



10.5281/zenodo.16609

IS THERE OPIUM HERE? - ANALYSIS OF CYPRIOT BASE RING JUGLETS FROM TEL BETH-SHEMESH, ISRAEL

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Received: 25/02/2015

Accepted: 25/03/2015

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ABSTRACT

Over half a century ago Robert Merrillees raised a brilliant hypothesis according to which Late Cypriot Base Ring juglets, supposedly shaped like inverted poppy seed pod to advertise their contents, traded opium over the Eastern Mediterranean. This most appealing idea was enthusiastically embraced by students of the Ancient Near East, in spite of the meager scientific evidence supporting it. In order to provide new insights to this intriguing issue four Base Ring I juglets recently found in a secured Late Bronze IIA (14th century BCE) context at Tel Beth-Shemesh, Israel, were submitted for residue analysis at the University of New York at Albany. No traces of opium were found in these juglets. Analysis of 14 additional Base Ring juglets and jugs from Cyprus yielded similar results. Rather, the juglets from Beth-Shemesh contained aromatic oils which could be used externally or consumed for their medicinal benefits. It seems that the one and only positive case as yet of a Base Ring juglet containing opium (from an unprovenanced origin, probably reused) is an exception that proves the rule - Base Ring juglets mainly carried non-narcotic substances.

KEYWORDS: Organic Residue Analysis (ORA), opium trade, GC-MS, Base Ring juglets, Cyprus, Tel Beth-Shemesh, Late Bronze Age

1. INTRODUCTION

In the course of the 2008-2009 seasons of excavations at Tel Beth-Shemesh, Israel, four Base Ring I juglets were found in a sealed and well-dated destruction context of a large edifice, presumably a 'palace'. They were part of a larger assemblage of pottery vessels and other artifacts dated to the local Late Bronze Age IIA (14th century BCE). A scarab bearing the name of Amenhotep III and two Knossian Late Minoan IIIA1 cups were unearthed alongside the Cypriote vessels, providing further chronological evidence. The Minoan cups and the scarab were the subject of two essays analyzing both finds and discussing their important implications for the study of Late Bronze Age Aegean cultural contacts and chronology (Bunimovitz et al., 2013; Brandl et al. 2013). The present article focuses on the contents of the Base Ring juglets from the 'palace' at Beth-Shemesh. Introducing new evidence for the substances contained in these vessels it challenges the hypothesis maintaining that Base Ring juglets traded opium over the Eastern Mediterranean.

2. THE ARCHAEOLOGICAL CONTEXT OF THE TEL BETH-SHEMESH BASE RING JUGLETS

2.1 *The Renewed Excavations at Tel Beth-Shemesh*

Tel Beth-Shemesh is a three hectares mound, located on the northern part of the gentle hilly low-land (Shephelah) between the southern coastal plain and the central mountain ridge of Israel (Fig. 1). This is a multi-period site, spanning more than 1100 years of occupational history. Three cycles of excavations (1911-12; 1928-1933; 1990-present) revealed that it was first settled in the Middle Bronze Age (17th century BCE), and finally deserted in the mid-seventh century BCE as a result of Assyrian and Philistine violence (Bunimovitz and Lederman 1993; 2008; 2009).

Previous excavations at Tel Beth-Shemesh exposed Late Bronze remains (15th-13th centuries BCE) spread all over

the site, indicating a prosperous city (Stratum IV; Grant and Wright 1939, 9-12, 35-50). The finds from this city attest to its wide cultural connections within the Eastern Mediterranean (e.g. Late Cypriot and Late Helladic IIIA-B pottery, and a cuneiform tablet written in the Ugaritic alphabet - Grant and Wright 1939, 118-121; Stubblings 1951, 64, 84; Leonard 1994; Sanders 2006, 157-160).

