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Extraction and analysis of total lipids in late Iron Age Bath-shaped basins from the Levant as a means of assessing vessel function

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ABSTRACT

Four Late Iron Age bath-shaped basins from three sites in the Southern Levant were subjected to organic residue analysis by gas chromatography–mass spectrometry (GC–MS) to test the hypothesis that the vessels were used for wool scouring and fulling. All lipid extracts of the samples contained saturated and unsaturated lipids. These were compared to the same compounds in a series of reference materials selected based on ethno-historical and literary documentation. A final comparison was made to lipids extracted from a bath-shaped basin from Turkey that had previously been found to contain a residue similar in compounds to date palm kernel oil. Results demonstrate that the total lipid extracts (TLEs) from the bath-shaped basins are more similar to each other and to date palm kernel oil than to the other comparative materials. This supports the accepted view that bath-shaped basins in the Levant, comparable in date and shape, had a common function, but suggests functional alternatives to traditional interpretations of human burial or bathing. While wool working is a viable hypothesis, it was not possible to identify the specific activity as several different behaviors could result in a similar organic residue.

1. Introduction

Organic residues from four Iron Age bath-shaped basins from three archaeological sites were analyzed to assess if bath-shaped basins had a common function that could have included wool-processing activities such as scouring and fulling. Scouring is the process of deep cleaning the raw wool to remove environmental contaminants (e.g. dirt, dung, vegetal matter) and natural impurities (e.g. wool wax and suint) (Collins and Davidson, 1997). Some of these can be easily extricated from the wool fibers by combing or washing the wool in water, but a wool fleece also contains lipid-like substances such as waxes that are not water soluble and inhibit certain qualities of the wool if not sufficiently removed before further processing. Scouring relies on high water temperatures to separate the waxes from the wool fiber. An excessively high-water temperature, however, can injure the wool fibers, for example if the water were to reach a boil, so scourers rely on textile soaps to enable wool wax removal at lower water temperatures. Fulling is an added-value technique that creates a more durable and waterproof weave. This finishing process causes the wool fibers to matt together by agitating the weave in soapy hot water A dilute ammonia solution can also be added, as seen in ancient references to stale urine (*lant*) for laundering and fulling woolen textiles, but plant-based oils, clays[2] and alkalis were also employed as textile soaps (Pliny the Elder, 1855, 35: 57; Waetzoldt, 1972: 159–161; Robertson, 1986; Firth, 2010).[3]

In modern textile manuals, olive oil is said to be the best textile soap for scouring and fulling as it is not injurious to wool fibers, but it is also described as the most expensive and therefore reserved for fine woolen weaves (International Textbook Company, 1902: 2; Hurst and Simmons 1921: 34). Ancient sources also mention olive oil for wool processing, particularly in the eastern Mediterranean (Melena, 1983: 117, 119; Rougemont, 2011). In Mesopotamian texts, the most commonly identified oil is sesame, but pig fat is also mentioned as are numerous occasions when the text refers only generically to “oil,” “plant-oil” or

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[2] “Fuller's earth,” specified in some documents, is technically clay composed of calcium montmorillonite, but many different type of clays with minerals of similar properties were referenced by this name (Robertson, 1986).

[3] Flohr (2003) argues that urine has been overemphasized because of its implications of impurity; it may have contributed only a minor role.

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"good oil" (Waetzoldt, 1972: 169). Based on a review of medieval European texts, Paardekooper (2007: 11) includes "butter, animal droppings, flour, soda, potassium, ammonia, lard, wine sediment, etc." Ancient descriptions of wool scouring and fulling indicate additional fat and oil sources such as soapwort/soapweed, radish oil, sesame oil, wine residue, white wax and lard (Pliny the Elder, 1855, IX, 8; XXIV, 58; 23: 31; Jacob, 1919: 9999; Levey, 1954, 1959; Firth, 2010; Konkol and Rasmussen, 2015: 261). The phrase *šmn rḥṣ* on an 8th century BCE ostracon from Samaria, although not necessarily associated with textiles, may also indicate the use of a specifically named washing oil (Demsky, 2007: 335).

Although there is no evidence of full woven wools in the Near East, both the activity of fulling and the occupation of fuller appear in texts from 21st/20th centuries BCE southern Iraq (Ur III) and 14th century BCE Aegean texts (Linear B), where fulling is noted as a specialist crafts position (Waetzoldt, 1972; Palaima, 1997; Firth, 2010, 2013). However, while fulling installations have been identified in the Classical world (Bradley, 2002; Flohr, 2013), no fulling establishment has yet been recognized in the archaeological record of the Bronze or Iron Ages Near East. Alternatively, the shape of Bronze and Iron Age bath-shaped basins, contextual association between them and textile equipment, and architectural parallels with Roman period fulleries that include similar-shaped basins have lead Mazow (2008, 2013) to posit that bath-shaped basins were used for wool scouring and fulling.

