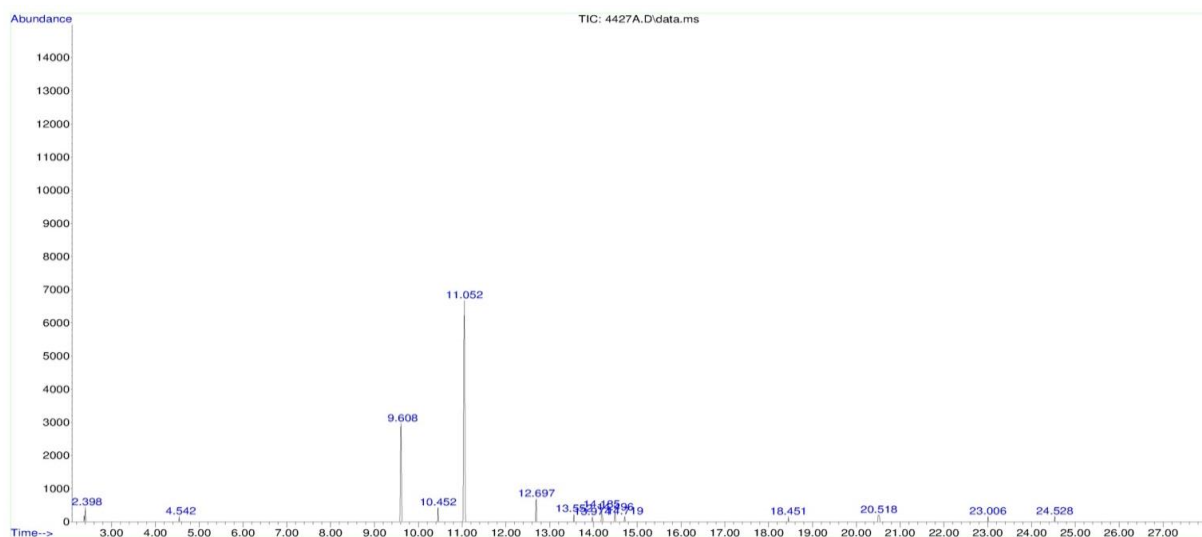


Figure 4. Total ion chromatogram from second extraction of MS4494

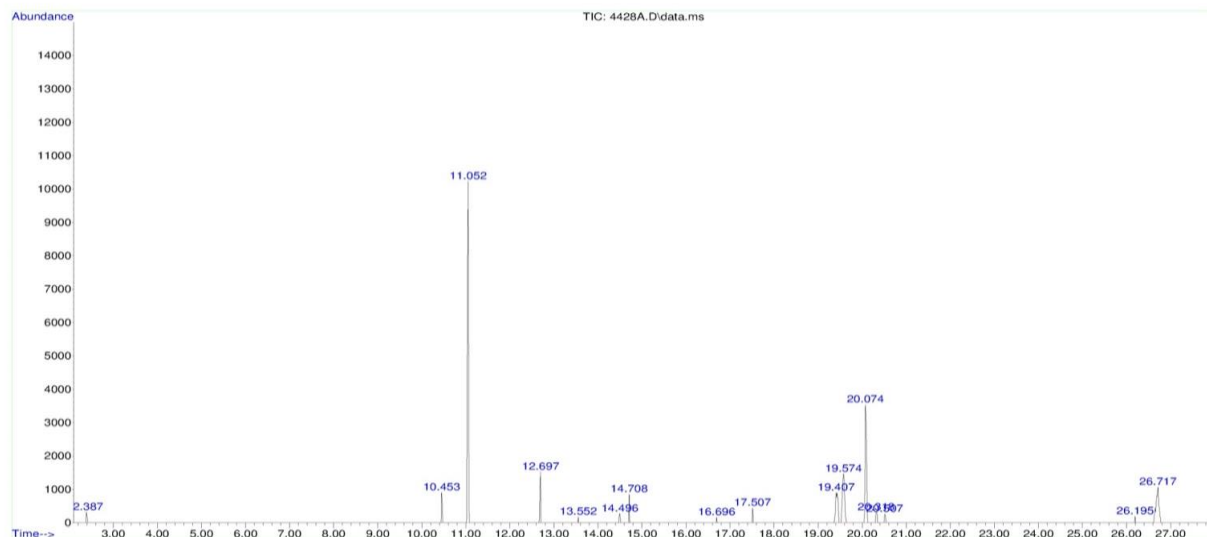


Figure 5. Total ion chromatogram from third extraction of MS4494

5. RESULTS OF ORA (FIGS. 3-5)

With the first sample (ARCHEM 4426), the anticipated dust and dirt were removed by hot filtration during the extraction process and azelaic acid, oleic acid, linalool, and manoyl oxide were subsequently identified by GC-MS after initial peak assignment using the National Institute of Standards and Technology mass spectral library, NIST 11. It was understood that these initial compounds could be by-products, or remains of modern contamination, until confirmed by subsequent extraction samples. The second sample (ARCHEM 4427) clearly pulled cinnamic acid, azelaic acid, camphor, and linalool from the ceramic matrix. In the third sample (ARCHEM 4428), oleic acid, linalool, and manoyl oxide were present again, confirming their presence as components of the original ancient residue.

5.1. Azelaic Acid ($C_9H_{16}O_4$, 188 MW, 11.05 minutes) and Oleic Acid ($C_{18}H_{34}O_2$, 282 MW, 16.70 minutes) from olive

Oleic acid is a monounsaturated fatty acid (18:1) that is a pale to brownish-yellow liquid at room temperature. It is the most abundant unsaturated fatty acid found in nature, but occurs in high concentrations (55-85%) only in olive oil from *Olea europaea*, which is abundant on the island. Oleic acid is rarely found in animals so it serves as a good biomarker for olive when detected in sufficient quantity.

In addition to being a widely available product of the Mediterranean region, olive oil (indicated in ancient samples by oleic acid and azelaic acid) pro-

vides a liquid base for perfumes that may be stored without evaporating or spoiling at ambient temperatures. After a decade of ORA research, the project has verified that legacy objects suspected of containing olive oil in antiquity contain large quantities of azelaic acid, a saturated dicarboxylic acid, in lieu of oleic acid due to ongoing oxidation processes once artifacts are exposed to the open environment (Regert et al. 1998; Ribechini et al. 2008).

