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Mesopotamian Interactions through the Perspective of Late Uruk Bottles

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Introduction

Archaeologists are only beginning to comprehend the implications of the increase of knowledge relevant to our worlds' first civilizations. For many areas of the world, new methods allow us to determine the age of past events with decadal precision, the life histories of individuals based on chemicals in their bones, the origins of materials based on parts per billion of trace elements, and many other datum points. No less important than the application of new methods are the posing of new kinds of questions. Archaeologists are asking questions about the productivity of labor, organization of households, the making of decisions, and the meaning of symbols, that – thirty or more years ago – were rarely asked and never answered with rigorous analysis of independent evidence. Here, I try to pose such questions about pottery production, distribution, and use and answer them with detailed study of pottery from the period of state emergence and urban growth in southwest Asia.

By 3600 BCE, communities in the basin of the Tigris and Euphrates, extending from the front ranges of the Taurus, Anti-Taurus, and Zagros west and south to the desert edges, increasingly shared a widespread material technology. Thanks to insight and courage of Guillermo Algaze (1993), we recognize this as the result of the "Uruk Expansion", a process which spread technically and stylistically similar material inventories throughout greater Mesopotamia. While most researchers accept the existence of an "Uruk Expansion" there is little agreement regarding how and why this happened. I will here focus on the issue of 'how', studying a particular class of material items, in a social economic perspective which owes a great debt to the work of Susan Pollock. First, almost three decades ago, Pollock emphasized the importance of a "bottom-up" perspective (Pollock 1992), viewing economic and political processes from the perspective of all of the participants, most of whom in the era of the early urban societies were members of working families concerned with basic productive activities in a social context of households. Second, in a subsequent paper (Pollock et al. 1996), she and her colleagues in the Abu Salabikh Uruk Mound project have emphasized the importance of studying not only production, but the distribution and consumption of products, all in their social contexts. It often seems that archaeologists' studies of ceramics treat pottery vessels as if they were created without the actions of human hands or the exercise of human cognition. Pollock unfailingly reminds us that this is not acceptable. There is much to be learned from humble sherds.

In this paper, I will use barely perceptible patterns of variation in the manufacturing process and form of spouted bottles to evaluate different models of the relations among Late Uruk potters in Mesopotamia. After introducing the Late Uruk Period and this particular vessel form and discussing

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the samples available for study, I will briefly discuss what is known about the uses of spouted bottles and the extent to which the bottles themselves were transported from settlement to settlement. I will then present a detailed study of minor variations in upper body attributes of bottles from four sites in different parts of Mesopotamia (**Fig. 1**) and their implications for the relations between regions and potters. I will conclude with a brief discussion of the implications of this study for future research on the Uruk World.

A brief introduction to Mesopotamia during the late 4th millennium BCE

Southwest Asia is an arid region; however, the rugged high Zagros, Anti-Taurus, and Taurus mountain chain captures rain and snow fall carried by winter storms from the Atlantic. These waters, released by Spring warmth, flow through deeply cut valleys and flood down the Tigris and Euphrates to fill the remnants of the Mesozoic Tethys Sea. By Mid-Holocene times the great rivers had cut broad channels into the rolling terrain of Upper Mesopotamia, and the braided channels of the rivers had pushed the alluvial plain of Lower Mesopotamia into the marshlands. The lakes and marshes at the head of the Gulf were rich estuarine environments (Hritz and Pournelle 2015; Pournelle 2003; 2019).

Only the Arabian Sea and the Persian Gulf were marine environments. Winter rains fed lush grasslands in Upper Mesopotamia, and floods nurtured river bank levees, already cultivated for two millennia, as

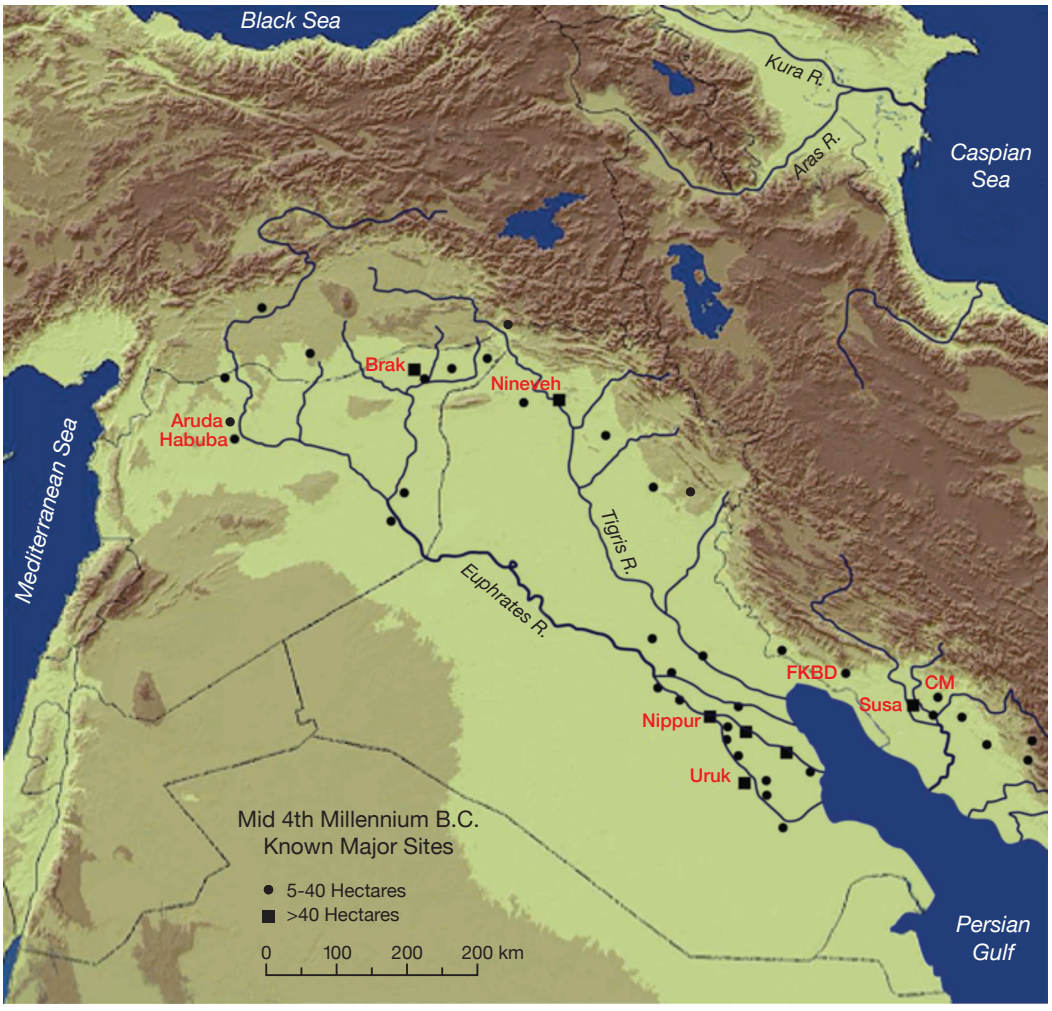

Fig. 1. Known major Uruk sites during the mid-4th millennium BCE. Artist: John Klausmeyer.

well as grasslands in the interfluves. In the Middle Holocene, conditions may have been somewhat wetter and warmer, with summer monsoon rainfall from the Indian Ocean reaching the Gulf and Lower Mesopotamia (El-Moslimany 1994; 2019). However, whether rain-fed agriculture was ever reliable in Lower Mesopotamia is uncertain.

By Late Uruk times, the dry farmed gardens and fields of Upper Mesopotamia to the northwest yielded crops of wheat, barley, and chick peas, and various fruits. The distribution of sickle blades (Rothman et al. 1998, 78, Fig. 11; Emberling et al. 1999, 31–36) shows that people concerned with harvest lived in both smaller villages and larger towns. Sheep, goats, and cows were the predominant herded animals. There is hunting in some areas, but little evidence of fishing. In the irrigated farmed fields and gardens of Lower Mesopotamia to the southeast, wheat, barley, and lentils and dates were major crops. Though no smaller Uruk sites have been excavated, Pollock (2001, 197–208) has assembled convincing evidence from intensive surveys of sites that Uruk people in both smaller villages and larger settlements participated in harvests. Sheep, goats, and cows were the predominant herded animals. There is little evidence of the hunting or gathering of wild foods in Lower Mesopotamia, but fishing was important for sites near the marshes, lakes, or larger rivers. Late Uruk and immediately post Uruk texts indicate that in the south plowing was done by experienced workers and teams of animals. Other activities involved ordinary workers and harvest demanded that much of the population work to get the crops out before floods, hail, locusts or other disasters ruined the crop (Wright 1969, 13, 22). We have no such early textual evidence of the organization of labor from the north.

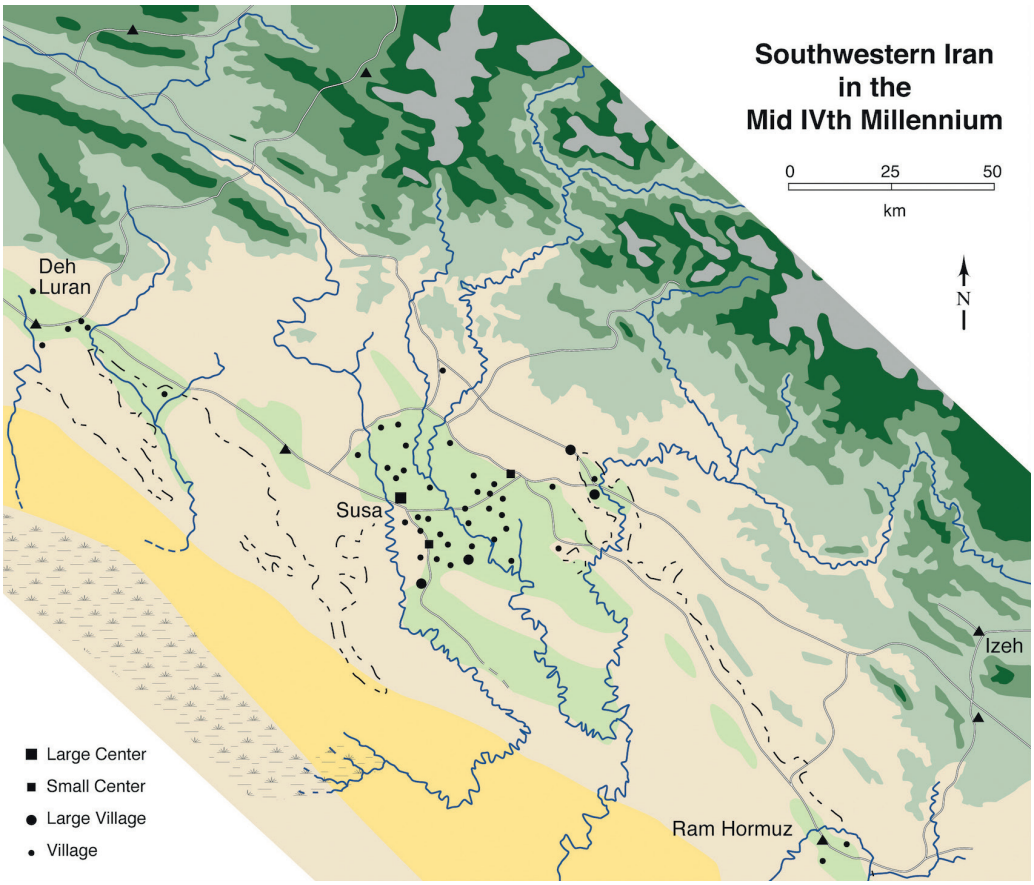

Fig. 2. Southwestern Iran during the mid-4th millennium BCE. Artist: Kay Clahassey.

Our considerations of Uruk regional organization are grounded in extensive archaeological surveys within regions, initiated by Robert McC. Adams, Hans Nissen, Gregory A. Johnson, Tony Wilkinson and others in various areas during the 1960s and 1970s. From these data, they could estimate human population, and assess land use and even the spatial structure of production, distribution, and consumption around major centers. This can be exemplified by a map of Mid-4th millennium settlement in Southwestern Iran (**Fig. 2**), based on analyses by Johnson (1973; 1987) of the Susiana Plain showing the small centers and villages dominated by Susa, of the smaller Deh Luran Plain to the northwest (Neely and Wright 1994) and of the even smaller Ram Hormuz plain to the southeast (Wright and Carter 2003; Alizadeh 2014). There is evidence that administration and manufacturing were centered in the towns, while grain and laborers were brought from rural settlements to the larger centers. Pottery production was primarily in the centers, and evidence indicates that pottery was procured by villagers from nearby towns (Johnson 1973; 1987). The exception is the mold-made beveled rim bowls, which appear to have been made everywhere (Berman 1986; Ghazal et al. 2008). Animals could have come from either villages or from transhumant nomads.

The astonishing homogeneity of Uruk material production is evident in struck flint blades, patterns of mud-brick construction, finely-crafted stone vessels and maceheads, counting devices, and the minutely-carved representations on seals repeated on sealings (Algaze 1993), but it is perhaps most widely represented by the products of the potter's craft. Uruk pottery was made using several *chaines opératoires*, with three general types of clay recipes: a poorly-sorted straw or dung tempered clay – basically that used to form mud bricks, *pisé*, and plasters – to make mold-made bowls or slab-built trays; a poorly-sorted clay tempered with coarse sand or crushed rock inclusions used to make heavy patch or ring built jars used over fires; and a fine levigated or water-sorted clay with predominantly fine inclusions, to make many varieties of bowls and jars constructed with a mix of patch-building and wheel-finishing, and used for many purposes. Kiln firing was usual, even for the simple mold-made bowls. The resulting suites of vessels are so similar in their proportion and decorations that one can only infer that potters spent long periods of apprenticeship practicing all aspects of production.