In this study, we focused on late Iron Age bath-shaped basins from the Levant. These are large clay containers, rectangular- to triangular-in shape, with one short straight wall opposite a rounded wall (Fig. 1). The long walls are parallel or bulge slightly outward in the middle, or are inwardly angled, giving the appearance of an isosceles trapezoid when viewed top-down. This form has its origins in Mesopotamia where a similar vessel shape appears at the end of the second millennium and continues through the Achaemenid period (Strommenger, 1964; Potts, 1997: 232).

The Levantine examples date from the 8th through 6th centuries BCE and are associated with Neo-Assyrian and Neo-Babylonian influences in the area (Amiran, 1959; Zorn, 1993; Routledge, 1997). Typically identified as burial coffins that reflect Mesopotamian burial traditions, bath-shaped basins in the Levant are found in both burial and non-burial contexts and therefore an interment interpretation does not uniformly fit the contextual evidence (Mazow, 2014). A second interpretation reconstructs bath-shaped basins as personal bathing tubs and the rooms in which bath-shaped basins have been found as bathrooms within Assyrian-style administrative buildings or elite residences (Kogan-Zehavi, 2006, 2007; Yassine and van der Steen, 2012), but supporting evidence for this reconstruction often relies on circular reasoning where rooms are defined as bathrooms because they contain a bathtub and vice versa (Mazow, 2013). An industrial function linked with wool fulling has been proposed for Bronze Age bath-shaped basins found in Cyprus and the Aegean (Mazow, 2008, 2013). While the archaeological evidence for fulling vessels is less visible in Mesopotamian contexts (where, as noted above, the Late Iron Age Levantine bath-shaped basins draw their parallels), the role of the fuller and his activities are well documented in the textual record, confirming the existence of such a technology and profession (Waetzoldt, 1972; Firth, 2010).

Fig. 1. Restored bath-shaped basin from Ashdod ad-Halom in storage at the Israel Antiquities Authority. Authors' photo with permissions E. Kogan-Zevahi, IAA.

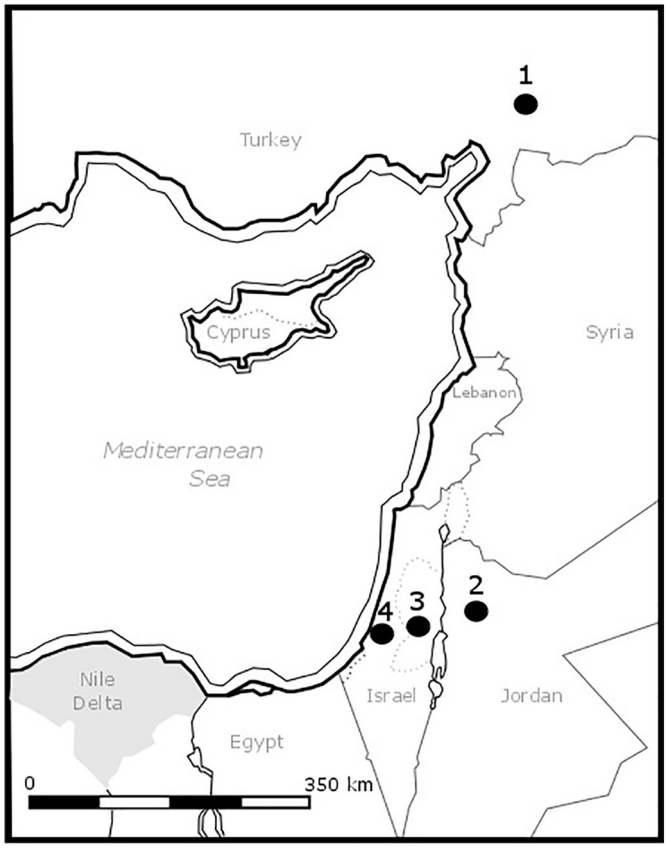

Fig. 2. Map showing locations of bath-shaped basins referenced in this study. 1. Zincirli; 2. Tall Jawa; 3. Beit Hama'ayan; 4. Ashdod ad-Halom.

In this study, gas chromatography coupled with mass spectrometry (GC–MS) was used to analyze the total lipid extracts (TLEs) of samples from the ceramic matrix of four bath-shaped basins from three different sites in Israel and Jordan (Fig. 2, Table 1). The TLEs from these four vessels were then compared with 1. a series of reference materials commonly associated with wool working practices in the ancient Near East; and 2. a fifth bath-shaped basin whose TLE, analyzed in a previous study, was determined to be similar to date palm kernel oil (Mazow et al., 2016). The results of these comparisons suggest that the TLEs from all five bath-shaped basins are similar to each other and to the lipid profile of date palm kernel oil. Finally, we review the archaeological and textual evidence for Iron Age wool processing, assessing the possible role of date palm kernel oil within these contexts.

2. Materials and methods

The four, ceramic bath-shaped basins analyzed come from relatively recent excavations where there was good documentation of post-excavation vessel handling that could account for modern contaminants. Three of the bath-shaped basins (13AR1, 13AR2 and 13CD) were sampled on location at the Israel Antiquities Authority facility in Har Hozvim, Jerusalem. These samples were then extracted and analyzed in the Organic Geochemistry lab, Department of Geological Sciences, East Carolina University (ECU). The fourth sample (13TJW1) was removed