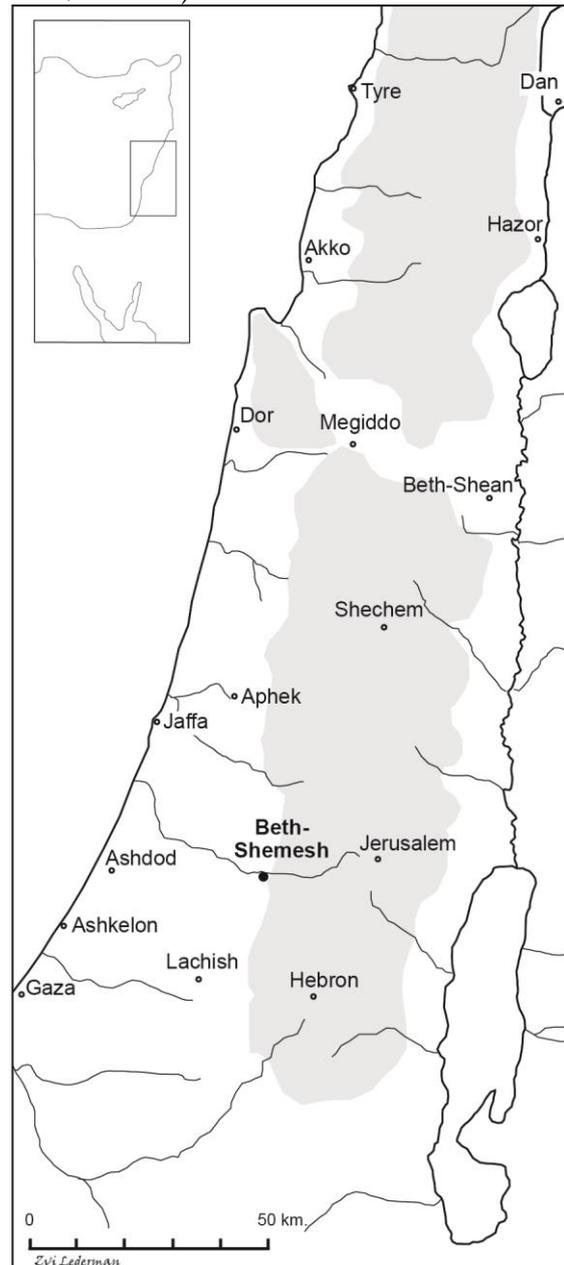


Figure 1: Location map of Tel Beth-Shemesh

The current investigation of the Late Bronze levels of Tel Beth-Shemesh is concentrated mainly on the northern slope of the mound. In this sector two Late Bronze

Age strata were exposed under early Iron Age remains from the 12th-11th centuries BCE. The upper one - Level 8 - dates from the 13th century BCE and comprises two large buildings separated by an alley. A thick destruction layer was unearthed immediately under the remains of Level 8 sealing a spacious building of Level 9 - tagged 'palace' by the current excavation directors due to its size, style of construction and rich contents. It is in two rooms of this architectural complex that the four Base Ring juglets were discovered.

2.2 The Late Bronze Age 'Palace' of Level 9

The 'palace' of Level 9 was found completely covered by a heavy mantle of fallen sun-dried mud bricks that had been fired by a tremendous conflagration when the entire complex was destroyed. So far, only a part of the northern quarters of this multi-roomed structure has been exposed, yet the architectural remains - at least 8-10 rooms - already extend over more than 250 sq.m. To the north, the building makes use of the massive city wall, which may have been originally constructed already in the Middle Bronze Age (17th century BCE), repaired and rebuilt in some sections during the Late Bronze Age. The southern sector of the large building is still hidden under later levels which are currently being excavated.

2.3 The Find Context of the Base Ring I Juglets

Three of the Base Ring juglets were found in a room located on the southern edge of the excavated quarters of the 'palace'. Indeed, part of the room is still concealed by later levels currently under investigation. Two parts of the same archaeological context of brick debris typical of the 'palace' destruction were found here on either side of a baulk and excavated as layers L1556 and L1530. Two of the juglets (Reg. Nos. 6282.03; 6319.01; Fig. 2) were found in layer L1556 adjacent to a remarkable assemblage of artifacts (Bunimovitz et al., 2013: Fig. 2). The assemblage comprises twenty-seven pottery vessels exposed nest-

ing within large pieces of what seems to have been a free standing half-barrel shape pottery bin. Presumably, the group of vessels was stored in the bin and both shattered under the collapsing walls of the room during the fire destruction. The composition of the assemblage - a group of fourteen carinated and open bowls, four chalices, a large jug, a krater, juglets (including the Cypriot ones) and a single oil lamp, supplemented by two Late Minoan IIIA1 cups and a bronze drinking straw tip-strainer for alcoholic beverages found in layer L1530 - may hint at ceremonial or ritual paraphernalia, packed all together. Presumably, the ceremony or ritual involved communal drinking and eating by a number of individuals. Notably, no food preparation vessels or tools were found in this room (e.g. cooking pots and grinding stones found in adjacent rooms). The idea of a ceremonial/ ritualistic assemblage is corroborated by finding among the pottery vessels a group of crude-looking, hand-made human and animal figurines and a boat model. Excavations in the western corner of this room, in context L1530 revealed a medium size commemorative scarab of Amenhotep III (Brandl et al., 2013) and a unique plaque figurine, presumably of a female ruler presented as a male (Ziffer et al., 2009). Other finds in this context include the aforementioned bronze strainer and a third Base Ring I juglet (Reg. No. 5994.07; Fig. 2).



Figure 2: Cypriot Base Ring I juglets from the 14th century BCE 'palace' at Tel Beth-Shemesh

The fourth Base Ring I juglet (Reg. No. 6062.16; Fig. 2)) comes from the layer of

destruction debris - L1505 - excavated in one of four rooms located along the eastern wall of the building. The room was packed with dozens of pottery vessels including at least fifteen storage jars containing a variety of plant remains currently under study.

3. BASE RING JUGLETS AND OPIUM TRADE

The idea that Cypriot Base Ring juglets functioned as specialized containers for the storage and transport of opium in the Eastern Mediterranean was introduced by Robert Merrillees over half a century ago (1962; also Merrillees, 1968: 154-161; 1974: 32-36; 1979: 169-170; 1989: 150*-154*). Since this intriguing suggestion has been repeatedly discussed and debated in the archaeological literature (e.g. Knapp, 1991: 23-25; Muhly 1996: 50-52; Steel, 2004: 170; Collard, 2008; Chovanec et al., 2012: 13-15, with additional literature; see also Merlin, 1984: 251-260), we shall summarily present here the essential pros and cons of the debate.