Most excavated Uruk sites were large centers such as Uruk, Nippur, Susa, Chogha Mish, Nineveh, Brak, and Habuba Kabira. The material evidence from these large Uruk centers provides compelling testimony of dominant elites, the mass production of consumer goods and hierarchically structured economic control, ritual, iconography and world view. However smaller towns, villages, and transhumant camps are often informative in ways that centers are not. Over many years, I have assembled evidence from both centers and smaller settlements occupied during the time from 3350 and 3100 BCE, from the marshy alluvium of Lower Mesopotamia on the southeast to the rolling steppes of Upper Mesopotamia on the northwest. Certainly the most common items found in archaeological samples from these sites are potsherds. These are the remains of vessels that have been made by, distributed to, used by, and broken and discarded by people on these sites. Studies of these can answer questions about the processes of material procurement, crafting, distribution, use, recycling, and ultimate disposal. Though there is a tradition called "Processual Archaeology", there are no processual studies of pottery from material procurement to disposal. We are fortunate to have some excellent process-oriented studies of Uruk pottery production (cf. Sürenhagen 1978; van der Leeuw 1994), and these have inspired my studies over almost five decades. Increasingly, scholars have also begun to

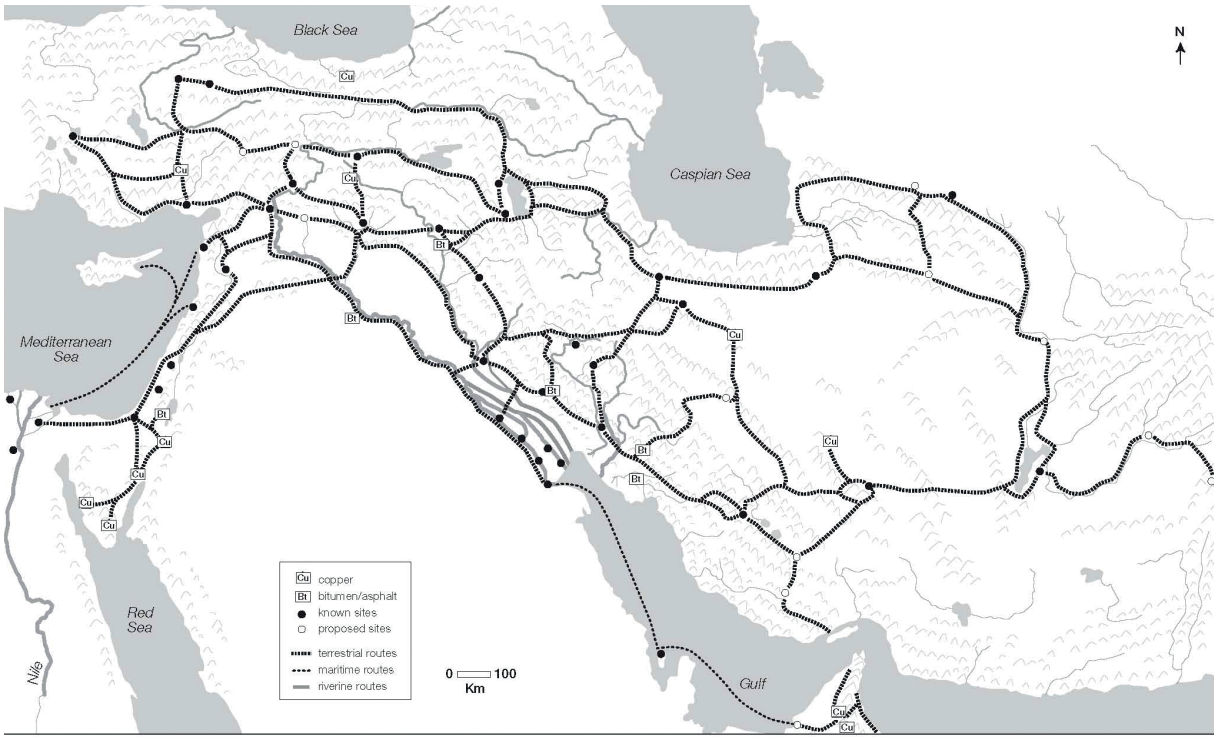

Fig. 3. Routes and resources in Southwest Asia during the late 4th millennium BCE. Artist: Kay Clahassey.

look at different types of food storage (Jones et al. 1986), preparation (Jauss 2015; 2018), brewing (McGovern 2017; Zarnkov et al. 2011), and wine-making (McGovern et al. 1996) as processes. Research on such diverse processing requires a range of methods, and variously these researchers have used seed and phytolith identification, macroscopic and microscopic surface alterations, residue analysis, and other methods. In addition to archaeological examination, almost all engage in some kind of replication experiments (Jauss 2018; Goulder 2010; Damerow 2012), though the beer replicators have a habit of drinking their product before it can be studied. Also, the study of Late Uruk processing and consumption of food has profited from iconographic and textual studies (Johnson J.C. 2015; Pollock 2012).

For the Late Uruk period, we have both artifactual and textual evidence of a wide range of material usage. There are, to name only some: animal- and plant-derived comestibles and fibers, wood, reeds, clays, gums, asphalts, coarse stones for heavy tools, fine grained silicates for flaking, fine grained soft stones for carving or drilling, cuprous metals, and precious metals. Many of these have limited sources in one or a few areas. The map of routes (**Fig. 3**) shows some of the sources of a few of the Late Uruk materials transported to supply distant craft workers and of the routes that connected regions and centers. These crafts with their complicated productive sequences yielding many identical types, not only of durable artifacts, but of ephemeral products such as kinds of bread, varieties of alcoholic drink, or musical performances, must have required long periods of learning and practice. That many activities in later 4th millennium Mesopotamia were carried out by specialist is confirmed by the "List of Professions" among the first written tablets of the Late Uruk period (Nissen 1974). As an example, I here introduce the study of one class of Late Uruk pottery, one thought relevant to the "Uruk Expansion".

Production, distribution, and consumption as seen in Late Uruk Bottles

How were Late Uruk bottles made?

The bottles with drooping or curved spouts may have been developed from small jars made in Middle Uruk times with a patch built body, a conical slightly curved spout, and a small wheel-finished neck and rim (e.g., Badler et al. 1996, Fig. 1; Pollock 2012, Fig. 3, lower row, middle; Wright 1981, Fig. 40b). The Late Uruk bottle was first created by bringing together a long tall form, a small bottle mouth, and a downwardly curved or "drooping" spout, a synthesis which marks the beginning of the Late Uruk Period. The category of 'bottle' is our own: there is no sign among the Late Uruk sign lists that clearly represents a bottle as opposed to a wider-bodied jar (Wagensonner 2015). Nearly complete examples indicate that Late Uruk bottles were made by assembling a number of parts, all of which appear to have been wheel-thrown. The lower bodies with a solid base were string-cut; an optional middle body was a cylinder attached to the lower body, the upper body was a cone, inverted and attached to the middle body; there may have been a separate shoulder. The shoulder was perforated from the inside and the spout was emplaced. Finally, the neck and rim were carefully thrown to make several varieties of rim – studied in detail below – then attached to the shoulder or upper body. Stratigraphic evidence from Uruk (Nissen 1970), Nippur (Hansen 1965) and Susa (Le Brun 1971; 1978; 1985) indicates that droop-spouted bottles appear late in their Uruk sequences, and in Lower Mesopotamia they continue to be made and used during post-Uruk times. Johnson (1973, 29–59) showed that they appear at about the same time as twisted handles, typically on small jars, groove- and slash designs on small jar shoulders, and incised cross-hatched triangles on large jar shoulders. He used these co-occurrences to define the beginning of the Late Uruk Period and I will follow this practice. This period dates between 3350 and 3100 BCE (Wright and Rupley 2001, 110–21) during the final centuries of the "Uruk Expansion".

Were Uruk Bottles transported between regions?

The area in which bottles were made can be inferred from textural and geochemical studies of the clay of vessels. We have every reason to predict that these durable, thick-walled forms might have been used as canteens transporting drinking water on trips or as amphora, carrying valuable liquids as gifts or for exchange.

Geoff Emberling and Leah Minc (2016) have studied samples from a large number of Uruk vessel fragments from throughout Mesopotamia including a number of bottles. They have made both thin sections and Neutron Activation Analyses (NAA) at the University of Oregon (Minc 2016). They were able to distinguish ceramic fabrics from the Nineveh area in the middle Tigris drainage, from Tell Brak in the Khabur drainage, from various parts of southwestern Iran, but there is overlap in the elemental composition of ceramics from the Euphrates terraces and alluvium, and it is only sometimes possible to ascribe a vessel to the middle versus lower Euphrates areas. The results of their study of 295 sherds from different types of Uruk vessels show most were broken in the region where their clay was obtained and that only 12 were transported from another region (Emberling and Minc 2016, 830–32, Table 2). The transported vessels include:

- two imported vessels found at Tell Brak, one small jar from the area of Nineveh, and one cross-hatch incised jar from Euphrates clays;
- four imported vessels found at Jebel Aruda, one cross-hatched incised jar from Lower Mesopotamia, and three large jars from yet unknown areas;

- five imported vessels found at Nineveh, one bottle from Tell Brak, three four-lugged jars from Euphrates clays, and one four-lugged jar from southwestern Iran;
- and one imported vessel found in Lower Mesopotamia at a small site near Uruk, which is a small jar perhaps from southwestern Iran.

Royal Ghazal and his team (2008) analyzed 253 sherds from both local vegetally tempered beveled-rim bowls and sand tempered large jars with cross-hatch incised shoulders. No bottles were analyzed. Neutron Activation Analysis at the University of Missouri shows that most were broken in the area from which their clay was obtained. None of the vessels studied were transported from other regions, through there is evidence for transport between sites within southwestern Iran.

The NAA characterization of clays used for sealings in several parts of Mesopotamia by Pittman and Blackman (2016) supports the Oregon ascriptions, and shows that, like pottery, unbaked clay administrative artifacts also moved rarely.

In sum, the available evidence suggests relatively little transport of ceramic vessels of any kind. It is unfortunate that we have few or no analyzed vessels from the largest centers in Lower Mesopotamia. It is possible that samples from sites like Uruk, Nippur, or Susa would have more evidence of import from other regions. It is particularly unfortunate that paired clay analyses and chemical residue analyses of spouted bottles from Lower Mesopotamia – particularly from large centers such as Uruk itself – has not been done, because Algaze (1996) has proposed that – since grapes would have flourished in the Piedmont and Zagros-Taurus mountain valleys of Upper Mesopotamia, but do not do well in Lower Mesopotamia – wine might well have been transported to Lower Mesopotamia. Such transport vessels should have the inimitable signatures of potting clays from their areas of origin.

How were Uruk Bottles used?

The uses to which bottles were put is indicated by the marks of use on the body and rims and by residues on the surfaces and in the clay bodies of vessels. Wear marks visible to the eye were noted in this study. Future experimental and chemical studies and microscopic examination will provide more definitive results. Like most Mesopotamian vessels fired at low temperatures, bottles have traces of abrasion of the rims probably resulting from storage upside down. More interesting are oblique scratches inside the rim apparently from a pointed instrument forced down to loosen a stopper. Clay stoppers for bottles are widely known. From Tepe Farukhabad in southwestern Iraq is an unbaked clay stopper (Wright ed. 1981, 157, Plate 16d) which was forced into a bottle neck 3.5 cm in diameter. Presumably clay stoppers could not have been used to conserve a fluid such as water, beer, or wine, as they would have dissolved the mud, though heavy viscous substances such as honey or an oil are possible. Interestingly, only one of the bottle necks with a groove on the interior of the neck has an interior scratch. Perhaps lighter liquids were kept in a bottle with an expanding stopper made of a perishable material. Surface residues have been studied on only a few jars. Perhaps most striking is one common residue that is not observed on bottles. There is no evidence of carbon or fire clouding from use over a fire – carefully studied by Carolin Jauss (D'Anna and Jauss 2015). Bottles could, however, have been used in other kinds of food preparation, such as baking, pickling, or fermenting (Pollock 2012). Indeed, traces of the residue from the fermenting of grapes, tartaric acid, has been found in a spouted jar from Uruk itself (Badler et al. 1996). In addition, a trace of tree resin was also found, perhaps an effort to hold liquids in the porous clay vessel. Alas,

as far as I know, no Uruk spouted bottles have been chemically tested for tartaric acid or resins. Also helpful are representations on seals and reliefs. Though many types of cups, basins, and jars are shown on seals, there are few representations of bottles with curved spout and these are not being used in identifiable contexts (Amiet 1980, Planche 48, 668, 673). However, the use of a wide-bodied spouted bottle in ritual is shown on the famous "Vase of Warka" (**Fig. 4**). In a procession of nine nude priests in the middle register, most presenting open basins or baskets, one priest holds a bottle vertically with the slightly curved spout forward, as one would expect with liquid contents. In sum, while spouted bottles were not used for cooking over fires, they were frequently used for storage or transport, if only locally. We can suggest a variety of possible contents, but none are definitely attested in bottles.

Fig. 4. Bottle carrier in the Warka vase (Iraq Museum). Photo: Osama Shukir Muhammed Amin, FRCP, Glasgow.

Late Uruk Bottles from four sites

Introduction

I have been assembling detailed attribute records on individual Late Uruk Bottles for more than five decades. This work focuses primarily on excavated samples from the steppes of Upper Mesopotamia. These are respectively Tell Brak, ancient Nagar, a major center in the Khabur Basin, today northeast Syria, and Jebel Aruda in the Middle Euphrates valley, today central Syria. We have measured fewer excavated bottles from sites the irrigated heartland of Lower Mesopotamia – ancient Sumer and Akkad. Fortunately there are some bottle necks available from the large center of Nippur on a Lower Euphrates channel in modern Southern Iraq, and from the small center of Tepe Farukhabad in a front range valley of the Zagros in modern Southwestern Iran.

The system of attributes was first developed to record rim sherds at the Early Dynastic I village of Sakheri Sughir near Ur in Lower Mesopotamia (Wright 1969, 123–40). This was expanded to express the variations in Uruk pottery by Johnson (1973, 27–29, 177–97) and used in the study of Tepe Farukhabad to the Northeast of Susa in Southwestern Iran (Wright ed. 1981, 330–70). These data have been used in attempts to compare Middle and Late Uruk assemblages from different parts of Mesopotamia (Wright ed. 1981, 186–88; Wright 2001, 134–36, Table 4.2). However, because at that time we had no access to excavated vessels fragments from sites other than Farukhabad, we measured rim sherds found on surveys which are not precisely dated. Since one's perception changes through time, rather than use Farukhabad measurements from the 1970s, I re-measured all stratified bottles in the Farukhabad collections in Ann Arbor in 2020.

The measured (or continuous) attributes used here are as follows.

- Diameter: This is the standard measure on the outside of the rim which, with bottles, can often be made directly with calipers. Sometimes it is necessary to estimate with a concentric circle chart. If the rim is warped, the maximum and

minimum diameters are averaged. In general, 'Diameter' is a replicable measurement. (**Fig. 12**) shows a range from 3.5 to 6.4 cm. A study of complete bottles will be needed to determine whether there were two or more size classes of bottles, rather than continuous variation.

- Neck Height (Also termed 'Space Height'): This is measured as a vertical chord from the bottom of the rim to the surface of the shoulder. Since most bottles are broken in mid-shoulder, this often has to be measured on the drawing to a reconstructed shoulder surface, and is not easily replicable. **Fig. 12** shows a range from .50 to 3.20 cm.
- Rim Height: This is measured with calipers from the bottom to top of the rim parallel to the plane of the rim band. Measuring this is straightforward and fairly replicable. **Fig. 12** shows a range from .67 to 2.42 cm.
- Shoulder Thickness: This is measured with calipers beyond the thickening caused by neck attachment if possible. When present, this is fairly replicable. The necks, however, are often broken so that often this cannot be measured. **Fig. 12** shows a range from .36 to .74 cm.
- Neck Thickness: This is measured with calipers below the rim modifications on the horizontal plane as close to midpoint of the neck as possible. This is easy to replicate unless the neck is thin at the bottom and thicker toward the top, in which event the mid-point thickness is measured. **Fig. 12** shows a range from .25 to 1.33 cm.
- Rim Thickness: This is similarly measured from the thickest point of the rim band on the horizontal plane to the interior of the neck. **Fig. 12** shows a range from .80 to 2.11 cm. This is difficult to do if there is an interior neck groove, and I do not view it as replicable.
- Rim Angle: This is the angle from the plane of the vessel mouth to the inside of the neck, so that a vertical neck will have a measure of 90°. If the inside of the neck has a convex curve, the angle is measured to the tangent of the curve. If the inside the neck is grooved, creating a concave curve, the angle is measured to the line from the lip to the neck constriction. This attribute can be reliably measured in degrees with a protractor from the 1:1 cross section drawing of the rim sherd. This method has proved easier to replicate than direct measurement from the sherd. **Fig. 12** shows a range from 48° to 101°. The lower angles could seat the known conical jar stoppers; an expanding stopper may also have been used in necks with interior groove. If so, such stoppers must have been of a perishable material.
- Lip Top Angle: Previously termed "Rim Top Angle", this angle is also measured from the 1:1 section drawing. If the lip is curved or rounded, the angle is measured to the tangent of that curve. A rim with a flat lip parallel to the vessel mouth will have a Lip Top Angle of about 90°; a ledge or oblique rim will have a Lip Top Angle greater than 90°. A flat, collared lip will have a Lip Top Angle close to 180°. **Fig. 12** shows a range from 119° to 188°.