5.2. Cinnamic Acid ($C_9H_8O_2$, 148 MW, 9.61 minutes) from sweetgum

Cinnamic acid is a carboxylic acid that is a white, crystalline compound with a pleasant, leathery odor and found naturally in plants. It was probably obtained from resin exuded from the bark of *Liquidambar orientalis* (sweetgum) found in a nearby well-watered ecosystem such as the Kephalo Vrisi Valley (Mesa Mouliana) or the Richtis Gorge (Exo Mouliana). The resin could also have been imported from the Dodecanese or southwest Anatolia, where it grows to this day. At Tourloti, it likely had the effect of lending the final aromatic product a storax balsam quality.

5.3. Camphor ($C_{10}H_{16}O$, 152 MW, 14.19 minutes) from wormwood

Camphor is a bicyclic terpenoid ketone that is a white (or clear), waxy crystal with a strong, pungent, aromatic odor. It is found in particularly large quantities in *Cinnamomum camphora* (i.e. camphor tree) and the *Artemisia* genus (e.g. wormwood). In the

ancient Mediterranean, the latter was the likely source as the camphor tree originates from East Asia. *Artemisia* is comprised of hardy shrubs that grow in dry or semi-dry climates and are known for their volatile oils. Due to its extremely bitter taste, plants in this genus are typically used for medicinal and aromatic purposes, not flavoring.¹⁰ Due to camphor's relatively common occurrence in trace amounts, sufficient quantities are needed, as with oleic acid, when interpreting its potential ancient sources. Camphor has traditionally been used as a pest repellent and antimicrobial agent.

5.4. Linalool ($C_{10}H_{18}O$, 154 MW, 14.50 minutes) from coriander

Linalool is a terpene alcohol found in plants with a pleasant, floral scent, hence its use in soaps and perfumes. Notably, it is the main constituent (50-60%) of the essential oil of coriander (*Coriandrum sativum* - κορίανδρον, ko-ri-ja-do-no in Linear B), which has been connected with the Late Bronze Age perfumed oil industry on Crete (Koh 2008) and the Greek mainland (Shelmerdine 1985) for its astringent properties.¹¹