The gist of Merrillees' hypothesis is the close resemblance between the form and decoration of Base Ring juglets and the seed head of an opium poppy incised to extract its latex. Supposedly, the external attributes of the vessel nonverbally advertised its specific contents. Since the narrow necks of the Base Ring juglets allow the passage only of fluid substances, it was suggested that the opium sap was transported within diluted syrup, such as honey.

Originally, Merrillees' ingenious idea lacked analytical support since early claims for opium content in a couple of Base Ring juglets from Late Bronze Age (New Kingdom) Egyptian burial contexts could not be verified (Merrillees, 1968: 157 with references; 1974: 34). More recent residue analyses on two Base Ring juglets from Tell el-cAjjul and from an unknown provenance reported the finding of opium (Merrillees, 1989); yet the results were criticized for their vague methodological basis and considered inconclusive (Koschel, 1996: 160; Chovanec et al., 2012: 14). It seems, therefore, that the only viable evidence for

opium in a Base Ring juglet (supposedly from Egypt) was presented by Koschel (1996). Notably, however, both Koschel (1996: 161) and Bisset et al. (1996: 203-204) warn against the use of this single analysis as vindication of Merrillees' hypothesis since in their opinion, many more analyses of the contents of Base Ring juglets from secure provenance are required to satisfactorily support it.

4. MATERIALS AND METHODS

The analysis of the Base Ring juglets from Tel Beth-Shemesh was part of a larger research program centered on the evaluation of Merrillees' suggestion that these vessels functioned as specialized containers for the storage and transport of opium in the Eastern Mediterranean.

A total of 17 Base Ring I and II jugs and juglets were analyzed during the course of the study (see Table 1 for a list of samples). In acknowledgement of the fact that organic remains, including residues, degrade over time, an artificial aging study was undertaken by Dr. Sean Rafferty and Dr. Zuzana Chovanec at the State University of New York at Albany. The goal of this study (for a detailed discussion, see Chovanec et al., 2012) was to document the long-term behavior of opium alkaloids and to identify the chemical constituents that are most likely to preserve in archaeological contexts.

Table 1: Sampled Base Ring jugs and Juglets

<i>Sample No.</i>	<i>Ware</i>	<i>Shape</i>	<i>Provenience</i>	<i>Site/Source</i>
5994.07	Base Ring I	Juglet	Layer L1530, Level 9	Tel Beth-Shemesh
6062.16	Base Ring I	Juglet	Layer L1505, Level 9	Tel Beth-Shemesh
6319.01	Base Ring I	Juglet	Layer L1556, Level 9	Tel Beth-Shemesh
74	Base Ring I	Jug	EB02 VII Lot 2 053	Episkopi <i>Bamboula</i>
75	Base Ring I	Closed	EB02 XII J28 W 2 060	Episkopi <i>Bamboula</i>
76	Base Ring I	Juglet	EB02 VIII T6 2AE 107	Episkopi <i>Bamboula</i>
77	Base Ring I	Juglet	EB02 VIII T6 2AE 107	Episkopi <i>Bamboula</i>
78	Base Ring I	Jug	EB02 VII 2 062	Episkopi <i>Bamboula</i>
79	Base Ring I	Jug	EB02 VIII T6 2E 065	Episkopi <i>Bamboula</i>
80	Base Ring I	Jug	EB02 VIII T6 2E 065	Episkopi <i>Bamboula</i>
81	Base Ring I	Jug	EB02 XII I28 W 4 077	Episkopi <i>Bamboula</i>
BC62	Base Ring II	Juglet	(Enkomi <i>Ayios Iakovos</i>)	Belcher Collection University of Albany
130.DK.5	Base Ring II	Juglet	(Dhali <i>Kafkalla</i>)	Barlow Collection University of Albany
151.DK.1	Base Ring II	Juglet	(Dhali <i>Kafkalla</i>)	Barlow Collection University of Albany
1995.10.543	Base Ring I	Juglet	(Cesnola Collection)	Harvard Semitic Museum
1995.1329	Base Ring I	Juglet	(Cesnola Collection)	Harvard Semitic Museum
1995.1332	Base Ring I	Juglet	(Cesnola Collection)	Harvard Semitic Museum

The key observation of the study was that morphine, the most abundant alkaloid in opium, was found to degrade rapidly, whereas the decomposition products of noscapine (cotarnine, hydrocotarnine, meconic acid, and opianic acid) were found to be rather stable after the initial decomposition of noscapine. Therefore, future studies that aim to identify opium residues should target these compounds rather than morphine. Molecular ions for the six opium

alkaloids identified during the study that should be utilized in future analyses aiming to identify opium alkaloids are listed in Table 2.

Analytical samples were obtained from three of the Tel Beth-Shemesh Base Ring juglets by scraping their interiors, thereby keeping the vessels intact (the fourth juglet Reg. No. 6282.03 was found to be too contaminated to produce reliable results). Each sample underwent the same extraction and analytical procedures that were developed during the course of the degradation research mentioned above. For data quality control, all glassware was cleaned and sterilized prior to use and blank solvent samples were analyzed between samples to ensure the detected compounds were in fact associated with the sample. Samples were extracted by placing the ground ceramic material in a cellulose thimble and heating it in a mixture of ethanol and methanol (25 mL, 1:1 (v/v) in a glass round bottom flask with reflux apparatus attached. After three hours of heating, the liquid sample was filtered and concentrated under a steady flow of nitrogen gas to a 1mL sample.