In addition, attributes unrelated to vessel shape were identified at low magnification as follows.

- Inclusions in the clay body includes mostly fine to medium rounded grains of sand. We not know whether naturally sandy clays were selected, or whether sand was deliberately mixed into the clay. Also noted are occasional fragments of limestone. A few plant fragments were recorded. Inclusions show some broad regional differences: the Lower Mesopotamian examples in the small sample from Nippur have exclusively fine sand; in contrast about 13% of the examples from Jebel Aruda on the Euphrates terraces and about 40% of the examples from Brak on the Khabur plain examples have mostly medium sand.
- Colors, both of the surface of the neck or rim and of the body just under the outer

surface, were recorded using a Munsell Color Chart. There are also some broad regional differences in body color which may relate to local sedimentary geology and ground water chemistry, as discussed below.

- Pre- and post-firing modifications: We have recorded some modifications made before firing which may inform us about the details of manufacture. Some are banal, but others are useful. Bits of clay remaining on surfaces tell us little. Curved swiping on the neck is often from the final pressing down of a spout; such spout traces are very helpful. Finger marks on the neck may indicate how the still-plastic vessels were moved from the wheel to the drying tray. The possible mark of a gloved finger on the shoulder of a Jebel Aruda bottle (**Fig. 9c**) is a precious witness of potters' use of gloves (Van der Leeuw 1994), without which the coarse inclusions of many Jebel Aruda clays would strip the skin from their hands.

We also often observed qualitative modifications made after firing. Some, such as lip top wear or abrasion and post-firing oblique scratches inside bottle necks, were first noted decades ago on the bottles from Farukhabad, and these have been reliably observed in all samples. The former may result from the abrasion from storing the bottles upside down on a floor, but they could also result from trampling broken bottle necks on the surfaces of settlements. The scratches, particularly multiple scratches, inside the neck, however, require a deliberate application of force with a pointed tool. I see no way this kind of modification can be created by being accidentally trampled, kicked, thrown, etc. Other post-firing modifications have been noted only recently – for example chipping and abrasion on lower edges of bottle lips – and we cannot be certain whether or not I correctly observed this kind of wear in samples studied years ago. Lip top chipping, like lip top abrasion, could be from accidental abrasion, but the curious damage to the well-protected bottom edges of lips could be from some kind of lashing around the neck. Replication and microscopic examination may help us to understand this. For the moment, however, we can only call the readers' attention to these types of modification and urge future recording and study.

Bottles from Tell Brak on the Upper Mesopotamian Jazira

Tell Brak (N36° 40' 02"/ E41° 03' 02") is a large high mound with surrounding lower town and smaller mounds, located on the Khabur plain near the southern border of rainfall adequate for wheat and barley cultivation and at the juncture of both north-south and east-west transport routes. Excavations during the 1930s by Max Mallowan and Agatha Christie led to a lengthy program under David and Joan Oates from 1970 until 2011. I am deeply indebted to the Oates, to Geoff Emberling, to Augusta MacMahon and all the team for their hospitality at Tell Brak. The Uruk bottle samples used here are mostly originating from trash filled pits in Level 12 of the TW excavation in the northeast area of the central mound (Emberling et al. 1999, 6–8; Emberling 2016: 40–55; Oates 2002) and thus from the earliest Late Uruk deposits known on the northeastern portion of Brak. A few are from the nearby TX and UA soundings. They were measured between other tasks during the 1998–2002 seasons.

Late Uruk Bottles from Tell Brak have 10–20% inclusions, comprising in order of frequency fine sand, medium sand, mica, and crushed limestone. The production sequence is illustrated by two complete examples. The narrow-bodied form with sloping shoulders (**Fig. 5a**) was made from 4 discrete parts. The less complete bottle necks on the right of **Fig. 5** as well as **Fig. 6k** can be tentatively ascribed to this narrower form. The wide-bodied form with flat shoulders (**Fig. 6a**) was made from at least 5 discrete parts. Less complete bottle necks (**Fig. 6b** and **6c**) can be ascribed to this form. The remainder are

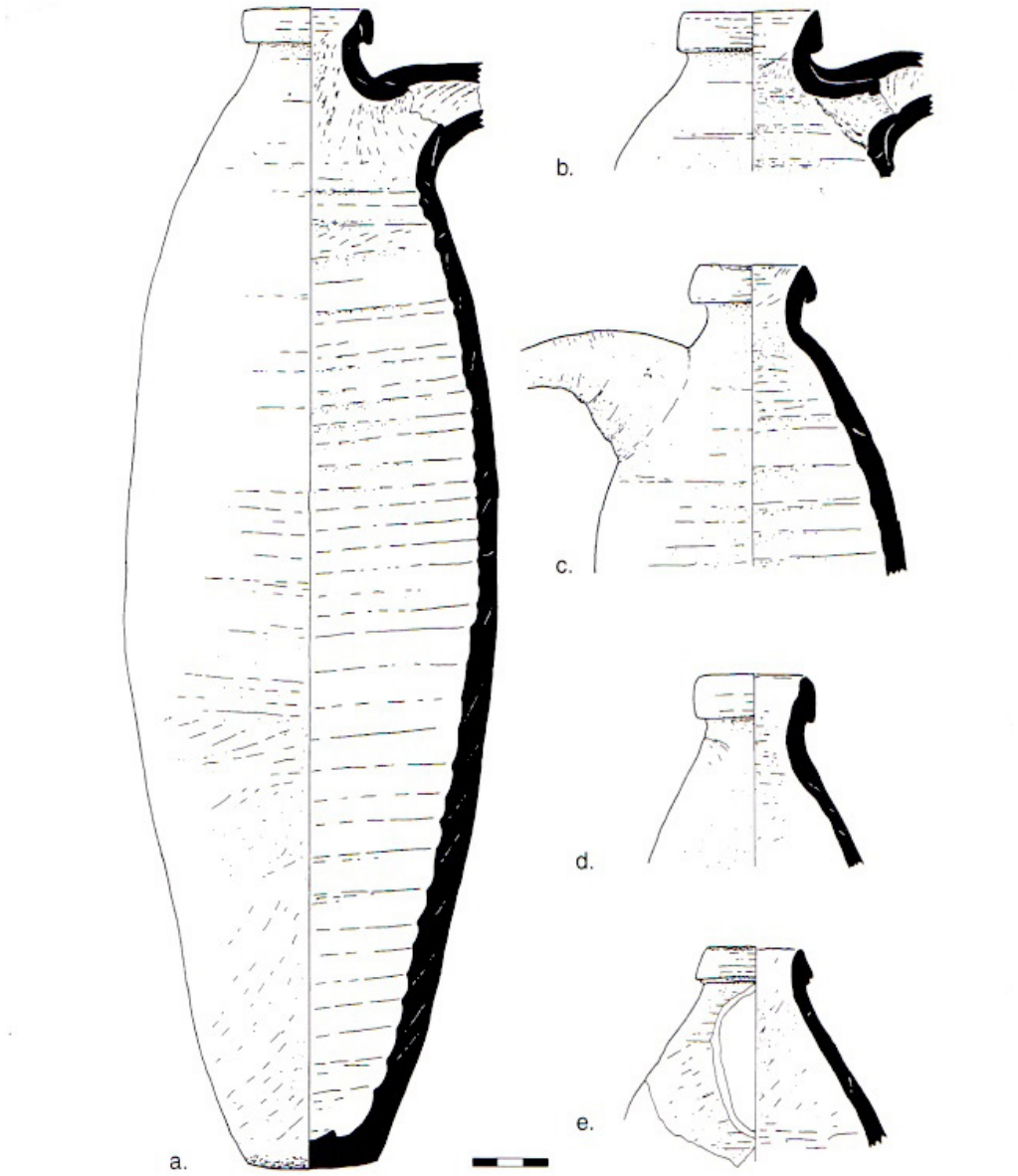

Fig. 5. Tell Brak: Near complete narrow-bodied bottle and bottle necks. Drawings: Henry T. Wright. Abbreviations used on Figures 5 to 10: incl: inclusions, diam: diameter, thk: thickness, ht: height.
a. Reconstructed narrow bottle (TW1038.103) Majority medium sand incl, Bottle ht: 45.6, Maximum bottle diam: 15.6, Rim diam: 5.6, Neck thk: .85, Rim ht: 1.50, Lip top angle: 175°, Rel. rim ht: .57, Lip rounding index: .10, Body reddish-yellow (5YR 7/5), Droop spout, Inner neck concavity, Abrasion on base, Wear on lip.
b. Bottle rim, neck & body (TW 1038.103) Majority fine sand incl, Rim diam: 6.2, Neck thk: .80, Rim ht:1.84, Lip top angle: 174°, Rel. rim ht: .66, Lip rounding index: .08, Body reddish-yellow (7.5YR 7/5), Droop Spout, Scratch inside neck.
c. Bottle rim, neck and shoulder (TW 1852.101) 20% Medium sand incl, Rim diam: 5.3, Neck thk: .72, Rim ht:1.55, Lip top angle: 154°, Rel. rim ht: .51, Lip rounding index: .17, Body light yellowish brown (10YR 6/5), Droop Spout, Scratches inside neck, Wear on lip.
d. Bottle rim and neck (TW 1044.101) 20% Medium sand incl, Rim diam: 5.1, Neck thk: .75, Rim ht: 1.90, Lip top angle: 180°, Rel. rim ht: .55, Lip rounding index: .10, Body Pink (7.5YR 7/4), Spout trace, Inner neck concavity, Wear on lip.
e. Bottle rim and neck (TW 1044.104) Majority fine limestone incl., Rim diam: 4.9, Neck thk: .63 Rim ht: 1.26, Lip top angle: 158°, Rel. rim ht: .58, Lip rounding index: .04, Body Pink (7.5YR 7/4), Scratches inside neck, Wear on lip.

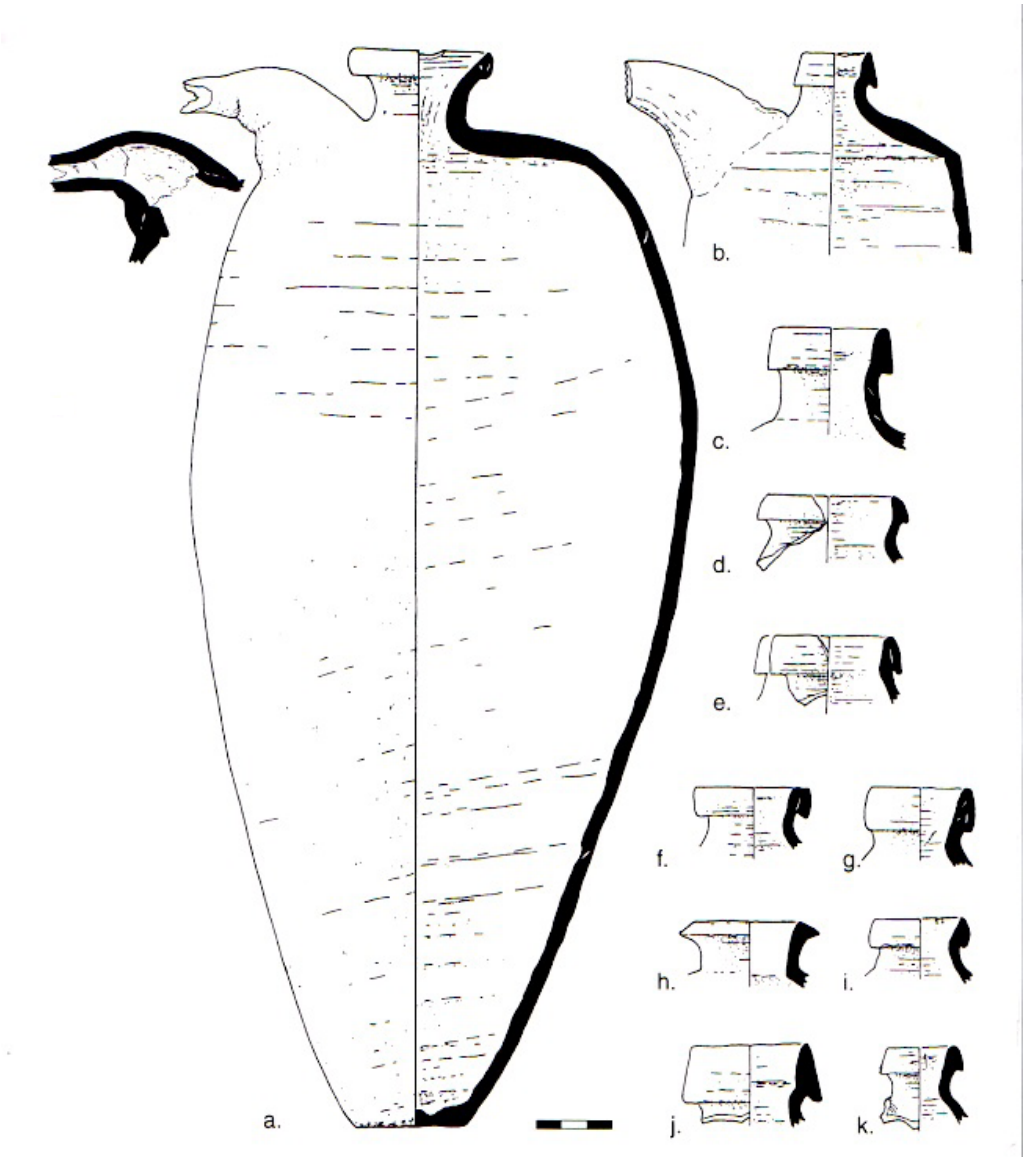

Fig. 6. Tell Brak: Near complete wide-bodied bottle and bottle necks. Drawings: Henry T. Wright.
a. Reconstructed wide bottle (TW 929.101) 20% Medium sand, limestone and mica incl, Bottle ht: 47.2, Maximum bottle diam: 22.4, Rim diam: 6.4, Neck thk: .85, Rim ht: 1.14, Lip top angle: 179°, Rel. rim ht: .34, Lip rounding index: .24, Body Reddish Yellow (5YR 7/6), Droop spout, Lip top finger mark, Possible pre-firing compression marks inside neck, Abrasion on base.
b. Bottle rim, neck and shoulder (TW 1053.104) Majority fine sand incl, Rim diam: 3.7, Neck thk: .54, Rim ht: 1.51, Lip top angle: 169°, Rel. rim ht: .61, Lip rounding index: .06, Body colors not recorded, Droop Spout, Inner neck concavity, Wear on lip.
c. Bottle rim and neck (TW 1044.102) Majority fine limestone incl, Rim diam: 5.5, Neck thk: .62, Rim ht: 1.85, Lip top angle: 171°, Rel. rim ht: .43, Lip rounding index: .04, Body reddish yellow (5YR 6/6), Inner neck concavity.
d. Bottle rim and neck (TW 1757.101) Majority fine sand incl, Rim diam: 6.2, Neck thk: .55, Rim ht: 1.22, Lip top angle: 151°, Rel. rim ht: .42, Lip rounding index: .14, Body reddish yellow (7.5YR /6), Inner neck concavity.
e. Bottle rim and neck (UA 39.101) 15% Med sand and mica incl, Rim diam: 6.4, Neck thk: .44, Rim ht: 1.26, Rel. rim ht: .63, Lip top angle: 158°, Lip rounding index: .07, Body Reddish yellow (7.5YR 5/6).
f. Bottle rim and neck (TX 37 Upper) 15% Fine sand incl, Rim diam: 5.2, Neck thk: .49, Rim ht: 1.07, Lip top angle: 183°, Rel. rim ht: .54, Lip rounding index: .11, Colors not recorded, Inner neck concavity.
g. Bottle rim and neck (TW 1852.102) 10% Medium sand incl, Rim diam: 5.0, Neck thk: .66, Rim ht: 2.04, Lip top angle: 178°, Rel. rim ht: .61, Lip rounding index: .10, Body Reddish yellow (7.5YR 6/5), Scratch inside neck.
h. Bottle rim and neck (TW 1798.101) 10% Fine sand and mica incl, Rim diam: 6.1, Neck thk: .55, Rim ht: .56, Lip top angle: 119°, Rel. rim ht: .23, Lip rounding index: .00, Body Reddish yellow (5YR 6/8), Light wear on lip.