5.5. Manoyl Oxide ($C_{20}H_{34}O$, 290 MW, 17.51 minutes) from rockrose

Manoyl oxide is a diterpenoid ether found in the Cistaceae (rockrose) and Pinaceae (pine) families. Manoyl oxide is found in labdanum, a resinous material obtained from *Cistus creticus*, or Cretan rockrose, which an LM IA fresco from Akrotiri, Thera seems to depict (Vlachopoulos 2008, fig. 41.33). To this day, labdanum is known for its use in perfumes, where it serves as both a pleasing aromatic and a fixative to help retain scents. The Mediterranean members of the *Cistus* genus are among the largest producers of labdanum, which has a long history of medicinal and aromatic use in ancient Egypt and Greece (Oller-López et al. 2005). *Cistus* resins are typically extracted by boiling leaves and twigs. *Cistus creticus* is native to the island of Crete and has several well-known cultivars including "Lasithi," the region in which Turloti resides. This cultivar was the likely source of the manoyl oxide found at Postpalatial Turloti and Neopalatial Mochlos as it grows abundantly in the western Siteia foothills. Manoyl oxide is one of the main substitutes for ambergris in the perfume industry today.

5.6. Summary of ORA

The collective chemical composition of the extracted residues indicates that the precious liquid commodity of MS4494 was a perfumed olive oil endowed with locally sourced botanical ingredients.

Significantly, these components align with those identified by the co-author at the LM IB (ca. 1500 B.C.) perfumed oil workshop at the nearby coastal site of Mochlos (Koh 2008). In fact, this present research, by encouraging a revisiting of that 13-year-old data, has solved an outstanding mystery from the previous study. Cinnamic acid (storax balsam) had not been identified in the course of that original study, but has now been retroactively identified as one of the repeatedly occurring compounds formerly placed into the unknown category.¹² The organic contents of MS4944 suggest that the jar held a precious, aromatic commodity tied to funerary ritual, an interpretation that has significant ramifications for the surrounding cultural and natural landscape.

6. DISCUSSION AND CONCLUSIONS

In his 2004 analysis of Minoanization, Broodbank advocates for a bottom-up approach that prioritizes manufacture and consumption over *things* (Broodbank 2004, 59). The Turloti jar and its contents offer an opportunity to reflect on both.

A Turloti tomb was supplied with a distinctively decorated local jar containing a refined, perfumed oil. Beyond its aesthetic or ritual value, the presence of this aromatic in an LM IIIC context invites a reconsideration of the cultural and economic landscape of Postpalatial East Crete. Traditional "refugee" narratives of the LM IIIB-C transition on Crete maintain that after the demise of the major urban centers, a significant portion of the population perished, or took to the sea, while the remaining groups retreated to relatively impoverished refuge sites where they retained few Mediterranean connections (Cf. Wallace 2010, 54-60). Luxury items, even for elites, often are presumed to be a distant memory during a period marked by the decline of craftsmanship and the loss of specialized knowledge (Dickinson 1994, 101, 126, 143, 188, 193; Rehak and Younger 2001, 462; MacDonald 2014, 539). Neither the producers of these specialized goods, nor the elite consumers with the means to acquire them, were generally thought to remain.¹³ The organic contents of MS4944 suggest otherwise.

Perfumes are, by nature, value-added commodities. They are products of skilled and specialized workshops (Gell 1992; Dobres 1999; Koh 2008; Routledge and McGeough 2009, 23; cf. Costin 1991) and appraised according to the quality of ingredients and the complexity of craftsmanship (Harmanşah 2008, 125; Murphy 2013, 249-250; Parkinson and Pullen 2014, 74). Their manufacture requires not only the ability to source, process, and preserve a diverse range of raw ingredients, but also a refined knowledge of multi-stage production processes, which employ techniques bordering on the pharma-

cological. The manufacturer of the perfumed oil in MS4494, for example, employed *stypsis*, a process by which the base olive oil is first infused with an astringent, such as coriander, to make it receptive to scents. Untreated olive oil on its own is resistant to extracting aromatic compounds, but requires pre-treatment in a minimum two-stage steeping process. This was the practice of the Late Bronze Age palatial perfume workshops, a costly and laborious process documented in Linear B tablets Un 267 and Vn 130 from Late Helladic (LH) III Pylos (Shelmerdine 1985; Palaima 2014), and empirically detailed in ORA carried out at the LM IB perfumed oil workshop at Mochlos (Koh 2008) and now also at Tourloti. The perfumed oil itself is clear evidence for specialized craft production of a luxury, value-added item in an LM IIIC environment.