Table 2: Molecular ions for targeting opium alkaloids in Selected Ion Monitoring (after Chovanec, 2013: 72-73).

Opium Alkaloid	Molecular Ions
Codeine	115, 124, 162, 188, 214, 229, 299, 300
Hydrocotarnine	133, 148, 163, 178, 205, 220, 221, 222
Morphine	115, 124, 162, 174, 215, 268, 284, 285, 286
Noscapine	147, 193, 205, 220, 221
Papaverine	178, 207, 293, 308, 324, 325, 338, 339
Thebaine	91, 165, 239, 296, 297, 311, 312

The samples were then analyzed with a Hewlett Packard 6890 gas chromatograph (GC) used in tandem with a 5972 selective mass detector using two sets of analytical parameters. The GC-MS is equipped with a 1 μ L auto-injector and fitted with an HP-5 capillary column measuring 30 m in length, 250 μ m in diameter with 5% phenylmethylsiloxane and a film thickness of 0.25 μ m. In the first parameter, an initial temperature of 150°C was held for 1 minute and then ramped up to 280°C at 15°C per minute and held for 3 minutes, making a total run time of 12.67 minutes. There was a splitless interface to the quadrupole mass selective detector with a 2 minute solvent (acetone) delay and a mass range from 50 to 500. In the second parameter, an initial temperature of 75°C was held for 2 minutes and then ramped up to 280°C at 15°C per minute and held for 30 minutes, making a total method run time of 45.00 minutes. There was a splitless interface to the quadrupole mass selective detector with a 3 minute solvent (heptane) delay and a mass range from 50 to 500. The 12.67 minute run is the same parameter that was developed during the course of the opium degradation study. The 45.00 minute run was also used to ensure detection of compounds (and their respective peaks) that required a greater resolution.

The GC was run in two modes: Scan and SIM. In the former, the instrument collects data on all compounds present in the sample. In the latter, SIM (Selected Ion Monitoring) allows one to target particular compounds by collecting data only on a certain set of molecular ions. All samples were run in scan mode using the analytical parameters described above, but also were run in SIM mode, targeting opium alkaloids using the molecular ions listed in Table 2.

Data interpretation involved comparison of the chemical compounds identified in reference samples with those present in archaeological residues. After injection into the instrument, the sample is separated into individual chemical constituents by

the GC and measured, according to their component ions, by the MS. The final output is a Total Ion Current (TIC) graph that plots all of the molecules that were detected in the sample based on their Retention Time (Barnard et al., 2007: 51; Pollard and Heron, 2008: 62; Rafferty, 2002: 900). The TIC plots all of the molecules detected in a sample with the most abundant molecule being set to 100% and all other molecules being plotted relative to that. Each peak in the TIC has a mass spectrum representing a series of ions based on the intensity of their mass (mass-to-charge ratio, m/z), the distribution of which is characteristic of the particular compound. In the GC-MS system utilized by the authors, the MS was linked to a mass spectral databank (NIST02.L) that aided in determining the likelihood of a match between a detected mass spectrum and the identity of a compound.

5. RESULTS

The three Base Ring juglets from Tel Beth-Shemesh, excavated in 2008, had already been reconstructed to a certain degree, which unfortunately resulted in the introduction of modern contaminants, such as glue. During the sampling process, efforts were made to avoid further contamination by wearing gloves, sterilizing all tools and containers, and avoiding the use of any plastics or inks. Despite these efforts, there is little doubt that the reconstruction materials complicated the identification of the ancient residue.

Another major observation that applied to all three vessels was the SIM analysis for the opium alkaloids codeine, hydrocotarine, morphine, noscapine, papaverine and thebaine gave no indication that the vessels contained detectable remnants of opium.

5.1 Base Ring I Juglet Reg. No. 5994.07

The contamination issue was particularly evident in the first sample with constituents presumably associated with the ancient residue being at a drastically reduced abundance than the contaminants