i. Bottle rim and neck (TW 1727.101) 10% Fine sand incl, Rim diam: 4.5, Neck thk: .40, Rim Ht: 1.30, Lip top angle: 174°, Rel. rim ht: .55, Lip rounding index: .08, Body Dark yellowish brown (5 YR 6/8), Chip inside lip, Abrasion on bottom of lip.
j. Bottle rim and neck (TW 1053.102) Majority medium sand incl, Rim diam: 6.2, Neck thk: .55, Rim ht: 2.56, Lip top angle: 169°, Rel. rim ht: .58, Lip rounding index: .03, Body Reddish yellow (5YR 6/5), Inner neck concavity.
k. Bottle rim, neck and shoulder (TW 1053.103) Majority fine sand incl, Rim diam: 3.8, Neck thk .46, Rim ht: 1.11, Lip top angle: 165°, Rel. rim ht: .37, Lip rounding index: .16, Body Pink (5YR 7/4), Spout Trace, Scratch inside neck.

uncertain. Among the 16 illustrated rims, visual examination suggests that among the illustrated rims there are seven Brak bottles with small rounded band rims (**Fig. 5a, c**; **6a, d, f, i, k**); five with flattened band rims or collars (**Fig. 5b, d**; **6c, e, g, j**), two with obliquely flattened rims (**Fig. 5e**; **6b**), and one with a ledge rim (**Fig. 6h**). Six of the 16 illustrated rims have lip wear, which simply indicates they were stored up-side down on their rims. Also, there are post-firing scratches inside five of the 16 rims, probably indicating the removal of conical stoppers.

Bottles from Jebel Aruda on the Upper Mesopotamian Euphrates

The Brak study alone was relatively un-informative. We needed representative samples from other Upper Mesopotamian sites and we found one in the Rijksmuseum van Oudhede in the Netherlands where the Jebel Aruda collections are well-curated. My thanks to Lucas Petit and Bleda Düring for their hospitality and for helping me to draw and measure some sherds from the Jebel Aruda collection.

Jebel Aruda was a small town nestled on the side of a high mountain, over-looking the left bank of the Euphrates (N36° 14' 03/ E 38° 05' 56"). It is well outside the limits of the reliable rainfall cultivation of wheat and barley, and its farmers would have to somehow draw water from the Euphrates. This mountain guards the approach from the north to the river terrace enclave of a large town – Habuba Kabira South (N36° 09' 40"/ E38° 03' 30) – only 9 km SSW of Aruda (Strommenger 1980). Jebel Aruda was excavated by Dutch teams under Sander Van der Leeuw, Henk Franken, and Govert Van Driel and Caroline Van Driel-Murray (Van Driel and Van Driel-Murray 1979; 1983) during the 1970s and 80s. The excavations revealed three contiguous areas of Late Uruk architecture. In the center are twin niched buildings thought to be temples on platforms and surrounded by a compound wall. Above to the southwest are large well-planned residences. Below to the northeast, isolated by a wall with a single entry, are smaller residences, un-planned and with much trash. Limited reconstruction of these buildings and tight clustering of the ^{14}C dates (Wright and Rupley 2001, 103–04) suggests a brief occupation of the town later in the Late Uruk Period. A series of Jebel Aruda sherds was recorded by Geoff Emberling, Carolin Jauss, Lucas Petit, and myself in 2014. Small pieces were taken from a sub-sample of vessels for thin sectioning and neutron activation analysis by Leah Minc at Oregon State (Minc 2016).

Late Uruk bottles from Jebel Aruda have inclusions varying from a trace to 10% inclusions, of fine sand, medium sand, crushed limestone and mica in that order of frequency. Production sequences for Aruda bottles are illustrated by two complete examples. The narrow-bodied form with sloping shoulders (**Fig. 7a**) was made from 4 discrete parts and has a small rounded band rim. Other such narrow bottles are illustrated on **Fig. 8a**, **d** and **i**; **Fig. 9a**, **c**, **f**, **g**, **h**; and **Fig. 10g** and **j**. The smaller wide-bodied form (**Fig. 7b**) was perhaps made from at least 5 discrete parts and has an oblique "cut" rim. Other possible wide bottles may be **Fig. 8f** and **Fig. 10k**.

Fig. 7. Near-complete bottles from Jebel Aruda. Drawings: Henry T. Wright.
a. Reconstructed narrow bottle (99 G 10, R69, Pit 1) 5% Fine sand, limestone incl, Bottle ht: ca. 30, Maximum body diam: 13.4, Rim diam: 5.4, Neck thk: 1.15, Rim ht: 1.70, Lip top angle: 183°, Rel. rim ht: .43, Lip rounding index: .19, Body Reddish yellow (7.5YR 6/5), Droop spout, Inner neck concavity, Scratches inside neck.
b. Reconstructed wide bottle (JA 78: 99 G 10, R69, Pit 1 org) (OSU 58) 5% Medium sand inclusions, Bottle ht: ca. 59, Maximum body diam: 14.3, Rim diam: 4.8, Neck thk: .80, Rim ht: .99, Lip top angle: 170°, Rel. rim ht: .46, Lip rounding index: .03, Body Reddish yellow (7.5YR 6/6), Droop spout, Scratch inside neck.

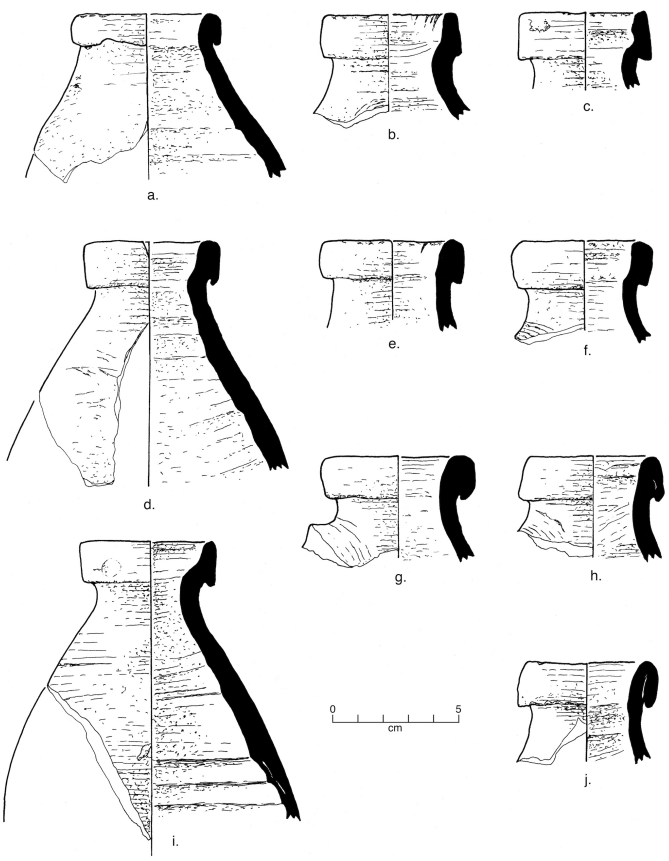

Fig. 8. Bottles from Aruda, R69 pit 1. Drawings: Henry T. Wright.
a. Bottle rim and neck (99 G 10, R69, Pit 1) 5% Fine sand, limestone incl, Rim diam: 5.6, Neck thk: .58, Rim ht:1.21, Lip top angle:171°, Rel. rim ht: .71, Lip rounding index: .22, Body Reddish yellow (7.5YR 7/5), Wear on lip.
b. Bottle rim, neck, and spout trace (99 G 10, R69, Pit 1) Trace of fine sand inclusions, Rim diam: 5.3, Neck thk: .77, Rim ht: 1.71, Lip top angle:171°, Rel. rim ht: .34, Lip rounding index: .05, Body Light brown (5YR 6/4), Inner neck concavity, Scratches inside neck, Wear on lip.
c. Bottle rim and neck (99 G 10, R69, Pit 1) 5% Fine sand, limestone incl, Rim diam: 5.1, Neck thk: .53, Rim ht: 1.92, Lip top angle: 173°, Lip rounding index: .15, Body light gray (10YR 7/2), Remnant of fired clay on lip, Light wear on lip.
d. Bottle Rim and Neck (99 G 10, R69, Pit 1) (OSU 18) Trace fine sand, limestone incl, Rim diam: 5.3, Neck thk: .61, Rim ht: 1.73, Lip top angle: 185°, Rel. rim ht: .59, Lip rounding index: .05, Body Light brownish gray (2.5YR 6/3), Over-fired and warped, Inner neck concavity.
e. Bottle rim and neck (99 G 10, R69, Pit 1) (OSU 23) Trace fine sand incl, Rim diam: 5.4, Neck thk: .51, Rim ht: 1.64 Lip top angle: 183°, Rel. rim ht: .49, Lip rounding index: .08, Body Reddish yellow (7.5YR 6/6), Scratch inside neck, Wear on lip.
f. Bottle rim, and neck (99 G 10, R69, Pit 1) 5% Medium sand, limestone incl, Rim diam: 5.4, Neck thk: .38, Rim ht: 1.78, Lip top angle: 189°, Rel. rim ht: .54, Lip rounding index: .10, Body Reddish yellow (7.5YR 7/6), Neck thk: .53, Spout trace, Inner neck concavity, Light wear on lip.
g. Bottle rim and neck, (99 G 10, R69, Pit 1) Trace fine sand, mica incl, Rim diam: 5.6, Neck thk: .70, Rim ht: 1.79, Lip top angle: 180°, Rel. rim ht: .50, Lip rounding index: .17, Body Reddish yellow (5YR 7/5), Spout trace.
h. Bottle rim and neck (99 G 10, R69, Pit 1) (OSU 26) Trace fine sand incl, Rim diam: 5.4, Neck thk: .64, Rim ht: 1.64, Lip top angle: 171°, Rel. rim ht: .38, Lip rounding index: .11, Body Pink (7.5YR 7/4), Spout trace.
i. Bottle rim and neck (99 G 10, R69, Pit 1) (OSU 17) Trace fine sand incl, Rim diam: 5.2, Neck thk: .70, Rim ht: 1.70, Lip top angle: 181°, Rel. rim ht: .42, Lip rounding index: -.01, Body Pink (7.5YR 8/3), Inner neck concavity, Possible finger mark on lip, Light wear on lip.
j. Bottle rim and neck (99 G 10, R69, Pit 1) (OSU 21) 10% Limestone, fine sand incl, Rim diam: 5.3, Neck thk: .46, Rim ht: 1.89, Lip top angle: 183°, Rel. rim ht: .49, Lip rounding index: .18, Body Reddish yellow (7.5YR 7/5), Abrasion on bottom of lip.

