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Münchener Abhandlungen zum Alten Orient

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Weights and Measures as a Window on Ancient Near Eastern Societies

edited by

Grégory Chambon and Adelheid Otto

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Preface

Grégory Chambon – Adelheid Otto

The study of metrology can open up new pathways into the study of Near Eastern societies. This, however, requires systematic interdisciplinary research, since the material and the written sources contain complementary information. Therefore, the editors of this volume—a French epigraphist and a German archaeologist, both interested above all in the historical and socio-cultural relevance of ancient sources—initiated the interdisciplinary project METROLOGIA. The idea was to go beyond the quantitative approach and to develop methods by crossing archaeological and epigraphic data, in order to understand the far-reaching implications of metrology for society and economy in the Ancient Near East.

The project was based on the cooperation between the University of Brest (Université de Bretagne Occidentale and Centre François Viète) on the one side, and the universities of Mainz (Johannes Gutenberg-Universität), then Munich (Ludwig-Maximilians-Universität) on the other side. Members of the METROLOGIA project were (in alphabetic order): Abdulmuin Almohemid, Stefanie Boskugel, Grégory Chambon, Sarah Clegg, Berthold Einwag, Christoph Fink, Michaël Guichard, Ioannis Kanellos, Janoscha Kreppner, Denis Lacambre, Anna Lorente-Gall, Lionel Marti, Martine Melein, Adelheid Otto, Tanja Pommerening, Lorenz Rahmstorf, Fabian Sarga.

Several scholars of other universities and countries were cooperating with this core group. The meetings during the first two years (2012-2013) were funded by the DAAD (German Academic Exchange Service) and Campus France (Partenariat Hubert Curien)[1]; the cooperation has been continued ever since.

Some of the results of the METROLOGIA project were presented in the workshop "Weights and Measures as a Window on Ancient Near Eastern Societies", which took place in Munich on December 14, 2013.[2] Other results were published elsewhere, some of them in the important volume on "Weights and Marketplaces", edited by Lorenz Rahmstorf and Edward Stratford in 2019. Rahmstorf's approach towards metrology is a cross-cultural one, since the principles of controlled economic exchange were similar in the ancient world and because most of the metrological systems stood either in direct contact or were developed on the model of previous ones.

The contributions by the members of the METROLOGIA Project form the core of this publication. Additionally, it includes papers that were handed in by invited speakers during the 2013 workshop in Munich (Etienne Bordreuil, Nicholas Postgate). Two more papers by William B. Hafford and Luca Peyronel perfectly complement the purpose of this publication and have been included during the last stage of the editorial work.

Many contributions by members of the METROLOGIA project resulted from work carried out jointly and were presented collectively. This form of presentation is based on the observation that a complementary approach between philologists and archaeologists and the pooling of research results can enrich considerably the studies on metrology.

1 Unfortunately, supranational research funding initiatives are far too rare still today. The more so are our sincere thanks due to the DAAD and to Campus France for bringing scholars from different countries, but working on similar topics, together.

2 We thank the Fritz Thyssen Foundation, which supported the workshop. It focused on the following questions: How was royal ideology concretised in practical life and "material culture"? To what extent did the royal authority control the use and development of standards in the field of weights and measures? Which other social groups were able to use and develop their own standards of measurement? How can we understand the process of 'standardisation' in the field of weights and measures? What was their social function in the Ancient Near East?

We would like to thank all the members of the METROLOGIA project for their long lasting cooperation, and the contributors to this volume for their in-depth studies of socially relevant aspects of metrology. Our apologies and sincere thanks are due to Etienne Bordreuil, Sarah Clegg, Lorenz Rahmstorf, and Nicholas Postgate, who submitted their papers many years ago. It took much longer than scheduled to assemble the papers and edit this volume. Our thanks are also due to Martin Gruber for the layout of this volume, to Ilona Spalinger for correcting the English of all papers, to Peter Werner of the PeWe editing house for his continuous assistance, and to the Institute of Near Eastern Archaeology at LMU Munich for supporting this publication.

The cover image of this book expresses well the aim of the collected contributions. It was taken in 2009 at a rest stop in Iran, where A. Otto observed oranges being weighed as a matter of course with simple stones that were no more officially calibrated than most in the Ancient Near East. Metrology is determined by sellers and buyers, by the acceptance and the regulations of society, and is therefore an ideal window into past ideas and concepts.

New perspectives in the study of weights and measures of the Ancient Near East

Grégory Chambon – Adelheid Otto

§ 1. Why weights and measures can serve as a window on Ancient Near Eastern societies

Trade and exchange connect people who share different habits and cultural values and who have possibly never met before. Thus, the *conditio sine qua non* of every functioning economy is the control of trade or, at least, of the practice of giving and counter-giving. Different means of control had developed over times in the Ancient Near East, the most important being the oversight of the payment and the "trade tools", especially the weight stones and balances, capacity measures, and seals. The control took place either centrally by the state, a temple, other institutions, or simply by counter-weighing. While these mechanisms seem to have been fairly similar in many cultures of the Near East, Egypt, the Aegean and the Indus region from at least the third millennium onwards, the metrological systems varied; different weight standards were in use in the mentioned extended areas and were disseminated through economic and cultural contacts (Powell 1987–1990).[1]

The study of weights and measures has developed into a separate field of study, metrology, which had often been considered as a minor research area of natural or economic sciences. But it is much more. The large variety of measuring systems and the diversity of ancient measuring methods represent important cultural markers of individual ancient societies. Metrology is not only relevant at a technical and mathematical level, but holds enormous historical and socio-cultural potential, because it involves human activities, gestures and social relationships that manage and control measurement practices within the framework of cultural traditions and innovations. The material weights and capacity containers constitute—despite their little spectacular appearance—an essential tool for defining cultural zones and borders and for understanding internal administrative procedures and external relations at a trading and political level. However, the relevance of metrology goes much further, well into the private sphere of individuals. Legal certainty has been the base of most functioning societies, and not only texts but also depictions in various pictorial media emphasize the role metrology played with respect to the ancient concepts of law, justice and righteousness, as will be shown in the following.

Archaeology and philology used to pursue their own methodological approaches towards studying the measures and weights of the Ancient Near East, based on the artefacts found in excavations or on the information gained from cuneiform texts. However, only the combined analysis of philological and archaeological sources allows the determination of the individual measuring and weight systems on site, and conclusions on the organisation of the local economic systems and the interre-

1 Rahmstorf (2012: 315): "The study of 3rd millennium weights […] in the region from the Aegean to the Indus Valley has shown that most probably only a handful of units of weights were in contemporaneous use around the middle of the millennium: one weight system with three interrelated weight units (7.83 g; 9.4 g; 11.75 g) in the East Mediterranean (Syria, Anatolia and the Aegean), one in the Indus region with a unit of 13.71 g, a Mesopotamian system of weight with a unit of c. 8.33 g, and finally an Egyptian unit (13–14.5 g?), which as yet escapes any precise fixation for the 3rd millennium BC […]"

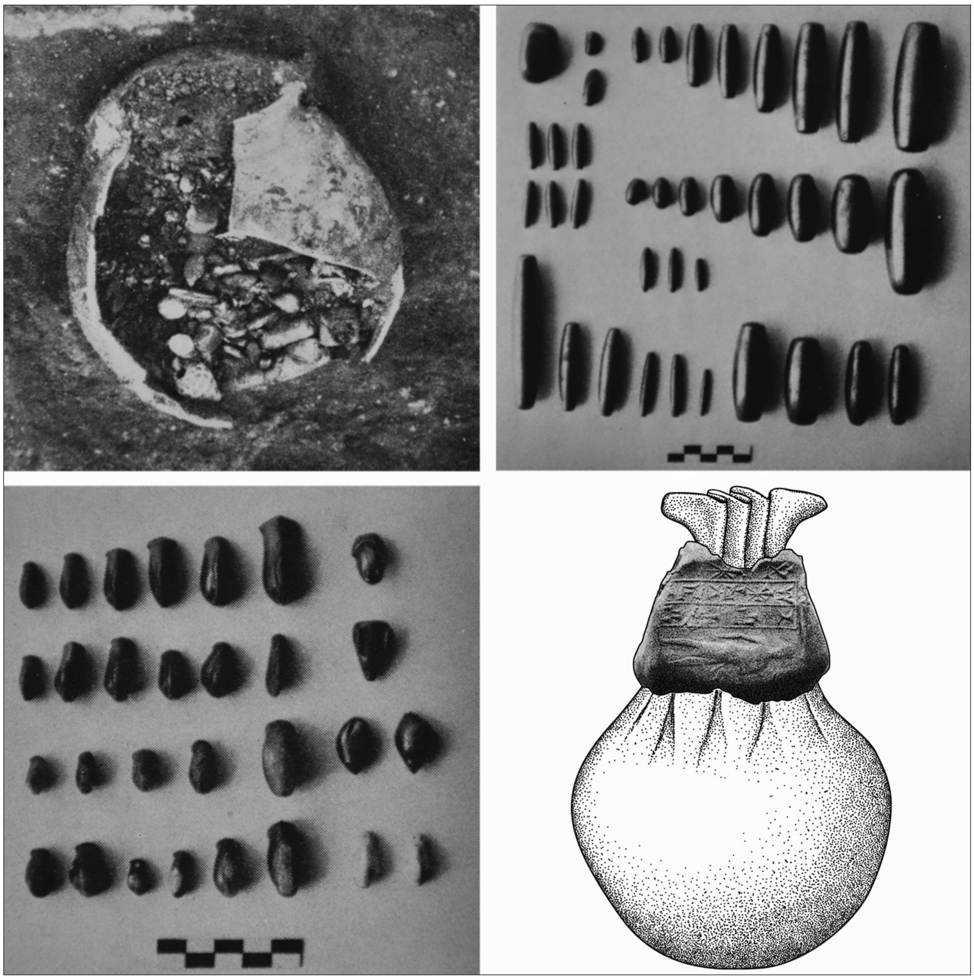

Fig. 1. The Larsa Hoard with sets of sphendonoid and duck-weights (Arnaud et al. 1979: Figs. 5, 15, 18) and the reconstruction of a sealed silver sack (A. Otto/M. Lerchl/photo of sealing: Arnaud et al. 1979: Pl. I,2).

gional political, cultural and economic contacts.[2] These range from the reconstruction of economic activities at local level (the administration of the palaces and temples, the management of resources etc.) to the relations at international level (trade, the exchange of presents between royal courts, military tributes etc.). Already in the third and second millennium, a successful economy was the basis for many flourishing societies, and sometimes those depending mainly on trade were strong enough to do without any royal authority.[3]

Yet, the study of weights and measures should not only serve an economic perspective through a quantitative approach, but should also take into account the political and social objectives as well as anthropological aspects of weighing and measuring. Nowadays, the interest in metrology is closely linked with the current debate concerning such concepts as "money", "market exchange" or "private business", which is largely based on the study of the circulation of precious metal—mostly silver—in Near Eastern societies (Powell 1996; Paoletti 2008; Van der Spek et al. 2018; Rahmstorf et al. 2021). In particular silver was used as a reference value and a medium of "commercial" exchange.[4] Since silver used to be recycled

2 This combined method has been successfully applied with the determination of Egyptian measures of capacity (Pommerening 2005).

3 It has to be pointed out that Near Eastern societies were organised differently; hierarchical power exercised in palatial systems were one model of organised power, but not the only one. Heterarchical models of power were frequent especially in societies which depended heavily on commerce, e. g. in the Old Assyrian–Old Anatolian trading communities or in Northern Mesopotamia during the Late Bronze Age—to name just a few.

4 The debate between the Substantivist and Formalist Schools, concerning whether the "money" function of silver existed or not (see

again and again and is found only in rare instances during excavations, e. g. when a hidden hoard had escaped the attention of ancient potential users, the early "money" must be studied through the balance weights that served for weighing the currency.[5] Only after stamped metal coins had come up in 6th century West Asia (Von Kaenel 2012), the weighing of the silver currency (or more rarely other metal) was no longer necessary. But already 2000 years earlier, weighed and sealed silver (*kaspum kankum*) was the obvious early currency, although not the silver itself, but the attached labels or clay closures of sacks containing the silver were impressed with seals (Stol 1999: 574),[6] which was described as *kīsum qadum kunukkiša*.[7]

This kind of "sealed silver" has been evidenced e. g. in the "Hoard from Larsa" (Arnaud et al. 1979). It comprises the equipment of the weighing office in the temple of the sun god or his daughter (more precisely in the *bît kittim*, the office for weights and measures; see Charpin 2017), where several balance weight sets of geometric and zoomorphic shapes were associated with large amounts of hacksilver, jewellery, seals and sealings. Although the respective involvement of the power organisations (palace, temple) in the control of the measuring process is still unclear, this case study exemplifies the procedures of controlled payment: precious metal was weighed, packed in small sacks, then the sack closure was sealed and the mass inscribed in the sealing by the officer for weights and measures (**Fig. 1**).[8] Therefore weight stones, silver, and seals had been closely interconnected from at least the third millennium onwards, since they were but different instruments within the same control system.[9]

Furthermore, some expressions in cuneiform texts refer to the certification of the quality and the value of silver, which was given to persons or used for trade (Chambon/Marti 2019). This value was determined by a certification office not mentioned in the texts (maybe an office for weights and measures, as seen above) and seemed to depend on the individual cities, because the texts mention amounts of silver weighed "according to the weights of this or that city", which certainly refers to both the market rate and the local economy. How these values were established therefore not only depended on economic conditions, but also on political decisions. In parallel with trade, the ceremonial exchange of silver between the elites occurred mainly through standardised objects, i. e. vessels and rings, which have both symbolic and economic value (Peyronel 2014: 310). Some evidence in the administrative documentation suggests that one should differentiate between the physical amount (the mass) of a precious object (Akkadian *kīnum*) and its "nominal value" (Akkadian *nībum*), i. e. a conventional value, which is based on a consensus among the parties in the diplomatic gift exchange of inter-state relations (Chambon/Marti 2019: 53–54). Thus, weighing and setting values took place within an economic as well as an ideological framework. The process of silver certification also involved social relationships between the political authorities and the weighmasters, who could be officials, merchants or craftsmen (Bartash 2019: 152–168).

§ 2. Philological and archaeological data on metrology

The Ancient Near East provides a wealth of material and epigraphic evidence with respect to weights and measures. However, it must be stressed that the studies of Mesopotamian metrology have so far not tapped their full potential since—on the one hand—many of them have been serving primarily the purpose of economic history, by giving quantitative data (amounts of commodities, weighing metals, field measurements …), and—on the other hand—because the archaeological and epigraphic information has been studied independently without being correlated or cross-referenced.

a summary of this debate in Stol 2004: 904–911), has been recently challenged: see Peyronel 2014 for the discussion on the role of silver in economic exchange.

5 The ongoing Italian SCANE project has been investigating silver hoards, hacksilver and weights more closely, Peyronel 2019 and in this volume. Reade 2018: 177 describes the situation for the 1st millennium: "The use of weighed silver money became essential to the Neo-Assyrian economy, but nearly all of the money has been buried or recycled and is no longer directly accessible. Its use can be studied in indirect ways, notably through the written documentation and through the evidence of artefacts such as inscribed weights and their archaeological associations."

6 Moneybags are also attested for other periods (see e. g. Vargyas 2005).

7 AEM I/2 387 no. 463 rev. 8; Stol 2004: 884–885.

8 Arnaud et al. 1979; Charpin 2017: 86–99: Half a mina silver, 66 weight stones, beads, cylinder seals and sealings were found together in a clay pot which had been hidden under a bench of Room 13 of the É.babbar shortly before the destruction by Samsu-iluna in 1738 BC. Some of the sack closures had been sealed with the seal of a certain Sîn-usili, weighing official of the *bît kittim* of Ur (KÙ.LÁ É.GI.NA *ša* URÍ), servant of Samsu-iluna. See also Otto/Chambon in this volume.

9 For the development of record-keeping procedures such as bullae, tags, seals and sealings, weights, containers from the 3rd millennium onwards, see Peyronel 2021.

The cuneiform documentation gives abundant information on metrology. From the archaic texts of Uruk at the end of the 4th millennium BC onwards, repertories of signs for numbers and measures used in the administrative documentation had evolved for several centuries. A dozen of numerical and metrological systems, which depended on the quantified or measured products, have been identified in these archaic documents (Nissen et al. 1993). Both quantitative and qualitative information is most often embodied in the same sign, whose numerical or metrological value depended on the system used. The first clear distinction between the signs for numbers or measures and the signs for products or objects, which became the rule during the 3rd millennium BC, has been interpreted as the emergence of a concept of "abstract numbers", not depending on the quantified objects or measured products.[10] But we have to keep in mind that this distinction was realised on clay according to scribal practices, which followed specific cultural traditions. We do not know to which extend it reflects the conception of numbers and measures of the ancient Mesopotamians. According to the epigraphic evidence, it actually seems that the notions of "container" (material), "content" (commodity) and "volume" (capacity measure) were highly intertwined.[11]

For example, vessels of standard volumes were used as a gauge unit for transporting liquids (wine or oil), and names of certain containers, given in particular on lexical lists, were confused with the capacity unit corresponding to their capacity. The main systems of notations for measures used in administrative texts until the 1st millennium BC concern capacities, weights, surfaces and lengths, and served as a means for managing and controlling the movements of goods and services by facilitating accounting practices.[12]

The earliest standardised material weights emerged with the formation of complex urban societies and city-states at the end of the 4th and beginning of the 3rd millennium (see Ascalone/Peyronel 2006a: 475–488 for an overview). Commodities were rare in the Mesopotamian lowlands and subsistence strategies had to be complemented by exchange and trade from the Chalcolithic period onwards. But also settlements in Northern Mesopotamia and Syria were heavily dependent on exchange and trade.[13] A few stone objects from Tepe Gawra Levels IX–VI, dated to the early Middle Uruk period (early 4th millennium), are among the earliest scale weights known so far (Hafford 2019). More weight stones from the Late Uruk period have been published recently: they originate from the Late Uruk trading station of Habuba Kabira South:[14] At least three of the eight recorded haematite pieces may be considered as balance weights, the remaining ones could be nodules of the precious raw material iron oxide, which occurs in the limestone heights bordering the nearby Euphrates valley (Melein 2018).

The first period for which the use of material weight stones is confirmed by textual evidence, namely a writing system including weight units, is the so-called Early Dynastic III period (c. 2600 BCE). The demand for standardised metrological values was clearly caused by the extension of trade and the increasing need for copper and other metals by the continually enhanced handicraft from the 5th millennium onwards. This growing need led to the conceptual and practical development of weighing and measuring on the one hand, and of the notation of metrological units on the other hand.

The material evidence of Near Eastern metrology seems to be quite abundant at first sight, but is relatively scarce, not only for objects connected with measuring, but even for those involved in weighing purposes. Millions of balance weights must have existed, if we assume that every man and woman who was involved in trading and selling activities during 3000 years of Near Eastern history must have possessed weights, more precisely sets of them. However, only several thousands of balance weights have been published or exhibited in museum collections so far. Only a fraction of them had come to light during regular excavations at archaeological sites in the vast area in and around Mesopotamia from the Mediterranean region to the Iranian plateau, and from Anatolia to the Persian Gulf.[15]

10 Damerow 2017. Concerning the issue of "abstract" numbers versus "concrete" numbers, see Overmann 2018.

11 See the remarks in Chambon 2011a: 50 and 68 and Chambon/Marti 2020: 89–90. In the lexical lists in particular, terms for units of measurement are included in (and often confused with) the names of containers and vessels (for example ^{dug}s i l a$_3$, "ceramic vessel of 1 (measure-)s i l a$_3$" or "^{dug}1 b á n", "ceramic vessel of 1 (measure-) b á n").

12 For an overview of these measuring systems, see Chambon 2021.

13 For example, Mari was situated in a very unfavourable place, outside the rainfed zone, in a fairly narrow fertile plain of the Euphrates valley. From its very beginning in the early 3rd millennium, this major Syro-Mesopotamian city could never have existed without an economic surplus through massive trade activities.

14 Strommenger et al. 2014: 271, Oberfl.: 44, AA X:71, DD XII:1, Oberfl.: 54; Pl. 165,9. More objects that are tentatively named gaming pieces might be balance weights, e. g. Pl. 164,2–10.

15 Good overviews of balance weights and studies on weights are offered by Alberti et al. 2006; Hafford 2012; Rahmstorf 2014; Kulakoğlu 2017. Unfortunately, even excavated and stratified weight stones have not been fully published, therefore every pub-

The disturbing scarcity of existing balance weights has several reasons, e. g. metal weights can have melted down, and the extremely stable stone weights can have been in constant use for centuries. We are, however, convinced that the main reason lies in our wrong conception of weights, which has urgently to be revised—hopefully also with the help of this volume. It is widely assumed that weight stones were of regular shape and corresponded to a few well-defined shapes (see **Fig. 1**), such as the sphendonoid, dome- or duck-shape, or—less frequently—the cylindrical, conical, spherical, cubical, ovoid, loaf or stele form.[16]

Yet, irregular forms of weights are by far more common than assumed. They fall into two categories: 'irregular weights', which are of various amorphous forms, but show clear traces of intentional working, and 'pebble weights', which are unworked stones used as weights—also called "make-weights". The latter can be detected only by their archaeological context or if they bear marks or inscriptions (Hafford 2005: 353–354). For example, an irregular goethite weight and a beautifully shaped haematite duck-weight were found together with two fayence Mittani Common Style cylinder seals and a bead in a house of 14th century Tall Bazi (**Fig. 2**).[17]

Fig. 2. An irregular goethite weight, a haematite duck-weight, two fayence cylinder seals and a bead found together in a house of 14th century Tall Bazi.

Certainly not every pebble was a weight stone, and it is often difficult to distinguish them from gaming pieces, tokens used for accounting, polishers, pounders or sling bullets (Hafford 2019: 17). But only when every single small, medium-sized and large stone is collected during excavations—a demanding task for archaeologists even today and clearly impossible in the former large-scale excavations with hundreds of workmen—it will become obvious how numerous the irregular and pebble weights were. Especially in regions close to the sources of the raw material, mostly iron oxide stones, the irregular and pebble weights outnumber the regularly shaped weights by far, e. g. at Ebla (Ascalone/Peyronel 2006a; 2006b) or Tall Bazi (Fink 2012 and in this volume).

Weighing scales have been found even more rarely than weighing stones, because parts of them were from organic material and perishable (strings and wooden parts such as the beams), and the balance pans—if they consisted from copper or bronze—were frequently melted down. Not many metal balance pans have survived in archaeological contexts, of which only a few recently discovered ones are mentioned here. Several pairs of small balance-pans—the equipment *par excellence* of the Assyrian and Anatolian merchants—were found in graves at Kültepe-Kaneš levels II and Ib (Kulakoğlu 2017). In Late Bronze Age Ugarit, several bronze balance pans, stone and metal weights were found (Bordreuil in this volume). One of the best examples of scales, which were found together with sets of weight stones, was found buried in the Late Bronze Age Uluburun shipwreck. According to C. Pulak, this was the professional equipment of a handful of Syro-Canaanite merchants travelling on this ship from the Levantine coast to the Mycenean centres; the 149 objects from the shipwreck which were catalogued as balance weights fall into four sets of sphendonoid precision weights for weighing silver or gold bullion, three sets of domed weights for weighing heavier goods, and several zoomorphic weights (Pulak 2000; 2008). Seven pairs of scale pans associated with balance weights have also been found in the Late Bronze Age houses in Akrotiri/Thera (Michailidou 2008). Even the remains of a large balance for weighing heavy commodities have been reported: A large carbonized balance beam found together with an ovoid pendant weight of 2 mina and unworked pieces of lapis lazuli served for weighing the precious commodity under royal supervision in Palace G at Ebla (Peyronel 2019: 69–70).

lication in this respect is extremely valuable; see the contribution by Rahmstorf in this volume.

16 Hafford 2005; 2012; Peyronel 2019. Hafford's study of 476 weights excavated by Woolley at Ur resulted in 307 (64.5 %) sphendonoid and 92 (19.3 %) duck weights (Hafford 2012: 30, Table 2). The total number of only 33 weights from the large Old Babylonian house quarter AH is much too low, if compared with the number of weights found in recent excavations at Ur (see Hafford/Einwag/Otto in this volume), and is just one of many examples for the little attention that weights and pebbles have received in most excavations.

17 Weststadt of Tell Bazi, House 41 South, secondary room e. Otto 2006: 120–125, Fig. 62.3 ; 64.1–2. The mass of the irregular weight (Bz 29/31:5) is 13.1 g, the mass of the duck-weight (Bz 29/31:3) is 16.0 g (see Fink in this volume).

Fig. 3. Syro-Hittite commemorative stele of a merchant holding two balances (Bonatz 2000: Pl. IX, C10).

Ancient images are our second archaeological source of metrology. A scene on the Rassam Obelisk found at Kalhu, dated to the reign of Aššurnasirpal II (883–859 BCE), shows two Neo-Assyrian officials weighing what may be round metal bars on a huge balance scale and provides an idea of what the weighing practices of heavy metal pieces might have been (Reade 1980). Another scene, on the famous wall relief depicting the looting of the Haldi temple in Muṣaṣir by the troops of Sargon II (Albenda 1986: pl. 133), relates the dismemberment of metal statues to the weighing procedures on large standing balances and also illustrates how quickly even objects bearing ritual significance could be reduced to their purely material value.

In general, scenes of everyday life were never depicted in Near Eastern pictorial media unless they fulfilled a specific function for the status or ideology of the image's sender or receiver. Consequently, the weighing or measuring procedures were only illustrated when the divine or royal role in the protection and warranting of the procedures should be emphasised. Therefore, it may

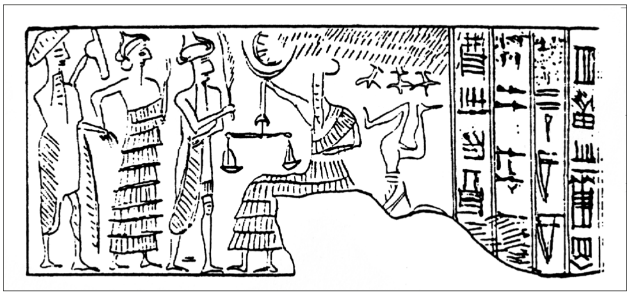

Fig. 4. Impression of a merchant's seal from Karum Kanesh II (Teissier 1994: no. 532).

be argued that the few depictions of the act of weighing were essential for the owner or sponsor of the image. The private Syro-Hittite memorial stele, depicting a merchant holding a small hand-held scale in both hands, emphasises that the balance was the tool par excellence and identifying feature of a merchant (**Fig. 3**).[18] In the case of cylinder seals with depictions of weighing and measuring practices, we can assume that they belonged to merchants, market overseers, official weighmasters or alike. For example, two Syro-Cappadocian seal impressions on tablets from Karum Kaneš II each show an audience scene in front of a deified king or god who is manipulating a hand-held balance, thus illustrating the royal or divine control over trade. One seal owner is qualified as a merchant (Sumerian dam.gar) by the inscription (**Fig. 4**).[19] The other seal is even more explicit and refers not only to the weighing but also to the measuring process (see below, **Fig. 12**, with further comments).