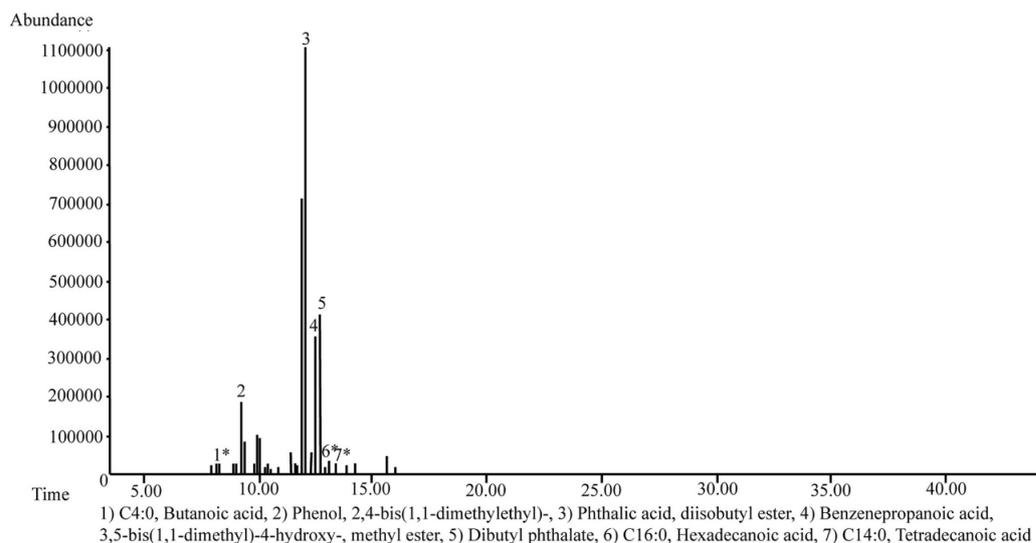


Figure 3: Chromatogram of Base Ring I juglet 5994.07

in the sample. Three compounds, all lipids, were identified that can be attributed to the ancient residue. Fig. 3 illustrates the resulting gas chromatogram, which is typical of the other Base Ring samples analyzed (see below). The four largest peaks represent modern contaminants commonly introduced through storage in plastic bags, reconstruction materials, and inherently in the laboratory; they have been identified in other chromatograms from the sample of Base Rings (listed above) that were stored in plastic bags or reconstructed in some fashion. The largest peaks in the chromatograms of the other two Base Ring juglets from Tel Beth-Shemesh represent a similar set of contaminants.

The three compounds detected include: 1) C4:0, butanoic acid, or butyric acid, 2) C16:0, hexadecanoic acid, or palmitic acid, and 3) C14:0, tetradecanoic acid, or myristic acid. The first is a short chain lipid that has a wide distribution, but is readily found in plant and animal oils, red and white wines and vinegars, and is known to play a role in fermentation (Ferriera et al., 2002: 4048-4050; Guth, 1997: 3027; Lambert, 1997: 37; Rocha et al., 2004: 257-258). Similarly, hexadecanoic acid has a wide distribution in both plant and animal oils. Tetradecanoic acid, on the other hand, occurs in large

concentrations in nutmeg butter and, according to Parry (1922: 268), myristicin (the primary constituent in nutmeg oil) degrades into myristic acid, which comprising 74.9% percent of the oil's lipid content (Leela, 2008: 167-168; www.lipomics.com). It is also a minor constituent in fig leaves (Muanda et al., 2010: 158), an observation which was corroborated in a botanical reference sample of fig leaf from Cyprus. The two longer chain lipids (C14:0 and C16:0) are also known to be present in milk (Barnard et al., 2007: 29), but there is little else to suggest the presence of dairy-derived product. While it is acknowledged that relative proportions of lipids have been used to differentiate between types of plants, land animals and fish, when applying this technique it is necessary for a range of saturated fatty acids (C12:0, C14:0, C16:0, C18:0, C18:1, C18:2, C18:3) to be present (Evershed, 1993; Evershed et al., 1999; Heron and Evershed, 1995: 260; Malainey et al., 1999: 95-96). Due to the paucity of the lipid profile and the overall lack of chemical biomarkers that could be attributed to a particular species of plant, the evidence points to an oil of unknown origin.

5.2 Base Ring I Juglet Reg. No. 6319.01

As with the previous sample, modern contamination likely contributed to

difficulties in detecting an ancient residue. Two compounds were identified (Fig. 4), one of which is a lipid that could be attributed to the ancient residue. C4:0, butanoic acid was also identified in the first sample and represents a short chain lipid that has a wide distribution, but which is readily found in plant and animal oils, red and white wines and vinegars, and is known to play a role in fermentation (Ferriera et al., 2002: 4048-4050; Guth, 1997: 3027; Lambert, 1997: 37; Rocha et al., 2004: 257-258).

The second compound Bicyclo[3.1.0]hexan-2-one, 1,5-bis (1,1-dimethylethyl)-3,3-dimethyl-, may be related to beta-thujene (Bicyclo[3.1.0]hex-2-ene, 4-methyl-1-(1-methylethyl)-, sabinone (Bicyclo[3.1.0]hexan-2-one, 5-isopropyl-) or another thujone derivative. It is also structurally similar to sabinene hydrate, 4-thujanone and sabinone, which are widely distributed in species of *Tanacetum*, *Achillea*, and *Artemisia* (Lee et al., 2005:134; Kordali et al., 2005: 1411; Teixeira de Silva, 2004: 707-712). Sabinone, cis-sabinone hydrate, and sabinyl acetate occur in many of these plants, as well as birthwort (*Aristolochia*), nutmeg, marjoram, mint, sage, a species of juniper (*Juniperus sabinus*), and coriander (Bowles, 2003: 57-58; Francisco et

al., 2008: 170; Leela, 2008: 165-189; Parry, 1922: 56; Parthasarathy and Zachariah, 2008: 190-210). In terms of use, Teixeira de Silva (2004: 707-12) highlights that sabinone is used primarily in perfumery, while beta-sabinyl acetate is used as a convulsant. Further, Parry (1922: 57) states that “[s]abinone appears to be fairly closely related to thujone (tanacetone) since both alpha-thujone and beta-thujone yield the same body, thujanone, ... as does sabinone...”.