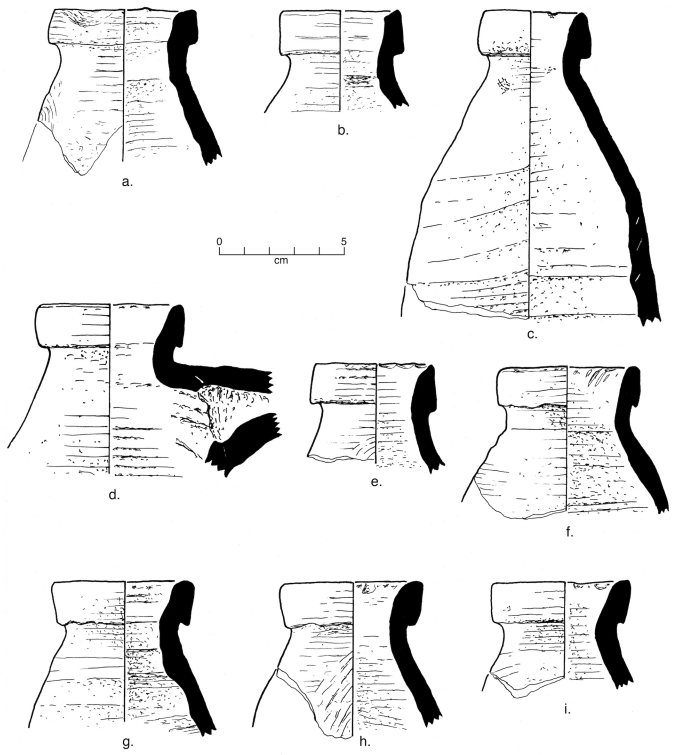

Fig. 9. Bottle necks from Jebel Aruda, R59 pit. Drawings: Henry T. Wright.
a. Bottle rim, neck (99 J 18, R59, Pit) (OSU 70) Trace of fine sand incl, Rim diam: 5.6, Neck thk: .71, Rim ht: 1.42, Lip top angle: 177°, Rel. rim ht: .46, Lip rounding index: .04, Body Very pale brown (10YR 7/3), Spout trace, Inner neck concavity, Possible finger impression on lip, Remnant fired clay on lip.
b. Bottle rim and neck (99 J 18, R59, Pit) 10% fine sand, mica incl, Rim diam: 5.6, Neck thk: .70, Rim ht: 1.78, Lip top angle: 184°, Rel. rim ht: .55, Lip rounding index: .01, Body Reddish yellow (5YR 6/7).
c. Bottle rim and neck (99 J 18, R59, Pit) (OSU66). 5% Fine limestone, fine sand incl, Rim diam: 4.5, Neck thk: .54, Rim ht: 1.67, Lip top angle: 171°, Rel. rim ht: .56, Lip rounding index: .08, Body Light brown (7.5YR 6/4), Possible gloved finger imprint on neck, Chip inside lip.
d. Bottle rim, neck, and spout (99 J 18, R59, Pit) (OSU68) 5% Fine sand, limestone incl, Rim diam: 5.7, Neck thk: .75, Rim ht: 1.70, Lip top angle: 183°, Rel. rim ht: .62, Lip rounding index: .06, Body Light reddish brown (7.5YR 6/3), Spout, Light wear on lip.
e. Bottle rim and neck (99 J 18, R59, Pit) (OSU 70) Trace of Fine sand incl, Rim diam: 5.1, Neck thk: .65, Rim ht: ca 1.80, Lip top angle: 177°, Rel. rim ht: .56, Lip rounding index: .02, Body Very pale brown (10YR 8/3), Spout trace, Wear and chips on lip.
f. Bottle rim and neck (99 J 18, R59, Pit) (OSU 25) Trace fine sand incl, Rim diam: 5.6, Neck thk: .56, Rim ht: 1.67, Lip top angle: 187°, Rel. rim ht: .55, Lip rounding index: .04, Body Pink (7.5YR7/4), Scratches inside neck, Light wear on lip, Abrasion on bottom of lip.
g. Bottle rim and neck (99 J 18, R59, Pit) (OSU 71) 10% Fine sand, limestone, mica, incl, Rim Diam: 5.6, Neck thk: .56, Rim ht: 1.72, Lip top angle: 189°, Rel. rim ht: .57, Lip rounding index: .09, Body Pinkish white (7.5YR 6/3), Inner neck concavity, Light wear inside lip, Abrasion on bottom of lip.
h. Bottle rim and neck (99 J 18, R59, Pit) 10% Fine sand, limestone incl, Rim diam: 5.7 Warped, Neck thk: .61, Rim ht: 1.73, Lip top angle: 189°, Rel. rim ht: .72, Lip rounding index: .13, Body Reddish yellow (5YR 6/6), Spout trace, Wear and chips on lip.
i. Bottle rim and neck (99 J 18, R59, Pit) (OSU 69) Trace of Fine sand incl, Rim diam: 5.6, Neck thk: .72, Rim ht: 1.67, Lip top angle: 187°, Rel. rim ht: .58, Lip rounding index: .09, Body Light brown (7.5YR 6/3), Light wear and chips on lip.

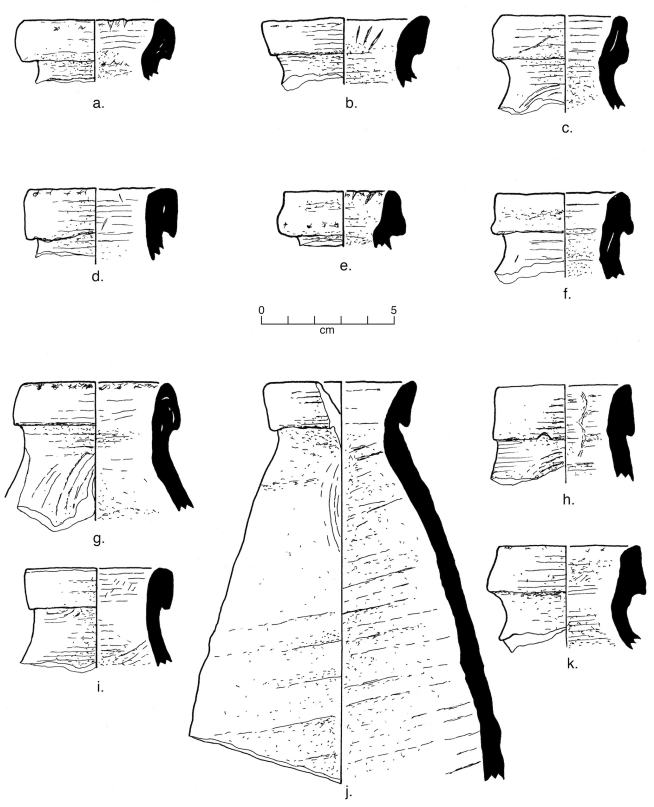

Fig. 10. Bottle necks from Jebel Aruda, Central "Tempel" and the pits. Drawings: Henry T. Wright.
a. Bottle rim (11C1 "Tempel") 10% Medium sand, limestone, mica incl, Rim diam: 5.8, Neck thk: .63, Rim ht: 1.55, Lip top angle: 159°, Lip rounding index: .26, Body Reddish yellow (7.5YR 6/5), Inner neck concavity, Scratches inside neck, Light wear on lip.
b. Bottle rim (1_C1 [Number partly defaced] "Tempel") 10% Fine sand, limestone, mica incl. Rim diam: 6.0, Neck thk: .56, Rim ht: 1.55, Lip top angle: 150°, Rel. rim ht: .70, Lip rounding index: .08, Body Reddish yellow (5YR 6/5), Scratches inside neck.
c. Bottle rim and neck (99 G 10, R69, Pit 1) (OSU 20) 10% Limestone, fine sand, mica incl, Rim diam: 4.9, Neck thk: .55, Rim ht: 1.66, Lip top angle: 156°, Rel. rim ht: .50, Lip rounding index: .10, Body Reddish yellow (5YR 7/6), Lip groove, Spout trace, Scratch outside lip.
d. Bottle rim (11B1 "Tempel") (OSU 5) 10% Fine sand, mica incl, Rim diam: 5.5, Neck thk: .62, Rim ht: 1.84, Lip top angle: 180°, Lip rounding index: .07, Body Light reddish brown (5YR 6/5), Light wear on lip, Scratches inside neck, Abrasion on bottom of lip.
e. Bottle rim (7A1 "Tempel") (OSU 6) 5% Fine sand, limestone incl, Rim diam: 4.5, Neck thk: .45, Rim ht: 1.73, Lip top angle: 162°, Lip rounding index: .06, Body Light reddish brown (5YR 6/5), Inner neck concavity, Exterior lip groove, Scratches inside neck, wear on lip.
f. Bottle rim (10C1 "Tempel") (OSU 4) 10% Medium sand incl, Rim diam: 5.2, Neck thk: .70, Rim ht: 1.54, Lip top angle: 169°, Rel. rim ht: .48, Lip rounding index: .14, Body White (2.5Y 8/2), Inner neck concavity, Exterior lip groove.
g. Bottle rim and neck (99G10 R69 Pit 1) (OSU 20) 5% Fine sand, limestone, mica incl, Rim diam: 6.0, Neck thk: .51, Rim ht: 1.66, Lip top angle: .178°, Rel. rim ht: .47, Lip rounding index: .11, Body Reddish yellow (7.5YR 7/6), Spout trace, Wear on lip.
h. Bottle rim (99G10 R69 Pit 1) 10% Fine sand, fine limestone, mica incl, Rim diam: 5.2, Neck thk: .59, Rim ht: 1.97, Lip top angle: 168°, Rel. rim ht: .55, Lip rounding index: .08, Body Reddish yellow (7.5YR 7/6), Spout trace.
i. Bottle rim (99G10 R69 Pit 1) 15% Fine sand, limestone incl, Rim diam: 5.4, Neck thk: ca .56, Rim ht: 1.82, Lip top angle: 169°, Rel. rim ht: .53, Lip rounding index: .11, Body Light brown (7.5YR 6/4), Light scratches inside neck.
j. Bottle rim and neck (99 J 18, R59) (OSU 67) 5% Fine sand, fine limestone incl, Rim diam: 5.8, Neck thk: .58, Rim ht: 1.89, Lip top angle: 190°, Rel. rim ht: .71, Lip rounding index: .03, Body Pink (7.5YR 7/3), Spout trace, Abrasion on bottom of lip.
k. Bottle rim and neck (99 G 10, R69, Pit 1) (OSU 24) Trace of fine sand incl, Rim diam: 5.5, Neck thk: .47, Rim ht: 1.95, Lip top angle: 170°, Rel. rim ht: .54, Lip rounding index: -.02, Body Pink (7.5YR 7/4), Inner neck concavity, Light scratches in neck? Light wear on lip.

Visual examination indicates that seventeen Aruda bottles have slightly rounded or flattened band rims (**Fig. 8b**, **c**, **d**, **h**, **i**, **j**; **9b**, **c**, **d**, **e**, **f**, **g**, **h**; **10h**, **i**, **k**); eight Aruda bottles have small rounded band rims (**Fig. 7a**; **8a**, **e**, **f**, **g**; **9h**; **10a**, **i**), one has an obliquely flattened rim (**Fig. 7b**) and none has a ledge rim. Fifteen of the 32 illustrated rims have lip wear, which probably indicates they were stored on their rims. Also, there are scratches inside 11 of the 32 rims, indicating the removal of stoppers.

The Late Uruk bottle necks from three loci at Jebel Aruda show significant form and use differences between areas, evident from visual examination alone.

- The R 69 Pit: This is a pit filled with both primary trash (judging by the near complete bottles) and secondary or tertiary trash (judging by the battered condition of many bottle necks). Visual inspection shows there are seven small rounded rims (**Fig. 8a**, **e**, **f**, **g**, **h**, **j**; **10g**) and seven high flat band or slightly rounded band rims (**Fig. 8b**, **c**, **d**, **i**; **10h**, **i**, **k**). Five of the 15 bottle necks have lip wear, and three have stopper removal scratches.
- The R 59 Pit: A pit also filled with a range of both well-preserved and battered necks suggesting mixing of several types of deposit. Visual inspection shows that nine of the ten are flat or slightly rounded band rims (**Fig. 9b**, **c**, **d**, **e**, **f**, **g**, **h**, **i**; **10j**). Five of the ten bottles have lip wear, but only one has stopper removal scratches.
- The central "Tempel" area: In this small very battered sample (**Fig. 10**), only one of the five bottles has a rounded band rim; the rest are high or concave band rims. Two of the five have lip wear. Only two out of the five have stopper removal scratches.

Bottles from Nippur on the Lower Alluvium of Mesopotamia

The vast mound of Tell an-Nuffar covers the remains of the city of Nippur (N32° 07' 40"/ E45° 13' 30"). Uruk deposits are under many meters of later debris, and stratified contexts are known only in the areas of the Inanna temple and the eastern wall, but the Uruk Period city may have covered 180 ha or more. Nippur is in the middle of Lower Mesopotamia, about 235 km northwest of Uruk-Warka (N 31° 19' 30"/ E 45° 38' 10"). Uruk deposits at Warka are better exposed, and several excavations and a thorough study of surface ceramics by Uwe Finkbeiner (1991; Boehmer 1991) show that the occupied area in the Late Uruk time was at least 210 ha, the largest known settlement in Mesopotamia in the later 4th millennium BCE. Unfortunately I have not been able to examine a sample of bottles from Uruk-Warka.

Since the mid 20th century, excavations at Nippur have been conducted by the University of Chicago. The available sample of Late Uruk ceramics were in Layers XVI to XVII of the Inanna Temple, excavated by Donald Hansen in 1961–63. In an initial publication, Hansen (1965) first defined Middle and Late Uruk ceramic assemblages, and noted the importance of bottles in delimiting Late Uruk. His samples are now curated on the Oriental Institute in Chicago. A detailed study of the early ceramics from the Inanna Temple is being prepared by Karen Wilson, who generously gave me permission to study the small but informative sample of bottle necks in the collection. I do not know the types of deposits in which these were found, but these necks are very battered, as is common in tertiary deposits.

We do not have access to any complete or partially complete bottles from Nippur and cannot comment on full shapes or manufacturing. We also have neither NAA or similar studies, nor residue studies, of Uruk ceramics from Nippur. The visual examination of the clay bodies show that all rims have only very fine sand inclusions typical of the Lower Mesopotamian alluvium. Some bottles with only fine sand inclusions are

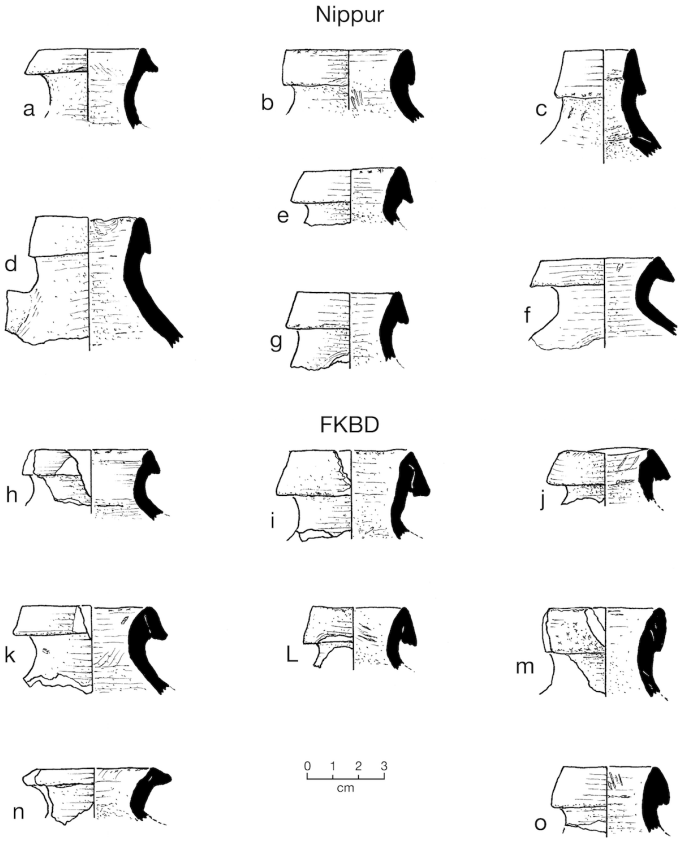

Fig. 11. Bottle necks from Nippur Inanna Temple and Tepe Farukhabad. Drawings: Henry T. Wright.
a. Bottle rim and neck (Nippur IT, 6N15, Level XV, A178753) Trace fine sand incl, Rim diam: 5.1, Neck thk: ca .52, Rim ht: .95, Lip top angle: 145°, Rel. rim ht: .27, Lip rounding index: -.08, Body Very pale brown (10YR 8/3), Wear on lip, Scratches inside neck.
b. Bottle rim and neck (Nippur IT349, 7NPx26, Level XVB, A173147) Trace Fine sand incl, Rim diam: 5.0, Neck thk: .48, Rim ht: 1.41, Lip top angle: 171°, Rel. rim ht: .34, Lip rounding index: .13, Body Very pale brown (10YR 8/3), Wear on lip, Scratches inside neck.
c. Bottle rim and neck (Nippur IT346, 7NP30, Level XV, A178533) Trace Fine sand incl, Rim diam: 3.4, Neck thk: ca. .58, Rim ht: 1.90, Lip top angle: 165°, Rel. rim ht: .57, Lip rounding index: -.03, Body pink (7.5YR 7/4), Abrasion on bottom of lip.
d. Bottle rim and neck (Nippur IT, 7NP257, Level XVI, A17834) 10% Fine sand incl, Rim diam: 4.7, Neck thk: .52, Rim ht: 1.47, Lip top angle: 164°, Rel. rim ht: .49, Lip rounding index: .08, Body Pink (10YR 7/4), Spout trace, Chip inside lip, Wear on lip.
e. Bottle rim (Nippur IT351, 7NPx29, Level XVI, A173146) Trace Fine sand incl, Rim diam: 4.6, Neck thk: .25, Rim ht: 1.27, Lip top angle: 166°, Rel. rim ht: .56, Lip rounding index: .08, Body Very pale brown (7.5YR 8/3), Light wear on lip.
f. Bottle rim and neck (Nippur IT, Level XVIII SE, A178562) Trace fine sand incl, Rim diam: 5.4, Neck thk: ca .40, Rim ht: .98, Lip top angle: 148°, Rel. rim ht: .39, Lip rounding index: .05, Body Greenish white (5Y 8/2), Spout trace, Scratches inside neck.
g. Bottle rim and neck (Nippur IT, Level XVI–XVII, A178563) 5% Fine sand incl, Rim diam: 4.7, Rim thk: 1.20, Neck thk: .35, Rim ht: 1.33, Lip top angle: 157°, Rel. rim ht: .53, Lip rounding index: .06, Body Very pale brown (10YR 8/3), Spout trace.
h. Bottle rim (FKBD Exc. A, Layer 19: X396, UMMA 60002.02) Trace fine sand incl, Rim diam: 5.2, Rim thk: .78, Neck thk: .42, Rim ht: .98, Lip top angle: 151°, Rel. rim ht: .39, Lip rounding index: .10, Body Very pale brown (10YR 8/3), Inner neck concavity, Wear on lip.
i. Bottle rim and neck (FKBD Exc. B, Layer 29 Lower, X369, UMMA 60455.01) 5% Fine sand & limestone incl, Rim diam: 4.0, Neck thk: .52, Rim ht: 1.47, Lip top angle: 154°, Rel. rim ht: .46, Lip rounding index: .01, Body Very pale brown (10YR 7/3), Wear on lip.