It is significant that the extant components used to make the LM IIIC perfumed oil in MS4494 echo almost exactly the varied ingredients used in the perfume production center at LM IB Mochlos.¹⁴ Even when using locally available ingredients, the reproduction of an LM I recipe with the same range and diversity of aromatic compounds is unlikely to be coincidental. One only needs to compare the LM III perfumed oil from Tourloti with ingredients listed in the LH III tablets at Pylos to note the variability in perfumed oil traditions between two regions with similar ecological profiles.¹⁵ Nor would all of these ingredients have been necessary for the creation of a perfumed oil, when the use of even a single aromatic would suffice to produce a sufficiently pleasing scent.¹⁶ While rough emulation might be possible, the careful selection of a rich profile of complementary aromatic ingredients, coupled with the sophistication of the underlying manufacturing process (such as *stypsis*), suggests instead that the Mochlos and Tourloti workshops belong to a shared regional tradition of established craftsmanship (Shelmerdine 1985, Tzedakis and Martlew 1999, 44-54; Koh 2008; Koh in press).¹⁷

Production of perfumed oils in LM III may have been reduced in scale relative to the preceding centuries, but the sophistication and quality of the contents of the Tourloti jar are proof of the propagation of a specialized knowledge and craft, both of which are usually assumed to have been lost in the region during the period after the LM IB destructions. The perfumed oil in MS4494 does not, however, indicate any limitation in resources or capabilities, but appears to be equivalent in quality to that of Neopalatial workshops (ca. 1700-1450 B.C.), when perfumed oil production was presumably at its peak on Crete. Continuing capacity to source and procure the same varied complement of raw ingredients supports the persistence of craft infrastructure and may be indica-

tive of the relative stability of the region. Moreover, the consistency of the recipe itself not only hints at the resilience of local traditions, but also implies continuity – at least to some degree – of demand for this special product. Its quality and complexity in a landscape considered bereft of luxury items is surprising; indeed, one could argue that any perfumed oil produced during LM IIIC should, by all rights, be inferior, cheaper, and less laborious in manufacture. The appearance instead of a refined perfumed oil suggests the regional presence of consumers for whom a quality, traditional product was meaningful and desirable. Conservative preferences for certain commodities may have been one means by which to negotiate identity and status in a Postpalatial landscape (Hitchcock and Maeir in press, 296). At present, the interplay between consumers and producers in this region cannot yet be fully understood, however the results from MS4494 clearly highlight the need for a more thorough exploration of the socio-economic mechanisms operative in this transitional period.

While the Tourloti jar is admittedly only a single example, it is not an outlier. Initial work on contemporary LM IIIC warrior tomb assemblages from adjacent Mouliana-Sellades – including ORA of five LM IIIC stirrup jars, some of which are similarly decorated in the Close Style octopus – shows additional evidence for perfumed oils and regional trade in wine,¹⁸ and even the possibility of continuity in Late Bronze Age metallurgical technology.¹⁹ Early results reveal a comparable picture of regional continuity in certain economic and consumption patterns in East Crete, despite the appearance of “Mycenaeanizing” elements in these LM IIIC Achaean-style warrior burials.²⁰ If a connection can be established between the distinctive contents of MS4494 and the Mouliana-Sellades Close Style jars, each of which are similarly decorated, then it may be possible to speak of the purposeful “branding” of commodities (i.e. Rutter’s “regional markers”²¹) in a Postpalatial environment.

The perfumed oil in MS4494 thus can be seen as a metonymic indicator of the persistence – at least in part – of a regional commercial and industrial network in Postpalatial East Crete (Koh 2016). This model echoes recent approaches to the Bronze Age Minoan and Mycenaean systems that recast the palatial centers as nodes in existing regional networks rather than centralized, monolithic centers of production (Smith 2005, 185; Parkinson and Galaty 2007; Day et al. 2010, 207-211; Knappett 2011; Knappett 2012; Parkinson et al. 2013). These networks were “vibrant, well-organized, and independent” systems (Parkinson et al. 2013, 417), only later brought under the palatial umbrella and, thus, situated to survive

their decline.²² The persistence of such a regional network in LM IIIC East Crete, as supported by ORA, offers an alternative to the unqualified assumption of “the Collapse,” which has been an enduring, if increasingly challenged, hallmark of studies concerning the LM III transition in Crete and beyond.