The presence of a degradation of a thujone-related compound may be suggestive of medicinal oil. As mentioned above, thujone and its related compounds are known constituents of various species of wormwood, sage, marjoram and several other aromatic plants. Here we will add that thujone and several of its derivatives have been identified experimentally in botanical reference samples of wormwood (species unknown), sage, hyssop, bay leaf, myrtle, and thyme. Lev (2006) highlights that the first three figure prominently in the traditional medicine of the area. Zohary (1982: 184) notes that the dry leaves of white wormwood (*Artemisia herba-alba*) have been used for gastrointestinal ailments. Tsintides et al., (2002: 410) also note the use of a related species, shrubby wormwood (*Artemisia abrotanum* L.) in “regulating the men-

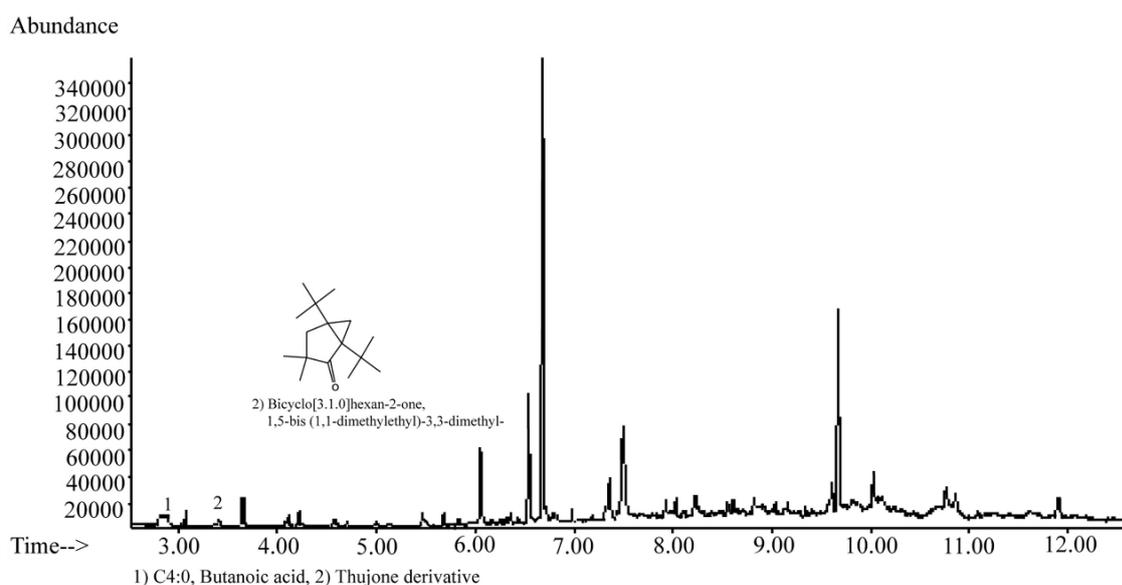


Figure 4: Chromatogram of Base Ring I juglet 6319.01

strual cycle and for its abortive properties". Of the larger *Artemisia* family, Nezhadali *et al.* (2008: 557) list uses in perfumery and medicine with particular application in treating gastrointestinal disorders, headache, high blood pressure, and more generally as an anti-bacterial and anti-fungal.

5.3 Base Ring I Juglet Reg. No. 6062.16

A total of five compounds presumably associated with an ancient residue were identified in this juglet. Four of these were lipids and include (Fig. 5): 1) C10:0, Decanoic acid (or capric acid), 2) C16:0 Hexadecanoic acid (or palmitic acid), 3) C18:0 Octadecanoic acid (or stearic acid), and 4) C14:0 Tetradecanoic acid (or myristic acid). As with the first juglet, the lipids present in this sample have a wide distribution in plant and animal oils. The presence of the butanoic acid may be related to the evidence for a fermented product, but again it is a small chain fatty acid that is likely distributed widely. The same is true for capric acid, though it has been identified in caper flowers and has been known to be present in milk products (Eerkens, 2005: 92; Hoffman and Heiden, 2000: 4-6; Romeo *et al.*, 2007: 1272). There

is, however, little else that suggests the presence of a dairy-derived product.

The three longer chain lipids (C14:0, C16:0, C18:0) have a wide distribution, particularly in plant oils (Barnard *et al.* 2007: 29; www.lipomics.com). In addition, the range of lipids in the sample is still insufficient for an application of the ratios for differentiating plant and animals sources on the basis of lipids (Malainey *et al.*, 1999: 95-96).

The fifth compound, (+)-isomenthone, is more promising (Fig. 6). The compound is related to menthol and both are major constituents in plants of the *Mentha* family, particularly peppermint (*Mentha piperita*) and pennyroyal (*Mentha pulegium*) (Bowles, 2003: 25-26, 69-71, 85, 88-89). In addition, menthone is a major constituent in caper (Romeo *et al.*, 2007: 1277) and species of *Ziziphora*. The primary constituent of the latter is pulegone, the same compound found in pennyroyal, and in a species *Ziziphora tenuior* L., the volatile oil contents of which consists of 80% pulegone (Meikle, 2000: 1258-1262, 1286-1267; Mehmood *et al.*, 2010; Sezik *et al.*, 1991; Verdian-Rivi, 2008). Three menthone-related compounds are also present in basil and thyme (Lee *et al.*, 2005: 134).