j. Bottle rim (FKBD Exc. B, Layer 29 Lower, X368, UMMA 60452.01. Fine sand incl? Vitrified and warped, Rim diam: 5.9, Neck thk: .21, Rim ht: 1.22, Lip top angle: .151°, Rel. rim ht: .51, Lip rounding index: .03, Body Pale yellow (5Y 7/3), Scratches inside neck, Light wear on lip.
k. Bottle rim and neck (FKBD Exc. B, Layer B30 Upper, X396, UMMA 60459) Trace fine sand and limestone incl, Rim diam: 5.7, Neck thk: .45, Rim ht: 1.20, Lip top angle: 150°, Rel. rim ht: .52, Lip rounding index: .04, Body Pale yellow (5Y 7/3), Scratch inside neck, Light wear on lip.
l. Bottle rim (FKBD Exc. B, Layer 30, X395, UMMA 61215) 5% Fine sand incl, Rim diam: 4.6, Neck thk: .39, Rim Ht: 1.48, Lip top angle: 163°, Rel. rim ht: .47, Lip rounding index: .06, Body Reddish yellow (7.5YR 7/5), Scratches inside neck, Light wear on lip.
m. Bottle Rim and Neck (FKBD Exc. B, Layer 30, X397, UMMA 61017.01) 10% Fine sand and limestone incl, Rim diam: 4.8, Neck thk: .38, Rim ht: 1.70, Lip top angle: 187°, Rel. rim ht: .49, Lip rounding index: .14, Body Light gray (2.5Y 7/2), Wear on lip, Abrasion on and below lip.
n. Bottle rim and neck (FKBD Exc. B, Layer 32 Upper, X429, UMMA 60489.01) Trace Very Fine sand incl, Rim diam: 5.8, Rim thk: 1.32, Neck thk: .54, Rim ht: .54, Lip top angle: 120°, Rel. rim ht: .21, Lip rounding index:.01, Body Reddish yellow (5YR 6/5), Light scratches inside neck), Light lip wear.
o. Bottle rim (FKBD Exc. B, Layer 33 Lower, X515, UMMA 60535.03+05) Trace fine sand, vegetal, and limestone incl, Rim diam: 4.6, Rim thk: 1.09, Neck: thk: .51, Rim ht: 1.55, Lip top angle: 160°, Rel. rim ht: .39, Lip rounding index: .12, Body color Pale yellow (5Y 7/4), Scratches inside neck.

found in every sample, and it always is possible that some were brought from other regions. Also, examination of this rim and neck sample (**Fig. 11a**, **b**, **c**, **d**, **e**, **f**). shows that most have oblique flattened rims. There is also one rounded band rim, of the form common in Upper Mesopotamia (**Fig. 11b**) and one high band rim from a relatively small bottle neck (**Fig. 11c**). Four of the seven illustrated rims have lip wear, which may simply indicate that they were stored on their rims. Also, there are scratches inside three of the rims, indicating the removal of stoppers.

Bottles from Farukhabad on the Alluvium of Southwestern Iran

Tepe Farukhabad is a high mound on the Deh Luran Plain, a relatively large foothill valley of the central Zagros in southwestern Iran (Wright 1981). The high mound and its lower town were estimated to have covered about three ha before the Mehmeh River carried away more than half of the site (N32° 35' 15"/ E47° 13' 27").

Three excavations by a University of Michigan-Iran Archaeological Service team in 1968 revealed evidence of almost continuous occupation from ca. 6200 BCE to 1400 BCE. The river is entrenched and the soils around Farukhabad are saline (Kirkby 1977, 255, 259). Salinity near the site is 0.7% or higher, 0.4% being enough to diminish crop yields. However, crops of barley, wheat and lentils were grown (Miller 1981) and sheep, goat and cows were herded (Redding 1981). Late Uruk deposits associated with both private and public buildings were well represented in the two larger excavations. Bottles from a 50% sample of the excavated sherds curated at the University of Michigan Museum of Anthropology were re-drawn andb re-measured for this paper. Additional samples curated at University Museum in Philadelphia PA and Peabody Museum in New Haven CT will be re-studied at a later date. Study of the full sample of bottles should facilitate propositions about the development of bottles during the Late Uruk Period.

The Michigan-Iran team sieved measured volumes from stratified deposits in the two excavated areas in the interior of the town of Late Uruk date. In Excavation A to the east were modest residential buildings (in Layers A20 to 18) comprising up to .35 m in a limited area. In Excavation B to the west were elaborate buildings and unusual platform features (in Layers B31 to 29) comprising about .65 m of well-stratified deposits over an area of about 150 m^2. This allows an assessment of

the social and economic contexts of spouted bottles and their association with other kinds of vessels. In general, measures of correlation using all Late Uruk deposit contexts indicate little, perhaps because many of the contexts are mixed secondary or tertiary fills (Wright 1981, tab. 45). We did not have enough samples to sort out associational groups with multivariant analysis, but there is a simpler alternative. If we look at the densities of artifacts in deposits directly associated with different types of architecture (Wright 1981, tab. 46), we see that bottle necks (as well as spouts; in these layers mainly the curved spouts found on bottles) and fine bases (many of which are bottle bases) are more common around the circular platforms. So are conical cup bases and rims, also thought to be used for the consumption of liquids. Simple round lip and band lip bowls perhaps for serving food are also more common here. So are larger round lip jars and small jars and their strap handles thought to be used in cooking. Many of these associations are not statistically significant and are thus merely provocative. In sum, it is possible that these vessels associated with drinking and cooking were being broken in or near this courtyard area with the circular platforms.

We do not have access to any complete or partially complete bottles from Farukhabad and cannot say much about full shapes or manufacturing. We also have neither NAA or similar studies, nor residue studies, of Uruk ceramics from Farukhabad. Visual examination of the bodies indicates some variation from fine to medium sand with rare inclusions of fine limestone particles and of round granules of red radiolarian chert, this last often but not always found in ceramics from Southwest Iran. Further study is needed. Examination of this small rim and neck sample (**Fig. 11h–o**) shows that most have oblique flattened rims. From a Middle Uruk layer is one rounded band rim bottle neck (a form common in Upper Mesopotamia), made on the local vegetal-tempered Sargarab Ware (**Fig. 11o**). Also there is one high band rim (**Fig. 11m**) and one ledge rim (**Fig. 11n**). Seven of the eight rims have lip wear suggesting they were often stored upside down. Also, there are scratches inside five of the rims, indicating the removal of stoppers.

Initial comparison of the four bottle samples

First Step

The first step in comparing the four bottle samples is to consider the interrelationships between the qualitative or discrete attributes. This is done in processual order, from attributes related to raw material source and preparation to attributes related to the interaction between raw material and firing, to attributes related to possible bottle use.

- Inclusions in the potting clay, whether they were natural ingredients in the utilized sediments or something added by potters, differ from vessel to vessel. This was discussed in the above presentation of the four samples. Mineral inclusions seem largely attributable to geological conditions and vegetal inclusions, which must be introduced by potters, are rare. However, understanding the nature of the mineral inclusions requires detailed studies of thin-sections.

- Grouping the continuous Munsell color measures into qualitative categories related to the firing of sediments with different chemical properties in different atmospheres, we note that all of the Khabur plain bottle bodies from Brak and 75% of the Euphrates terrace bottle bodies from Jebel Aruda, but less than 30% of the Lower Mesopotamian bottles from Nippur and Farukhabad, have pink to reddish yellow to yellowish brown colors. This is commonly observed throughout the world in low fired ceramics, and usually results from the oxidization of ferrous oxide in the clay to a reddish ferric oxide. In contrast, none of the Upper Mesopotamian examples, 15%

of the Euphrates alluvium examples from Nippur, and 25% of the southwestern Iran bottle bodies from Farukhabad have a light yellowish or green surface color. The causes of this yellowish green tint have been known for a long time. The first researcher to study ancient ceramic technology in the Middle East, Frederick Matson (1971) showed that this tint can result from use of salty clays in which, when fired, there was an accumulation of ferrous chloride, a compound of the iron from ferrous oxide and the chlorine from sodium chloride. The ground water of Lower Mesopotamia is very salty and fallow fields in alluvial Lower Mesopotamia and in southwestern Iran are often white with salt. It is also the case that sherds in sewers and latrines often develop a yellowish or greenish tint. Latrines are universal, and patches of salty soil can be seen on the Khabur Plains and the Middle Euphrates terraces, so one cannot assume that a greenish sherd from Brak or Aruda is a southern import. Note that some greenish bottles were so highly fired that they were slightly vitrified (**Fig. 11j**), which would make them more brittle, but perhaps less porous. In addition to these relatively well understood reddish and greenish body colors, some bottle bodies are pale brown, light gray or even white, and the surface color of many bottles is often very light brown or even white. I have no doubt that Mesopotamian potters were able to produce a wide range of colors and that this preference for very light surface colors was deliberate, but at present we do not know exactly how they produced this color. Future research on firing would profit from experimental studies with briquets of different Mesopotamian sediments fired under differing conditions.

- Though our observations of patterns of wear are subjective, consideration of the relation between observed wear patterns on the rims and aspects of upper body form of bottles may facilitate more rigorous future studies. Visible post-firing scratches inside necks appear, with few exceptions, to go from upper right to lower left, indicating that most people who opened the bottles were right-handed. Since people in almost all human populations are predominantly right-handed, this is not surprising. These occur inside predominantly oblique flat lips in Lower Mesopotamia and rounded lips in Upper Mesopotamia, but these are the most common lip variants in these two areas, so this is also not surprising. It is perhaps more significant that there is only one occurrence of post-firing scratches inside the neck of a bottle with a distinct interior concavity (**Fig. 10a**). As previously noted, this suggests that most jar necks with concave interiors had stoppers different from the conical stoppers removed with a pointed tool. In contrast, the few bottle necks recently noted with abrasion, both wear and chipping below the lip, all have relatively high band rims (**Fig. 6i**; **8j**; **9h**; **11c**, and **11m**) with neither concave neck interiors nor interior post-firing scratches. This suggests yet another way of protecting the contents of a bottle. Future research on possible capping techniques would profit from experimental studies with different kinds of bottle stoppers and microscopic examination and comparison of both experimental replicas and ancient examples. Correlating stopper techniques with bottle contents would be difficult because indications of stoppers are found on necks and rims, while residues on jars (and presumably also on bottles) have been identified only at bases. As far as I know, no museum collection has a large sample of complete Late Uruk bottles where one could study both stopper traces and residues.

Second Step

The second step in comparing the four bottle samples is to consider the interrelations between the quantitative or continuous attributes. These attributes are created by the forming process, after clay preparation and before drying and firing. However, potters are forming vessels with future uses in mind, as well as future symbolic perceptions of themselves by other potters or of users by

the people with whom they interact. The following figure represents the variation in three particularly robust variables (**Fig. 12**). The first two – Rim Diameter and Lip Top Angle – are not difficult to measure and sequential measurements are usually the same. The third – Lip Rounding Index – is a synthetic measure based on two direct measures, which has not been tested repeatedly, but which is useful in evaluating the subjective observation that lip rounding was more common in the Upper Mesopotamia samples. Because we have so few measured bottle necks, the four site samples are combined into two regional samples. Even so, our regional sample from Lower Mesopotamia is tiny, but we use what we have.

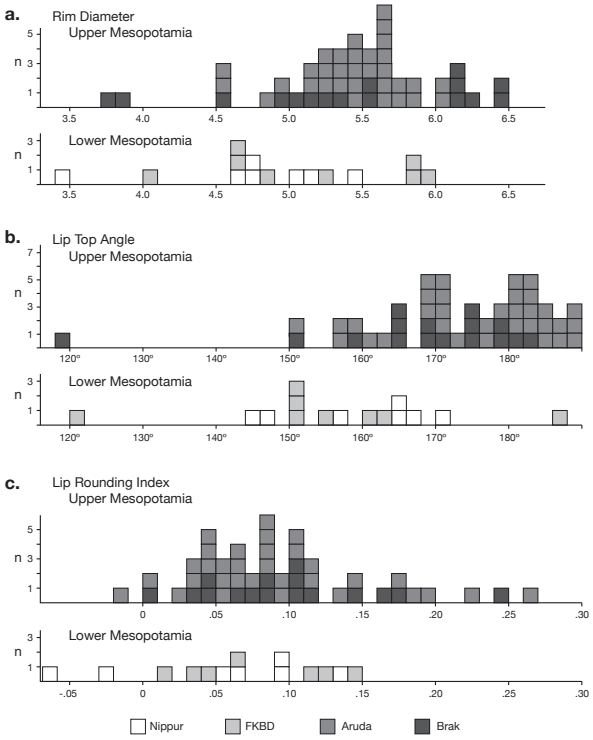

Fig. 12. Histograms of Rim Diameter, Lip Top Angle, and the Lip Rounding Index for the four Late Uruk bottle samples.

- Rim Diameter (**Fig. 12a**) is our best proxy for the size of a bottle. The distributions of Diameters for Nippur and Farukhabad in Lower Mesopotamia overlap completely and a non-parametric Mann-Whitney U test indicates that they are probably drawn from the same population. Likewise, the distributions of diameters for Brak and Aruda in Upper Mesopotamia overlap completely and the test indicates a similar probability. Visual examination of the histograms shows that the combined Lower and Upper Mesopotamian samples are slightly different. Both of them have a few small bottles with diameters between 3.4 and 4.5 cm, and a larger middle grouping between 4.5 to 6.0 cm in diameter. However, only Upper Mesopotamia appears to have a larger grouping between 6.0 and to 6.5 cm in diameter. It is interesting that most of these larger examples are from Tell Brak, where the excavated buildings were of the larger, tripartite plan. It could be that consumers in such larger buildings had access to more of whatever was distributed in bottles.