There is abundant textual evidence that not only balance weights, but also standardised vessels of different capacities were produced in order to facilitate the practical and economic activities of daily life (see e. g. Gruber 2015). Their size and range were configured according to the needs of storage, transport and trade exchange and could vary from place to place. Capacity measures most often appear as measures of dry commodities such as grain, predominantly barley (as ^{giš}ba.ri$_2$.ga/*parsiktu*, ^{giš}ban$_2$/*sūtu*, anše/*imēru*, ^{giš}PA/*parīsu* etc.), but standardised jars[20] were also used to transport

18 Stele from sandstone, H. 0.55 cm. Paris, Louvre AO 19221; probably from Maraş (Bonatz 2000: 17).

19 Seal impression from Karum Kaneš II (Teissier 1994: 178, no. 532).

20 For example, according to the Old Babylonian text ARM 9 n°6 from Mari, a "standardised" jar (dug/*karpatum*) for oil transport contains 10 (measure)-sila$_3$ (= 10 or 5 liters, depending on the modern value given to sila$_3$ in the region of Mari: see for this issue Chambon 2011a: 178–179 and Reculeau 2018: 109). We thank Laurent Colonna d'Istria for informing us that, during the period of

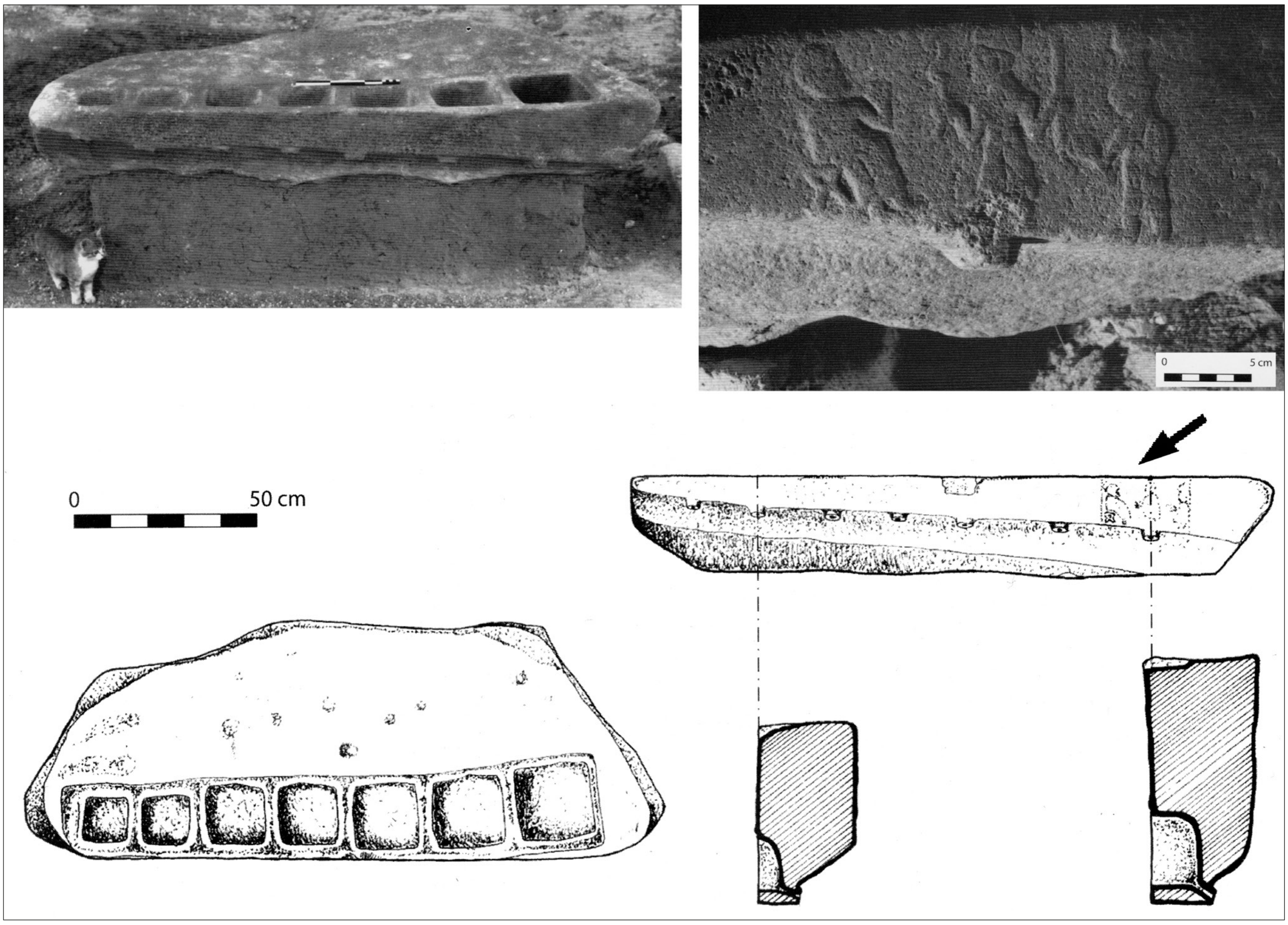

Fig. 5. Capacity measuring table TT.81.F.100 from Tall Tuqan, decorated with a man holding balance and strickle (Baffi 2006: 292 Figs. 1–2).

or distribute oil and wine (*karpatum*, *našpakum*, *diqārum* etc.). The determinatives of these vessels mentioned in thousands of cuneiform texts inform us that these vessels of standardised volume consisted mainly of wood (GIŠ) or reed (GI). The archaeological remains of capacity measures, by contrast, are disappointingly meagre: not a single measuring standard vessel—i. e. a container which could easily be manipulated for measuring dry products like barley, flour or fish, or liquid products like beer, oil, dairy products and others—has been materially identified so far. In this respect, it is useful to throw a glance at Egypt, where metal and wooden standard vessels used for measuring grain—often of cylindrical form—have been preserved; additionally, there are numerous depictions of the measuring of grain and other agricultural products in cylindrical vessels, especially from the Old Kingdom (see e. g. Pommerening 2013). In analogy, it can be assumed that most Mesopotamian capacity measuring vessels also consisted of wood, reed or bark, which explains why no archaeological evidence has remained in the wetter environment of Mesopotamia. However, there are probably at least two depictions of a cylindrical measuring container for grain on Late Akkadian seals (see below; **Fig. 6** and **Fig. 11**).

Several factors make it improbable that pottery vessels were used for precise measuring procedures. One is the production process including potting and shrinkage of the clay during the process of drying and firing. Another is the heaviness of clay containers. A large or medium-sized jar from clay can be lifted only with difficulties already while empty; but it would be extremely hard to manipulate a filled one. Instead, scholars have concentrated on studying a very small number of clay jars and vessels bearing inscriptions that may indicate their capacity, in order to obtain equivalences between the ancient standard units and that of our present system (see below).

the second Lagaš dynasty (22nd century BCE), the oil jars also had standardised capacities of 15, 30 and 60 sila₃ (Colonna d'Istria 2022).

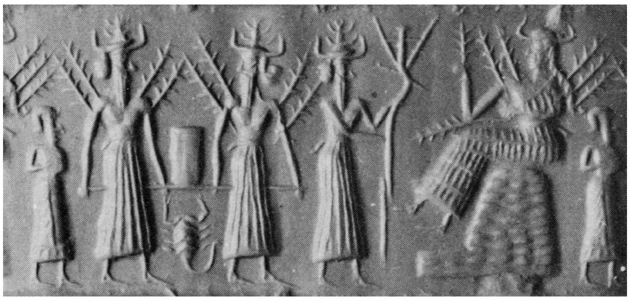

Fig. 6. Akkadian cylinder seal BM 129478 depicting two male vegetation gods carrying the measuring vessel to the goddess Nisaba, who is seated on a grain heap (Collon 1987: no. 106).

A single basalt table with seven square cavities for capacity measurements has been excavated to date (**Fig. 5**).[21] The large object came to light in the city gate of Tell Tuqan in Syria (Middle Bronze I), in deliberate proximity to the market area which was often situated near the city gate.[22] The aligned square cavities held capacities in ascending order between 500 cl and 4500 cl and had small openings on the lower side in order to allow the grain flow into a receiving container (Fiorentino 2006).[23] There is a scene of three figures depicted on the side of this referential measuring table: Two men approach a seated person; the central man holding a different object in each hand, which could be a balance in his right hand and a strickle for levelling the grain smooth in his left hand. It seems that these two instruments were the symbols for weighing and measuring (see § 8).

§ 3. Earlier studies on metrology

The so-called "comparative metrology" (*vergleichende Metrologie*), initiated in 1838 by A. Böckh, was based on the preconceived notion that several, or even all, measuring systems in the Ancient Near East and the Mediterranean area were related to each other by simple arithmetic relationships (Böckh 1838). According to C. F. Lehmann-Haupt (1912), the Roman pound of 327.45 g would correspond to 2/3 of the "normal" Babylonian mina of 491.2 g, while the Egyptian pound of 90.96 g would represent 1/6 of the "light" Babylonian silver mina of 545.8 g (Chambon 2011a: 30–31). According to this point of view, all ancient capacity and weight systems were interconnected and could be studied separately, regardless of the societies that produced and used them. The network of numerical relationships obtained between all the measure standards masked possible geographical and chronological peculiarities, and therefore led to a fictitious global vision.

At the beginning of the 20th century, F. H. Weissbach (1907) and O. Viedebantt (1923) criticized this approach, which was not based on homogeneous material corpora, but on data from different geographical areas and periods, and preferred an "inductive metrology". This empirical method consisted of studying material objects (especially weights) from the same culture very precisely, in order to reconstruct local measure standards, like the standard mina of Sargon II established at 501 g by F. H. Weissbach (1916). Unlike comparative metrology, which envisaged a multiplicity of arithmetically related measure standards, this new approach makes it possible to assume the existence of several measure standards with no rational relationship, and to draw chronological and geographical boundaries between them. At the beginning of the 20th century, the philologist F. Thureau-Dangin (1909; 1937) used a combination of comparative and inductive metrology at a micro-geographical level. He assumed that the capacity standard (Sumerian sila$_3$, Akkadian *qa*), the weight standard (Sumerian ma-na, Akkadian *manûm*), and the length standard (Sumerian kuš$_3$, Akkadian *ammatum*) from Southern Mesopotamia were related to each other, thus opening up the field of metrology to philological studies. This type of study had a certain impact on the research on metrology, and the results concerning "Mesopotamian standards" obtained by F. Thureau-Dangin constituted for decades the *opinio communis* in Assyriology: the capacity standard sila$_3$ was set as approx. 0.8 to 1 liter, a standard mina as approx. 500 g, and a cubit as approx. 50 cm, for all periods and places.

Studies on Mesopotamian metrology according to epigraphic data were revived from the 1980s onwards. This was partly due to new trends in the study of mathematical texts and metrological lists/tables,[24] which paid more attention to the vocabulary and the aim of this scholarly literature, and partly due to a better understanding of the earliest measurement systems in archaic texts or even in the accounting token systems used before the advent of writing.[25] On the archaeological

21 Basalt table TT.81.F.100 (Baffi 2006: 292, Fig. 1).

22 See Otto 2019 for more examples of market places in second millennium Syro-Mesopotamia.

23 The volume of each cavity was studied by A. Archi.

24 See for example the works of Jens Høyrup (1990) and Jöran Friberg (1987–1990).

25 See for example the works on tokens initiated by D. Schmandt-Besserat (1996) and the works on archaic measurement systems by H. Nissen, P. Damerow and R. K. Englund (1993).

side, the issue of accuracy has become central to data processing, by establishing the exact mass of the weight standards and the volume of capacity standards, or by estimating the precision of ancient scales (see § 4). The methodologies focused above all on arithmetical and absolute values of measure and weight units (see § 6). This led to M. A. Powell's important synthesis of weights and measures in the *Reallexikon der Assyriologie und Vorderasiatischen Archäologie* (Powell 1987–1990). It postulated—as many works based on it afterwards—a diversity of the material standards in everyday practice, reflected by various designations in the administrative documentation—an assumption that is difficult to verify by archaeology. For instance, the terms used for capacity measures refer in particular to material, religious or administrative aspects, such as the "big *sūtu* (capacity measure)", "the *bariga* of (the sun god) Šamaš", "the weight of the royal office", "the mina (weight measure) of the (city) Karkemiš", etc.[26] Powell's approach was primarily arithmetic in reconstructing the structure of measurement systems and the numerical relationship between measurement standards, and did not pay much attention to the context of use or the actual function of these different standards.

These earlier treatments of weights and measures provide important epigraphic and archaeological data and give a good understanding of the structure of the main measurement systems used in Ancient Near East, with the relationship between the measure units. This is particularly useful for philological work, when trying to interpret the quantities of foodstuffs recorded in documents from different regions and therefore sometimes referring to different measurement systems. However, they did not provide evidence for the actual form and function of the measuring vessels or of the material weights, and also the various contexts and practices of measuring remained largely unexamined for a long time.

§ 4. The issue of accuracy in studying metrology

Current research still focuses on the notions of accuracy, precision and norm when studying material measure standards. The values given for ancient weights and measures are often expressed with several figures after the decimal point, and are supposed to vary around ideal but fictitious standards, like—for example—the "Mesopotamian" shekel of 8.416 g. But does this notion of accuracy and metrological norm not merely reflect modern scientific thought, which is influenced by our accurate and uniform metric system, and is far away from the practical concerns of ancient societies? By analysing a sample of balance weights from Ur of Middle Bronze Age date, which is structured around the Mesopotamian shekel of c. 8.4 g (Hafford 2012), N. Ialongo and L. Rahmstorf noted that the standard deviation around this value is strikingly higher than the normal expectations for ancient weights. They concluded that these results "strongly argue against the common practice of setting pre-determined thresholds for the accuracy of ancient measures, since the real structure of weight systems is much more approximate than it is usually believed to be" (Ialongo/Rahmstorf 2019: 117). The study of recently excavated weight stones from Ur also corroborates this observation (see Hafford/Einwag/Otto in this volume).

The current use of precise quantitative methods is in fact based on the implicit model of the natural sciences, itself derived from the metrology of 18th century astronomers and physicists, who postulate a reality independent of the observer, which they attempt to measure precisely with increasingly precise instruments and fewer technical errors. However, before the emergence of this model in Europe, ancient measure standards were set more on the basis of practical and social requirements rather than scientific and technical motives. It would certainly not have been possible in antiquity to manufacture vessels and weights with a high degree of precision or consistency. Regarding the empirical evidence, K. M. Petruso points out that: "Given that most sets of balance weights were likely manufactured by duplicating existing sets, errors were necessarily introduced in the manufacture of each set, and would likely be compounded in the manufacture of subsequent copies of copies. It follows that basing calculations on a single chosen mass standard—to two decimal places, no less—is highly arbitrary, and ensures that all calculations that arise from any such choice are suspect." (Petruso 2019: 6 note 1).

Furthermore, precision and accuracy were not necessarily the purpose of ancient accountants, who had another notion of "standard" than we do. The term "standardisation" literally refers nowadays to the process of unifying dimensions, types, procedures or similar, the aim of which is to create common "standards". In contrast, the term "standard" has different nuances of meaning: It can describe the product of a standardisation process: a uniform or unified, widely accepted way of producing or carrying out something that has prevailed

26 See for these designations the remarkable studies by Veenhof 1985 for the Old Babylonian period and by Postgate 2016 for the Middle Assyrian period.

over others. "Standard" then characterises a rule or normal case, e. g. a standard version in the areas of "production technology" (industry standards, graphic standards, e. g. PDF format, etc.).

If argued from a bottom-up perspective, the accuracy of weight stones or capacity measures was certainly much less important for the ancient people than we assume today, since trade relied on mutuality. Weighing was not performed by one party only, but counter-weighing was a usual practice, which must have been so effective that deviations from the standard—which can be observed for nearly all the ancient everyday weight stones—were negligible.

Although capacity measures and weights served as an ideal means of measuring and weighing consistently, the main concern of ancient bureaucrats was not technical accuracy but efficiency and righteousness in administrative transactions. T.C. Wilkinson assumes that "Weighing systems imply a need for establishing trust between strangers" (Wilkinson 2018: 41). The quantitative data in a text, the results of a measurement or weighing, are not necessarily a very accurate reflection of reality, but correspond above all to a consensus between the different protagonists of the transaction (merchants, officials, craftsmen…), who have agreed on these data. As a result, any technical precision in the process of measuring or weighing must be sought in the archaeological data rather than in the epigraphic ones on the one hand, and a (modern) degree of tolerance must be applied when studying (ancient) measuring and weighing materials on the other hand.

The evaluation of large archaeological data sets of balance weights have resulted in giving an average ratio of deviation which seems to have been accepted in the daily practice of weighing (Hafford 2012: 38; Fink 2012). This ratio clusters around 5 %, which seems a reasonably low rate; but it means that a weight stone of one Mesopotamian shekel of ideally 8.3–8.4 g could have had a tolerated mass of 7.88–8.82 g.

§ 5. Deities, kings and other guarantors of accuracy and righteousness

In Mesopotamia, the above-described notion of standard and accuracy was above all linked with the ideological concepts of righteousness and truth, rather than with that of rational thinking and technical precision. We find a concrete counterpart in metrology. In Sumerian literature, for example, the goddesses Nisaba and Ninlil are given the means (the 1-rod reed and lapis lazuli measuring rope) to measure land justly and accurately for an equitable distribution of the harvest.[27] Nisaba is attested as the goddess of grain from the Early Dynastic period onwards, and developed to become the patroness of accounting and writing—an evolution which is clearly related to her authority as the guarantor for the righteousness of the measured grain. She is also the chief scribe of the goddess Nanše and shares with her a controlling function.

Nisaba's superior position in the process of grain measuring was possibly depicted on an Akkadian cylinder seal (**Fig. 6**)[28]: A female goddess with long hair, stalks of grain sprouting out of her shoulders and holding grain in both hands, is seated high up on a large heap of grain. Three male gods are approaching her, the first one carrying a plough, the second and third one—characterized as grain gods by grain stalks sprouting out of their shoulders—carrying along a heavy object on two poles. This object might very well be a large cylindrical capacity measurement container for grain.

At last, a hymn to the goddess Nanše, who also was responsible for the correct weighing procedures, concerns the potential fraudulent use of weights (Heimpel 1981: 67; see Otto/Chambon, in this volume). This role, attributed to the superior local female goddesses in the third millennium, was in large parts taken over by Utu/*Šamaš*, sun god and god of justice, from the second millennium onwards. The sun god was also considered as a supervisor of the correctness in commercial transactions, as becomes explicit in the hymn to Ḫendursanga,[29] and was occasionally explicitly associated with weighing (Rainey 1965; Stol 1999). Material evidence comes from large (duck-)weights with inscriptions in the name of Šamaš.[30]

The ideal of metrological justice is also reflected in royal rhetoric (Robson 2008: 119), particularly in the law

27 Lipit-Eštar Hymn B (ETCSL 2.5.5.2, l. 18–24) and the literary text "Enki and the World Order" (ETCSL 1.1.3, l. 412–417): see comments by Robson 2008: 117–118.

28 BM 129478 (Southesk Coll.). Boehmer 1965: no. 1266, Fig. 541; Collon 1982: No. 209. The goddess has been identified as a vegetation goddess (without attributing a name), and there has been no explanation for the carried object so far. We think that the depiction of the cylindrical measuring container is not unique, see remarks on Fig. 11 below.

29 See the hymn to Ḫendursanga A in ETCSL 4.06.1, segment C., l. 32.

30 E. g. a large sphendonoid weight of ½ true mina from Nippur (Hafford 2005) ; a large duck-weight "3 mina of the god Šamaš" (Marzahn et al. 2008: no. 194, Fig. 184). A complete inscribed duck-weight (26.7 kg) of "1 true (Sumerian gi-na) talent" was found in the ziqqurat precinct at Babylon; the inscription ends "may Shamash take away whoever removes (this weight)"; Aruz et al. 2008: 371, no. 236.

collections promulgated by various kings of the third millennium and the Old Babylonian period. In this respect, the "metrological reforms" attributed to Ur-Namma (Ur III period) should certainly not be understood as political efforts to unify and standardise all weights and measures according to a single accurate standard in his empire, but rather as the will to use metrological rhetoric in order to make explicit the king's function as the supreme guarantor for justice and economic control (Chambon 2011a: 55). In practice, the measure units described in the reforms probably served as reliable standards of reference for the royal administration, in order to manage and record economic flows, and as one of the means of uniting legal obligations within the newly established state. However, some Ur III documents indicate the use of various capacity standards, which refer in particular to the specific density of grain at certain stages of processing and to the use of grain. To which extent (and how) the local measure standards were in competition with the royal standards is to be investigated further (see for this issue Clegg in this volume).

The control of trade—already described in § 1 as essential for every functioning economy—was exercised through legalised divine or human authorities: Gods and goddesses, the temple, the king, the palace, the city house, the market overseer, experts in measuring practices and many more. The tools of these different authorities needed obvious marks so that they could be immediately identified as referential objects. In the textual documentation they were labelled with the specific expression for "measure standards" (see Pommerening/Chambon/Marti in this volume in this volume). It is commonly accepted that these reference weights or standards were visibly marked as such. This could be done in material culture in various ways: either the balance weights and containers of 'normal shape and appearance' were marked by inscriptions that mentioned the kind of measuring standard used. In the case of containers, these were for example *ina* gišban$_2$ dutu "according to the standard (measure-)*sūtu* of (the god) Šamaš"; on material weights this was the Sumerian term gi-na "certified/established" (most often by the king) associated with weight units, or they were marked by geometrical symbols, or both. In some cases, the objects differed already considerably from ordinary measuring objects: either in material and colour[31], the elaborateness of the finish and the precision

Fig. 7. Three bronze lion-weights with inscription from Kalhu, North-West Palace, Room B (Curtis/Reade 1995: 193)

of the mass[32], or the shape. Typical examples of the latter are zoomorphic balance weights, among which the lion-shape, the 'duck'-shape[33] and the bull-shape are the most common ones. It may be assumed that the choice of these animals—at least of some of them—was deliberate and in some cases possibly related to deities or other powers, although the meaning of a frog, a fly, a shell or a boar's head is difficult to grasp.

The form of the lion-weights has long been accepted as being related to the royal Assyrian ideology. The best examples are the 16 Neo-Assyrian bronze lion weights that were found by A. H. Layard in Throne Room B of the North-West Palace in Nimrud/Kalhu, more precisely in Doorway b under the collapsed colossi (**Fig. 7**).[34] Reade (2018: 147–148) convincingly argues that "the bronze lion-weights from Room B with their royal inscriptions were special [...] the Nimrud lion-weights had the formal status of approved government standards [...]". Some of

31 Approx. 200 weight stones were found in houses, temples, defensive structures and palaces of Middle Bronze I–II Ebla; most of them were made from iron oxide stones and of sphendonoid, domed or spherical shape. However, one outstanding weight in form of a lion of 913 g, i. e. approx. 2 Syrian mina of 470 g, was found in the Western Palace and has convincingly been interpreted as a royal weight (Mazzoni 1980 ; Peyronel 2019). This shining black lion figure had bright red eyes and cheeks, inlaid with red stones, which made this referential royal weight immediately outstanding by its appearance.

32 Good examples are bronze lying bulls from Ugarit, which are not only unique, extremely finely modelled, objects (cast in the lost-wax-method), but had also been adjusted to the exact mass by coils of bronze wire strung around the neck.

33 For the so-called duck-shaped weights, their identification as goose-weights and their relation with specific deities see Otto/Chambon in this volume.

34 Peyronel 2015. Reade (2018: 180) describes them in detail: "B 6. Bronze lion-weight with handle (Fig. 1). BM 91221 = 1848,1104.67. Peyronel 2, Fig. 2; Fales 2; Curtis 534, Pl. XLII + analysis; RINAP 1, 171f.; SAA 6, Fig. 3a, c; Mitchell 2 style A; Curtis & Reade 1995, 193 (colour). Cuneiform on top: Palace of Shalmaneser; 5 minas "of the king". Left side: 5 strokes. Aramaic on right side: 5 minas "of the land", and 5 "of the king" on base. Provenance: see B 1. L 19.7, H 10.2 cm. Mass: 5,042.805g (Chisholm I, 2). 5,043 ÷ 5 = 1009g."

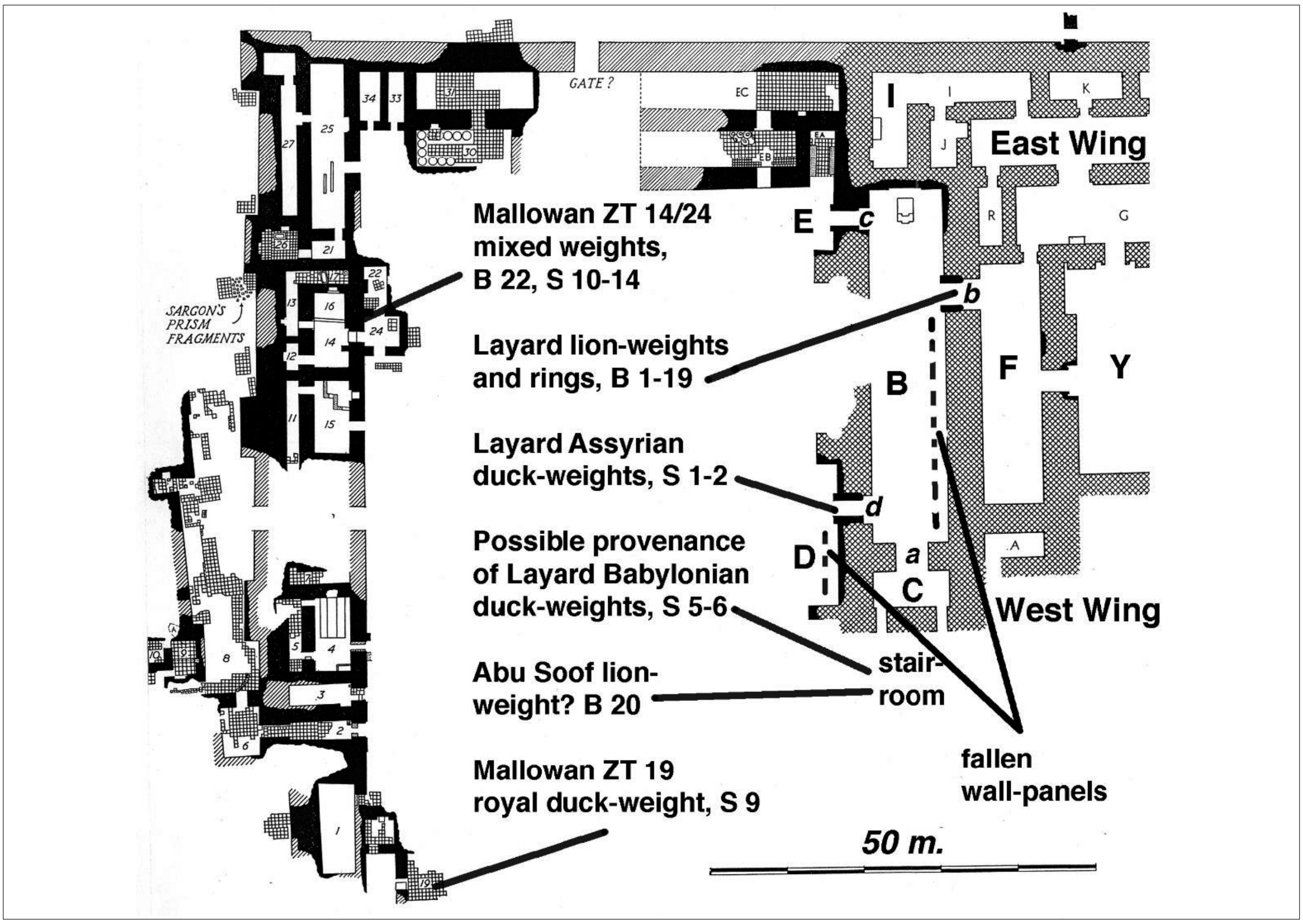

Fig. 8. Map of the approved government weights in the North-West Palace at Kalhu (Reade 2018: 129, Fig. 2).

them bore one inscription in cuneiform: "weight of the king", an additional inscription in Aramaic "weight of the land" and/or "weight of the king", and a number of vertical incisions indicating the number of units. Apparently, these government standards should be understandable by Assyrian, Aramaic and illiterate users of these referential weights within the huge Assyrian empire.