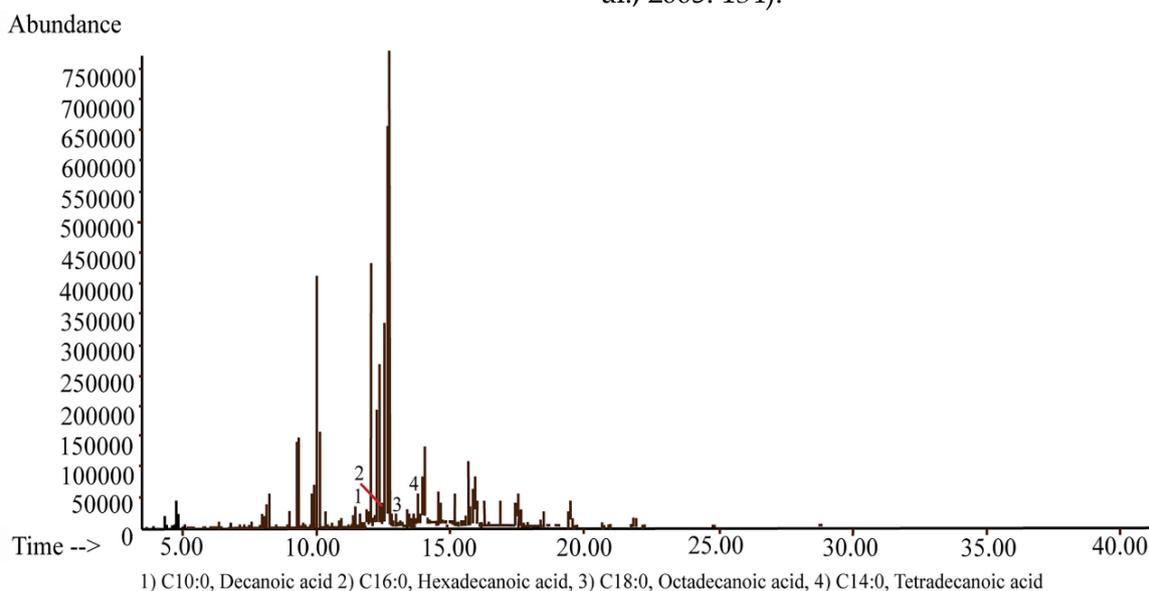


Figure 5: Chromatogram of Base Ring juglet 6062.16 (second analytical parameter)

Mint (and specifically *Mentha longifolia* and *M. spicata*) is a common species that grows in the region and which has docu-

mented gastrointestinal benefits (Lev, 2006; Zohary, 1982: 88). While it is necessary to specifically characterize locally available

species of mint, the sample of peppermint that underwent lipid extraction and analysis showed no lipids. This suggests that the mint was added to oil deriving from another plant. It has been suggested that in the Eastern Mediterranean, olive oil may have been used for this purpose. In this case, however, the absence of oleic acid (C18:1n9, 9-octadenoic acid) and linoleic acid (C18:2n6, 9, 12-octadecadienoic acid)

make it unlikely that the oil derived from olives. In terms of a potential aromatic substance, Theophrastus (Concerning Odours, 4.14) noted that sesame oil and olive oil were perhaps the least receptive plant oils for the retention of scents (Hadjikyriakou, 2007: 29). Based on the available data, the contents of the vessel may have contained oil of unknown origin infused with mint.

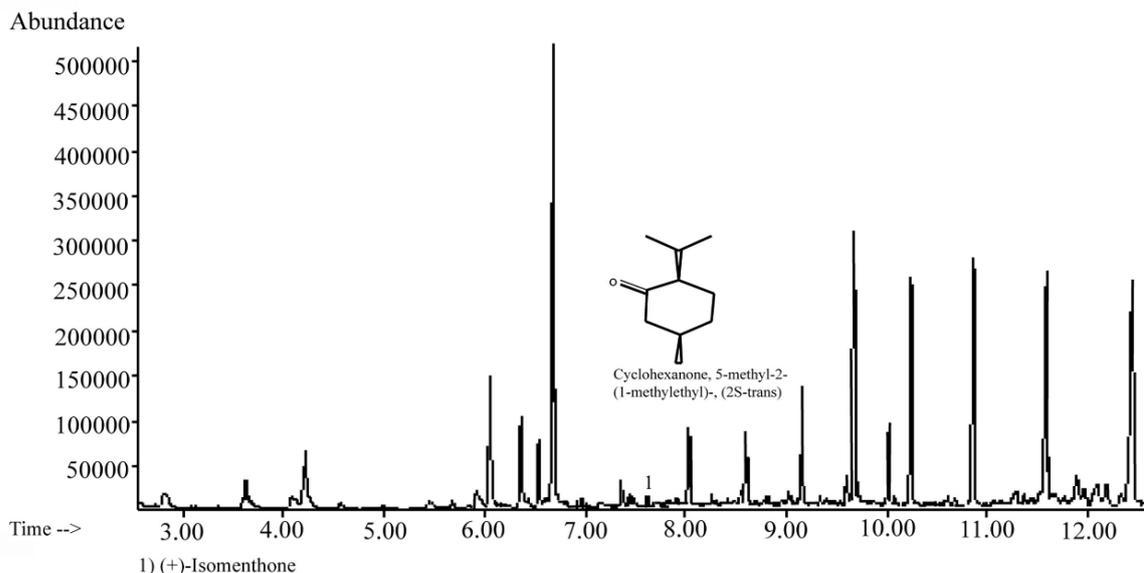


Figure 6: Chromatogram of Base Ring juglet 6062.16 (first analytical parameter)