- Lip Top Angle (**Fig. 12b**) is a proportional variable, one that should not change as a function of vessel size. The distributions of Lip Top Angles for Nippur and Farukhabad in Lower Mesopotamia overlap completely and a non-parametric Mann-Whitney U test indicates that they are probably drawn from the same population. Likewise, the distributions of Lip Top Angles for Brak and Aruda in Upper Mesopotamia overlap completely and the test indicates a similar probability. Visual Examination shows there are outliers with Lip Top Angles of about 120°, and a scattering of Lip Top Angles at an oblique angle between 144° and 168° in both Lower and Upper Mesopotamia. Only in Upper Mesopotamia is there a substantial representation of bottles with Lip Top Angles greater than 168°. A Mann-Whitney U test indicates that the probability that the samples of bottles from Lower and Upper Mesopotamia were drawn from different populations is greater than .96. The fact that only 12% of the bottle necks from slightly earlier Brak sample have lips greater than 180°, while almost 50% of the bottles from the slightly later Aruda sample have such lips, suggests that in Upper Mesopotamia a vertical flat lip or collared variant was becoming more common. The

site-by-site visual characterization of rims suggested an increase in both rounded and flatter lips; evaluation of this idea requires a variable which separates flat from round rims.

- Lip Rounding Index (**Fig. 12c**) is a new variable designed to measure the extent to which lips vary from concave to flat to convex. This is measured from the 1:1 drawing of the rim section. First a line tangent to the curve of the lip is established; second, the length of the tangent between the upper lip and the lower lip is measured; third, the distance from this line to maximum curvature away from this line is measured: if the lip is convex, this number will be positive, if the lip is flat, this will be zero, and if the lip is concave, this will be a negative number. This third deviation measure is then divided by the second length measure to provide the scale free Lip Rounding Index. This is only a first approximation at designing a rounding index; the measures are not easy to make and the same observer can get different results on different days. In addition, this index does not identify three rims from Aruda, which have a distinct groove on the lip (**Fig. 10c**, **e**, **f**). Whatever its deficits this index for measured bottle necks ranges from -0.07 to +0.27. The distributions of the Lip Rounding Indices for Nippur and Farukhabad in Lower Mesopotamia overlap completely and a non-parametric Mann-Whitney U test indicates that they are probably drawn from the same population. Likewise, the distributions of the Lip Rounding Indices for Brak and Aruda in Upper Mesopotamia overlap completely and the test indicates a similar probability. In contrast to the Rim Diameter and Lip Top Angle, however, the combined samples from Lower and Upper Mesopotamia, show dissimilar distributions. A Mann-Whitney U test indicates that the probability that the samples of bottles from Lower and Upper Mesopotamia were drawn from different populations is less than .68. In Upper Mesopotamia, rather than a distinct large cluster as in Lip Top Angles, there is a long tail to the right, indicating a diminishing number of increasingly rounded lips.

There are several possible explanations for these differences.

a. Different techniques of forming the vessels: While all bottles were made with a fast wheel, there are differences in the tools used to finish the rims. Potters using wheels usually make a rounded lip with a soft piece of fabric or leather, but they make a flat lip with a straight "rib" of wood, bone, or metal. Perhaps potters in Upper Mesopotamia made less use of ribs, and more use of a soft smoother.
b. Different intended uses for varieties of bottles: Some uses, or at least some kind of stopper might require a stronger rim or a rim with a certain angle to tie the stopper in place.
c. Social differences between groups of potters: Potters learn motor habits which create distinctive shapes either unconsciously or deliberately to distinguish their work from others.

Third Step

The next step in comparing bottles from the four samples would be to use multivariate analysis to define underlying dimensions of variability captured by different measures in different ways. This step is best delayed until more measurements are available, as is outlined in the final section below. However, as a first step in such a multivariate approach, let us consider the relation between pairs of variables, easily presented as bi-variate cross-plots.

- The first cross-plot is that of Lip Top Angle and Relative Rim Height (**Fig. 13a**). This pair was selected first because in a previous study of complete jar rim assemblages these two variables separated the assemblage into a series of discrete clusters representing

different jar shapes. One of these clusters was ledge rim jars, represented on this cross plot by two points on the lower left. Most of the other points form a single diffuse cluster. Within this cluster, all but one of the bottles with Lip Top Angles between 168° and 190° are from Upper Mesopotamia, and most are from Aruda. This adds nothing to what we inferred from the histogram of Lip Top Angle.

- The second cross-plot is that of Lip Top Angle and Lip Rounding Index (**Fig. 13b**). This proves to be more interesting for several reasons. In the first place, in the lower central part of the plot there is a discrete cluster of bottles with Lip Top Angles varying from 145° to 167° and lips ranging from slightly concave to slightly convex. This includes most of the bottles from Lower Mesopotamia and a few from Upper Mesopotamia. There is a small linear scatter toward the lower right of the plot with similar Lip Top Angles, but increasingly marked lip rounding. The bottles in this linear scatter are from Upper Mesopotamia. In contrast, in the upper central part of the plot is a discrete cluster of bottles with Lip Top Angles between 168° and 190° and lips ranging from flat to slightly rounded. There is a small linear scatter toward the upper right of the plot with similar Lip Top Angles, but increasingly marked lip rounding. The bottles in these two clusters are largely from Upper Mesopotamia; most are from Aruda.

Given that we can assume that this ceramic tradition developed first in Lower Mesopotamia and that most ceramics including bottles were made close to where they were found, we can interpret the evidence of this bi-variate plot in terms of economic and social variation in a context of a migration of potters (Alden and Minc 2016). In Lower Mesopotamia, most bottles in our admittedly small samples have oblique, relatively flat rims. There are also some of these bottles with oblique flat rims from Upper Mesopotamia, particularly among the possibly earlier bottles from Tell Brak. In contrast, in Upper Mesopotamia most bottles have vertical flat or slightly rounded collars. There are also some of these bottles with collars from Lower Mesopotamia. Discrete clusters like these have to be maintained by some kind of practical considerations. One possibility is that the bottles with different types of lip had different kind of stoppers and perhaps therefore different uses. We cannot definitively test this idea because only one of three kinds of stoppers is well-defined – we have consistent recognition only of the conical stoppers sometimes removed with a pointed tool – but the internal scratches left by such tools are found in bottles with all types of lips. Another possibility is the clearly visible lip types marked the products of particular production traditions. Thus angular flap lips would mark a Lower Mesopotamian tradition, and flat collars would mark an Upper Mesopotamian tradition. Given that the NAA evidence indicates that very few vessels were moved from region to region, the few examples of collared lips in the south and angular lips in the north would be an indication of potters moving from one region to another. We will only be able to test this when we have better chronological control over samples of bottles from both parts of Mesopotamia and some understanding of workshop organization in the two areas. The small linear scatters to the right of the two clusters with markedly rounder lips have a different structure and require a different explanation. The fact that Upper Mesopotamian potters are increasing the rounding of some of both the angular and collared varieties of lip in the same way suggests an experimental process. This may simply be an innovation to increase the strength of the lip and thus of the neck as a whole. It is, however, worth noting that, in the local Late Chalcolithic ceramic tradition of Upper Mesopotamia, thickened round lips were common on both jars and bowls. It is possible that this is not an innovation but a borrowing of a technique from long-established local potters by potters manufacturing Uruk Ware.

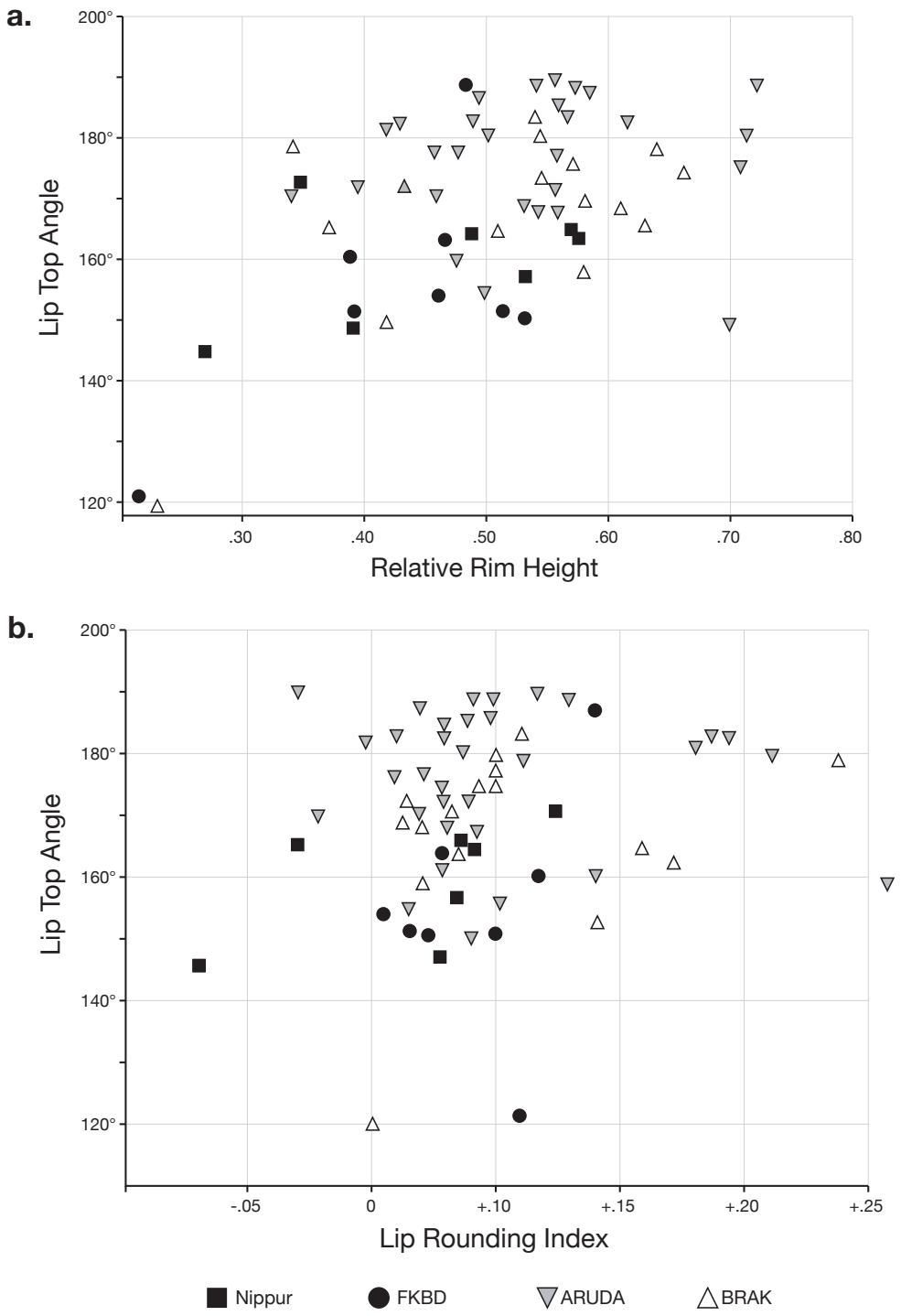

Fig. 13. Cross Plots of Selected attributes of the four Late Uruk bottle samples.

Future directions

There is more to be learned about Late Uruk bottles. This study using limited samples, simple measurement techniques, and basic statistical approaches, has resolved few issues, but it points to many directions for fruitful future research.

- First there should be attribute measurement of samples of Late Uruk bottles accessible in museums. I have already mentioned additional bottles in Farukhabad samples at the University Museum in Philadelphia and Peabody Museum at Yale, which not only would increase the sample

size of bottles from this site, but might show chronological change in bottles during the Late Uruk Period. Even more important are the large samples from Chogha Mish in Southwestern Iran (N33° 13' 37"/E 48° 33' 20"), Habuba Kabira South on the Middle Euphrates (N36° 09' 40"/ E38° 03' 30"), and perhaps Uruk itself (N31° 19' 25"/ E45° 38' 15"). Large recently excavated samples are available from the first two, and large excavations are planned in the near future at Uruk and other sites in Lower Mesopotamia proper with Uruk occupations. Additional measurements would allow multivariate analyses as discussed above.

- Second, petrographic identification of inclusions and Neutron Activation Analysis of actual bottle sherds from more sites will determine whether some bottles were transported out of their region of origin and would put to test our tentative inference of limited transport from region to region.
- Third, better knowledge of the uses of bottles is needed. Use-wear analysis undertaken by Carolin Jauss at the Freie Universität Berlin and residue analysis undertaken by Jauss at the lab of Richard Evershed at the University of Bristol show complex patterns of the uses of Uruk cooking jars. Such studies should be extended to other types of Uruk vessels such as bottles. Use and stopper technology must be better controlled with study of visible and microscopic scratches and also polishes (which we have not yet tried to study).
- Finally, the issues of production techniques variations of the habits of individual potters, which may have social implications, can most easily be studied with samples from production localities, rather than domestic discard localities. Uruk potting localities have been (de Miroschedji 1986; Delougaz et al. 1996; Alizadeh 2008) or are being (Vallet et al. 2017) excavated. Large samples from such kilns and potter's dumps should be kept, and subjected to detailed analyses.

References

Alden, John R., and Leah Minc. 2016. "Itinerant Potters and the Transmission of Ceramic Technologies and Styles during the Proto-Elamite Period in Iran." *Journal of Archaeological Science: Reports* 7: 863–76. DOI: 10.1016/j.jasrep.2016.03.022.

Algaze, Guillermo. 1993. *The Uruk World System: The Dynamics of Expansion of Early Mesopotamian Civilization.* Chicago: The University of Chicago Press.

Algaze, Guillermo. 1996. "Fourth Millennium B.C. Trade in Greater Mesopotamia. Did It Include Wine?" In *The Origins and Ancient History of Wine*, edited by Patrick E. McGovern, Stuart J. Fleming, and Solomon H. Katz, 89–96. Food & Nutrition in History & Anthropology Series 11. Amsterdam: Gordon and Breach Publishers.

Alizadeh, Abbas, ed. 2008. *Chogha Mish II: The Development of a Prehistoric Regional Center in Lowland Susiana, Southwestern Iran.* OIP 130. Chicago: The Oriental Institute of the University of Chicago.

Alizadeh, Abbas. 2014. *Ancient Settlement Systems and Cultures in the Ram Hormuz Plain, Southwestern Iran: Excavations at Tall-E Geser and Regional Survey in the Ram Hormuz Area.* OIP 140. Chicago: The Oriental Institute of the University of Chicago.

Amiet, Pierre. 1980. *La glyptique mésopotamienne archaïque.* Paris: Éditions du CNRS.

Badler, Virginia R., Patrick E. McGovern, and Donald L. Glusker. 1996. "Chemical Evidence for a Wine Residue from Warka (Uruk) Inside a Late Uruk Period Spouted Jar." *Baghdader Mitteilungen* 27: 39–43.