Reade illustrates the find spots of the weights in the very heart of this palace (**Fig. 8**) and also mentions a ceramic tub which was found near these 16 lion-weights (Reade 2018: 131–133). This tub (BM 91941) is a capacious straight-sided open ceramic tub—an unusual form of Neo-Assyrian vessels (**Fig. 9**). Two figures are applied in low relief to the side of the vessel, representing the scorpion-man or *girtablilu*. Reade argues that the scorpion-man's task in Mesopotamia was to guard the residence of the sun god, and that one of the duties of the god Šamaš was to ensure justice and equity. Therefore, he relates the cylindrical tub to the "worlds of commerce and taxation", and suggests that the lion-weights originally had been stored inside the tub (Reade 2018: 132–133). However, he seems to doubt his own explanation because he wonders why no green stain from verdigris was visible inside. One might add that no reasonable person would store heavy bronze tools in a fragile terracotta container, since the slightest blow would break it. Another explanation seems to impose itself: This container was the "approved government standard for capacity measures", which was kept side by side with the approved weight standards. Its capacity can be approximately calculated, since both height and rim-diameter are indicated as ca. 51cm. This would make a capacity of approx. 40 litres and equals the supposed capacity of the "5 *sūtu* measure" (if 1 *qa* = 0.8 litres) from Middle Assyrian texts (see Postgate in this volume). If the idea put forward here holds true, this would be the first royal capacity standard having survived so far—discovered by Layard at the dawn of the archaeological exploration of the Near East. There are more arguments in favour of this idea. It has been generally accepted that the Assyrian king had a close relationship to the sun god. Aššurnaṣirpal II chose the sun god in the winged disc to dominate the sacred tree in the two central relief slabs behind the

Fig. 9. Ceramic tub from NW-Palace, decorated with scorpion-men (*girtablilu*), probably the approved government standard for capacity measures (Reade 2018: 133, Fig. 3)

Fig. 10. Duck-weight marked as an Assyrian standard with the incised figure of a lion (Curtis/Reade 1995: 194, no. 206).

two throne pedestals in Room B.[35] Both the lion-weights and the capacity standard were found close to these two pictorial ideological statements that highlight the role of Aššurnaṣirpal. He is referred to as the "Sun (god) of all people", which means the executor of the supreme god of justice. The proximity of the main metrological reference tools to the royal throne is a distinct proof of how both the king and the sun god served as guarantors for the righteousness of metrological reference tools—still in the first millennium BC.[36]

Even more referential weights were excavated by Layard in 1846 in Throne Room B, this time in Doorway d under the collapsed lion-centaurs. The two "duck-weights" both show an incision of their mass and are marked as an Assyrian standard by the incised figure of a lion striding left (**Fig. 10**) (Reade 2018: 136–139, Fig. 8). More duck-weights are reported for Throne Room B and the area nearby, both of a mass given as 30 minas and weighing approx. 15 kg. They bear inscriptions of the Babylonian kings Nabû-šumu-lībūr (c. 1033–1026 BC) and Erība-Marduk (c. 775–765 BC). These Babylonian standard royal weights must have been kept in Babylon until the city was captured by the Assyrians, and then brought to Nimrud as a tribute. Apparently, the duck-weights represented so much the Babylonian standard that the need was felt to incise on them the striding lion, the Assyrian royal symbol. The mentioned examples hint at the possibility that also carved imagery was used to mark specific reference tools, containers or other objects as official referential documents—but this has to remain a field of further studies.[37]

§ 6. Capacity measures and the conversion of old measurement units into modern ones

Nowadays, the study of Mesopotamian metrology aims mainly at reconstructing the relative values in each measuring system, i. e. the values by which one unit of the system was converted into another—either as a multiple or a submultiple. Another objective is to identify absolute values of these units, expressed in our modern systems (in l, kg, m, m^2 …). This renders a lot of quantita-

35 Unfortunately, the old idea that the god in the sun disc represents the supreme god Ashur can still be found in literature, even in quite recent one. Ursula Seidl (2020) has convincingly demonstrated that this god in the sun disc is no other than the sun god.

36 It is right that none of the visible inscriptions on the inscribed weights refers to Aššurnasirpal, but most mention Šalmaneser, a few Tiglathpileser, Sargon and Sennacherib. This does not contradict our argument, but indicates that old reference weights had continuously been replaced by new ones, and that Throne Room B remained in use as the royal Assyrian metrological headquarter until the end of the Assyrian empire.

37 Especially interesting is the case of small duck-shaped objects with carved images on the lower side from the Neo-Babylonian period (e. g. YPM BC 038126; https://collections.peabody.yale.edu/search/Record/YPM-BC-038126). It will be interesting to investigate if these were used as weights or as stamp seals, or both.

tive data, based on the information recorded in texts or provided by material culture (volume of standard vessels or mass of material weights). All these data are primarily used for studies on economic history, e. g. for calculating the extent of the flow of goods in agricultural production, the volume of food rations delivered to the palace servants, or the quantities of traded precious metals.

For example, there are two main methods for establishing the value of Mesopotamian capacity units in litres. The first and most common one is to calculate the volume of a 'standard' vessel, found during archaeological excavations, and to compare it—if possible—with any metric data written on its neck or belly (Nicolle 2020). The capacity of the sila$_3$ has been established in this way, when the capacity (180 l) of a large Ur III vessel found at Nippur was related to the indicated 175 5/6 sila$_3$, which makes 1 sila$_3$ corresponding to approx. 1 litre (Gelb 1982). Another example is the inscribed Old Babylonian jar from Tall Rimah which gives a sila$_3$ of approx. 0.8 l (Postgate 1978). However, this method poses several problems. Firstly, it is difficult to generalise the values for the capacity standard reconstructed from only a few rare examples of jars inscribed with metric data for the whole of Mesopotamia. The multiplicity of measurement standards used in the ancient Mediterranean area, or even in the European cities of the Middle Ages, call for caution before postulating the uniform use of the same standard of capacity over a vast geographical area and an extended chronological scale. Secondly, the question arises as to the choice of the modern technique for establishing the volume of these jars and comparing it with the metric data of the inscriptions: should the total volume of the jar be calculated up to the rim—which is what is usually done—or only up to the neck, or even lower? And thirdly, why did the scribes record these metric inscriptions only on some (rare) jars and not on others? Finally, one may wonder if measuring the volume of the jars is not the wrong target. As Ch. Nicolle reminds us: "It is not the container (receiver) that allows us to evaluate a possible volume standard, it is the measuring vessel (dispenser), not a single example of which has been identified to date on Mesopotamian excavations".[38] It must be stressed, however, that the measuring vessels mentioned in the texts were made of reed or wood, and have therefore disappeared (see above § 2). The crucial question is therefore what was meant by the "standardisation" of ceramics? (see Kreppner/Sarga in this volume).

A second method of reconstructing the value of ancient capacity units is to combine socio-economic data from texts with practical realities. For instance by using rates of sowing and/or yield of fields in the Ancient Near East, or by estimating the load a donkey could carry, which was the most common means of transporting goods (Lewy 1965; Powell 1987–1990: 500; Freydank 2012: 210; Reculeau 2018: 103–105).

The first case can give interesting results on the capacity units that were used to express the volumes of sowing or harvesting as a function of field areas, but does not avoid the risk of circular reasoning. The very value of units of the length system, itself in line with the system for measuring areas, is in fact not certain at a given period and seems to vary with time and perhaps place. Recently, the study of a text from Umma dated to the Ur III period has made it possible to establish relevant hypotheses on the value of capacity units, by comparing the volume and weight of the dates recorded in the texts (thanks to the density of the latter) (Brunke 2011: 7–8). The method of comparing text data with practical reality is therefore promising but needs to be more contextualised. One cannot apply the value assumed for a measure unit, which was found in a specific place according to its documentation, over a large geographical area or a whole period of time. For example, the capacity unit sila$_3$, which is usually estimated to have been about one metric litre, had more precise absolute values that seem to have varied historically and regionally (see above), as Powell had already pointed out (Powell 1987–1990: 503–504).

More broadly, the reconstruction of the value of a unit, or of the arithmetical relationships between this unit and the lower and upper ones of the same system, is useful but does not explain its actual function and use in society. It is convenient from a modern point of view to quantify the flows of commodities of the ancient organisations, in order to gain insight into economic situations and behaviour, but it does not tell us much about the "metrological thinking" of ancient Mesopotamians, i. e. how they chose, used and represented units of measurement for practical as well as ideological purposes.

§ 7. Cross-reference of textual information and archaeological data

It is therefore not surprising that philologists are usually dedicating a paragraph or so to metrology in the introduction of their editions of administrative or legal documents. The aim is—above all—to give the keys for reading

38 Nicolle 2020: "Ce n'est pas le contenant (récepteur) qui permet d'évaluer une éventuelle norme de volume, c'est l'élément verseur (distributeur) dont aucun exemple n'a été identifié à ce jour dans les chantiers archéologiques de Mésopotamie".

the quantitative data in the texts (amounts of commodities, weighing of metals, field measurements …) and to justify the editorial choices of transcription that have not been standardised yet for weights and measures.[39] Most editions refer to Powell's work (Powell 1987–1990) and merely describe the order of units of measurement and the arithmetic relations between these units.

But it must be stressed that the aim of cuneiform texts was not limited to recording quantitative and qualitative information for the management of goods. They were written within the framework of accounting practices taking place in the main organisations (palace, temple, large household…), in order to participate in a memorisation of networks, useful for setting up and controlling the fiscal regime and for clearing up the responsibilities of each person in this system (Chambon 2020: 252). These organisations based the management of resources on an asymmetric relationship (between kings, vassals, high or low ranking officials, craftsmen, merchants, farmers…), which created "multiple subjectivities", to use Seth Richardson's terms (Richardson 2020). Therefore, quantitative data, as well as designations for measure and weight standards as seen above, were mainly based on a consensus between the persons involved in the transaction, rather than on an accurate and objective description of the transaction. As K. Veenhof (1985) pointed out, followed by N. Postgate (in this volume), it is actually hard to know whether these designations referred to physical containers or measurement standards with different volumes according to the offices using them at a material level, or to abstract volumes, fixed in relation to other norms, for accounting at a functional level.[40] The main concern was to agree on the value attributed to the commodities involved in a transaction and the quantities recorded in texts rather than on the equivalencies between local standards; this could explain the fact that no "conversion table" has been found so far in the administrative documentation of three millennia. Indeed, the amount of barley or metal recorded in the texts is above all the product of conventional values, which are based on a consensus among the parties in the exchange system (see above). In this respect, some expressions, which were considered to refer to the conversion of one weight or measure standard into another, should be reinterpreted in the light of administrative and fiscal concerns (Chambon/Marti 2017 and Pommerening/Chambon/Marti in this volume).

Therefore, studying metrological expressions involves first of all understanding the real function and purpose of administrative texts, which go beyond a description of accounting and bookkeeping practices.[41] Against this background, archaeology plays an important role in balancing approaches to ancient metrology. As already pointed out, textual sources often come from the highest levels of the social order and intended to facilitate the accounting practices and to set up exchange values within the framework of resource management—thereby conveing a distorted picture. Archaeological data, by contrast, offer the possibility to examine the remains of all levels of society and to study the daily use of weights and measures in material culture. In this respect, the archaeological approaches to the corpus of material weights of the recent years have become more contextual, by taking better into account the material found with these artefacts and their possible function in the place where they were found. Moreover, the numerous material balance weights and ceramic vessels that have been found in several Near Eastern sites allow archaeologists to make statistical and comparative studies of their volume and mass, and to draw up a "metrological topology", in synchrony and diachrony.

§ 8. The depiction of law and justice through symbols of measuring and weighing

A unique Akkadian cylinder seal depicts in a remarkably elaborate way the sun god's role as the protector of weighing and measuring (**Fig. 11**).[42] Three men are approaching the enthroned sun god. Only the man in the middle, carrying a kid in one hand and raising the other in adoration, behaves as usual in ritual scenes. The first and the third man are acting exceptionally: the first

39 See Proust 2009: 8–9, and Chambon 2013: 379. Concerning the problems of transcription of the capacity measure BÁN (*sûtu*) see Postgate 2013: 56.

40 The designations for measures in the texts are often ambiguous. In his study on the meaning of the term *sûtu* in state/private business in the Larsa kingdom, Z. Földi quite rightly stresses that this administrative term, which he translates as "concession" (for the right of collecting the commodities purchased by individual entrepreneurs from the state), has a "logographic writing ^{giš}bán—[which] suggests that it has a strong connection with *sûtu* as a capacity measure (and measuring vessel)" (Földi 2014: 108).

41 G. Chambon, Pourquoi écrire et tenir des comptes? Etude de la comptabilité dans le Palais de Mari au 18e siècle av. J.-C., in E. Bordreuil – V. Matoïan – J. Tavernier (eds.), *Administration et pratiques comptables au Proche-Orient* (PIOL), Leuven (in print).

42 Cylinder seal from the Moore Collection: Boehmer 1965, no. 1105, Fig. 458.

Fig. 11. Akkadian cylinder seal showing the act of weighing with a hand-held scale and the filling and levelling of a measuring container with a strickle (Boehmer 1965: Fig. 458)

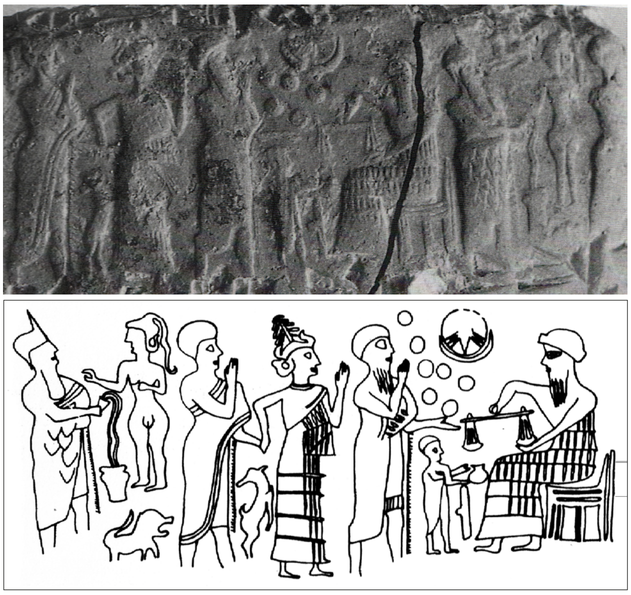

Fig. 12. Old Syrian seal impression from Karum Kanesh II (Özgüç 2006: Pl. 263; Teissier 1994: no. 533).

man is holding a balance above the altar in front of the god. The third one—depicted smaller and dressed in a short skirt, thus probably an assistant—is actively working (expressed by his bent body) in manipulating a linear object above a rectangular or cylindrical object. He is depicted—like the man holding the balance—with a high elbow, which expresses activity in Akkadian art. His action has not been understood so far, but since this is the only seal known to date where the seal owner explicitly stresses the act of weighing under divine control, we interpret this as a metrological action, too. As J. N. Postgate shows in this volume, measuring grain needed a container and a strickle (*mešēqum*), with which the grain was smoothed flat, level with the rim.[43]

43 Postgate refers to the translation of *mešēqum* in Old Babylonian texts by C. Wilcke (1983: 55–56) as "Glattstreich-Holz ».

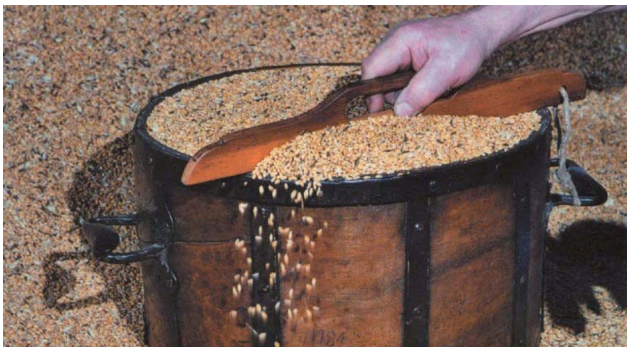

Fig. 13. Strickle from 18th century AD France in use (https://fdmf.fr/les-mesures-a-grains-du-xviiieme-siecle/)

In the texts, the strickle can be of three types, thick (*kabrum*), medium (*birûyum*) or thin (*raqqum*). According to Postgate (2016), following Veenhof (1985), these types refer probably to the size of the wooden tool, which could be more or less thick. There were actually different ways of filling a grain container: filling it until the grain is horizontally flush with the rim, or heaping it up into the highest possible conical mound, and therefore different measuring procedures were possible.

In any case, this depiction on the Akkadian seal is to our knowledge unique in showing the act of weighing with a small hand-held scale and the filling and levelling of a measuring container. Because scenes on cylinder seals from the 3rd millennium have sometimes clear allusions to the profession of the seal owner, we may assume that this seal (unfortunately without provenance) belonged to a merchant or to a weighing office which stood perhaps under control of the sun god.

However, in the course of this study we have come to the conclusion that the depiction of the strickle (*mešēqum*), with which the grain was smoothed flat, was not a motif which disappeared from the imagery after the Akkadian period. We think on the contrary that the strickle became the symbol of the righteousness of economic transactions in general and therefore gained extreme popularity on cylinder seals, which were essential tools in trade control and any legal matters.[44]

An Old Syrian seal on a tablet from a merchant's house in Karum Kaneš II shows an audience and introduction scene in front of a deified king who himself is manipulating a hand-held balance, thus addressing the royal or

44 This is in line with a similarly used object, 'the measuring rod', which was depicted in the hand of major deities. This device became the symbol of fairness and justice in the management of the cadastre of arable land, since it is the essential tool in demarcating boundaries; Wiggermann 2007.

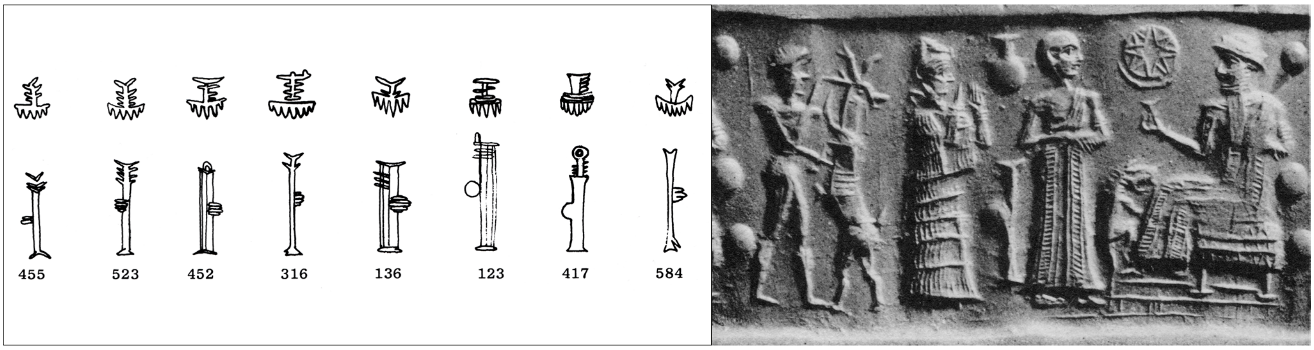

Fig. 14. Left: The "ball-and-staff" and "pot" on Old Babylonian cylinder seals (Collon 1986: 49); right: Old Babylonian cylinder seal depicting "ball-and-staff" and "pot" (Porada 1948: no. 320).

Fig. 15. Old Syrian cylinder seal showing a large man holding the strickle (*mešēqum*) and a small man holding a pot (Collon 1987: no. 139).

divine control of commerce (**Fig. 12**).[45] This object is very similar to the so-far enigmatic symbol "ball-and-staff", consisting of a vertical line with a short stroke across each end, and a circular or semi-circular excrescence on one side. It is frequently associated with an equally enigmatic object called "pot".[46] Dominique Collon (1986) has collected all the suggested interpretations, and more are being added constantly.[47] Grain was measured in Europe until the 19th century AD in a wooden cylindrical measuring container, and was either heaped or smoothed flat with a strickle consisting of an elongated tool of hard wood with a handle in the middle. A cord was added on one side, which served as an easy suspension when the tool was out of use (**Fig. 13**).[48] This corresponds exactly to how "ball-and-staff" motifs on seals are depicted (**Fig. 14**): in most instances they appeared isolated in the field (although often near the "pot"), but exceptionally also as an attribute: An Old Syrian seal (**Fig. 15**) shows a worshipper in front of a seated deity holding a ball-and-staff in his extended left hand (Collon 1987: no. 139).

Since it has been known since long that the "ball-and-staff" was one of the most frequently depicted motifs on cylinder seals of the second millennium, it was evident that its symbolic value was considerable, but no hitherto proposed identifications have been convincing. On the basis of the above-mentioned considerations we propose that the ball-and-staff motif goes back to the depiction of the strickle, in the course of time became the symbol for measuring and weighing under divine control, and developed further into the general symbol of law and justice. This idea is not unique for Mesopotamia. Until today, and at least since Roman times, the balance has been the attribute of Iustitia and the symbol of law and justice worldwide.

Few things are more challenging in art than the depiction of abstract concepts. It requires easily understandable symbols of theoretical notions and complex processes. Cylinder seals of the second millennium contain the maximally condensed information about the conception of the seal owner and his plea for protection, depicted in various meaningful scenes, but above all in numerous symbols. The protection against injustice was certainly

45 Seal impression CS 767, Kt. n/k 1926 C from Karum Kanesh (Özgüç 2006 : Pl. 263; Teissier 1994 : no. 533).

46 The object has often been called comb since the body looks striated; however, this is due to stylistic abstractions. Elaborate depictions show that indeed a vessel was intended to be depicted. It seems that the pot also related to the same or similar measuring procedures as the strickle, but its exact function or designation must wait for further study.

47 Collon (1986: 49–51) mentions interpretations of the "ball-and-staff" as a balance, a gate-post (and aryballos = the"pot") of water deities, a vertical loom, an elixir vase, a dropping tube for removing wine from a container, a water-pipe for smoking. B. N. Porter (2001: 31) suggested a case for holding drinking tubes, and E. Rossberger (2018: 121) a spouted jar for libations.

48 Drevet 2010. https://fdmf.fr/les-mesures-a-grains-du-xviiieme-siecle/ (download 25.05.2021).

not least important, which explains the enormously frequent depiction of the "ball-and-staff".[49]

§ 9. Conclusion

We may conclude that the study of practices associated with weights and measures has become essential for better delineating economic and cultural boundaries, for describing administrative processes and for understanding commercial and political relations. It requires a systematic comparison of archaeological and epigraphic sources that respond to and complement each other, because they do not concern the same aspect of metrology, and thus offer the possibility of better understanding the use and function of the different standards of measurement—both at local and interregional level.

The epigraphic sources facilitate an approach towards metrological practices mainly through the point of view of the accountants and administrators of economic and political organisations, while archaeological sources grant insight into the daily activities of craftsmen, measurement experts and palace or temple staff. The former sources give very little information about the weighing and measuring procedures (because only the results were relevant for accounting purposes) while the latter sources enable us to reconstruct the daily use of weights and capacity measures. It is in this respect that these two types of sources must be cross-referenced, in order to get a relevant picture of the use of weights and measures in Ancient Near Eastern societies, both against their economic and social background.

Metrology has been long understood as a valuable tool for better understanding commerce and interactions—the subject of thousands of ancient texts. However, the value of metrology for archaeological studies has not yet been fully recognised. It goes far beyond the better understanding of strangely shaped stones found in excavations, and well into the interpretation of images. The ancient desires and conceptions have found their way also into imagery, especially on cylinder seals, which encapsulate maximally condensed information. As far as we understand it now, depictions on seals often contained the explicit plea for law and justice, symbolised by metrological tools.

We hope that this book can demonstrate in how far the study of weights and measures can open the window on Ancient Near Eastern societies.

49 The contribution of archaeology to abstract concepts has not yet been evaluated. For example, the entry on law "Recht" in the *Reallexikon für Assyriologie und Vorderasiatische Archäologie* 11 (2006–2008) has no section "B. Archäologie", although socially fundamental concepts were certainly depicted—it is just not easy to understand the symbolic representations of abstract concepts.

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Mesopotamian weights, a potential Indus weight and other tools in the Archaeological Museum in Istanbul

LORENZ RAHMSTORF

Abstract[1]

Nearly 250 possible balance weights from excavations of the late 19th and early 20th century BC at Mesopotamian sites of Assur, Bismaya, Fara, Nippur, Tello, and other sites are stored in the Near Eastern Collection of the Archaeological Museum in Istanbul. They were published only descriptively by E. UNGER in 1918. A promised volume with illustrations never appeared. In 2005, T. H. ZEYREK and Z. KIZILTAN published a paper on 49 of these objects illustrating them with photographs. In 2007 the author was allowed to restudy another 31 of the objects in the store rooms of the museum. The other objects were either displayed in the permanent exhibition or not accessible to me. 17 of the total 31 studied stone objects were rather easily identified as typical Mesopotamian weights due to their shape, material, mass and in a few cases also due to their markings. Two weights have short inscriptions. Of great interest is a potential cubical Indus weight from Nippur. Such typical weights of the mature Harappan culture have been known so far only from Ur, Susa and the Gulf outside the Indus region. However, the object is slightly fragmented and the mass is a bit too heavy for an easy assignment to the Indus weight standard. The other stone objects studied are in the shape of flat reels or spools and rough cubes. In these cases, their function as balance weights is rather doubtful and cannot yet be proven. Contextual evidence from other well documented excavations may help to verify any potential function of these objects. Whilst the whole sample lacks any information about context and dating, it is still an important addition to the rather limited corpus of sufficiently published weights from ancient Mesopotamia.

Introduction

15 years ago, I obtained a small pamphlet published nearly 100 years before in Istanbul but written in German: "Katalog der babylonischen und assyrischen Sammlung III: Geräte 1. Gewichte und gewichtsähnliche Stücke" (**Fig. 1**). The author was Eckhard UNGER, who is considered to be one of the first scholars of Near Eastern Archaeology in Germany (WEIDNER 1968/1969). The publication contained no illustrations of the objects besides two sketches of inscriptions (UNGER 1918: 39). I was especially enthralled by chapter 10 in this publication called "Garnrolle" (= spool). Could there be spool-shaped potential balance weights from Mesopotamian sites as they are known from the Early Bronze Age (EBA) Aegean and Anatolia (RAHMSTORF 2010: Fig. 8.1–2)? This assumption has not been proven by the personal inspection of the objects, which I was allowed to do thanks to the permission of the authorities in 2007. The flat reels from Meso-

1 I would like to thank first of all Adelheid OTTO and Grégory CHAMBON for the invitation to the Metrologia-Conference and the preceding workshops in Brest, but also Lucia QUARANTA for her professional work on the illustrations and Sarah A. CLEGG for her comments, which improve the text. The publication was supported by ERC-2014-CoG ›WEIGHTANDVALUE: Weight metrology and its economic and social impact on Bronze Age Europe, West and South Asia‹ [Grant no. 648055]. The research trip to Istanbul in September 2007 was funded by the Fritz Thyssen Stiftung, Cologne. I am most grateful for their support.—Due to the detailed data provided by UNGER (1918) in his catalogue, no descriptive catalogue of the objects illustrated here in the plates 1–8 has been attached.—This manuscript was written in July 2016. Only minor additions were made in 2020. Many general problems which are addressed in this paper have been discussed further in the volume edited by RAHMSTORF/STRATFORD 2019.

Fig. 1. The front cover of the catalogue by E. Unger 1918

potamian sites (Pl. 9 top) have nothing in common with the spool-shaped potential balance weights from EBA Aegean and Anatolian sites. Nevertheless, the investigation of the objects was rewarding: an interesting sample of Mesopotamian weights could be documented for the first time in text, drawings, and photographs. With this documentation, the interpretations of Unger can now be critically assessed based on our present knowledge of ancient Mesopotamian weight metrology.

Provenance

The objects were found in Tello (cat.-nos. 1–3, 5), Fara (cat.-nos. 6, 18, 22, 24–25), Nippur (cat.-nos. 8–15, 21, 23, 26–28, 31), Assur (cat.-nos. 16–17), and Bismaya (cat.-nos. 19). In some cases, their provenance is unknown (cat.-nos. 7, 20) or is labelled with a question mark (cat.-nos. 4, 29–30). Contextual information on the find spots is unfortunately missing. It shall be briefly presented here which periods at these sites are best known from an archaeological perspective from the early explorations. The 150 ha large tell of Nuffar/Nippur was investigated between 1888 and 1900 by J. P. Peters and H. V. Hilprecht, and the 73 objects from Nippur published by Unger all derive from these early excavation campaigns. Nippur was a major Mesopotamian centre for many millennia, but is archaeologically especially well known for the later third and early second millennium BC (Akkadian to Old Babylonian). The find spots of portable objects were recorded, if at all, very vaguely in the early campaigns. They are rather useless for any attempt to date these objects through their archaeological context (cf. Hafford 2005: 364–365).[2] Slightly better is the situation in Fara/Šuruppak, where W. Andrae and R. Koldewey were excavating with the help of up to 200 workmen, in 855 trenches of 8 m by 3 m for a period of nine months between 1902 and 1903 (Heinrich/Andrae 1931; Martin 1988: 302). The finds from Fara reached the Museum in Istanbul, then Constantinople, in 1906 (Unger 1918: VII. XVIII). Fara was occupied from the Jemdet Nasr until the Ur III or early Isin-Larsa period, and had its greatest dimension as a city (c. 180–250 ha) in the ED (Early Dynastic) III period. Since Fara was abandoned early in the second millennium, the weights cannot date later than the Isin-Larsa period (Otto/Einwag 2020).