6. DISCUSSION

The analysis of the three Base Ring I juglets from Tel Beth-Shemesh has demonstrated that the vessels did not contain opium. Based on the size and dimensions of the juglets and the fact that a range of lipids were present, it seems likely that they contained aromatic oils. The aromatic nature of the oils is suggested by the presence of volatile compounds in two of the juglets that likely originated from a species of mint in one case and species of wormwood, sage or hyssop (though others are possible), in the other. The origin of the oil in which these aromatics were infused is unclear, as is the ultimate purpose that the oils served. While perfumed oil that could have been used externally or for ritual anointing purposes is possible, the fact that

the proposed aromatic plants do have health benefits may equally suggest that the oils were consumed.

These intriguing results are supplemented by the analysis of further samples of Base Ring I and II juglets and jugs originating from Cypriot sites (Table 3). In terms of general patterns, there are similarities in the types of plants being utilized with aromatic plants, such as mint, lavender and sage, being represented. The products being made from these locally available plants seem to be aromatic mixtures that may equally serve medicinal, culinary and cosmetic functions. These analytical results are discussed in detail in Chovanec (2013) and were presented at the 2012 annual meeting of the American Schools of Oriental Research (ASOR).

Aware of the feeble support provided by chemical investigations to the idea of Base Ring juglets as opium containers, Merrillees has raised the possibility of reuse of these vessels (1968: 157-158; 1974: 34-36). In his opinion, the non-opiate substances found in Base Ring juglets could have been put into them after the original contents were consumed. Since it is obvious that the Base Ring juglets were designed to hold liquids, the detection of thick substances such as fats and waxes in a few juglets found in Egypt are interpreted by Merrillees as evidence for secondary use. A seemingly local Egyptian origin for linen patches tied over the mouth of a couple of other Base Ring juglets from Egypt are also considered by him as proof for reuse of these juglets.

It should be noted that the argument of reuse of Base Ring juglets for holding substances other than opium is a double edged sword. One may argue, no less

persuasively than Merrillees, that Base Ring juglets normally carried a variety of scented oils and medicinal compounds yet a few of them might have been later reused by their purchasers to hold opium solutions.

CONCLUSIONS

Residue analysis of three Base Ring I juglets from a secured Late Bronze IIA (14th century BCE) context at Tel Beth-Shemesh revealed no traces of opium. Rather, the vessels contained aromatic oils which may have been used for medicinal purposes or ritual anointing. These results concur with the lack of evidence for opium in additional analyzed Base Ring juglets and jugs from Cyprus. Both analyses cast grave doubts on the assumption entertained for the last half a century that Base Ring juglets traded opium over the Eastern Mediterranean.

Table 3: Summary of analytical results for Base Ring Ware

Sample No.	Ware	Shape	
5994.07	Base Ring I	Juglet	An unidentified oil
6062.16	Base Ring I	Juglet	An oil from unknown origin infused with mint
6319.01	Base Ring I	Juglet	Medicinal oil containing derivative of thujone
74	Base Ring I	Jug	An aromatic oil possibly containing mint
75	Base Ring I	Closed	Medicinal oil containing wormwood
76	Base Ring I	Juglet	An unidentified oil
77	Base Ring I	Juglet	Medicine or other substance containing a tree probably turpentine
78	Base Ring I	Jug	An aromatic oil potentially containing lavender or sage
79	Base Ring I	Jug	No identifiable residue
80	Base Ring I	Jug	No identifiable residue
81	Base Ring I	Jug	An aromatic medicine potentially containing sage, rosemary, lavender or species or wormwood
BC62	Base Ring II	Juglet	An unidentified oil
130.DK.5	Base Ring II	Juglet	An unidentified plant oil
151.DK.1	Base Ring II	Juglet	No identifiable residue
1995.10.543	Base Ring I	Juglet	No identifiable residue
1995.1329	Base Ring I	Juglet	No identifiable residue
1995.1332	Base Ring I	Juglet	No identifiable residue

ACKNOWLEDGEMENTS

The excavations at Tel Beth-Shemesh are directed by S. Bunimovitz and Z. Lederman under the auspices of the Institute of Archaeology at Tel Aviv University. Participating consortium institutions include University of Lethbridge, Alberta, Canada and Harding University, Arkansas, USA.

The research was supported by the Israel Science foundation (ISF) (grant nos. 898/99; 980/03; 1068/11), the National Science Foundation (NSF) (grant nos. 0822493 and 10310527), the Institute of Cypriot Studies at the University at Albany, the Goldhirsh Foundation, the Memorial Foundation for Jewish Culture, and by an Early Israel grant (New Horizons project), Tel Aviv University. Special thanks to Dr. Stuart Swiny, Dr. Sean Rafferty, and Mr. Colin Henck and Dr. Burz in the Chemistry Department at the University at Albany. The Base Ring juglets from Beth-Shemesh were restored by Y. Wiener and photographed by P. Shrago at the Institute of Archaeology, Tel Aviv University. We would like to extend our gratitude to the anonymous reviewers for constructive comments.

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