Berman, Judith C. 1986. "Ceramic Production and the Development of Complex Polities in Late Prehistoric Southwestern Iran." PhD diss., City University of New York.

Boehmer, Rainer Michael. 1991. "Uruk 1980-1990: A Progress Report." *Antiquity* 65: 465–78. DOI: 10.1017/S0003598X00080078.

Damerow, Peter. 2012. "Sumerian Beer: The Origins of Brewing Technology in Ancient Mesopotamia." *Cuneiform Digital Library Journal* 2. http://cdli.ucla.edu/pubs/cdlj/2012/cdlj2012002.html.

D'Anna, Maria Bianca, and Carolin Jauss. 2015. "Cooking in the Fourth Millennium BCE: Investigating the Social via the Material." In *Commensality: From Everyday Food to Feast*, edited by Susanne Kerner, Cynthia Chou, and Morten Warmind, 65–85. London: Bloomsbury.

Delougaz, Pinhas, Helene J. Kantor, and Abbas Alizadeh. 1996. *Chogha Mish: The First Five Seasons of Excavations; 1961-1971*. OIP 101. Chicago: The Oriental Institute of the University of Chicago.

El-Moslimany, Ann P. 1994. "Evidence of early Holocene summer precipitation in the Middle East." In *Late Quaternary Chronology and Paleoclimates of the Eastern Mediterranean*, edited by Ofer Bar Yosef and Renee S. Kra, 121–30. Tucson: Radiocarbon Publications.

El-Moslimany, Ann P. 2019. "Reduced Poaceae pollen under conditions of severe summer drought in the Middle East: Implications for rainfall seasonality in pollen diagrams." *Review of Palaeobotany and Palynology* 271: 1–4. DOI: 10.1016/J.REVPALBO.2019.04.007.

Emberling, Geoff. 2016. "Structures of Authority: Feasting and Political Practice in the Earliest Mesopotamian States." In *Social Theory in Archaeology and Ancient History: The Present and Future of Counternarratives*, edited by Geoff Emberling, 35–59. New York: Cambridge University Press.

Emberling, Geoff, Jack Cheng, Torben E. Larsen, Holly Pittman, Tim B. B. Skuldboel, Jill Weber, and Henry T. Wright. 1999. "Excavations at Tell Brak 1998: Preliminary Report." *Iraq* 61: 1–41. DOI: 10.2307/4200465.

Emberling, Geoff, and Leah Minc. 2016. "Ceramics and Long-Distance Trade in Early Mesopotamian States." *Journal of Archaeological Science: Reports* 7: 819–34. DOI: 10.1016/j.jasrep.2016.02.024.

Finkbeiner, Uwe. 1991. *Uruk Kampagne 35-37, 1982-1984: Die Archäologische Oberflächenuntersuchung (Survey)*. Ausgrabungen in Uruk-Warka 4. Mainz am Rhein: Philipp von Zabern.

Ghazal, Royal, Nicholas Kouchoukos, Robert J. Speakman, Michael Glascock, and Christophe Descantes. 2008. "Production Zone Sourcing and Intra-Regional Exchange of Ceramics in the Fourth Millennium BC Susiana Plain. An INAA Case Study, Appendix I." In *Chogha Mish II: The Development of a Prehistoric Regional Center in Lowland Susiana, Southwestern Iran*, edited by Abbas Alizadeh, 93–152. OIP 130. Chicago: The Oriental Institute of the University of Chicago.

Goulder, Jill. 2010. "Administrators' Bread: An Experiment-Based Re-Assessment of the Functional and Cultural Role of the Uruk Bevel-Rim Bowl." *Antiquity* 84: 351–62. DOI: 10.1017/S0003598X0006662X.

Hansen, Donald P. 1965. "The Relative Chronology of Nippur from the Middle Uruk to the End of the Old Babylonian Period (3400–1600 B.C.)." In *Chronologies in Old World Archaeology*, edited by Robert W. Ehrich, 201–13. Chicago: The University of Chicago Press.

Hritz, Carrie, and Jennifer R. Pournelle. 2015. "Feeding History. Deltaic Resilience, Inherited Practice, and Millennial-Scale Sustainability in an Urbanized Landscape." In *Viewing the Future in the Past: Historical Ecology Applications to Environmental Issues*, edited by Thomas Foster, David J. Goldstein, and Lisa M. Paciulli. Columbia, SC: The University of South Carolina Press.

Jauss, Carolin. 2015. "Pottery Vessels and Food Practice: Some Reflections on Vessels and Texts." In "Food and Urbanization: Material and Textual Perspectives on Alimentary Practice in Early Mesopotamia." Edited by Maria Bianca D'Anna, Carolin Jauss, and J. Cale Johnson, *Origini* XXXVII: 28–34.

Jauss, Carolin. 2018. "Cooking Techniques and the Role of Cooks in an Early Urban Society. Vessel Analysis, Experiment, Archaeological Context and Texts." *Zeitschrift für Orient-Archäologie* 11: 180–96.

Johnson, Gregory A. 1973. *Local Exchange and Early State Development in Southwestern Iran*. Anthropological Papers 51. Ann Arbor: Museum of Anthropology, University of Michigan.

Johnson, Gregory A. 1987. "The Changing Organization of Uruk Administration on the Susiana Plain." In *The Archaeology of Western Iran: Settlement and Society from Prehistory to the Islamic Conquest*, edited by Frank Hole, 107–37. Smithsonian Series in Archaeological Inquiry. Washington and London: Smithsonian Institution Press.

Johnson, J. Cale. 2015. "Deciphering the Late Uruk Butchering Texts." In "Food and Urbanization: Material and Textual Perspectives on Alimentary Practice in Early Mesopotamia.". Edited by Maria Bianca D'Anna, Carolin Jauss, and J. Cale Johnson, *Origini* XXXVII: 46–55.

Jones, Glynnis, Wardle, K. A., Paul Halstead, and Diana Wardle. 1986. "Crop Storage at Assiros." *Scientific American* 254 (3): 96–103.

Kirkby, Michael J. 1977. "Land and water resources of the Deh Luran and Khuzistan plains." In *Studies in the Archaeological History of the Deh Luran Plain. The Excavation of Chagha Sefid*, edited by Frank Hole, 251–88. Memoirs of the Museum of Anthropology, University of Michigan 9. Ann Arbor: Museum of Anthropology.

Le Brun, Alain. 1971. "Recherches stratigraphiques à l'Acropole De Suse (1969-1971)." *Cahiers de la D.A.F.I.* 1: 163–216.

Le Brun, Alain. 1978. "Le Niveau 17B de l'Acropole de Suse (Campagne de 1972)." *Cahiers de la D.A.F.I.* 9: 57–154.

Le Brun, Alain. 1985. "Le Niveau 18 de l'Acropole de Suse: Mémoire d'argile, mémoire du temps." *Paléorient* 11 (2): 31–36. DOI: 10.3406/paleo.1985.4391.

Matson, Frederick R. 1971. "A study of temperatures used in firing ancient Mesopotamian pottery." In *Science and Archaeology*, edited by Robert Brill, 65–79. Cambridge: The M.I.T. Press.

McGovern, Patrick E. 2017. *Ancient Brews: Rediscovered and Re-Created*. New York and London: W. W. Norton & Company.

McGovern, Patrick E., Stuart James Fleming, and Solomon H. Katz, eds. 1996. *The Origins and Ancient History of Wine*. Food & Nutrition in History & Anthropology Series 11. Amsterdam: Gordon and Breach Publishers.

Miller, Naomi F. 1981. "The Plant Remains." In *An Early Town on the Deh Luran Plain: Excavations at Tepe Farukhabad*, edited by Henry T. Wright, 227–32. Memoirs of the Museum of Anthropology, University of Michigan 13. Ann Arbor: Museum of Anthropology.

Minc, Leah. 2016. "Trace-Element Analyses of Uruk Ceramics. Establishing a Database to Track Interregional Exchange." *Journal of Archaeological Science: Reports* 7: 782–92. DOI: 10.1016/j.jasrep.2016.03.025.

Minc, Leah, and Geoff Emberling. 2016. "Trade and Interaction During the Era of the Uruk Expansion: Recent Insights from Archaeometric Analyses." *Journal of Archaeological Science: Reports* 7: 793–97. DOI: 10.1016/j.jasrep.2016.03.032.

de Miroschedji, Pierre. 1986. "Un four de potier du IVéme millénaire sur le tell de l'Alpadana." *Cahiers de la DAFI* 7: 13–46.

Neely, James A., and Henry T. Wright. 1994. *Early Settlement and Irrigation on the Deh Luran Plain: Village and Early State Societies in Southwestern Iran*. University of Michigan Museum of Anthropology Technical Report 26. Ann Arbor: Museum of Anthropology.

Nissen, Hans Jörg. 1970. "Grabungen in Den Quadranten K/L XII in Uruk-Warka." *Baghdader Mitteilungen* 5: 101–91.

Nissen, Hans Jörg. 1974. "Zur Frage Der Arbeitsorganisation in Babylonien Während Der Späturuk-Zeit." *Acta Antiqua Academiae Scientiarum Hungaricae* 22: 5–14.

Oates, Joan L. 2002. "Tell Brak: The 4th Millennium Sequence and Its Implications." In *Artefacts of Complexity: Tracking the Uruk in the Near East*, edited by John N. Postgate, 111–22. IAR 5. Warminster: Aris & Phillips.

Pittman, Holly, and M. James Blackman. 2016. "Mobile or Stationary? Chemical Analysis of Clay Administrative Devices from Tell Brak in the Late Uruk Period." *Journal of Archaeological Science: Reports* 7: 877–83. DOI: 10.1016/j.jasrep.2016.03.015.

Pollock, Susan. 1992. "Bureaucrats and Managers, Peasants, and Pastoralists, Imperialists and Traders: Research on the Uruk and Jemdat Nasr Periods in Mesopotamia." *Journal of World Prehistory* 6 (3): 297–336. DOI: 10.1007/BF00980430.

Pollock, Susan. 2001. "The Uruk Period in Southern Mesopotamia." In *Uruk Mesopotamia & Its Neighbors: Cross-Cultural Interactions in the Era of State Formation*, edited by Mitchell S. Rothman, 181–231. SAR Advanced Seminar Series. Santa Fe: SAR Press.

Pollock, Susan. 2012. "Politics of Food in Early Mesopotamian Centralized Societies." *Origini* XXIV: 153–68.

Pollock, Susan, Melody Pope, and Cheryl L. Coursey. 1996. "Household Production at the Uruk Mound, Abu Salabikh, Iraq." *American Journal of Archaeology* 100 (4): 683–98. DOI: 10.2307/506673.

Pournelle, Jennifer R. 2003. "Marshland of Cities. Deltaic Landscapes and the Evolution of Early Mesopotamian Civilization." PhD diss., University of California. DOI: 10.13140/RG.2.2.34918.11847.

Pournelle, Jennifer R. 2019. "Fields, Gardens and Staple States." *The Journal of Peasant Studies* 6 (4): 878–84. DOI: 10.1080/03066150.2019.1609777.

Redding, Richard W. 1981. "The Faunal Remains." In *An Early Town on the Deh Luran Plain: Excavations at Tepe Farukhabad*, edited by Henry T. Wright, 233–61. Memoirs of the Museum of Anthropology, University of Michigan 13. Ann Arbor: Museum of Anthropology.

Rothman, Mitchell S., Rifat Ergeç, Naomi F. Miller, Jill Weber, and Gülriz Kozbe. 1998. "Yarım Höyük and the Uruk Expansion (Part I)." *Anatolica* XXIV: 65–145. DOI: 10.2143/ANA.24.0.2015477.

Strommenger, Eva. 1980. *Habuba Kabira: Eine Stadt vor 5000 Jahren.* Sendschrift der DOG 12. Mainz: Philipp von Zabern.

Sürenhagen, Dietrich. 1978. *Keramikproduktion in Ḥabūba Kabira-Süd: Untersuchungen zur Keramikproduktion innerhalb der Spät-Urukzeitlichen Siedlung Ḥabūba Kabira-Süd in Nordsyrien.* Berlin: Hessling.

Vallet, Regis, Johnny S. Baldi, Hugo Naccaro, Kamal Rasheed, Saber Ahmad Saber, and Sami J. Hamarasheed. 2017. "New Evidence on Uruk Expansion in the Central Mesopotamian Zagros Piedmont." *Paléorient* 43 (1): 61–87. DOI: 10.3406/paleo.2017.5752.

van der Leeuw, Sander. 1994. "The Pottery from a Middle-Uruk Dump at Tepe Sharafabad, Iran. A Technological Study." In *Terre cuite et société*, edited by Didier Binder, 269–301. Antibes: Editions A.P.C.D.A.

van Driel, Govert, and Caroline van Driel-Murray. 1979. "Jebel Aruda, 1977-78 Seasons." *Akkadica* 12: 12–28.

van Driel, Govert, and Caroline van Driel-Murray. 1983. "Jebel Aruda, The 1982 Season of Excavation. Interim Report." *Akkadica* 33: 1–26.

Wagensonner, Klaus. 2015. "Vessels and Other Containers for the Storage of Food According to the Early Lexical Record." In "Food and Urbanization: Material and Textual Perspectives on Alimentary Practice in Early Mesopotamia." Edited by Maria Bianca D'Anna, Carolin Jauss, and J. Cale Johnson, *Origini* XXXVII: 15–27.

Wright, Henry T. 1969. *The Administration of Rural Production in an Early Mesopotamian Town.* Memoirs of the Museum of Anthropology, University of Michigan 38. Ann Arbor: Museum of Anthropology.

Wright, Henry T., ed. 1981. *An Early Town on the Deh Luran Plain: Excavations at Tepe Farukhabad.* Memoirs of the Museum of Anthropology, University of Michigan 13. Ann Arbor: Museum of Anthropology.

Wright, Henry T. 2001. "Cultural action in the Uruk world." In *Uruk Mesopotamia & Its Neighbors: Cross-Cultural Interactions in the Era of State Formation*, edited by Mitchell S. Rothman, 123–48. SAR Advanced Seminar Series. Santa Fe: SAR Press.

Wright, Henry T., and Elizabeth Carter. 2003. "Archaeological Survey on the Western Ram Hormuz Plain 1969." In *Yeki Bud, Yeki Na Bud. Essays on Iranian Archaeology in Honor of William Sumner*, edited by Naomi F. Miller and Kamyar Abdi, 61–82. Los Angeles/Philadelphia: Cotsen Institute of Archaeology/American Institute of Iranian Studies.

Wright, Henry T., and Eric S.A. Rupley. 2001. "Calibrated Radiocarbon Age Determinations of Uruk-Related Assemblages." In *Uruk Mesopotamia & Its Neighbors: Cross-Cultural Interactions in the Era of State Formation*, edited by Mitchell S. Rothman, 85–122. SAR Advanced Seminar Series. Santa Fe: SAR Press.

Zarnkow, Martin, Adelheid Otto, and Berthold Einwag. 2011. "Interdisciplinary Investigations into the Brewing Technology of the Ancient Near East and the Potential of the Cold Mashing Process." In *Liquid Bread: Beer and Brewing in Cross-Cultural Perspective*, edited by Wulf Schiefenhövel and Helen M. Macbeth, 47–54. New York: Berghahn Books.