The early (late 19th and early 20th centuries AD) French excavations at Tello by E. de Sarzec, G. Cros and others were mainly driven by the desire to discover cuneiform tablets. The insufficient documentation is especially frustrating here, but the renewed excavations may provide more stratified material in the future (cf. Falkenstein/Opificius 1968/1969: 386; Rey 2016). Again, as in Fara, only sporadic finds can be dated to the second millennium BC. Tello, ancient Girsu, is known as the royal residence city during the Early Dynastic period and remained a major Sumerian city during the Akkadian and Ur III periods. Assur in today's Northern Iraq was excavated under the direction of W. Andrae between 1903 and 1914. The main occupation period here is the second and first millennium BC, which overlay Early Dynastic, Akkadian and Ur III levels. Finally, the early explorations at Bismaya/Adab, only recently fully published, revealed finds mainly from the late Early Dynastic to the Old Babylonian period (Wilson 2012).

Morphology

Due to the lack of any contextual or stratigraphical dating of the objects, comparisons to well-dated exemplars may give some insight. However, the definition of pre-

2 For a summary on the archaeological work at the site see Gibson et al. 2001.

cise geometric shapes remains difficult, as the variations are fluent. In addition, comparative data has often not yet been studied or has been published insufficiently.[3] This applies for example to the large perforated weight from Tello (cat.-no. 1). Such stone objects are common finds at Mesopotamian sites, but most often not presented as metrological weights but rather as loom or counter weights.[4] It is indeed unlikely that all such perforated stone objects were metrological weights, but without detailed publication (including their mass) we will not get closer to solving this functional dilemma. For a few exemplars an interpretation as metrological weights is obvious. For example, a slightly more piriform weight from the Akkadian levels at Nippur weighs three minas (1495 g) just as the one from Tello (McMahon 2006: 135 Pl. 163, 18). It was found in a room in level XIIa in the Area WF Sounding, where not only cuneiform texts mentioning precise weighed amounts of textiles and silver, but also gold and lapis lazuli were recovered (Biggs 2006: 166. 168–169 Pl. 192, 2–3. 193, 2–3). The piriform perforated weights from the Early Bronze age Palace G at Ebla also indicate the use of such objects as mina-weights (Ascalone/Peyronel 2006: Pl. XXI–XXII; Peyronel 2019: 69–70).[5]

The most common shape in the sample is sphendonoid or ellipsoid (cat.-nos. 2–3. 11–13) or barrel-shaped when the ends are more flattened (cat.-nos. 5. 8. 10. 14). Others, like cat.-nos. 4 and 9, can also be considered as variants of this basic shape. The egg-shaped weight from Fara (cat.-no. 6) for instance, the only weight from Fara presented here, finds parallels in the later Early Bronze Age in Alişar Höyük (Rahmstorf 2008: 204 Fig. 3, 2) and Tarsus (Goldman 1956: 275 Fig. 420, 118. 120; Rahmstorf 2010: Fig. 8.3, 2. 9) in Anatolia, less clearly in Ebla in Western Syria (Ascalone/Peyronel 2006: Pl. VII, 19. VIII, 21) and in Nippur in Southern Mesopotamia (McMahon 2006: Pl. 165, 25). This comparative material implies also a date in the mid or later third millennium BC. A rough spherical weight is represented by only one exemplar (cat.-no. 7), although it is a very common shape for example in Early and Middle Bronze Age Ebla (Ascalone/Peyronel 2006: Pl. VIII, 22–24. IX–XIII. XLVII–XLIX). Interesting is the loaf shape of cat.-no 17 from Assur. It is comparable to weights from Karum Kanesh (Kulakoğlu/Kangal 2010: cat.-nos. 391. 395). In the light of Assur's well-known trade relations to Kültepe, it is interesting to note its unit of approximately 11.5 g, the so-called Anatolian weight unit or shekel. A weight (68.7 g) from Ebla with six parallel incisions documents the existence of this unit already in the Early Bronze Age (Ascalone/Peyronel 2006: 99–100 Pl. II, 5). However, the loaf shape of cat.-no. 17 finds also parallels in Mesopotamia, as for example at Nippur (Hafford 2005: Fig. 6). The inscribed weight cat.-no. 16 can be assigned to the same loaf-shape category. Unique in the sample of weights presented here is a cubical weight (cat.-no. 15; Unger: "blue-green marble"), and it was a surprise as it was listed with seven rough cubes (cat.-nos. 25–31) in Unger's publication without any remark on its much more sharply profiled edges (Unger 1918: 35–36). It is considered here to be a Harappan weight, well known through about thousands of such objects from the greater Indus region, even if its weight is not fitting very well to the usual weight standard used in the Indus Civilisation (see below). Unger should not be blamed for not yet having recognized this object as a Harappan weight: when he published his catalogue in 1918, the Harappan Culture had not yet been rediscovered as a Bronze Age civilisation. The first cubical weights were published from Mohenjo-daro only in the 1920s. Harappan weights are not unknown in Southern Mesopotamia. A cube of yellow carnelian (U 17673; 13.5 g) was found in Ur and "its material, shape, and weight leave no doubt that it is a Harappan weight" (Ratnagar 2004: 250).[6] More such weights west of the greater Indus region have been found in Susa and the Persian Gulf region (Rahmstorf 2020: Fig. 4).

Signs, markings and metrology

Two of 17 weights bear inscriptions, another four show incisions in the form of parallel lines on their surfaces. The Sumerian inscription on the large weight cat.-no. 1 can be read as "*ma-na* ku$_3$.babbar", mina of silver.[7] Unger and F. H. Weissbach reported also three parallel incisions next to the inscription. I could not verify this

3 The monographic publication on the weights from Ebla is a very notable exception, see Ascalone/Peyronel 2006. For a recent systematic study of the morphology of EBA and MBA weights see Peyronel 2019.

4 Cf., for example, such objects from Uruk: Heinz/Müller-Neuhof 2000: 126–129 Pl. 101–105 ("Gewichtssteine mit Durchbohrung").

5 One such weight was found together with unworked pieces of lapis lazuli near the royal reception room.

6 More recently, another Harappan weight was found in an Old Babylonian house at AH in Ur. For this and more details about the newly excavated weights from Ur see Hafford/Einwag/Otto in this volume.

7 I would like to thank Sarah A. Clegg for the translation and comments. For an early reading of the inscription see Weissbach 1916: 50.

Table 1. Suggested weight units of the objects presented here as weights

Cat.-no. (Unger 1918, inv.-no.)	Provenance	Material (Unger)	Marking/inscription	Weight (gram)	Suggested ratio/unit
1 (1, 6258)	Tello	Limestone	3 Minas	1520	3 (506.6)
2 (45, 2432)	Tello	Limestone	-	83.6	1 (83.6) 10 (8.36)
3 (48, 2434)	Tello	Hematite	-	41.05	½ (82.1) 5 (8.21)
4 (54, 6348)	Tello (?)	Limestone	5	43.2	½ (86.4) 5 (8.64)
5 (62, 2433)	Tello	Limestone	3	34.9	3 (11.63)
6 (18, 7253)	Fara	Marble	-	54.7	6 (9.12) 7 (7.81)
7 (2, 7312)	?	Hematite	-	51.3	6 (8.55)
8 (38, 956)	Nippur	Granite	2	167.7	2 (83.85) 20 (8.39)
9 (46, 954)	Nippur	Hematite	-	83.7	1 (83.7) 10 (8.37)
10 (83, 959)	Nippur	Hematite	-	9.1	1 (9.1)
11 (136, 7250)	Nippur	Hematite	-	1.3	1/6 (7.8)
12 (139, 7252)	Nippur	Hematite	-	1	1/8 (8)
13 (140, 7251)	Nippur	Hematite	-	0.7	1/12 (8.4)
14 (53, 953)	Nippur	Basalt	-	43.2	½ (86.4) 5 (8.64)
15 (241, 964)	Nippur	Marble	-	28.6 (-) 31.6 rec.	2 (14.3 -) 2 (15.8 rec.) 4 (7.9 rec.)
16 (43, 7191)	Assur	Limestone	Inscription	101.3 (-)	12 (8.44 -)
17 (42, 7360)	Assur	Gypsum stone	10 and cross	114.7	10 (11.47)

during my examinations. The surface of the object is heavily worn, Unger suggests that 20 g may be missing. If there were indeed three lines, this would imply a mina of 506.7 g in the preserved state or of about 513 g in the reconstructed state. Anyway, it points to a heavy Mesopotamian mina of approximately 500 g. This is interesting, as S. A. Clegg would date the weight—due to the shape of the signs and the word order—to the Early Dynastic period (pers. comm. 30.06.2016). So far, we have little archaeological evidence for a metrological fixation of the Mesopotamian mina before the Akkadian period. The egg-shaped weight from Fara (cat.-no. 6) weighing 54.7 g could imply the 7.8 g-unit or 9.1–9.4 g-unit (**Table 1**). Another egg-shaped or piriform weight from Fara (Unger 1918: 3–4, no. 19), which I could not study, has a weight of 44.55 g, again maybe pointing to the 9.1–9.4 g-unit. Two more weights from Fara (Unger 1918: 9, no. 61 (35.65 g = 4 × 8.91) and 10, no. 65 (28 g = 3 × 9.33)), which again were not accessible to me, could again be assigned to this unit. Also a weight from Nippur (cat.-no. 10) seems to represent this unit as one shekel. The weights from Fara—assuming that they all date to Early Dynastic III—could indicate that this unit was used in Southern Mesopotamia in the Late Early Dynastic before the Mesopotamia shekel of approx. 8.3–8.4 g became the dominant shekel[8], which might be connected to the metrological reforms under Naram-Sîn. All other weights of the sample fit the Mesopotamian shekel and

8 See for example the weights from an Akkadian hoard at Nippur (McMahon 2006: Pl. 163).

Table 2. Potential weight units of the flattened spool-shaped objects—if they were weights

Cat.-no. (Unger 1918, inv.-no.)	Provenance	Material (Unger)	Marking/inscription	Weight (gram)	Suggested ratio/unit
18 (243, 7298)	Fara	Diorite	-	48.7	6 (8.12)
19 (242, 3104)	Bismaya	Diorite	-	50.7	6 (8.45)
20 (244, 7039)	?	Hematite	-	25.5	3 (8.55)
21 (247, 965)	Nippur	Alabaster	-	16.9	2 (8.45)
22 (245, 7299)	Fara	Alabaster	-	19.1	2 (9.55)
23 (246, 1016)	Nippur	Limestone	-	18.2	2 (9.1)
24 (248, 7300)	Fara	Alabaster	-	8.8	1 (8.8)

this may indicate their chronological position in the late third or early second millennium BC. The already mentioned marked weight from Assur (cat.-no. 17) apparently reflects the Anatolian unit of about 11.5–11.75 g, as well as the barrel-shaped weight from Tello (cat.-no. 5). The ten parallel incised lines on cat.-no. 17 imply this. The cross incised on the bottom of the same object is understood as the sign "½" (Unger 1918: 7). It remains unclear how we should interpret this here. The double weight of the object (then approximately 230 g) would still be only half of the so-called Western mina of about 470 g. There are, however, weights with the same sign where this interpretation makes more sense than in the case of a weight (4.3 g = 1/2 of 8.6 g = half of a Mesopotamian shekel) from Mashkan-shapir (Stone/Zimansky 2004: 122 Fig. 71, AbD 87-93).

The potential Harappan weight from Nippur is chipped. In its present state of preservation, it weighs 28.6 g, which would imply a slightly over-weighed Harappan unit (2 × 14.3), considering that the standard was set at approximately 13.7 g. A reconstruction with plastic modelling mass and weighing of the reconstructed volume resulted in the original weight of 31.6 g. This method is however not very precise, and 3D scanning and reconstruction which are now available were not yet possible in 2007. Very few cubical Harappan weights have a mass between 29 and 32 g (Hendrickx-Baudot 1972: 23). Does this result undermine the proposed interpretation of the object as a Harappan weight? Certainly, it would be easier to accept this interpretation if this object's mass fitted well as a multiple or fraction of the Harappan unit. There is one possible solution to this problem. It has been argued elsewhere (Rahmstorf 2020) that foreign weight shapes used a wider range of precision to allow their application in two or even more weight systems at the same time. This would allow traders to use the same weights for calculations in both the local and the foreign weighing system. The twenty-or-so Mesopotamian-style balance weights (of sphendonoid shape) in the greater Indus region might imply this (Rahmstorf 2020: Tab. 2–3). Hence, it is possible that the potential Indus weight in Southern Mesopotamian could be used at the same time as an over-weighed two-›shekel‹ Indus weight and as a slightly under-weighed four-shekel Mesopotamian weight. Beside these, all other weights easily fit as multiples or fractions of the Mesopotamian shekel with a range from 8–8.6 g (**Table 1**). Only a tiny weight from Nippur is less precise (cat.-no. 11). It is, however, observable that weights below 5 g, i. e. fractions of the unit, are lacking the precision that more heavy weights, i. e. multiples of the unit, can achieve.

Other tools

Flattened spool-shaped stone objects (cat.-nos. 18–24, "Garnrollen", see **Table 2**) were published by Unger as weights or weight-similar objects ("Gewichte und gewichtsähnliche Stücke") and are also known from other publications where they have been published as beads (with perforation?), ear studs or gaming tokens (Heinrich/Andrae 1931: 77 Pl. 35, p4; Hall/Woolley 1927: 53). It is thus possible to assign them to multiples of the Mesopotamian shekel (8.3–8.4 g: cat.-nos. 18–21. 24?) or the 9.1–9.4 g unit (cat.-nos. 22–23. 24?). Whilst it is not impossible that they were indeed used as weights, many more such objects need to be sampled before any conclusive interpretation can be put forward. In addition, contextual archaeological data (were they sometimes found in concentration? with which other objects? etc.) may give some insight. If further data will indeed strengthen such an interpretation, the objects illustrated here (Pl. 9 top) will also be presented with drawings which will allow their better appraisal.

Table 3. Spherical stone cubes, not considered to be weights

Cat.-no. (Unger 1918, inv.-no.)	Provenance	Material (Unger)	Marking/ inscription	Weight (gram)	Suggested ratio/unit
25 (233, 7303)	Fara	Diorite	-	394	?
26 (234, 1193)	Nippur	Limestone	-	388	?
27 (236, 1191)	Nippur	Limestone	-	135.3	?
28 (235, 6351)	Nippur	Diorite	-	188.4	?
29 (237, 6350)	Tello (?)	Limestone	-	160.5	?
30 (239, 6349)	Tello (?)	Diorite	-	108.8	?
31 (240, 1190)	Nippur	Diorite	-	71.9	?

Another group of objects considered by Unger as "weights or weight-similar objects" were the spherical stone cubes (**Table 3**). Some of these have flattened or even polished surfaces, but most of the surfaces of these objects have remained very coarse. Normally they are considered as grinding tools. The mass of the objects in the sample does not easily conform to any known weight standard, or at least show a great deal of variance, as also W. B. Hafford (2005: 359) has observed for similar objects from Nippur: "it is thus a probable conclusion that these objects did not serve as weights at Nippur and were likely to have been grinding tools".

Concluding remarks

Unger's publication was ground-breaking a hundred years ago because he assembled a large array of weights and potential weights. Unfortunately, the promised second publication with illustrations never appeared. With the present publication at hand this shortcoming can be solved for at least 31 of the objects. In addition, 49 other weights were published with photographs by T. H. Zeyrek and Z. Kiziltan (2005) but still a large portion of the material presented by Unger is not available with illustrations. I hope that it has become evident that the functional question (weight or not weight) may be solved only with the help of illustrations of the objects. Only on the basis of such visual data, a precise identification—as in the case of the potential Harappan weight—will be possible. Unger was ahead of his time when he published potential weights, like the flattened spool-shaped object or the coarse spherical cubes. 100 years later, it is finally time to solve the problem of the use of such objects for weighing purposes in Mesopotamia and beyond.

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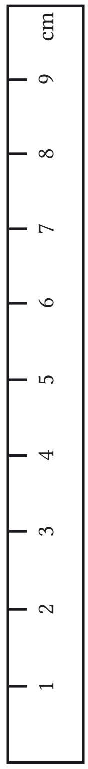
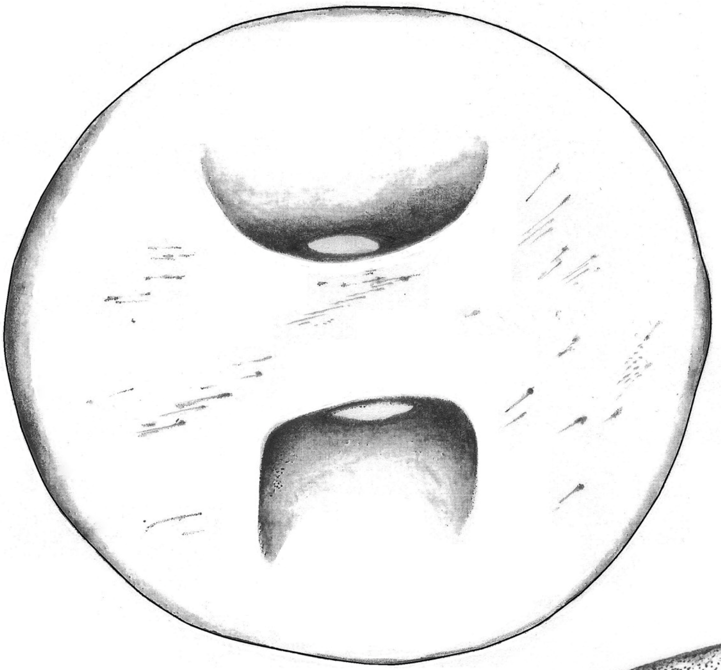
Plate 1





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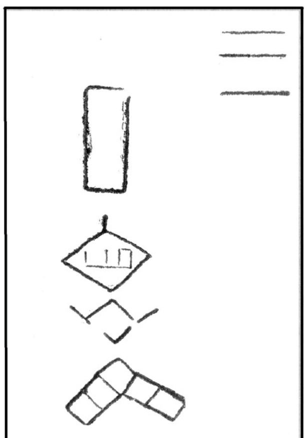
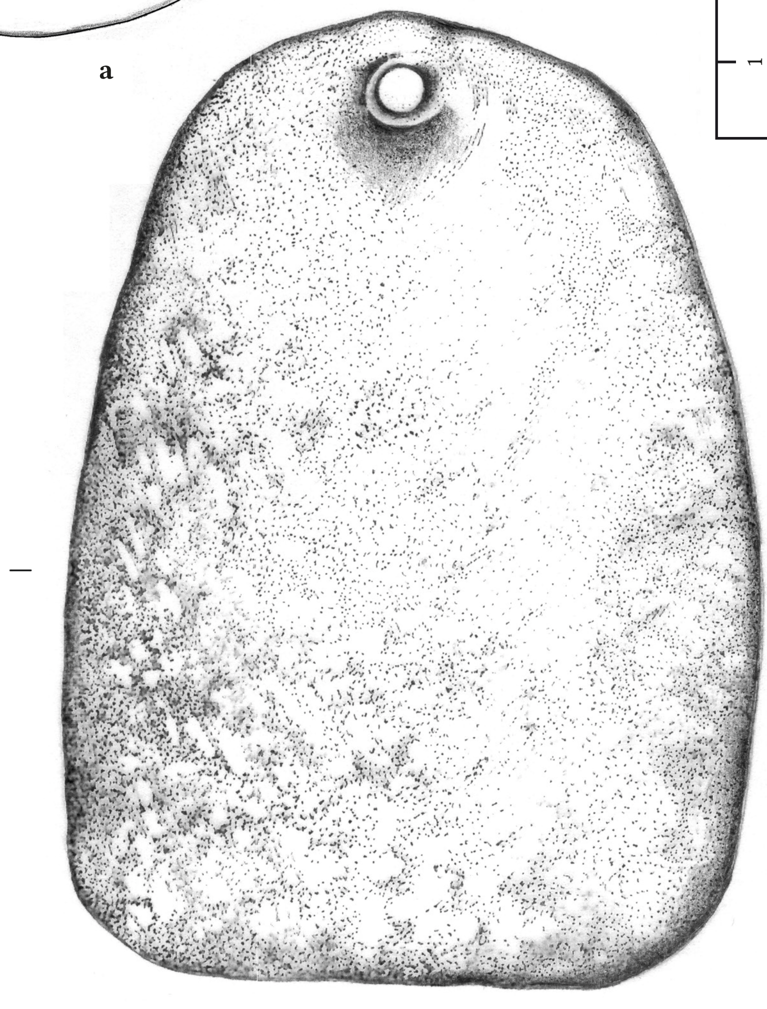


b



c

1 Tello 1 (6258)

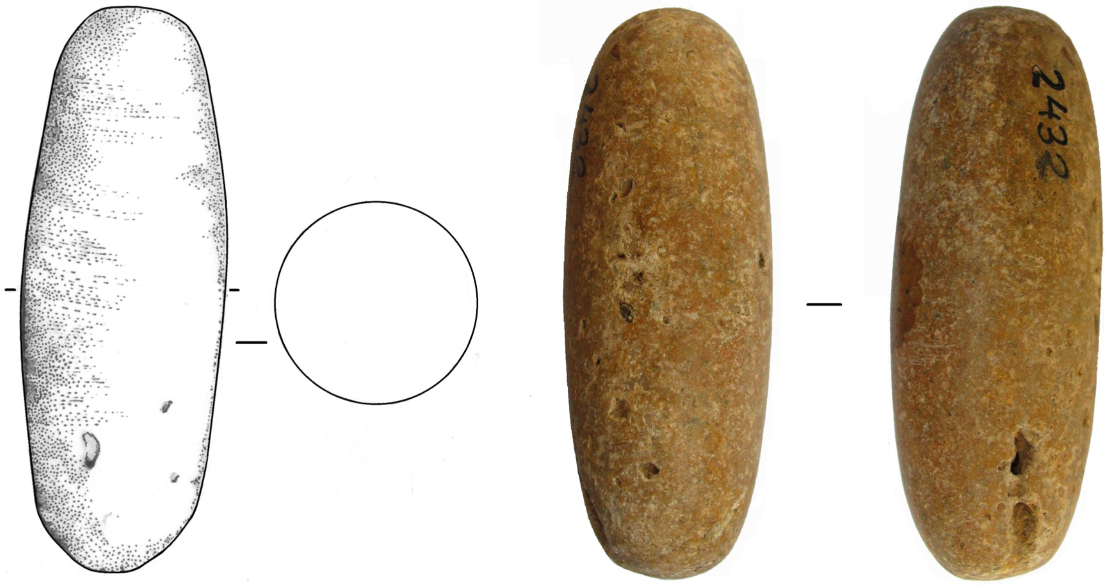
Weight from Tello

Plate 2

1 Tello 1 (6258)

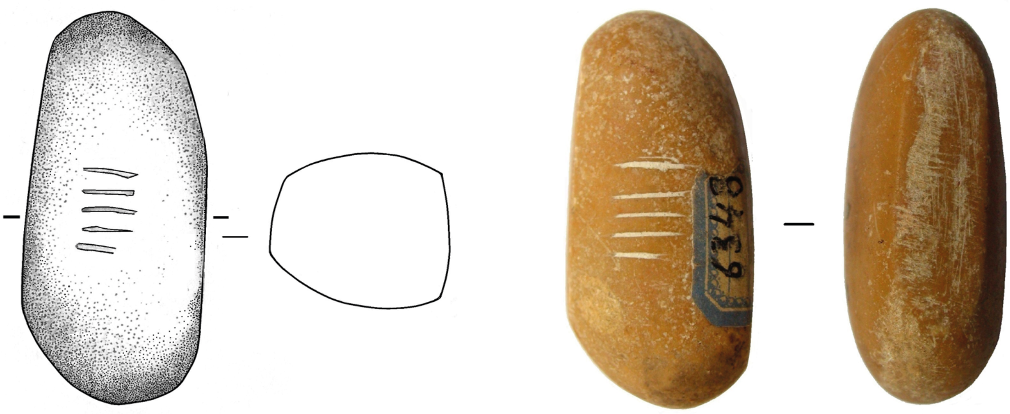
Weight from Tello

Plate 3

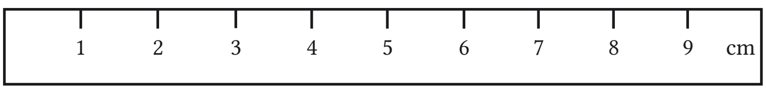


2 Tello 45 (2432)

3 Tello 48 (2434)

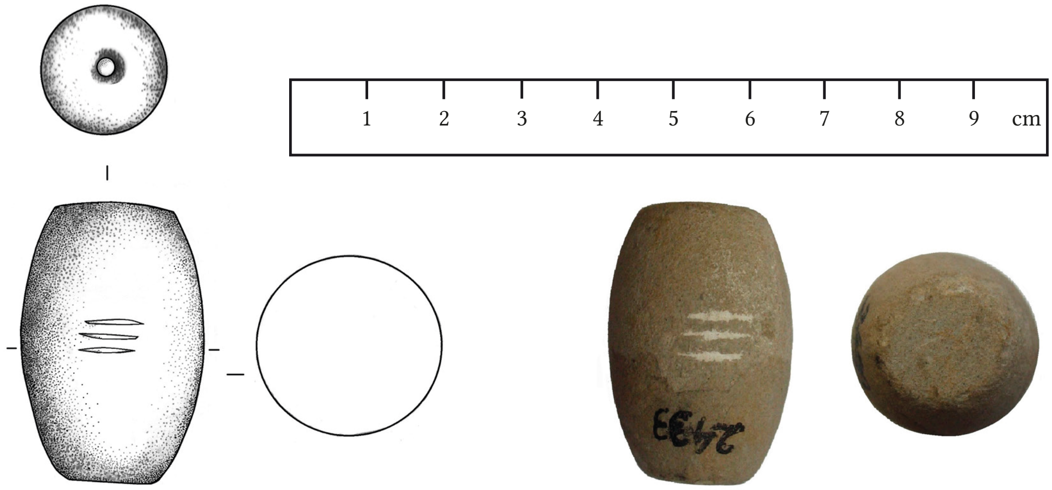


4 Tello (?) 54 (6348)

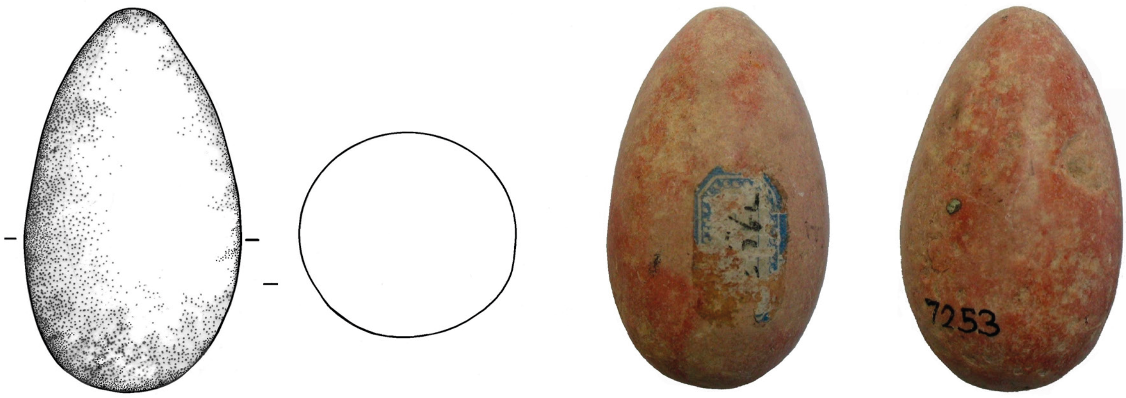


Weights from Tello

Plate 4



5 Tello 62 (2433)

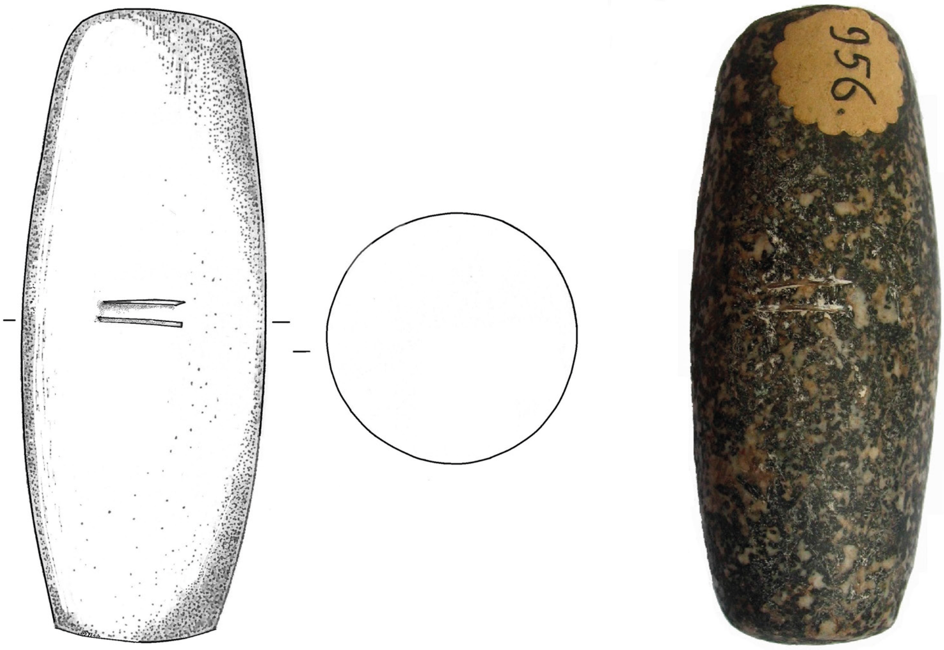


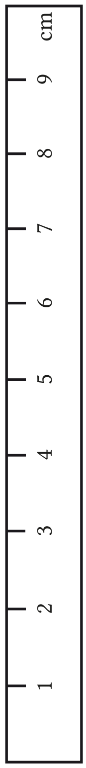
6 Fara 18 (7253)