ACKNOWLEDGEMENTS

We extend our sincerest gratitude to the number of scholars who have facilitated this study. Special mention must be made of C. R. Floyd for graciously reviewing drafts of this study and offering insight into MS4494 from her considerable knowledge of Minoan ceramics. We deeply thank P. P. Betancourt for taking time to read an early version of this study. J. G. Younger generously shared his map of East Crete while L. A. Hitchcock did the same with a publication in press. Our three anonymous reviewers offered their keen insight and helped make this research article better. We, of course, take full responsibility for any oversights in the manuscript. At the Penn Museum, C. B. Rose and L. Makowsky of the Mediterranean Section hosted us warmly. L. Grant and the Penn Museum Scientific Testing Committee offered us feedback and the use of the Conservation Department facilities. A.M. Berlin has offered invaluable advice during the startup of the OpenARCHEM archaeometric database. A. Crandall of the ARCHEM project continued to lend her assistance and share her considerable enthusiasm for archaeological science with us. Colleagues at our home institutions – A. O. Koloski-Ostrow, C. Parslow, L. Muellner, J. Christensen, B. Snider, C. Thomas, C. Wade, and A. Krohn – remain our pillars of support. This research was supported stateside by the Brandeis University Florence Levy Kay Fellowship and the Office of the Dean of Arts & Sciences, and in Greece by the Institute for Aegean Prehistory and the University of Pennsylvania. In East Crete, Koh received support from P. P. Betancourt, T. M. Brogan, C. Davaras, J. S. Soles, J. Moody, M. G. Clinton, E. J. Huffman, E. Nodarou, S. Chlouveraki, K. Hall, M. Roggenbucke, D. Faulmann, J. E. Morrison, and S. C. Ferrence in collaboration with the INSTAP Study Center for East Crete and the 24th Ephorate of Prehistoric and Classical Antiquities.

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NOTES

¹ OpenARCHEM (<http://openarchem.wordpress.com>) is a new open-access repository, resource, and publication outlet for archaeometric data, a natural outgrowth of the established ARCHEM Project, an ORA initiative which has collected thousands of samples throughout the eastern Mediterranean.

² These mountains connect the Ierapetra plain in the west with the Pentelis (modern Stomion) river valley in the east near Siteia. Two rocky massifs comprise the mountains: at the south, Thripti rises in a southwest-to-northeast ridge with its summit at Afendis Stavromenos (1,476 m); to the north, Orno rises in a west-to-east ridge with its summit at Askordalia (1,238 m). North of the Orno range lie the western Siteia foothills in which Tourloti-Plakalona resides.

³ Some general studies make reference to Tourloti while addressing the entire island (Pendlebury 1939; Kanta 1980; Nowicki 2000; Eaby 2007; Eaby 2011), the entire area of the western Siteia massifs (Nowicki 1990; 2004), the Siteia district (Bennet 1987; Tsiopoulou 1995), or the funerary landscapes of all of East Crete (Vavouranakis 2007; Langohr in press).

⁴ Around this time, a resident of the region, Manolis Gygetakis, presented the local archaeological service with objects from the Tourloti cemetery, including jars and a larnax that became the focus of a thorough study by Tsiopoulou and Vagnetti 1999.

⁵ Over the intervening decades, LM III tombs have been found sporadically in the vicinity of the modern villages of Chamezi (Kimouriotos), Exo Moulia (Sellia), Mesa Moulia (Sellades), Myrsini (Aspropilia), Tourloti (Plakalona), and Lastros (Langades). These were mentioned as “metochia” (hamlets) in the 1834 Egyptian census.

⁶ The 2009 study by Paschalidis presented a reassessment of the Tourloti chamber and tholos tombs, but, rather than detailing their architecture or general cultural history, the work focused primarily on their assemblages.

⁷ In addition to Betancourt 1983, mention of the jar is made in Betancourt 1985, 183; Tsiopoulou 1995, 180; Tsiopoulou and Vagnetti 1999, 123; and Paschalidis 2009, 3.

⁸ Calculated as an ellipsoid, total volume is 373 ml; we are accounting here for the fact that the vessel was unlikely to have been filled to capacity.

⁹ The right tentacle probably was similarly decorated, but all traces of the white paint are now lost. For the use of white paint on octopus tentacles on stirrup jars see Kanta 1980, 257.

¹⁰ Cf. Nezhadali, Akbarpour, and Zarrabi Shirvan 2008, 557. This bitter characteristic was well known in the ancient Mediterranean world. In the biblical book of Revelation 8:11, the author envisions an angel casting a star into the waters making them undrinkably bitter - “καὶ τὸ ὄνομα τοῦ ἀστέρους λέγεται ὁ Ἄψινθος” (and the name of the star is called Apsinthos - i.e. wormwood).

¹¹ In addition to Linear B tablet Un 267 from Pylos (Shelmerdine 1985, 17-18), Ga 676 found in the West Wing of the palace at Knossos details a large quantity of coriander related to the perfumed oil industry (Powell 2009, 144).

¹² The open, collaborative, and crowd-sourced nature of the OpenARCHEM archaeometric database is designed to encourage future discoveries such as this one.

¹³ Pendlebury 1939, 303 and more recently Nowicki 2011.

¹⁴ MS4494 is missing evidence for linden (*Tilia*), a tree that has the potential to grow locally today in the adjacent Kephalo Vrisi Valley of Moulia, and which appears to have been deliberately cultivated on the island during the LM I period, judging by palynological evidence (Moody et al. 1996, 278-291; Moody 2012, 258; Moody 2014, 28). As Tourloti is closer to Moulia than the LM IB perfumed oil workshop at Mochlos (cf. Koh 2008), this is understood to mean that linden flowers were no longer used in the LM III recipe, perhaps due to a lack of cultivation of trees, which is a potential interpretation of pollen data. It is also possible that linden’s biomarker, docosane, has not survived in the Penn Museum legacy jar, which was excavated over a century ago. A comprehensive comparison of the perfumed oil in MS4494 with the one produced earlier at Mochlos is the subject of a complementary study in preparation with A. Crandall that will offer insight into how legacy ORA samples differ from freshly excavated samples of the same type.

¹⁵ It should be noted that the two production centers are roughly contemporary, perhaps separated by a generation, by virtue of their LM/LH IIIB2/IIIC Early dates (Mountjoy 1997, 110).

¹⁶ Consider, for example, the single aromatic ingredient iris perfume from Middle Minoan IA Chamalevri (Tzedakis and Martlew 2002, 44).

¹⁷ Perhaps most intriguing is the clearly Minoan nature of the comparanda from LM IB Mochlos given the firmly Postpalatial date of the present evidence from Tourloti, when Crete is presumed to have come under the strong influence of Mycenaean culture after the LM IB destructions. Cf. Brogan et al. 2002; Smith 2004; Wiener 2015; Gorgogianni et al. 2016; Wiener 2016.

¹⁸ Initial results presented in a paper by Koh, Clinton, and Flouda at the 2017 Archaeological Institute of America Annual Meeting. Cf. Xanthoudidis 1904; Popham 1965; Haskell 1984; MacDonald 1986; Knapp 1991.

¹⁹ Initial results presented in a poster by Crandall, Drake, Clinton, Flouda and Koh at the 2017 Archaeological Institute of America Annual Meeting.

²⁰ *Supra* 18.

²¹ Rutter states, "In the case of this particular form of post-palatial ceramic pictorialism, its purpose appears to be as a regional marker, a way of identifying the source of the luxury product that each such jar contained" (*Aegean Prehistoric Archaeology*, http://www.dartmouth.edu/~prehistory/aegean/?page_id=608). The use of morphological or decorative traits in the branding of wines and perfumes has been widely recognized in later periods, particularly for the Persian and Hellenistic periods (Monachov 1999; Lawall 2002; Hein et al. 2008).

²² Parkinson et al. 2013, 417; see also Parkinson and Pullen 2014, 79. Certainly, elements of perfume production in Mycenaean Greece were already, by necessity, decentralized to some extent, as verified by Pylos tablet Vn 130, which records the provision of vessels and fire logs for perfume-boiling at four of the nine principal districts in the Hither Province and five other localities, perhaps specific sites within the five other principal districts (Palaima 2014, 88-89). In Crete, Smith's (2004) study of ceramic patterns in the area of Mochlos and Myrsini also shows strong support for regional LM III networks. Perhaps the region's cultural resilience into LM III is a result of its growing significance as a conduit to the East during LM IB when it could serve as an alternative outlet leveraged by Knossos after the LM IA destruction of its gateway to the north, Thera (Koh 2016). Having survived the LM IB destructions in some form, Knossos' influence would have presumably continued until it too was destroyed for a final time in LM III when regionalism comes to the forefront across the island.