7 2 (7312)

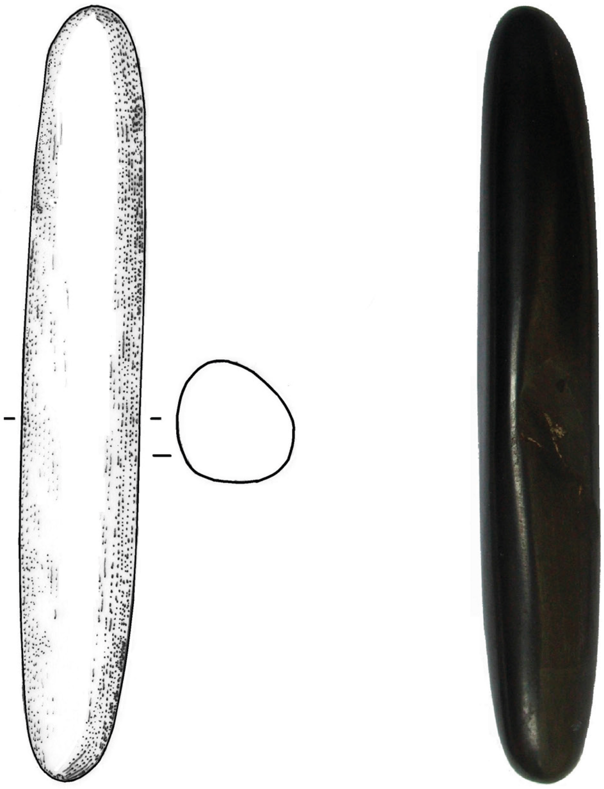
Weights from Tello, Fara and an unknown site

Plate 5





8 Nippur 38 (956)



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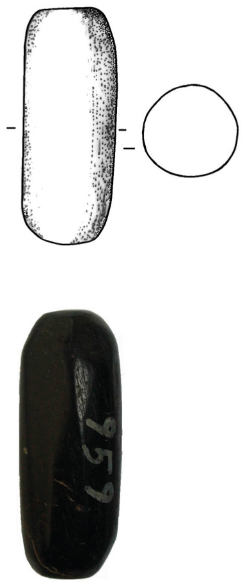
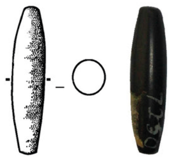


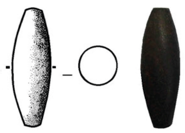
10 Nippur 83 (959)

Weights from Nippur

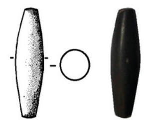
Plate 6



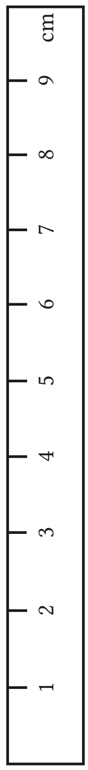
11 Nippur 136 (7250)

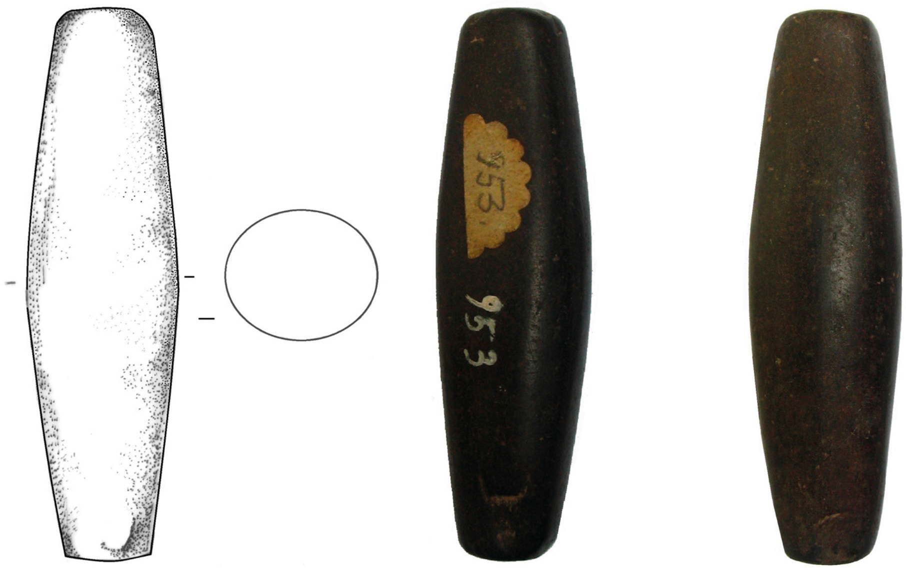


12 Nippur 130 (7252)

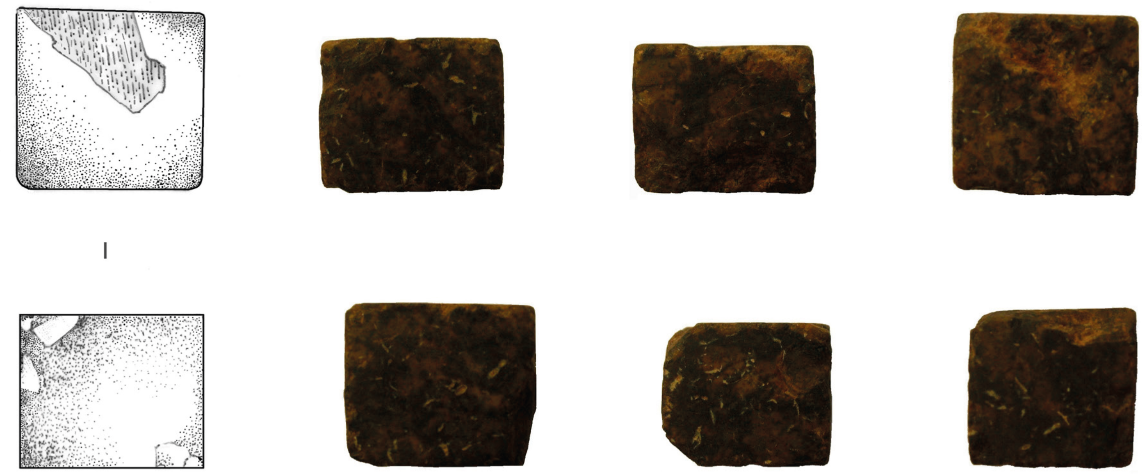


13 Nippur 140 (7251)





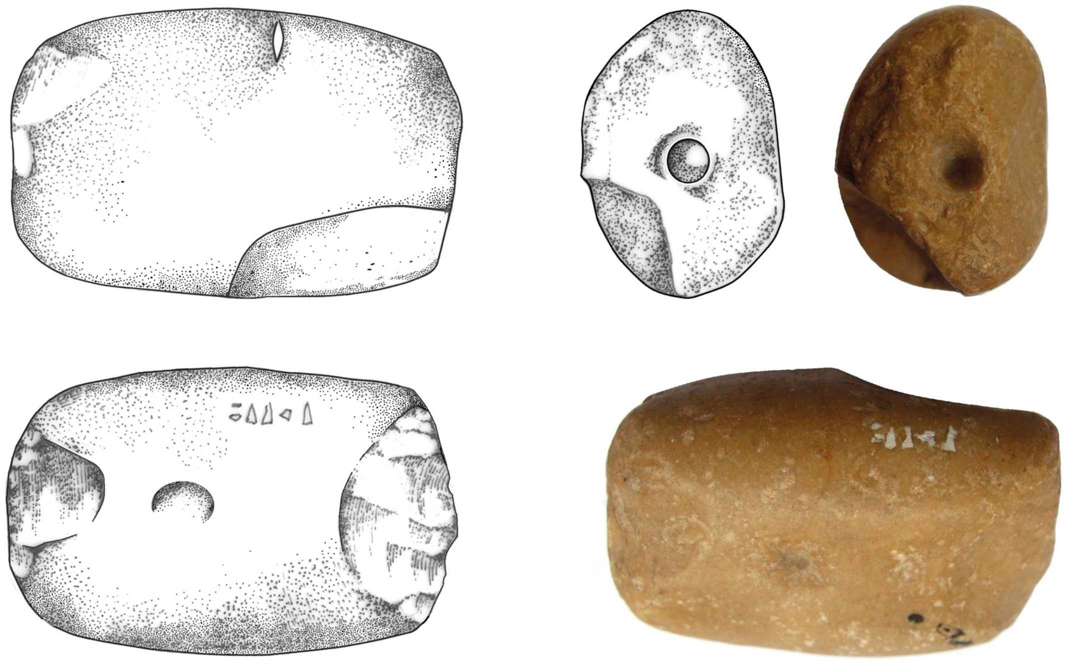
14 Nippur 53 (953)



15 Nippur 241 (964)

Weights from Nippur

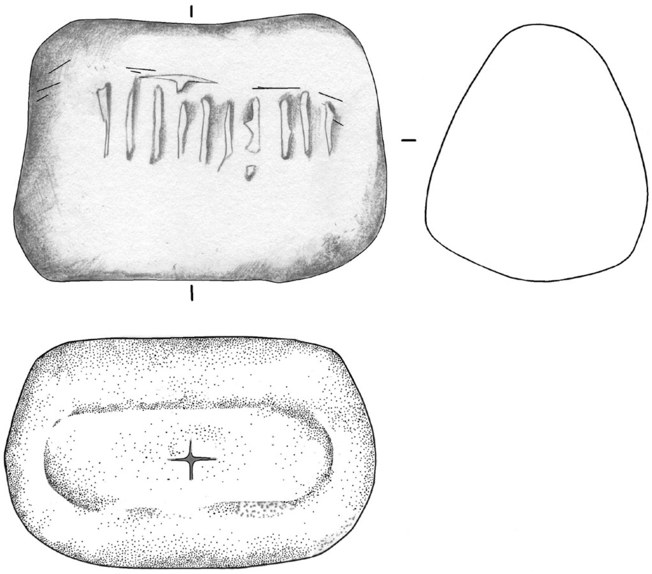
Plate 7



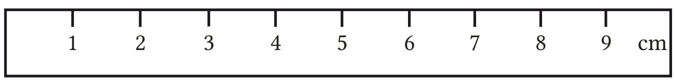
16 Assur 43 (7191)

Weight from Assur

Plate 8



17 Assur 42 (7360)



Weight from Assur

Plate 9

18 Fara 243 (7298)

19 Bismaya 242 (3104)

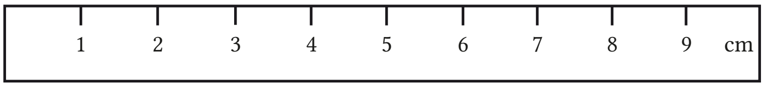
20 ? 244 (7039)

21 Nippur 247 (965)

22 Fara 245 (7299)

23 Nippur 246 (1016)

24 Fara 248 (7300)



25 Fara 247 (7303)

26 Nippur 234 (1193)

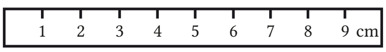
27 Nippur 236 (1191)

28 Nippur
235 (6351)

29 Tello (?)
237 (6350)

30 Tello (?)
239 (6349)

31 Nippur
240 (1190)



Tools from Fara, Nippur, Bismaya and Tello (?) and an unknown site

Why do “duck-weights” have the form of a water-bird? Goose-weights and their relation to the goddesses Nanše and Ningal[1]

Adelheid Otto – Grégory Chambon

“If it looks like a duck, swims like a duck, and quacks like a duck, then it, most probably, is a … goose.”
(slightly modified English proverb)

The most characteristic and elegant form of a Mesopotamian weight-stone is that of a recumbent bird turning its head back to lie along the body. These so-called “duck-shaped weights” or “duck-weights” are attested for the late third millennium onwards. Apparently, this form was so successful and meaningful that it was in use nearly everywhere in the Near East. The ancient people must have been aware of its meaning, which however escapes us. It is argued here that the shape of weights, especially referential weights, was not meaningless, as is the case with the Assyrian royal weight, which has the form of a lion.[2] But although every handbook on the Near East and every museum with Near Eastern objects proudly exhibit the aesthetically appealing duck-weights, no satisfactory explanation has yet been proposed for why a weight-stone should have the shape of a resting water-bird—be it a duck, a goose or any other water-bird.[3]

The earliest “duck-weights” and the concept of certified weight-stones

Recent research makes clear that balance pan weights were in use not only from the Early Dynastic period onwards, but already in the fourth millennium, thus con-

1 This article was born from a simple email-conversation between the authors during the first hard Corona lockdown in April 2020, when the authors were working on the edition of this volume. Otto, an archaeologist widely interested in iconography, asked Chambon, a philologist and expert of metrology, about the most common scholarly explanation for the “duck-shape” of weight-stones. Upon his perplexing answer that there was no accepted explanation, Otto started this research, which was enriched by Chambon’s input and—in the course of that year, in kind of a ping-pong—developed into an interdisciplinary study. The first draft of the manuscript received many critical remarks from Michael Roaf, who has to be thanked warmly. The paper profited further from comments by William B. Hafford, Elisa Rossberger, Enrique Jiménez and Berthold Einwag. Ilona Spalinger is to be thanked for smoothing the English.

2 The meaning of the duck-shape in analogy with the lion-shape associated with Assyrian royalty was considered by E. Cancik-Kirschbaum (2012: 17), without finding a satisfactory answer: “Während eine überzeugende Erklärung für die »Ente« als formgebendes Motiv noch aussteht, fungiert eine andere in metrischen Serien verwendete Tiergestalt, der Löwe, als Emblem-Tier des assyrischen Königs.”

3 The identity of the water-bird has been a matter of discussion for a long time. Powell 1979: 80 already argued that they represented geese or swans, not ducks. E. Jiménez brought a Latin poem written by Jean-Vincent Scheil to our attention, where Scheil proposed an original, very French explanation, what the goose and a weight-stone have in common; in Scheil’s words: “Quid vobis apud Assyrios, o pondus et anser, est commune, parem qui geritis speciem?” Scheil’s explanation is centered on the similarity of the Akkadian word *kabittu*, that he interpreted as “weight” from the verb *kabātum*, “to become heavy” and the word for the most delicious part of the goose, the liver (*kabattu*, in earlier publications often *kabittu*) (Jiménez 2020: 295). However, this gourmet explanation seems not to have been accepted by anyone else.

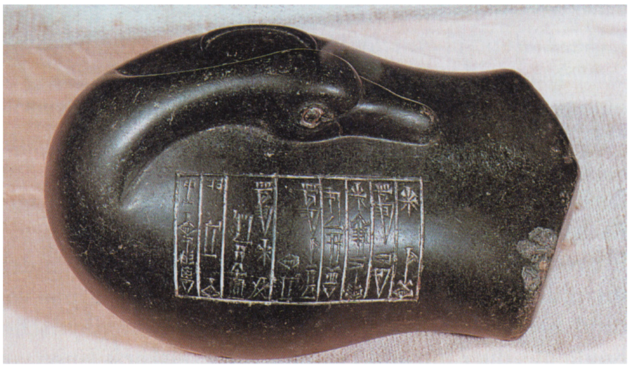


Fig. 1. Five Mina diorite goose-weight from Etemenniguru at Ur, dedicated to Nanna by Šulgi (Hrouda 1991: 208)

stituting another relevant element of the emerging complex urban societies.[4] Yet the earliest weight stones are sphendonoid, cylindrical, domed, sphere- or egg-shaped. No duck-shaped weight can be dated earlier than the Lagaš II period for sure.

A tiny little number of duck-shaped weights seems to date to an earlier period at first sight only. Among these are a duck-weight from Chagar Bazar, one from Kiš and one from Tepe Gawra, which however are either intrusive in the levels, date as well to the early Ur III period or are no duck-weights.[5] The allegedly earliest inscribed duck-shaped weight bears an inscription of Narām-Sîn.[6] Since this inscription is probably not genuine, however, there is no securely attested duck-weight until after the end of the Akkadian period.[7]

Thus, the earliest dated duck-weight seems to originate from the Lagaš II dynasty. It is exceptionally large (49.5 cm long), from granite, and bears the inscription: "2 talents, Ur-Ningirsu, ensi$_2$ of Lagaš".[8] It weighs 60.555 kg, which corresponds to two Mesopotamian talents of approx. 30 kg (120 mina of 504.62 g, 7200 shekel of 8.41 g). Meanwhile another duck-weight dating to the Lagaš II dynasty has been published.[9] Duck-weights became more frequent during the Ur III period. Some of them were marked as the officially fixed/certified (Sumerian gi-na, verb gi.n) standard by an inscription referring to the king. This goes hand in hand with the well-known reform by the Ur III kings, who set the standards (Sallaberger 2014: 425).

Luca Peyronel assembled the eleven known weight-stones bearing inscriptions of Ur III kings (Peyronel 2012: 19, Tab. 1). All of them were made of diorite. Seven inscriptions state that the king standardised/certified (gi-na) the weight; four mention the god to whom they were dedicated. For example, the duck-weight from Etemenniguru at Ur (Iraq Museum IM 3580), weighing 2478 g, is inscribed: "For Nanna, his lord, divine Šulgi, the mighty man, king of Ur, king of the four regions, has standardised/certified the 5 mina." (**Fig. 1**).[10] Seven of these diorite weight-stones are in form of a "duck", one

4 W. B. Hafford (2019) clearly demonstrated this with the material from Tepe Gawra. See also Rahmstorf 2006 for a wide perspective on the earliest balance weight stones.

5 A seemingly early duck-weight from Chagar Bazar Level 5 (Mallowan 1937: 131, Fig. 11, No. 6) was found in a disturbed area and is probably intrusive. Max Mallowan (1947: 109, no. 18O) proposed the possible development of the duck-shape from pierced Jemdet Nasr amulets; however, the time gap between the amulets and the earliest attestation of duck-weights makes this suggestion somewhat arbitrary. A unique Agade duck-weight from Ebla dates to the Middle Bronze Age (see Ascalone/Peyronel 2011 and Peyronel 2019). The 47 weight-stones in the Early Bronze IVA Palace G at Ebla constitute the earliest well stratified assemblage of politically controlled weight-stones to date, but none of the weights has the shape of a water-bird (Peyronel 2019: 68–70). A large duck-shaped stone weight from Kiš/Tell Ingharra can be associated with Monument Z, Phase 13b, which contains mixed material from the Akkadian and Ur III period (Zaina 2020: 126, Pl. CXVIII.7). One duck-weight is said to have been found in Nintu Temple VII at Khafajah (Early Dynastic III–Akkadian period), but it might well be intrusive from the later private houses which were built above the temple (Delougaz/Lloyd 1942: 79–82, 150). W. B. Hafford (2019: 19, note 5) showed that there is no clear evidence for the alleged early duck-weights from Tepe Gawra.

6 MM. 740.004: Museo dell'Oriente Biblico di Montserrat, Barcelona (Molina 1989).

7 L. Peyronel and G. Marchesi doubt that the inscription is genuine, since it is written horizontally and not vertically and says only "*na-ra-am-*^{d}EN.ZU LUGAL". RIME Narām-Sîn E2.1.4.44 (Peyronel 2012: 14–15, Pl. I,2).

8 BM 104724 (King 1912, Pl. 50. RIME 3/1.01.01. add07, ex. 01. Peyronel 2012: 15–16, Pl. I,3. https://www.britishmuseum.org/collection/object/W_1912-0511-239). Two rulers of Lagaš were actually named Ur-Ningirsu (Maeda 1988); the first ensi$_2$ (head of the city) of Lagaš was a contemporary of the last kings of Akkad and the second, son of Gudea, ruled slightly earlier than the beginning of the Ur III dynasty (Sallaberger/Schrakamp 2015: 31). As the inscription mentions only "king of Lagaš" and not "son of Gudea", which is regularly indicated in the inscriptions of the second ruler, one might think that it refers to the first ensi$_2$. But this argument *ex silentio* can not explain why we have no similar inscribed specimen dated to his successors of the second Dynasty of Lagaš, especially Ur-bau and Gudea, for whom we have a lot of inscriptions on several types of media. It therefore seems more plausible that it dates to the reign of Ur-Ningirsu II, which just precedes or is contemporary with the foundation of the Ur III Dynasty.

9 Another duck-weight that is referenced as dating to the Lagaš II dynasty has been auctioned (see Theis 2017), but we have no indication of its mass or the content of the inscription; only its length of 21 cm is known.

10 Duck-weight from Ur, Etemenniguru. Iraq Museum IM 3580 (Woolley 1974: 99, Pl. 48b).

is sphendonoid and one in stele-form (**Fig. 12**),[11] two more are too fragmentary to recognise their shape. Eight were found at Ur in the temple area (at Gipar-ku, Etemenniguru, Edublamah and Ganunmah), and two were found at Tello. Three of them (one from Ur, one from Tello, one from the art market) explicitly mention the city-god Nanna. One duck-weight from Ur was dedicated to Ningal, the supreme goddess of Ur, Nanna's consort.[12] This weight was found at Gipar-ku, Ningal's sacred compound and temple. The inscription on the heavily damaged object reads: „For Ningal, his lady, Šulgi the mighty man, king of Ur, king of the four regions."[13]

These heavy weight-stones, whose accuracy and righteousness were officially guaranteed by the king, clearly belonged to the set of reference weights of the Ur III state for both economic and ideological purposes. They were kept in the temenos area around the ziggurat, which was also used as the supreme court and the treasury. The findspots of these weight-stones and the fact that they were expressly related to the supreme deities of Ur, Nanna and Ningal, emphasise the important function of this sanctuary complex and temples in general as the place where the official reference weights were kept and where the correctness of financial transactions was guaranteed.

The existence of "weigh-masters" (officials, merchants or craftsmen) involved in the process of weighing or of controlling the procedure is already attested in the administrative documentation from the Early Dynastic and Akkadian periods, which records abundant quantities of metal and valuable material.[14] For example, a letter from the chancery of Ebla mentions a dispute about the use of correct weights for the purchase of clothing from Mari by a merchant from Ebla. While the merchant is weighing the clothes with his own weights, the market overseer's son and then the market overseer himself come to prompt him to use the king's weights (Sumerian na_4 lugal) from now on.[15] Although the text does not inform us about the shape of these weights, there is no doubt that they could be visually distinguished from the series of weights used by the merchants. In any case, the predominant use of king's weights reflects a form of control by the royal administration (of Mari in this case) of the market economy; in particular, the text states that the amount of silver (hence the purchase price) increases (Akk. verb *kabātum*) when the quantity of clothing is weighed with the king's weights.

Yet it remains difficult to know exactly to what extent the organisations (palaces, temples) were involved in the choice and the use of sets of weight standards.[16] However, an administrative text from the Ur III period, dated to the reign of Amar-Sîn, clearly refers to the reception of two different sets of weights by two officials (ugula "super-intendents") responsible for the administration of the wool industry in the city of Umma (Finkel 1987). We may assume that these weight sets were disbursed either by the local administration of Umma or by the royal administration of Ur (unfortunately not specified in the text) and that in any case, following Irving Finkel's interpretation, this document reflects a deliberate attempt to ensure the use of uniform weights. The form of these weights, listed by decreasing order from 10 minas to 10 shekels, has unfortunately not been specified by the scribe.

What is particularly interesting is that epigraphic documentation refers to "bird-stones". On a lexical list from Old Babylonian Nippur,[17] the entry ^{na_4}ki-ta (an error for ^{na_4}ki-lá, "weighing stone")[18] is followed by the entries ^{na_4}uz "duck$^?$ stone"[19], ^{na_4}ḫuduš (an unknown type of stone shape), [^{na_4}]⌜nunuz$^?$⌝ "egg-shaped? stone",

11 The term 'stele-form' describes a form which is a mixture between conical and flat. Hafford (2012: 26) explains that the term 'sphendonoid' was coined by Sir Athur Evans and means 'sling-bullet-shaped'. This form is sometimes also referred to as barrel-shaped, bi-conical or oval, and the names vary considerably as well in other languages. For a convincing terminology of shapes see Hafford 2012 and Peyronel 2019.

12 Three of the four duck-weights bearing inscriptions of Šulgi were dedicated to Nanna (AO 2218; IM 3580; one in Istanbul Museum), one was dedicated to Ningal (BM 118552).

13 U. 6954, BM 1927,0527.25; BM 118552 (Gadd/Legrain 1928: n. 55, Pl. 12. Frayne 1997: 155 E3/2.1.2.53). No photo is available, not even on Ur-online. W. B. Hafford notes: "Large duck weight, one side partly preserved up to head on back. One eye of head seen engraved, below on side is inscription of Shulgi: For Ningal, his lady, Shulgi the mighty man king of Ur king of the four regions; badly broken, loss ca. 80 %." (http://www.ur-online.org/subject/6241/).

14 See the study of the terminology of such specialists in Bartash 2017.

15 Leonid Kogan drew our attention to ARET 13, 15 during a lecture he held in Munich in May 2021; he is presently preparing a new interpretation of the text. Two verbs for "to weigh" are used in ARET 13, 15: the usual Akkadian verb *šaqālum* and the verb on the root *wzn*, known later in Arabic as "to weigh" and certainly having the same meaning in Ebla. We do not know whether these verbs refer to two different weighing activities or to two dialectical ways of expressing weighing, depending on the region (Mari or Ebla).

16 Except for the "administrator of date orchards", certainly belonging to a royal household, who weighed silver for a merchant (OSP 2, n°62: Bartash 2017: 85–86).

17 CBS 10183, published in MSL 10 and on the online Digital Corpus of Cuneiform Lexical texts (http://oracc.museum.upenn.edu/dcclt/corpus). We thank Manon Ramez for bringing it to our attention.

18 According to the Digital Corpus of Cuneiform Lexical texts.

19 See below for a discussion of the meaning of the Sumerian uz.

na$_4$ ⸢eš$_5$⸣ [še][20] "(weighing) stone of 3 barleycorns", na$_4$ min [še] "(weighing) stone of 2 barleycorns", na$_4$ diš [še] "(weighing) stone of 1 barleycorn". This list seems to have been extracted from the classical so-called Ur$_5$-ra list, but with the new entry ^{na_4}uz. As this extract begins with the entry "weighing stone" and ends with the entry "(weighing) stone of 1 barleycorn", it seems to concern a set of material weights that are described according to their shape or weight. The expression ^{na_4}nunuz is usually considered to refer to a bead, which can be white or black, according to some lexical Ur$_5$-ra lists.[21] The term nunuz, however, which means "egg-shaped", could refer to egg-shaped weights, which are not too frequently found among the material weights, or could refer more generally to sphendonoid or other roughly oval weight-stones.

Another Old Babylonian lexical list from unknown provenance mentions ^{na_4}uz "duck? stone", followed by the entries ^{na_4}uz babbar "white duck? stone", ^{na_4}uz ĝe$_6$ "black duck? stone". The white and black colours for ^{na_4}nunuz "egg-shaped stone" and ^{na_4}uz "duck? stone" in these lexical lists find counterparts in material data, since the material weights are either from white limestone or from grey-black haematite (for the smaller weights) and diorite respectively (for the larger ones) (Hafford 2012: 31–32).

Grégory Chambon and Dominique Charpin have made clear that an important function of some Old Babylonian temples was their use as the "office of weights and measures". Chambon realised that some weighing of metal in the 'Grand Palais' of Mari took place in the 'Ishtar chapel', and that the existence of weight stones in temples was not to be understood symbolically, but that these were the reference weight sets of the city.[22] Furthermore, some loan contracts from Mari mentioning refined and certified (*ṣarpum*) silver according to the "weight of the city of Mari" concern economic activities of temples (Chambon/Marti 2019: 58), in the same way as the mentioning of the "weight of (the god) Šamaš" refers to loan contracts established in the temple of the sun god in Sippar (Stol 1999: 580). Charpin (2017: 85–106) convincingly argued that "Egina", the "house of the gi-na (certified/verified)" was the room or chapel of *Kittum* (é ^{d}*ki-it-tim*), the personification of justice, inside a temple where the verified reference weights and measures were kept, which served to ensure the fairness of the transactions and to certify the quality of silver.

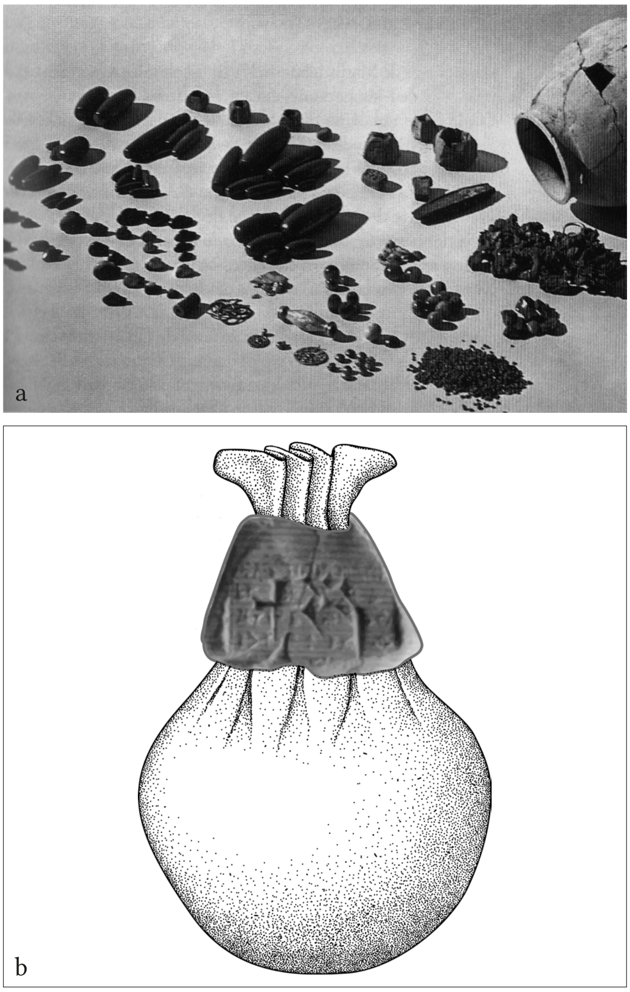


Fig. 2. (a) The hoard from E.BABBAR at Larsa, including sealed silver and complete sets of weight-stones (Huot 2004: 29). (b) Sealing of a sack with weighed silver and tentative reconstruction of the sack (drawing A. Otto/M. Lerchl after Arnaud et al. 1979: Pl. I.2).

Charpin (2017: 86–94) also re-examined the hoard from Larsa, which had been found under the floor of Room 13 of the Ebabbar at Larsa (Arnaud et al. 1979; Huot 2004). The buried pot contained the equipment of the weighing office including sets of sphendonoid and duck-shaped weight stones, scrap silver and gold, sealed and inscribed sack closures (**Fig. 2a**). Charpin demonstrated that the person responsible for the weighing procedure, who was directly controlled by the Babylonian

20 This philological restitution is based on the canonical Ur$_5$-ra list from Nippur, in which the section with the weight units by decreasing order (from the unit gun$_2$ "talents" until the lowest unit še "barleycorns") is followed by a list of plants as in CBS 10183.

21 See for example CBS 4608+ o iii 46 on the Digital Corpus of Cuneiform Lexical texts.

22 Chambon (2011: 153–154) thinks that they belonged to a set of weights which was kept in this sacred space, used to validate transactions in metals and to prevent possible deviations. He concludes: "… ces exemplaires jouaient un rôle administratif de première importance en offrant une garantie sur la validité de manipulations de métaux."

king, had produced several sacks of weighed, "certified/verified" (gi-na) silver and guaranteed the exact mass of the content by impressing his official seal on the clay sealings of the sacks. We followed this idea and tried to reconstruct such a sack of weighed silver (**Fig. 2b**). The idea of this "sealed" (*kankum*) silver is clearly the same as that which more than 1000 years later led to the development of silver and gold coins stamped with the official seal of a king or state.

It may be concluded from this short overview that duck-weights came into use around 2100 BC. They continued to be in use for nearly 2000 years.[23] But what does the 'duck' stand for? Dominique Collon, when discussing the so-called "Filling Motifs" on seals, made clear that every single motif on a seal had a specific significance, and therefore investigated the meaning of the lion and the duck or goose (Collon 1995). It has been acknowledged since long that the motif of the lion was the symbol of the Assyrian royalty. As such it was used to mark seals, vessels and other objects as property of the palace, and was also the shape of official royal Assyrian standard weights. In the Neo-Assyrian period, the duck-weight was considered as so typically Babylonian that the duck-weights in the North-West Palace in Nimrud had a striding lion incised on their flanks in order to underline their official status as standard weights in the Assyrian royal palace.[24] Collon then asked, what—in analogy with the lion-weights—the duck-shaped weights would stand for. Since the long-necked bird (duck or goose) appeared frequently on seals and terracotta plaques from Ur in the late third millennium, she related this bird to the city of Ur in a way which will be explained in the following. She argued: "This 'duck'-weight was presumably used by the merchants of Ur, and throughout the Ur III trade empire it would have come to be regarded as a standard. As a result, the 'duck'-shape was adopted as the weight *par excellence*, at least into Achaemenid times." (Collon 1995, 72). Even if this explanation overemphasises the role of the Ur merchants, Collon is certainly right in establishing a relation between the duck or goose and Ur.

The goose and its relation to Mesopotamian goddesses

The water-birds most commonly depicted in Southern Mesopotamian art have long necks and long legs, which are typical of geese but not of ducks.[25] Wild geese of various kinds actually appear as winter visitors in the Near East; several are even attested throughout the year and are breeding in Iraq (Porter et al. 2010). Elisabeth von der Osten-Sacken (2015: 229–270) discussed in length the various species of water-birds in modern and ancient Near East and convincingly argued from the depictions, palaeozoological remains and texts that the duck played only a minor role in ancient Mesopotamia. Not least because ducks were not domesticated before the Roman period and geese were economically important animals. The faunal remains indicate more geese in third and second millennium Southern Mesopotamian sites (Isin, Nippur, Der, Uruk and others) than ducks (Osten-Sacken 2015: 492–512). She noted on the other hand that wild and domesticated geese were fairly frequent in the administrative records and that the Sumerian words uz and uz-tur (the sign combination UZ.TUR is read bibad in lexical lists) must be identified with the wild and domestic goose respectively (Osten-Sacken 2015: 229–270).[26] The problem is that the semantics of bird names may have shifted in the course of time and depended on the context described in the texts: they could be used either as generic or specific terms.[27] As the term uz is written ŠE.MUŠEN, literally "barley/bird", one may spontaneously think of a fattened (and thus domesticated) bird, but in some cases uz could refer to a wild bird, and a lexical list (Ur_5-ra style from Old Babylonian Nippur) clearly mentions a fattened bird, bibad niga^{mušen}. Nick Veldhuis prefers to consider bibad^{mušen} as a duck, because in

23 See for example the duck-weights used in the Assyrian Empire and studied by Reade 2018, or Reade 2018: 146 for a post-Assyrian duck-weight.

24 Reade 2018; see also the contribution by Chambon and Otto in this volume.

25 This has already been pointed out by several scholars, most recently by Julian Reade (2018: 127) in his study on the relationship between Assyrian weights and money.

26 Benno Landsberger (1966: 250–251) argued that uz^{mušen} was the wild duck but correlated the Arabic *iwazz* and late Hebrew *awazz* for goose with the Sumerian uz, which resulted in the Akkadian loan-word *usû*: "Vielleicht war *awazz*/*usu* von Anfang an ambivalent Gans-Ente, ähnlich uz/uz-tur" (Landsberger 1966: 257). He showed that the term uz^{mušen} in Early Dynastic, Akkad and Ur III documentations was identical to bibad^{mušen} (UZ.TUR^{mušen}) in Ur III and later documentation. According to him, this replacement may be seen as an indication of the progressive domestication of the wild duck/goose. The Sumerian term kur-gi/Akkadian *kurkû* was also used for "goose", maybe for both "wild goose" and "tame goose" (Landsberger 1966: 246).

27 These terms could refer generically but ambiguously (for a modern reader) to 'goose' or 'duck' (Black/Al-Rawi 1987).

Fig. 3. A goose standard depicted on cylinder seals from Tello (Parrot 1948: Pl. XXX, no. 532) and Ur (Legrain 1951: Pl. 18, no. 247).

some administrative texts from Ur III Lagaš, this kind of bird receives an identical or lower grain ration than the birds named u$_{5}^{\text{mušen}}$ (written SI.MUŠEN$^{\text{mušen}}$) and the kur-gi$_{16}^{\text{mušen}}$ (Akkadian *kurkû*)[28], which he proposes to identify (most of the time but not necessarily always)[29] with the captive goose of the wild variety and the domestic goose respectively.[30] Anyway, an Old Babylonian proverb of unknown provenance clearly distinguishes the bird uz$^{\text{mušen}}$ from the bird kur-gi$_{4}^{\text{mušen}}$, even if its interpretation is still unclear: "The Tigris is a duck, the Euphrates is a goose…".[31] The terms uz$^{\text{mušen}}$ and u$_{5}^{\text{mušen}}$ are already mentioned in the lexical bird lists dated to the Early Dynastic period, while kur-gi$^{\text{mušen}}$ appears later in Old Akkadian administrative texts from Adab, Girsu and Umma.[32] The u$_{5}^{\text{mušen}}$ bird still opens the Old Babylonian bird list and has to be regarded as the bird par excellence (Veldhuis 2014: 45). It plays a prominent role in the introduction to the literary text 'Nanše and the Birds' and is closely associated in literature with this goddess (see below). Various meanings of this term have been proposed (cock, swan, pelican, cormorant, gull and goose), but Veldhuis has convincingly argued that the translations pelican, cormorant or gull are unlikely because u$_{5}^{\text{mušen}}$ is mentioned in Ur III grain distribution texts and this bird is said to raise its voice in 'Nanše and the Birds' (Veldhuis 2004: 294). Furthermore, the messenger of the literary text 'Enmerkar and the Lord of Aratta' is compared to an "u$_{5}^{\text{mušen}}$ in the mountains", which could perfectly refer to a goose as migratory bird and rule out the swan hypothesis.

Geese need water, love to graze in wet meadows, are easy to handle, grow fast and have the perfect size of a meat portion for one nice meal. In short: the goose is the ideal animal to be herded in the marshes of Southern Babylonia, which is now extremely rich in wetland habitats and used to be even more so in the third and early second millennium. In the Ur III period, the two most important city-states in southernmost Babylonia, situated near the marshes and close to the former shore of the Gulf, were clearly Girsu–Lagaš–Nigin and Ur.

Collon's explanation is appealing, but a supposed relationship between the "goddess on the goose" and the city of Ur is less easy to understand. Collon referred to the article by K. R. Maxwell-Hyslop (1992) in which she proposed to identify the "goddess on the goose" with Nanše, the supreme goddess of Lagaš and Girsu. Maxwell-Hyslop and before her Opificius (1961) and Douglas van Buren (1933) conclusively argued that the interpretation as the goddess Bau was caused by a misunderstanding. J. M. Asher-Greve and Goodnick Westen-

28 This term is usually written kur-gi$_{16}^{\text{mušen}}$ in Lagaš, kur-gi$^{\text{mušen}}$ in Ur, Drehem and Umma, and kur-gi$_{4}^{\text{mušen}}$ in Old Babylonian documentation (Veldhuis 2004: 264).

29 In the Sumerian story named "Goose and Raven", kur-gi$_{4}^{\text{mušen}}$ refers clearly to a wild migratory bird (Alster 1980: 45). According to Veldhuis (2004: 264), the semantic of the word kur-gi/gi$_{4}$/gi$_{16}^{\text{mušen}}$ evolved over time from domestic goose in Sumerian over goose in general in Sumerian and Akkadian to crane in Aramaic and Arabic.

30 Texts ITT 3/2 6415, ITT 9630, TÉL 95, TCTI II 2814; TCTI II 354 (see Veldhuis 2004: 223, 234 and 264). Furthermore, he points out that the large quantities of eggs recorded in Girsu texts can only come from ducks (as they lay more eggs than geese). And finally, he suggests that "the word bibad is probably a loan-word from Akkadian *paspasu* [duck] and was used originally as a qualification of uz, not as a name for a separate species".

31 IM 62823 (Alster 1997: 298). We would like to thank Michael Roaf for drawing our attention to this text.

32 See occurrences in EPSD2. For example, for Adab: CUSAS 19, 144: o 7 and CUSAS 19, 196: o 2, for Girsu: ITT 2, 04374: o 1 and ITT 2, 04444: o 1 and for Umma: TIMA 1, 105: o 2 and TIMA 2, 106: o 2.

Fig. 4. The goddess on the geese holding a sack: terracotta plaques from Tello and Ur (Barrelet 1968: Pl. XXVIII, no. 291; Woolley/Mallowan 1976: Pl. 80, no. 147).

holz (2013: 227–231), who name the deity “the Goddess on Anserini” corroborated this view. Much more convincing is the interpretation as Nanše due to the textual evidence where Nanše is frequently associated with birds and fish. Especially the Sumerian literary text ‘Nanše and the Birds’ makes her close relationship to the u_5 bird clear (Veldhuis 2004: 294). Nanše perceived the beauty (ḫi-li) of the u_5 bird and adopted it. In ‘Enki and the World Order’ even the position of the goose at the feet of Nanše is mentioned: “the holy (kù) u_5 fell to/stood by her feet” (Heimpel 1998: 153). Gudea Cyl. A xiv 23 also describes the standard (šu-nir) of Nanše as a “holy u_5”. A goose standard is depicted on Akkadian to Ur III cylinder seals found at Tello and Ur (**Fig. 3**).[33] It is not clear how far back the relation of the goose with Lagaš or Ur can be traced, but certainly until the ED IIIb period according to iconographic motifs.[34]

Nanše’s aspect as a sea goddess and her association with water-birds and fish is not surprising with her main temple Sirara being located in ancient Nigin (Tell Zurghul), the third city in the state of Lagaš, situated on a turtleback in a marshland environment which must have periodically stood out from the water like an island.[35] But Nanše was also linked to the Eridu—Ur region further to the west: she was “the child born in Eridu” and was regarded as the daughter of Enki. She was the sister

33 The cylinder seal from Ur depicts a goose-standard and the introduction of a woman to an enthroned goddess in the upper register and swimming water-birds in the lower register (Legrain 1951: 22, Pl. 18, no. 247). The seal from Lagaš depicts a female person in adoration before a goose-standard (Parrot 1948: 261, Pl. XXX, no. 532).

34 An ED IIIb or early Akkadian votive plaque depicts a goddess on a goose holding a fish; it was found in Nippur, but its place of manufacture is not certain (Boese 1971: Pl. XVIII, 4; Maxwell-Hyslop 1992: Pl. VIIIb). An ED IIIb cylinder seal impression depicts two lying geese below an eagle; above one goose are the sign GAL and a crescent moon and disc. Unger interpreted this as a “Stadtwappen” (Unger 1957–71: 140; Weber 1920: Nr. 162). Administrative texts mentioning geese and found in Girsu are dated to the Akkadian period (kur-gi^{mušen} in CUSAS 19, 019, 144, 196 and TCBI 1, 158) and to the Ur III period (kur-gi^{mušen} in ITT 3, 06415, ITT 5, 06768 and ITT 5, 06889 ; $u_5^{mušen}$ in ITT 2, 00736, ITT 3, 04968 and *passim*). The kur-$gi_{16}^{mušen}$ appears on Gudea Statues E and G.

35 The ongoing excavations at Tell Zurghul have recovered several clay cones commemorating the construction of Nanše’s temple by Gudea. Gudea’s temple itself has been completely eroded except for its artificial terrace, but presumably the underlying sequence of Ubaid period temples shows that the site of the temple had already been sacred some two thousand years earlier; the latest occupation of Nigin dates to the very beginning of the second millennium (Nadali/Polcaro 2020).

Fig. 5. (left) Terracotta plaque depicting a goddess on the goose-throne holding two sacks in both hands (Opificius 1961: 253, no. 251). (right) Terracotta plaque depicting frontally an enthroned goddess (Ningal) holding two sacks in both hands (Woolley/Mallowan 1976: Pl. 78, no. 125).

of Ningirsu, was associated with divination, and became famous as the interpreter of Gudea's dream (Heimpel 1998). In the Nanše Hymn, she is not only praised as the protector of the weak, but also as being responsible for checking the accuracy of weights and measures. The literary text "Nanše A"[36] concerns the misusage of stone weights and capacity measures by taking a small weight instead of a large weight and a small ban_2-capacity measure instead of a large ban_2-capacity measure (lines 142–143). In lines 234 and 241, "a correct stone to weigh precious metal" (na_4-gi-na ku_3 la_2-e-de_3) is mentioned. Lines 232–236 read: "At the temple, power (ME) has been granted from the *Abzu*, in Sirara, the gods of Lagaš gather around her. To weigh precious metal with a standard weight, to use standardised size of reed baskets, to give an agreed ban_2-capacity measure in the hands of all countries."[37] This hymn emphasizes the role of Nanše as the goddess who assures the righteousness of the metrological standards and who prevents cheating in economic practices. This role of her as the guarantor of measures endured in the later literary tradition, as is shown by an Akkadian hymn to the goddess Gula,

36 Heimpel 1981; http://etcsl.orinst.ox.ac.uk/section4/tr4141.htm. See the new edition in Attinger 2019.

37 http://etcsl.orinst.ox.ac.uk/section4/tr4141.htm. Lines 241–243 are identical to the second sentence.

who is equated with Nanše, "who handles the yardstick, the cubit made of reeds, the 1-rod reed" (Foster 2005: 583–591). Since the goose was the animal closely linked with Nanše, and since her temple where she established the metrological standards was surrounded by water, it is easily understandable why the goose became the standard form of the earliest guaranteed weight-stones.[38] However, the cult of Nanše faded with the general decline of the territory of Lagaš after the Ur III period (Heimpel 1998). Therefore, it is clear that not all goose-weights were associated with Nanše, for example those with royal inscriptions of Ur III kings dedicated to Nanna and Ningal and numerous later examples.

Who is the goddess on the goose? Reconsidering the iconography of Nanše and Ningal

K. R. Maxwell-Hyslop argued that the numerous Ur III and Old Babylonian terracotta plaques depicting a goddess seated on a goose represent Nanše. Most of them were found at Tello/Girsu and Ur.[39] Eva Braun-Holzinger (1998-1999: 162) argued that water-birds in connection with goddesses were so frequently depicted in Babylonia from the Akkadian to the early Old Babylonian period, that this pictorial motif was not reserved for Nanše, but was also associated with other goddesses. Her argumentation arose from the fact that the goddess on a goose and goose standards were depicted not only on seals of priests of Nanše but also on those of priests of other goddesses such as Bau.[40] However, it is rash and in most cases wrong to assume that the deities depicted on seals were identical to those mentioned in the seal inscriptions. We will show in the following that at least one other goddess, Ningal, was also associated with the goose.[41]

One specific type of the motif "goddess on a goose-throne" is attested on several plaques from Tello and Ur:[42] The goddess on the goose is depicted with her upper body frontally and her lower body in profile without any astral symbol (**Fig. 4**).[43] The depiction on these plaques merits a closer look. Marie-Thérèse Barrelet (1968: 231) remarked that this goddess was characterised by exaggeratedly large ears—an exceptional attribute. The ear was not only regarded as the organ of hearing, but had a wider connotation of intelligence and wisdom.[44] When Nanše was depicted with overly large ears, this might have been intended to emphasise her intellectual competence, perhaps in juridical procedures. Also the way in which the goddess extends one hand forward with a widely open palm, not holding any object, is a rare gestus the meaning of which has escaped us so far.[45] What is more relevant here is the small oval or round object she is holding in her other hand. This object is usually interpreted as an aryballos-like vessel. However, this is not beyond doubt. Usually water is streaming out of a vessel if it is characterised as a water-pot. In this case, however, nothing is coming out of this object. Therefore, it is proposed here that the goddess is holding a sack of weighed, guaranteed (gi-na) silver in one hand—the perfect depiction of a goddess who is responsible for justice.[46]

There is another type of terracotta plaque, probably from Ur, which shows a goddess on a goose-throne holding two similar objects (sacks or pots?) in both hands (**Fig. 5** left).[47] Many other terracotta plaques from Ur depict frontally a seated goddess, wearing a peculiar

38 In the same way, the animal symbol of the goddess Nininsina/Gula, a dog, has been materialised for example in a steatite stone as votif dog dedicated to this goddess "for the life of Sumu-El, king of Larsa" (19th century BC: AO 4349, Louvre Museum).

39 From Tello: Barrelet 1968: nos. 291–295, 298. From Ur: Maxwell-Hyslop 1992: Pls. 7 and 8; Woolley/Mallowan 1976: Pl. 80, nos. 147, 148; Pl. 81, no. 151; Pl. 89, nos. 225, 227. There are only very few other plaques published with this motif (Wrede 2003: 296–299, nos. 1076–1078).

40 Braun-Holzinger (1998–1999: 162) refers to Ur III sealings mentioning priests of Nanše and Bau and depicting the goddess with the goose or goose standard (Fischer 1997: seals 10–12). Fischer (1997: 122–128) also notes the association of the inscription with the image but is more cautious about the implications.

41 After we had finished this article, A. Otto discovered that Claudia Suter (2007: 336) had already come to a similar conclusion: "I suggest that similar images from Ur represented Ningal, with whom texts also associate water birds."

42 From Tello: Barrelet 1968: 230–231, Pl. XXVIII, nos. 291–295. From Ur: Woolley/Mallowan 1976: Pl. 80, no. 147; Maxwell-Hyslop 1992: Pl. 7a. Even a mould was found in Ur: http://www.ur-online.org/subject/6225.

43 Braun-Holzinger (1998–99: 160) cautiously accepts the identification with the goddess Nanše, since several Ur III cylinder seals owned by priests of Nanše depict prominently the goddess on the goose, e. g. Fischer 1997: 122 (Fig. 11b).

44 AHW III, *uznu*(*m*), has a triple meaning: "Ohr, Weisheit, Verstand".

45 It is probable that this gestus designates the action of judgement, but we had no time to investigate this in depth.

46 A. Otto thanks Elisa Rossberger for discussing this with her and for corroborating her identification of these objects as sacks.

47 The plaque depicted here is from the art market (Opificius 1961: 81–82. 253, no. 251), but it is model-identical to a more eroded plaque found at Ur–Diqdiqqah: Woolley/Mallowan 1976: Pl. 89, no. 225.

Fig. 6. Clay throne decorated with two crescent standards of Nanna and Ningal, and a goose-throne depicting geese flanking a moon standard; from Ur–Diqdiqqah (Woolley/Mallowan 1976: Pl. 88, nos. 210, 211).

crenellated or battlemented crown and holding two similar oval objects in both hands (**Fig. 5** right)[48]. Woolley remarks that this is "one of the most common types of terracotta. Fragmentary examples were numerous, many giving slight modifications but conforming generally to the one pattern." (Woolley/Mallowan 1976: 177). We put forward the hypothesis that these plaques are depictions of Ur's supreme goddess Ningal emphasising her role as protector of rectitude by holding sacks of weighed and certified silver. The star-like rosettes framing her image may be characteristic of Ningal.[49] Ningal's temple in Ur still fulfilled a relevant economic and financial function in the Old Babylonian period (van de Mieroop 1992: 105. 208–210 and Charpin et al. 2020), in particular by centralising the imports of copper and precious stones (see for instance the Old Babylonian texts UET 5 526, 546, 549 and 678).

A fairly common type of furniture model from clay is an empty throne with a high back. Some of them are depicting two moon standards, clearly representing the couple Nanna and Ningal (**Fig. 6** left), others depict a moon standard flanked by two geese (**Fig. 6** right), or pairs of geese associated with circles and star-like rosettes (Woolley/Mallowan 1976: Pl. 89, nos. 213, 223). These clay models of an empty throne decorated with geese have been reported for Ur, Tello/Girsu, Ishchali/Nerebtum, and other sites.[50] Probably it symbolises the deity seated on the goose-throne but avoids its anthropomorphic representation.[51] The moon standard between the geese was depicted on several goose-thrones (see **Fig. 6** right).[52] Therefore, it seems fairly obvious that the goddess who would have sat on a throne associated with geese or with a moon-standard was Ningal, that the empty goose-thrones symbolised the same goddess, and that the goose became a symbol of Ningal in Ur.

48 Woolley/Mallowan 1976: Pl. 78, no. 125.

49 Star-like rosettes tend to be associated with Inanna/Ištar, but here it seems more plausible to relate them to Ningal, whose epithet is: ^{d}Nin-mul-nun-na ("Mistress, star of the ruler") (Zgoll 2000: 353).

50 From Ur: Woolley/Mallowan 1976: Pl 88, nos. 209–214. From Tello: Parrot 1948: Pl. 51i. A new fragment from Ishchali was published in Sumer 65 (2019) Arabic section: 60, Pl. 10, 26.

51 There has been no convincing explanation so far why the symbolic representation was favoured for some deities and in some regions. But especially the moon god seems to have been represented more often in symbolic than in anthropomorphic form. Apparently, the symbolic representation of Nanna's consort Ningal was also frequent.

52 Woolley/Mallowan 1976: Pl. 88, no. 211.

Fig. 7. Ningal on the goose-throne, statue from Gipar-ku (Woolley/Mallowan 1976: Pl. 54).

This is not the right place to discuss the iconography of Ningal in detail—a real desideratum.[53] Already an archaic seal impression from the SIS stratum at Ur depicts a goddess on a large goose-boat.[54] The famous little statue U.6779B from Gipar-ku at Ur—the only complete statue found in this building—shows a goddess in a flounced garment seated on a throne supported by two geese[55] and with water below it (**Fig. 7**). She puts her feet on two more water-birds, which are quite massive and have their neck and head closely attached to the body—more resembling goose-weights than living geese.[56]

Another terracotta type from Ur represents the enthroned goddess on a goose-throne, holding tree-like objects in both hands (**Fig. 8**).[57] Crescent moons on both sides of her horned crown help to identify her as the mistress of Ur.[58] The type of enthroned goddess most frequently found at Ur or Diqdiqqah is that of a goddess with a huge horned crown topped by a crescent; two small geese are depicted on either side of her shoulders (**Fig. 9**). It seems beyond doubt that this is to represent the goddess of Ur, Ningal.

There are several other plaques from Ur–Diqdiqqah depicting the goddess on a goose-throne *en face*, with two crescents on either side of her horned crown (**Fig. 10**).[59] Here the geese are marked with circles, probably indicating the speckles of their feathers. While the goose serving as the goddess' seat is stretching its head up, the goose below her feet is turning its head to rest on its back—depicted alike the geese of the goose-weights. This plaque type is a rare one that shows the goddess on the geese holding a vase with streaming water, which probably refers to the natural habitat of the water-birds in the Southern Mesopotamian marshlands.

Fig. 8. Ningal enthroned on a goose-throne, plaque from Ur–Diqdiqqah (Woolley/Mallowan 1976: Pl. 81, no. 151).

Several references in cuneiform texts corroborate the association of Ningal with the goose (Zgoll 2000; Asher-Greve/Westenholz 2013: 227–231). Her name "^{d}Ù-a-nun-na" was interpreted as "the goose of the ruler".[60] Piotr Steinkeller (1994) takes the u$_{5}$-bi bird as Ningal's attribute. Ningal is named "zirru ^{d}Nanna", female

53 The short entry "Ningal. B." in the RlA (Braun-Holzinger 2000) provides a useful starting point for a more detailed study, but is certainly not the last word about Ningal's iconography. Valeriya Minaeva submitted a Master's thesis (unpublished) on the iconography of Ningal at LMU Munich in March 2021.

54 Legrain 1936: no. 531; for the date see id. 45: "later than the First Dynasty".

55 These water-birds have been named geese (Woolley/Mallowan 1976: 225) or swans (Spycket 1981: 234, 235).

56 The statue, only 29 cm high and from diorite, was found in Room C20—the antecella of the Old Babylonian Ningal Temple—and probably dates to the Old Babylonian period (Woolley/Mallowan 1976: pp. 6, 56, 169, 225, Pl. 54); the find context is certainly Old Babylonian: a label of a servant of Hammurabi was found near it (ibid. 56).

57 Woolley/Mallowan 1976: 178–179, Pl. 81, no. 151.

58 It has to be stressed that the motif of the crescent moon (or the crescent and disc) on a cylinder seal does not necessarily distinguish the deity depicted aside. However, this is different with terracotta plaques, where astral or other symbols depicted next to the deities were meant to facilitate their identification.

59 At least four model-identical plaques are known (Maxwell-Hyslop 1992, Pl. VIIb: U.17163; Woolley/Mallowan 1976: 178, Pl. 80, 148: U.7076). Woolley ibid. mentions another model-identical plaque U.978 = Opificius 1961: no. 244. Opificius 1961: no. 243 is another model-identical one.

60 Zgoll (2000: 353) mentions the proposition by C. Wilcke that ù was used for u$_{5}$.

Fig. 9. Ningal enthroned, two geese above her shoulder, plaque from Ur, AH (BM 1927,1003.157) © http://www.ur-online.org/subject/2332

Fig. 10. The goddess on the goose, below her feet a speckled goose with head laid along the body like a goose-weight (Maxwell-Hyslop 1992: Pl. VIIb).

bird of Nanna,[61] and u$_5$-bí bird in the balbale to Nanna (Nanna B).[62] One month in Ur called "The Eating of the u$_5$-bí bird" is associated with a minor festival for Nanna's spouse Ningal (Sallaberger 1993: 195). A relation between Nanše and Ningal in Ur is attested during the Isin-Larsa period in the form of offerings Nanše received together with Ningal (Charpin 1986).

The iconography on cylinder seals gives no clues to any differentiation between Nanše and Ningal. A seal bought in 1886/1887 AD in Zurghul (ancient Nigin, where Nanše's temple Sirara was situated) shows a priestess being introduced to a seated goddess, in front of which a goose is standing (**Fig. 11a**).[63] Due to the findspot of the seal, it is tempting to identify this goddess as Nanše, al-

61 For a discussion of *zirru* see D. Charpin in Charpin et al. 2020: 196–197. Charpin (ibid.: Fig. 2) refers to a Neo-Babylonian cylinder-seal (BM 89311), where the symbol of a bird on a pedestal (evidently the symbol of Ningal) is depicted next to the crescent on a similar pedestal, the divine symbol of Nanna; but its species is difficult to define (hen, goose?).

62 Westenholz 1989: 541–551; http://etcsl.orinst.ox.ac.uk/section4/c41302.htm.

63 Moortgat 1940: 108, Pl. 36, no. 271. The cylinder seal was acquired by the German Babylonian Expedition of 1886/87 in Zurghul.

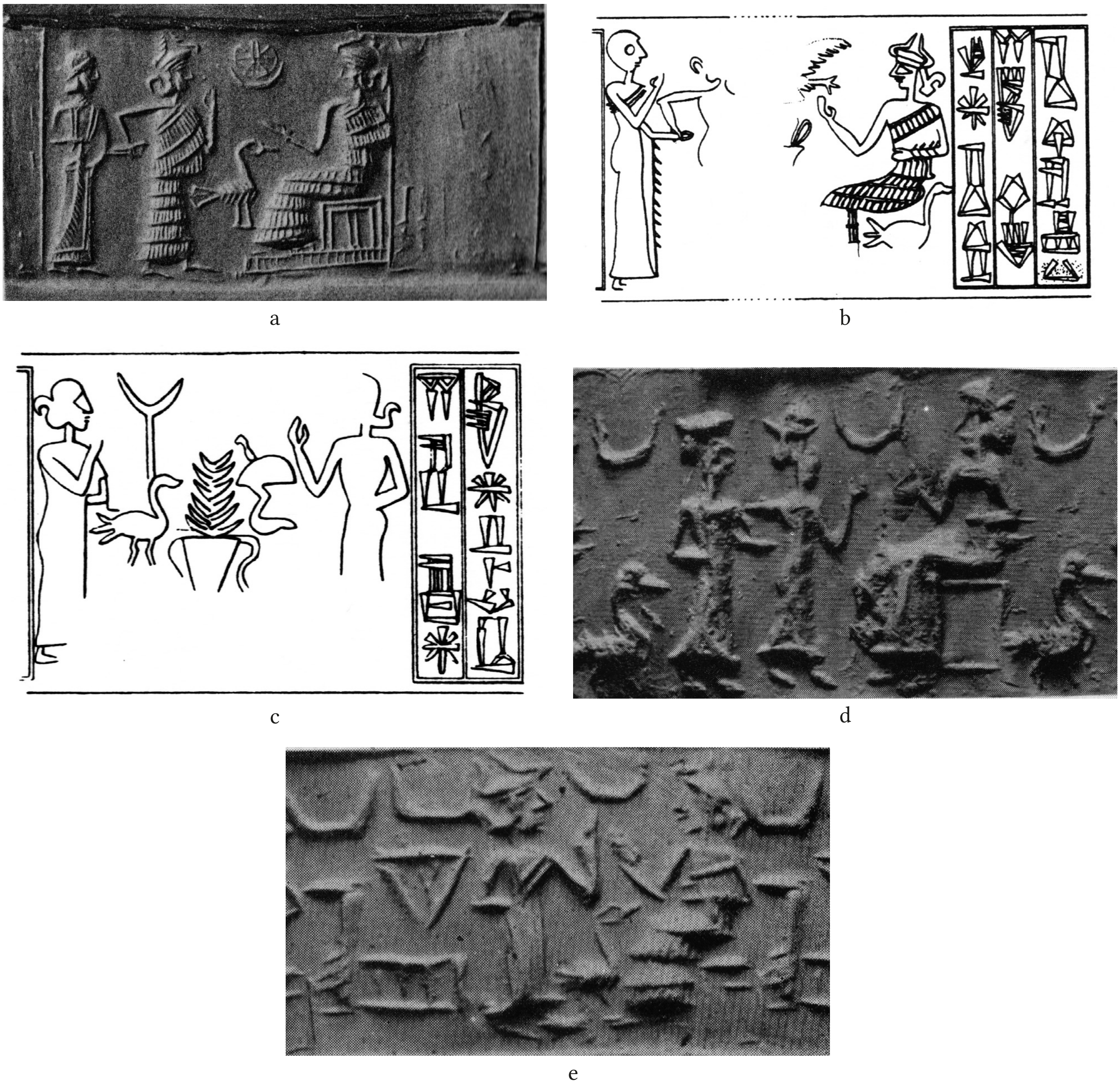


Fig. 11. The goddess with the goose on Post-Akkadian–Ur III cylinder seals from Zurghul/Nigin (a), Lagaš (b–c) and Ur (d–e) (Moortgat 1940:Pl. 36, no. 271; Fischer 1997: nos. 12 and 53; Legrain 1951: Pl. 19, no. 288; Pl. 22, no. 353).

though the priestess resembles the Entu priestesses from Ur. Several seal impressions depicting the goddess on a goose throne or with a goose standard were found on Ur III tablets from Lagaš. Some can clearly be related to Nanše (**Fig. 11b**), others to Ningal (**Fig. 11c**).[64] Many other seals with similar introduction scenes to the goddess with the goose were found at Ur (**Fig. 11d–e**)[65]. They depict so prominently the crescent moon near the goddess and the goose that it is difficult to recognise in this goddess anyone else than Ningal.

Braun-Holzinger (1998–1999: 162) argued that water-birds in connection with goddesses were so frequent-

64 Fischer 1997: 122–125, nos. 10–12, 17 and 53. No. 12 (here **Fig. 11b**) is associated with the bird of Ningirsu and should depict Nanše. The goose of No. 53 (here **Fig. 11c**) supports a moon standard and certainly symbolises Ningal.

65 Legrain 1951: Pl. 19, no. 288; Pl. 22, nos. 352, 353. There are many more similar depictions on seals from Ur, Tello, and the art market.

Fig. 12. Weight-stone in stele-form (251 g) with votive inscription of Šulgi, who sets the standard for half a mina. Louvre, AO 22187 (Thomas 2016: 60).

Fig. 13. Weight-stone in stele-form (978.3 g) with inscription stating that it was a copy of a weight that Nebuchadnezzar II had made after the standard of Šulgi, property of Marduk-šar-ilani. BM 91005, acquired 1892 by the British Museum (https://www.britishmuseum.org/collection/object/W_1892-1214-1)

ly attested in Babylonia from the Akkadian to the early Old Babylonian period, that this pictorial representation was not limited to depictions of Nanše. She concluded that the goose-throne referred to a certain aspect of several female goddesses, which could be represented by Nanše at Lagaš and Girsu, but could also be associated with other goddesses in other cities. Braun-Holzinger did not specify which aspect she meant. In our opinion, this aspect is that of the supreme goddess of a city, whose task was—amongst others—to protect law and order, which often seems to have been the duty of goddesses in the third millennium. Ningal was entitled "the Mistress of Ur", the "Mother of Ur" and "the Mother of Ur-Namma", and played an important role in juridical procedures (Zgoll 2000: 354). For example, an oath before Ningal in the court of Ekišnugal is reported (see UET 6/2 402, which mentions a man who swore inside the main court facing Ekišnugal and facing "Ningal of the Egadi")—the same area where some reference duck-weights were found by Woolley. Penalty fees paid to Ningal for breach of contract are attested until the first millennium (Zgoll 2000: 354).

Evidently, Ningal was a guarantor of the accuracy of weights and measures for centuries. The goose probably developed as a symbol of "the correct weight from Ur" during the Ur III period, when Ningal and Nanna as the supreme deities of Ur both were the guarantors of justice. But there is also a stele-shaped official weight-stone decorated with the crescent moon, which Šulgi dedicated to Nanna (**Fig. 12**).[66] We may even conclude that this reference weight-stone was part of a set that was kept in the sacred area of Ur for centuries. The inscription on a similarly shaped weight-stone states that Nebuchadnezzar II had made a copy of a standard weight from Šulgi (**Fig. 13**), pointing to a 1500-year period of display of these reference weights.[67]

But why did the goose and not the crescent moon become the dominant motif of weight stones? The preference for the goose is indicated by a 2 minas goose-weight

66 This object was probably kept for centuries in the temple, since there is a Neo-Babylonian weight saying that it was formed after Shulgi's weight stone.

67 https://www.britishmuseum.org/collection/object/W_1892-1214-1. It is interesting that the crescent, Nanna's symbol, was not copied, but that Marduk's spade was added instead on one side. This was discussed already by Unger 1918: XI.

dedicated to Nanna by Šulgi, on which a crescent, Nanna's symbol, was engraved on its left side.[68] We argue that the goose was the ideal form, since it was related to several female goddesses in Babylonia, who often held a supreme rank in their cities. Since it were mainly goddesses (Nanše, Ningal, Nisaba, Ninlil, Kittum…) and not male gods who were involved in weighing and measuring operations, the goose being associated with female deities would have been a most suitable form. The exception was Šamaš, who had a more general role concerning justice and the smooth running of trade and was occasionally associated with weighing (Robson 2008: 114–120), but he too was associated with Ningal being her son and being born in her temple É.NUN at Ur (Zgoll 2000: 352).[69] His prominence in this field can be understood as part of the general transformation of the Mesopotamian pantheon from the third to the second millennium, when many goddesses lost their superior positions and their tasks were taken over by male gods (Sallaberger 2003–2005: 307–308).

Additionally, the goose can also be related to security and protection, and guard geese have been known throughout history until today. It is well known that geese begin to chatter when a foreign person approaches, better than any watchdog (the most famous example being the Geese of the Capitol in Rome). There were in particular two "goose figures" of one talent erected in front of the door called "Protective Goddess" of the Aššur Temple by Erišum.[70] Perhaps it is not by chance that the "duck-weights" from the North-West Palace at Nimrud were discovered in a doorway (Reade 2018: 129 fig. 2, 136–137). An Old Babylonian literary text also refers to a goose-weight (^{na_4}kur-gi$_4$) during the building process of a temple for Enki, but without specifying either the exact place or the function of this weight.[71]

68 Unger 1918: XI, XVIf. 23–24, no. 170; found 1894 in Tello.

69 See for example the "duck-weight" dated to the Old Babylonian period and found in Tell Haddad, with its inscription "2 minas, certified (gi-na), belonging to Šamaš" (Al-Rawi 1994: 38). But the weight is not dedicated to the god or symbolically associated with him, as was the case with Nanše, Ningal or even Nanna. It seems that it plays a role in the economic activities linked with the (temples Egina of the) sun god (for example in Sippar/Tell ed-Der or other cities: see Charpin 2017: 97–98) during the Old Babylonian period, as the mentioning of the "weights of Šamaš" in legal and administrative documents from Sippar or Kiš (for example YOS 13, 174) clearly shows (Stol 2010).

70 RIMA 1, 20, Erišum i A.0.33.10 13.

71 UET 6 29 + UET 6 498, r. col.i, l. 8'.

Conclusions

It became clear during this study that it is impossible to distinguish between the iconography of Nanše and Ningal. This is understandable only if we accept that Nanše and Ningal were different local deities who had similar divine functions and aspects. They were the supreme goddesses of the water-rich marshy southernmost area of Mesopotamia from Eridu in the west over Ur to Girsu–Lagaš–Nigin in the east, and shared many functions and characteristics, amongst which their responsibility for juridical procedures and righteousness in the economic transactions. Nin-gal—literally "the Great Mistress", more a title than a proper name—seems to have represented these aspects in Ur, while Nanše stood for them in Lagaš. Therefore, it is not surprising that Nanše and Ningal shared also a similar iconography, except for the crescent moon. The goose, the economically most important water-bird of Southern Mesopotamian wetlands, was associated with these goddesses, named differently in different cities, and its image appeared as their accompanying animal, the icon on their standards, and ultimately the weight-stone under their supervision.

It seems that Nanše, supreme goddess of Lagaš–Girsu–Nigin during the third millennium, had set the trend for goose-weights. Since she guaranteed the accuracy of metrological procedures, her accompanying animal was transformed into a weight-stone for the first time during the Lagaš II-period, as the earliest securely dated "goose-weights" show. Roughly at the same time, or perhaps slightly later, this idea was adopted by the Ur III kings. Their centralised administration needed iconic hallmarks in order to make royal certified weights easily recognisable. With the temple of Ningal (and that of Nanna) in Ur having become the main places of economic and financial transactions with silver, the functions of the goddesses Nanše and Ningal in this field were gradually merged.

Nanše's and Ningal's task as the supreme supervisors of metrological accuracy, correct juridical processes and economic transactions was most visibly expressed by goose-weights, which were immediately recognisable as standing under divine supervision.[72] It was a touch of genius to choose the goose—the ideal guard animal—as

72 A similar prominent position in metrological and economic procedures can be observed with the goddesses Nisaba and Ninlil, who were mostly associated with scribal arts, including writing, accounting and surveying, in order to measure land justly and accurately (Robson 2008: 118).

a symbol for the deities who watched over the righteousness of economic and juridical procedures.

During the Ur III period, other Mesopotamian cities may have adopted this particular shape of a goose, since it was related to both their supreme goddesses—who were as well the guarantors of the financial procedures—and to the royal administration. In the second millennium, when Nanše's position faded due to the decline of the territory of Lagaš, the goose was associated mainly with Ningal, and goose-weights developed into one of the most characteristic standard forms of reference weights (especially the heavy ones) in South Babylonia and beyond.

The reference weights, often inscribed or marked, were reliable weights used as reference in case of dispute, and were often kept in temples. However, many other goose-weights for daily purpose were in circulation. While in the beginning this particular shape of weight-stone was used mostly by temple and royal administrators, it soon became one of the standard forms of Babylonian weights, used by merchants and many other people involved in economy. From the Old Babylonian period onwards, the goose-weight developed into a common standard in administrative as well as trade activities. Apparently, the weight-stone shaped liked a goose proved to be so successful, that this habit spread throughout the Near East and was continued at least until the Achaemenid period.

Finally, we maybe need to change the idealised vision of "un roi, une loi, un poids" recommended by the 'cahiers de doléances' during the French Revolution into "un roi, une oie, un poids" in the case of Mesopotamia…

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The weights of Ras Shamra-Ugarit in the Late Bronze Age—Weight units in the texts, typology of the weights and statistical study

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in collaboration with Gaël Benabou[1]

Introduction

The site of Ras Shamra was inhabited almost continuously from the eighth millennium until the early twelfth century B.C. (Yon 1997: 25–35; Singer 1999: 603–733; Freu 2006: 25–257). The 575 weights analysed here date for the most part to the Late Bronze Age levels, from the fourteenth to twelfth century B.C. Most are uninscribed, which means that the absolute mass of any given example can easily be assigned but that the system to which each one belonged usually remains to be determined (Bordreuil 2006: 203–232). Contemporary Akkadian or Ugaritic texts mention various weights.[2] Thus, one of the principal challenges in studying the weights from a site such as Ras Shamra is working out the proper correlations between the archaeological and the textual data.

I will first analyse the textual data, then present the parameters of classification of the weights, and finally propose a statistical analysis of the mass of the weights to evaluate which weighing system was really in fact used in Ugarit in the Late Bronze Age.

1. Weight units in the texts from Ras Shamra

I will start with weight units in the Sumero-Akkadian cuneiform texts.

1.1 Sumero-Akkadian cuneiform texts

There are eleven metrological lists in Sumero-Akkadian cuneiform,[3] only three of these, however, are useful for a study of the weight systems actually used in Ugarit.[4]

The eleven Sumero-Akkadian tablets and fragments provide what Jean Nougayrol presented as a "table of weights and measures" (Nougayrol 1968: 251–257). The entries on five of these tablets were originally arranged in three columns per side, which contain the units of capacity, of weight, and of surface-measure.[5] Two of the tablets bear two columns per side and only tabulate one or two of these types of units.[6] Four of the fragments are so small that it is impossible to determine the form of the

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2 Bordreuil 1975: 19–30; 1981: 301–311; Bordreuil/Pardee 1991: 139–172; Bordreuil et al. 2012: 10–214; Dahood 1971: 31–35; Dietrich et al. 1995: 1–488; 2013: 1–600; McGeough/Smith 2011: 33-604; Malbran-Labat 1991a; 27–64; 1991b: 127–130; Nougayrol 1955: 1–214; 1956: 29–242; 1968: 1–446; 1970: 2–130; Thureau-Dangin 1934: 137–146.

3 Nougayrol 1968: 425–431 fig. 143 RS 20.160 N fig. 144 RS 21.10 fig. 145 RS 20.196 A fig. 146 RS 20.161 D fig. 147 RS 21.05 D fig. 148 p.t. 1844 fig. 149 RS 20.14 fig. 150 RS 21.63 A fig. 151 RS 21.07 H fig. 152 RS 6 X. 446 fig. 173 RS 25.511 B.

4 Nougayrol 1968: 425–426 fig. 144 RS 21.10. 428–430 fig. 146 RS 20.161 D. fig. 149 RS 20.14.

5 Nougayrol 1968: 252. 425–428 fig. 143 RS 20.160 N fig. 144 RS 21.10 fig. 145 RS 20.196 A fig. 146 RS 20.161 D. fig. 148 p.t. 1844.

6 Nougayrol 1968: 252. 429–431 fig. 149 RS 20.14. fig. 152 RS 6 X.

original text.[7] RS 20.014, the only tablet of the lot that has been completely preserved, shows two columns per side and 122 entries indicating units of weight (Nougayrol 1968: 429–430 fig. 149 RS 20.14).

The weight units are indicated in increasing order, starting from half a grain to sixty talents. The entries are entirely logographic, with the appropriate symbols for numbers, fractions, units of weight, and the metal in question (Bordreuil 2006: 216–222).

The ordering and numbering of units follows precise rules. The passage from one unit to the next is incremental and the increment remains constant until the following step upwards (Bordreuil 2006: 216–226).

The function of texts of this type was apparently pedagogical.[8] The metrological lists discovered at Ras Shamra represent the Western diffusion of Mesopotamian metrological science (Bordreuil 2006: 227; 2010: 23; 2013: 66–67). Metrology was taught in Ugarit during the fourteenth to the twelfth century, as in Mesopotamia during the Old Babylonian period.[9]

Metrological lists are theoretical texts, and the weight units appear in increasing order: ŠE (grain), GÍN (shekel), MA.NA (mina), GUN (talent) (Bordreuil 2006: 228–229). In the Akkadian administrative texts, which are dealing with practical administration, only a selection of these weight units are in use: GÍN (shekel) and GUN (talent), but not ŠE (grain) and MA.NA (mina).[10]

1.2 Cuneiform alphabetical texts

The Ugaritic administrative texts provide numerous mentions of weight units.[11] One can notice some mentions of weight units in Sumero-Akkadian cuneiform, GÍN (shekel) and GUN (talent), as we saw previously in the Akkadian administrative texts. For the most part, the weight units are written in alphabetical cuneiform: *ṯql* (shekel) and *kkr* (talent), but in most cases no reference to a particular weight system can be established (Bordreuil 2012: 283–296).

However, two distinct weight units appear in an administrative text recording wool quantities weighed in talents: *kkr ủgrt* "talent of Ugarit" and *kkr ảḏdd* "talent of Ashdod".[12]

The weight unit *kkr ủgrt* "talent of Ugarit" can be ascribed to the local system, i.e. to the weight system of Ugarit, which is characterized by a mean value of the shekel of 9.4 g and a talent corresponding to 3000 shekels (Parise 1970–1971: 3–36; Courtois 1990: 119–127; Bordreuil 2006: 205–209).

Another weight system was known that might have been used in Ugarit, which is shown by the expression *kkr ảḏdd* "talent of Ashdod". But how to determine the value of the fundamental unit and the numerical equivalence between this unit and the sub-units?

Mario Liverani states that the total weight of the wool is seven talents of Ashdod, which is equivalent to five talents of Ugarit and 1800 shekels. Consequently, the talent of Ashdod is equivalent to four-fifth of the talent of Ugarit (Liverani 1972: 193–199).

Mario Liverani considers that the same quantity of wool was weighed with the talent of Ashdod in the first paragraph (lines 1–2) and with the talent of Ugarit in the second paragraph (lines 3–5). If one agrees with this translation, one may consider that the particle *wav* is used as an explicative conjunction, the equivalent of the English "that is" (Liverani 1972: 193–199).

In the Ugaritic documentation, Josef Tropper shows different utilisations of the conjunction wav. He gives several specific examples from administrative texts: the copulative *wav*, which means "and", the "komitativ" *wav*, meaning "in common, with", the explicative wav, meaning "that is" and finally the adversative wav which means "but, however" (Tropper 2000: 782–788).

We have no other example of the use of the explicative *wav* at the beginning of paragraphs in administrative texts but only of the copulative *wav*. Therefore, we propose a new translation of the recto of this text.

RS[varia 13]/RS "1957.701"/CAT 4.709

Recto

1) šbʿ . kkr . šʿrt	1) seven talents of wool
2) b . kkr . ảḏdd	2) according to the talent of Ashdod.
———————	———————————————
3) w b kkr . ủgrt	3) And according to the

7 Nougayrol 1968: 252. 428 fig. 147 RS 21.05 D. fig. 150 RS 21.63 A fig. 151 RS 21.07 H. 446 fig. 173 RS 25.511 B.

8 Friberg 1987–1990: 542–544; Nemet-Nejat 1995: 253–260; Robson 1999: 14; 2008: 100; Chambon 2002: 497–501; Høyrup 2002: 8; Proust 2007: 97–117; Bordreuil 2006: 226; 2010: 13–32; 2013: 56–57.

9 Friberg 1987–1990: 542–544; Nemet-Nejat 1995: 253–260; Robson 1999: 14; 2008: 100; Chambon 2002: 503; Høyrup 2002: 8; Proust 2007: 242–248; Bordreuil 2006: 227; 2010: 23; 2013: 66–67.

10 Malbran-Labat 1991b: 127–130; Nougayrol 1955: 177–210; 1968: 16–22; 1970: 68–125; Thureau-Dangin 1934: 137–146.

11 Bordreuil 1975: 19–30; Bordreuil et al. 2012: 10–133; Dahood 1971: 31–35; Dietrich et al. 1995: 205–488; 2013: 247–600; McGeough/Smith 2011: 33-604.

12 RS[varia 13]/RS "1957.701"/KTU 4.709: Dahood 1971: 31–35; Dietrich et al. 1995: 459 KTU 4.709; 2013: 531 KTU 4.709; Bordreuil 2007: 389–397; McGeough/Smith 2011: 575.

	talent of Ugarit,
4) ḫmš . kkrm	4) five talents
5) ảlp . ṯmn . mảt kbd	5) one thousand eight hundred (shekels)
6) d . mnḥt	6) of tribute.

As we read a copulative *wav* in line 3, it cannot be proved that the seven talents of wool according to the talent of Ashdod equal the five talents and 1800 shekels of wool according to the talent of Ugarit. Therefore, it cannot be proved that one talent of Ashdod equals four-fifth of one talent of Ugarit. It thus seems that we are not able to reconstruct the Ashdod system from this text (Bordreuil 2007: 389–397).

However, this is the only known text which shows that a scribe from Ugarit was dealing with both the local weight system and with another weight system related to a different kingdom. On the other hand, considering administrative cuneiform alphabetical texts dealing with quantities of copper/bronze, it is probable that only the Ugarit local weight system of one talent equalling 3000 shekels had been used (Bordreuil 2012: 283–296). The question arises whether this is also the case with the archaeological documentation, precisely the weights.

In summary, the purpose of the Sumero-Akkadian cuneiform metrological lists was to teach metrology through theoretical texts, and not to draw up a list of a hypothetical merchant's collection of weights (Bordreuil 2006: 229). Consequently, one should be very careful when using those textual data in studying the corpus of weights discovered during the excavations at Ras Shamra-Ugarit (Courtois 1990: 119–127). Therefore, it is advisable to choose, by preference, administrative texts in Sumero-Akkadian cuneiform or in alphabetical cuneiform that could provide practical weight measure data, which in turn could be used for a statistical study of the weights.

2. The weights

The corpus of the weights discovered during the excavations at Ras Shamra–Ugarit between 1929 and 2002 includes more than 600 samples. The present study is based on the analysis of 575 of these objects (Bordreuil 2004: 50–51. 136–139. 212; 2006: 203–216; 2008: 215–245; 2014: 331–333; 2019: vol. II, 4–205). This selection may be considered representative.

My study intends to update our knowledge on this topic taking into account the contributions of the earlier studies by Nicolas Parise (1970–1971: 3–36) and Jacques Claude Courtois (1990: 119–127).

2.1 The inscribed weights

Some of the weights show marks that may be interpreted as number symbols designating the units of a system of weights. The value of the unit is determined by dividing the real mass of a given weight by the number inscribed The inscriptions may indicate either a number noun fully written out in Ugaritic (**Fig. 1**) or a number represented by a sign from the Mesopotamian cuneiform system of

Fig. 1. Sphendonoid-shaped weight RS 15.226 (Damascus museum): cuneiform alphabetic inscription: *ʿšrt* "ten", mass: 89.5 g, weight unit: 8.95 g, length: 0.044 m, diameter: 0.029 m, height: 0.025 m, material: hematite (picture É. Bordreuil).

Fig. 2. Sphendonoid-shaped weight RS 18.091 (Damascus museum): sumero-akkadian cuneiform inscription: DIŠ "one", mass: 10 g, weight unit: 10 g, length: 0.0278 m, diameter: 0.0101 m, height: 0.0092 m, material: bronze (picture É. Bordreuil).

Fig. 3. Dome-shaped weight RS 18.060 (Damascus museum): mass: 178.7 g, length: 0.0545 m, diameter: 0.035 m, material: limestone (picture É. Bordreuil).

Fig. 4. Weight in the shape of a genius or head of Bes RS 18.202 (Damascus museum): mass: 81.4 g, length: 0.0408 m, thickness: 0.0279 m, height: 0.035 m, material: bronze (picture É. Bordreuil).

symbols used to represent numbers (**Fig. 2**), by an Egyptian hieroglyphic symbol, or by a sign from a system of numeric symbols common to several writing systems (Bordreuil 2006: 204–205).

Five inscribed weights may be cited to permit a definition of the local system: they allow us to determine the average mass of the shekel of Ugarit at 9.4 g and attest to the real average variation (above and below the average) from 8.95 g to 10 g. Only one weight provides the data necessary for defining the value of the Hittite shekel at 11.7 g (Bordreuil 2006: 205–210 fig. 1–6).

The fact remains that most of the weights bear no inscription. A typological classification therefore needs to be based on other features such as material, form, mass, and measurements.

There are three categories of classification by material: stone, metal, or stone combined with metal. The different types of stone used belong to three groups: sedimentary, igneous, and jewellery-grade stones. Two metals are attested: bronze and lead. The mixed category consists of weights made of stone with attached metal parts. Stone is the material most often used, with metal less well attested and composite objects the rarest. Three types of stone provide the majority of the samples: hematite, the steatite/chlorite group, and the limestone group (Bordreuil 2006: 211–212).

Two principal types emerge in the classification by form: geometrical and representational forms. The attested geometrical forms are the following: sphendonoid-shaped,[13] sphendonoid-shaped with additional string-hole,[14] dome-shaped (that includes: spherical,[15] an inverted truncated cone with flattened ribs[16], **Fig. 3**), conical (that includes: a cone,[17] a truncated cone with a convex top[18]), cylindrical,[19] ring-shaped, lenticular, ovoid,[20] a truncated pyramid, a parallelepiped,[21] a trapezoid, or a prism. The representational forms (**Fig. 4**) are animal or human (Schaeffer 1937: p. 147–151 pl. XXIII–XXIV; Bordreuil 2004: 50–51 fig. 42–43. 139 fig. 132. 212 fig. 221; 2006: 210, fig. 6; 2008: 231–233 fig 24–27; 2014: 333 fig. 17.9). Geometrical shapes are far more common than the representational ones. The group formed by the sphendonoid-shaped and dome-shaped weights is by far the most common one (Bordreuil 2006: 211–213).

The size range of the entire weights is as follows: the length ranges from 0.01 m to 0.243 m, the diameter from 0.0052 m to 0.248 m, the thickness from 0.0045 m to 0.197 m and the height from 0.0057 m to 0.167 m (Bordreuil 2006: 213).

The absolute mass of the uninscribed weights lies between 1.1 g and 28900 g. All were weighed on an electronic scale accurate to 0.1 g. The only exception was the largest weight, with 28900 g, for which the accuracy is only within 10 g (Bordreuil 2006: 213).

3. Statistical analysis of the mass of the weights

(in collaboration with Gaël Benabou)

With respect to a classification by weight, we can derive from the inscribed weights that the average weight of the local Ugarit shekel—i. e. 9.4 g—varies from 8.95 g to 10 g (Parise 1970–1971: 7–13; Bordreuil 2006: 205–209), while the value of the Hittite shekel is 11.7 g (Otten 1954–1955: 128–131; Parise 1981: 156; van den Hout 1990: 517–530; Rahmstorf 2006: 21–22). Based on a statistical analysis of the mass of 573 weights (because 2 of the 575

13 Schaeffer 1937: 148 fig. 13; 1962: 72 fig 60 E. 98 fig. 80; Bordreuil 2004: 137, fig. 126–127. 138, fig. 131; 2006: 207–208, fig. 1–4. 210, fig. 7; 2008: 218–220, fig. 1–6.

14 Schaeffer 1937: 148 fig. 13; Bordreuil 2004: 138 fig. 130.

15 Bordreuil 2004: 137 fig. 128; 2006: 208, fig. 5; 2008: 221–224, fig. 7–12.

16 Schaeffer 1937: 148 fig. 13; 1962, 72 fig. 60 C–D. 172 fig. 60 B; Bordreuil 2004: 136–137 fig. 123–124; 2008: 225–226 fig. 14–16.

17 Schaeffer 1937: 148 fig. 13; Bordreuil 2008: 227 fig. 17.

18 Schaeffer 1962: 72 fig. 60 G; Bordreuil 2008: 227 fig. 18–19.

19 Bordreuil 2004: 137 fig. 125; 2008: 228 fig. 20.

20 Bordreuil 2008: 230 fig. 23.

21 Bordreuil 2008: 229–230 fig. 21–22.

weights were broken), we shall try here to answer the following questions:

1) Firstly, do all the weights as multiples and fractions correspond to a single fundamental unit?
2) Secondly, if this were the case, what would be the most probable mean value of this unit?
3) Thirdly, considering another possibility: If there were two or more units, what could be their most likely corresponding mean values?
4) Fourth, which multiples and fractions would then be used according to this hypothesis?

3.1 Histogram

The histogram clearly shows a high peak at around 9.5 g, and lower peaks at around 3 g, 5 g, 6.3 g, 18.5 g, 28 g, 45.5 g, 91 g, which could correspond to the coefficients of 1/3, 1/2, 2/3, 2, 3, 5, 10 (**Fig. 5**). Analysing the rest of the weights, one can also find peaks corresponding to the coefficients of 20, 30, 50, 100, 200, 300, 500, 1000, 2000, 3000 (**Fig. 6** and **Fig. 7**).

It is interesting to notice that (the peak value of) 9.5 g is very close to 9.4 g, which is the commonly assumed mean value of the shekel of Ugarit (Parise 1970–1971: 7–13; Bordreuil 2006: 205–209).

Employing the following list of coefficients: 1/6, 1/5, 1/4, 1/3, 1/2, 2/3, 5/6, 1, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500, 1000, 2000, 3000, we conducted several tests, including the "Chi-squared goodness of fit" test, and the more powerful "Shapiro-Wilk test".[22] Any theoretical explanations of these tests are not the objective of this study, since they are well known and have sufficiently been documented by John R. Taylor (1997: 261–277), Samuel Shapiro, and Martin Wilk (1965: 591–611).

These tests show statistical evidence against the hypothesis of a single fundamental unit of around 9.5 g. Should our list of coefficients prove to be correct, this statistical evidence would indicate a very high probability of there being at least two fundamental units.

3.2 Statistical method of Karl M. Petruso

A previous method had already been used for discovering weighing systems from the statistical analysis of corpus of Aegean balance weights, which is the statistical method of Karl M. Petruso (1992: 1–87). He had used a specific statistical method, based on the formula of David George Kendall (1974: 231–266), to determine the weighing systems of Bronze Age balance weights employed at Ayia Irini (Petruso 1992: 69–75). Therefore, one can propose that it could be applied to the data of Ras-Shamra/Ugarit. The Petruso method consists of studying the maxima of the following function (Petruso 1992: 71–72).

$$\Phi(x)=\sum_{j=1}^{N}\cos\left(2\pi\frac{x_j}{x}\right)$$

In this formula, N denotes the size of the studied corpus of weights, and the parameter x_j takes all the mass values within this corpus. A maximum of this function corresponds to a value of x, of which a large number of cosines are close to 1. We obtain this maximum when x_j/x is close to an integer number, which is the case when x is close to a probable fundamental unit or one of its fractions.

The problem that arises at this point is the extremely complex shape of this function with a very large set of weights, which shows a huge number of peaks (**Fig. 8**). One can determine the right one by applying the following method:

- We look at the first lowest peak (which should be the global minimum of the function). In this case, it is clearly around x=12.2 g (**Fig. 9**).
- The last highest peak to the left of the lowest peak corresponds to the most likely fundamental unit (**Fig. 8**). The other highest peaks on the left correspond to submultiples of this unit (here, 1/2, 1/3 are clearly visible). Here it is obtained for approximately x=9.15 g (**Fig. 10**). Observing the histogram shown previously (**Fig. 5**), this value seems to be a little bit too low.

The Petruso method certainly gives us an interesting clue, but it is not sufficient to determine the issue more precisely. Consequently, we then deployed two other statistical classifying methods, which we will present in the following.

3.3 Iterative deterministic method and simulated annealing method.

Two ways of research are used consecutively: the iterative statistical method and the simulated annealing method.

22 The list of coefficients is based on attested weight measuring data from administrative texts of Ras Shamra/Ugarit: Bordreuil 1975: 19–30; Bordreuil et al. 2012: 10-133; Dahood 1971: 31–35; Dietrich et al. 1995: 205–488; 2013: 247–600; McGeough/Smith 2011: 4–586; Malbran-Labat 1991b: 127–130; Nougayrol 1955: 177–210; 1968: 16–22; 1970: 68–125; Thureau-Dangin 1934: 137–146.

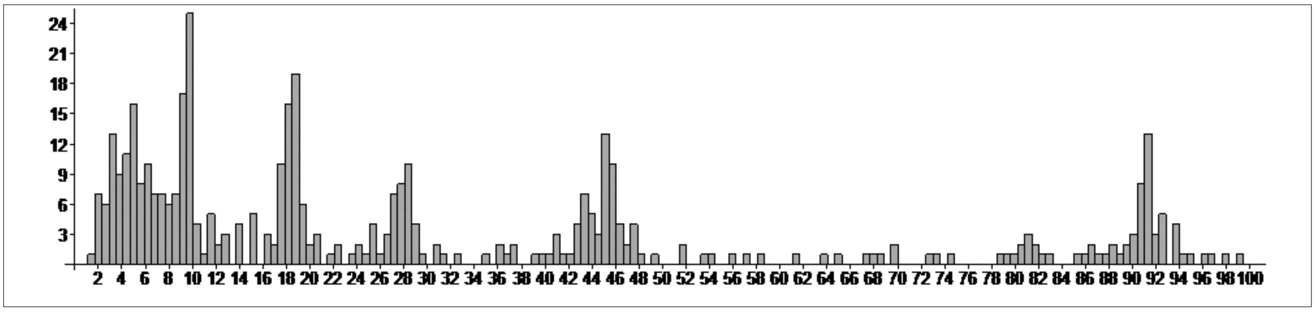

Fig. 5. Histogram of the weights from 1 g to 99,9 g (É. Bordreuil/G. Benabou).

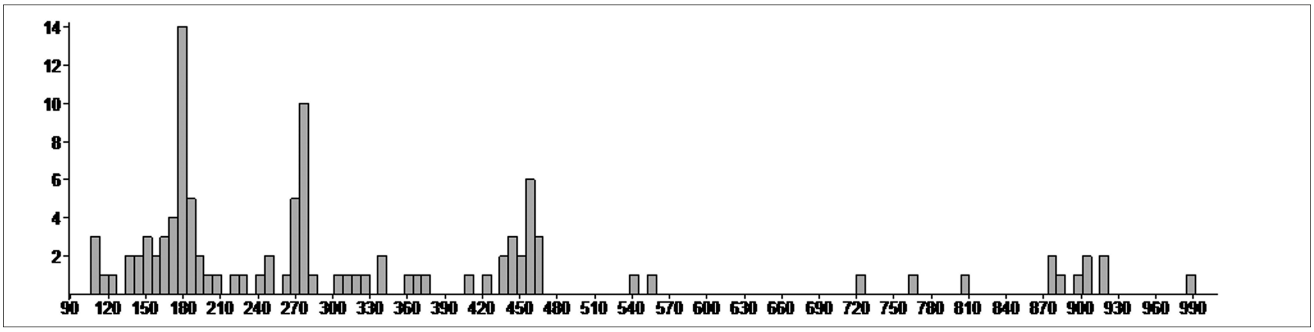

Fig. 6. Histogram of the weights from 100 g to 999.9 g (É. Bordreuil/G. Benabou).

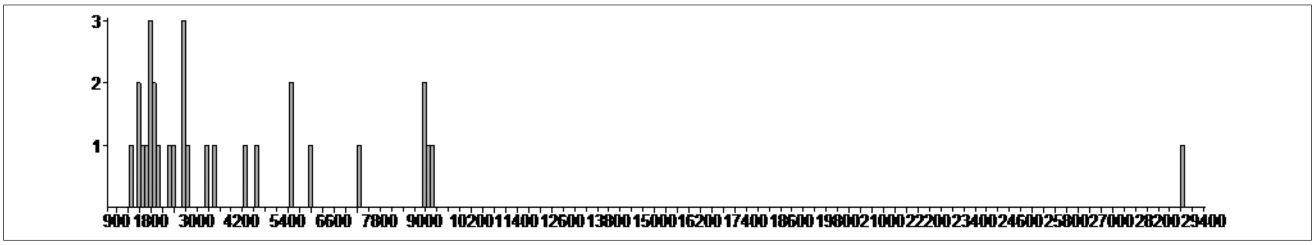

Fig. 7. Histogram of the weights from 1000 g to 28900 g (É. Bordreuil/G. Benabou).

3.3.1 Iterative deterministic method

This iterative statistical method is based on an iterative algorithm. In our research, let us suppose, for instance, that we are trying to know if 9.5 g and 7.8 g are reasonable fundamental units (the value 9.5 g corresponds to the highest peak of the histogram, and 7.8 g is the most commonly assumed mean value of the Karkemish shekel—but, of course, it is just an example).[23]

3.3.1.1 Initialization of the algorithm

At the beginning of the algorithm, the list of weights is split in two classes. Each class contains the weights that can reasonably be attached to one of the two fundamental units (9.5 g and 7.8 g in our example). Each weight is assigned a coefficient that corresponds to the unit. For instance, if the weight "21.5 g" is in the 9.5 g class, its coefficient is 2. One then computes the variances of the two classes, in which each weight is divided by its coefficient. Meaning that the variance of a list of numbers is the average of the squared differences to the mean. More precisely, our interest is in the maximum of these two variances and this choice has been made in order to obtain close variances at the end of the algorithm. This conforms to the hypothesis that the weighing technique accuracy was approximately the same for all craftsmen of the Late Bronze Age.[24]

3.3.1.2 Iteration

At each step of the algorithm, we undertake the following tasks.

23 9.5 g is very near to 9.4 g, which is the commonly assumed mean value of the "shekel of Ugarit": Parise 1970–1971: 7–13; Bordreuil 2006: 205–209; 7.8 g is the mean value of the "shekel of Karkemish": Parise 1984: 157–159; Archi 1987: 48–52; Ascalone/Peyronel 2006a: 55–56; 2006b: 128–139; Rahmstorf 2006: 21.

24 For ancient Mesopotamia, the methodology of weight metrology has been pointed out by Powell 1971: 167–197; 1979: 71–109.

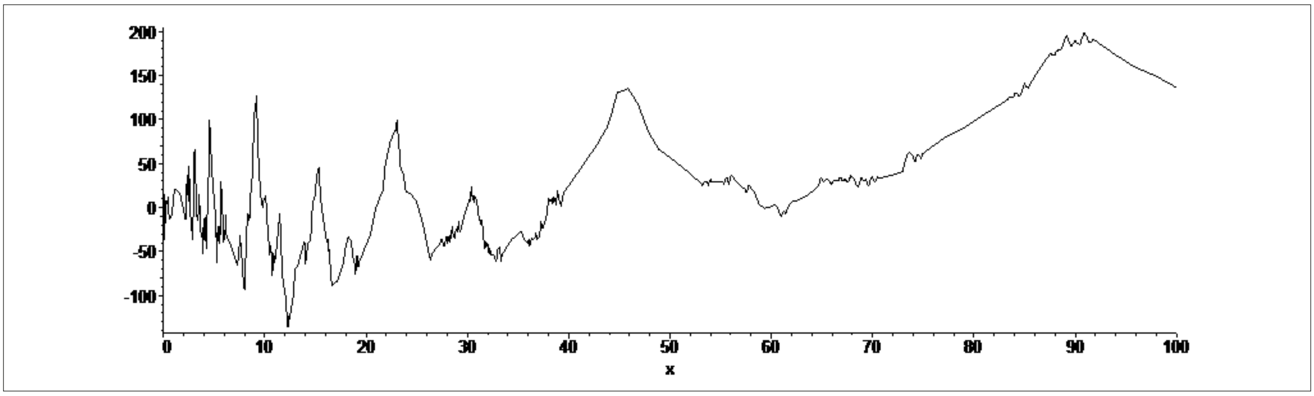

Fig. 8. Graph of the function Φ for abscissa from 0 g to 100 g (É. Bordreuil/G. Benabou).

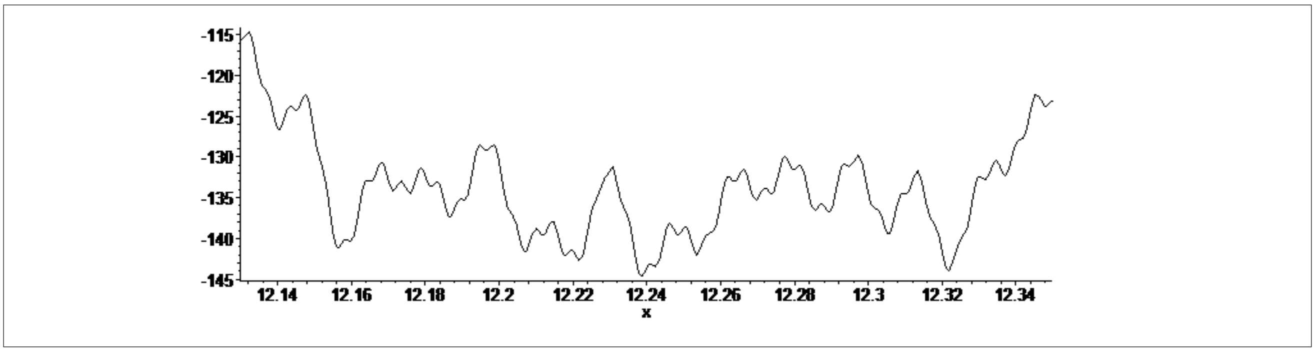

Fig. 9. Detail of the graph of the function Φ for abscissa from 12.13 g to 12.35 g (É. Bordreuil/G. Benabou).

Firstly, we build up a list of "good" exchanges between the two classes. Let us say, for instance, that we are studying the weight "21.5 g", which is currently assigned to the 9.5 class with coefficient 2. We then try to place it in the 7.8 class, with a suitable coefficient, in this case 3. If this exchange decreases the maximum of the variances of the two lists, then we record this in the list of "good" exchanges. However, we do not actually make the exchange at this stage. When this process is completed for all weights, we obtain a list of all "good" exchanges that can be made between the two classes.

Secondly, we actually make the exchanges, starting with the best one and continuing until the end of the list of "good" exchanges. In this process, however, there is always a possibility of detecting an exchange that has become unsuitable, due to the previous ones. Consequently, we must test again each exchange of the list, in order to check if these exchanges are still "good" ones. The result of this computation is a new cutting of the list into two classes.

3.3.1.3 End of the iteration

The previous steps are iterated until no "good" exchange is recorded. In this case, we simply stop the research and consider we have a satisfying cutting of the list.

It is now necessary to make a test, for instance a Shapiro-Wilk test, in order to know if the result is quite satisfactory. This method was used to find suitable cuttings for the following pairs: 5 g/9.5 g, 6.5 g/9.5 g, 7.8 g/9.5 g, but no satisfying cutting of the list has been obtained. This is one of the reasons why we have tried another method, the "simulated annealing" method.

3.3.2 Simulated annealing method

The simulated annealing method was invented in the 1980ies (its name originates from an analogy with an industrial technique, but there is no real correlation between this industrial technique and the method in question) (Kirkpatrick et al. 1983: 671–680). It is a general algorithmic method, which gives approximate solutions to a large class of optimization problems. Theoretically, this method is well understood (Kirkpatrick et al. 1983: 671–680). Moreover, it leads to quite simple algorithms. Let us consider our problem this way: if all our weights are multiples or fractions of one out of two fundamental units, we want to find the best cutting of our list into two sub-lists, each of them corresponding to one of these two units. This problem is what we call an "optimization problem": we are looking for the best configuration (the

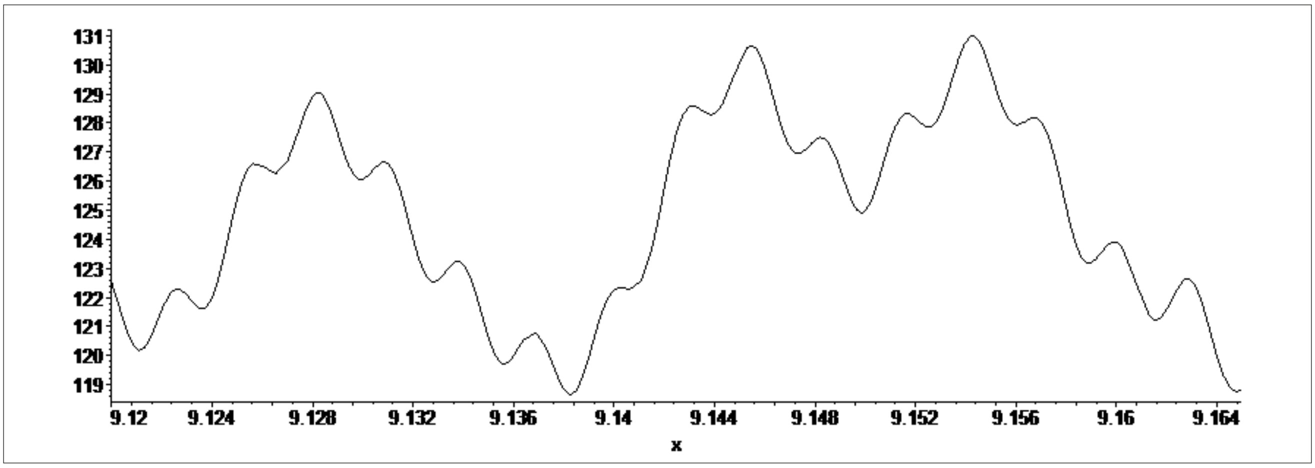

Fig. 10. Detail of the graph of the function Φ for abscissa from 9.115 g to 9.165 g (É. Bordreuil/G. Benabou).

best cutting of our list) from a very large set of possible configurations (all the possible cuttings of our list into two sub-lists: here, there are more than 10^{172} such cuttings!).

3.3.2.1 General situation of the problem

Let us consider a very general "optimization problem". We consider a very large set S of configurations. We associate a score s(c), which is a non-negative real number, to each configuration c in S. The objective is to find the configuration that attains the minimal score. The set S is too large to simply compute the score of every configuration, so it is necessary to search for another way of obtaining the solution to our problem. The simulated annealing method does no guarantee for achieving the best configuration in general, but at least a very good approximation to it.

3.3.2.2 Description of the method

It is once more an iterative method, however not deterministic: it uses random methods.

- Step 1: a parameter T called "temperature" (in analogy with the original industrial method), is fixed to an initial value. We also choose an arbitrary configuration c_0.
- Step 2: now we make the choice of another configuration c' close to c_0 (the definition of the word "close" depends on the problem we are studying).
- Step 3: if c' suits better than c_0, that is if $s(c')<s(c_0)$ we "accept" it (keep in mind that we search for the configuration c that makes s(c) minimal). If c' is worse than c_0, it is still acceptable with probability $p(c_0,c',T)$ defined by $p(c_0,c',T)=\exp(-(s(c')-s(c_0))/T)$. This quantity decreases very fast as $s(c')-s(c_0)$ grows (we rarely accept a configuration far worse than c_0) and it increases very fast as T grows (smaller T means that we are more restrictive while accepting c' if it is worse than c_0). If we define $p(c_0,c',T)$ so that $p(c_0,c',T)=1$ if $s(c')<s(c_0)$, we can sum up this step by writing that: $c_1=c'$ with probability $p(c_0,c',T)$ and $c_1=c_0$ with probability $1-p(c_0,c',T)$
- Step 4: we now go back to steps 2 and 3, in order to choose a configuration c' close to c_1, then proceeding to define c_2 with respect to c_1, in the same manner as was done for c_1 with respect to c_0, etc.
- Step 5: periodically, we decrease the value of parameter T to be more selective.

At each step, we keep in memory the best configuration achieved this far. The process ends when the temperature reaches a certain value, fixed in advance, and low enough to ensure that this best configuration is close enough to a real solution of the problem. This configuration is then retained.

3.3.2.3 Interest of the method

Some would find it unusual to accept configurations that seem worse than the one we already have, but there are good reasons to do so. For instance, let us imagine that the process would automatically reject these configurations, and that we would reach a configuration c that is an unsatisfactory approximation for the solution of the minimum of the score, but sufficient so that no configuration close to c is better. The algorithm would be "stuck" forever at c. In this case, it is important that we can "go up" to explore other configurations, with the hope to find eventually a better one that is not close to c.

3.3.2.4 Convergence of the method

Under relatively unrestrictive conditions, we can assert that with the help of this method, in a certain probabilistic meaning, we converge a solution of the problem. However, one of these conditions requires that the temperature decrease sufficiently slowly at step 5 (we spare the reader the theoretical details), which generates very long computation times (because it increases the number of iterations needed to reach the fixed low value of the "temperature" that ends the process). Actually, in practice, we make the temperature decrease much faster. This does not ensure the conformity of the method, but results in much shorter computation times and allows us to use the algorithm many times.

3.3.2.5 Application to our problem

We apply this method to the following problem: can we split the series L of weights in two different classes, each corresponding to a fundamental unit and its multiples and sub-multiples? Actually, for our study, we have only considered the weights ranging from 1.1 g to 99.4 g (that means 435 elements out of 573 weights), as it seemed to us that there were not sufficient of the heaviest weights to include them in the study without taking a high risk of error.

In this case, a configuration c is the cutting of L in two classes, C1 and C2, each of them corresponding to a fundamental unit. The score of a configuration c is the maximum of the variances of the two classes.

We start from the cutting (step 1) of L in two classes, C1 and C2, which is configuration c_0. In step 2, we move a random element of L from one class to the other. The fundamental units corresponding to the new classes are now adjusted in the best possible way by minimizing the variances of the two classes. This new configuration is c'. Steps 3 and 4 are executed, and this procedure is repeated. T is decreased (step 5) every 435 executions of steps 2-3-4 (the number of elements in L being 435).

3.3.2.6 Choosing the coefficients

One of the most difficult problems we face is the choice of the suitable coefficients. Which multiples and sub-multiples were used in Ugarit in the Late Bronze Age? We have used the coefficients 1/6, 1/4, 1/2, 2/3, 5/6, 1, 2, 3, 5, 10, which correspond to the peaks of the function Φ defined above.

3.3.2.7 Testing the results

At the end of the computation, we obtain a new cutting of L, which is better than the initial one. We then execute a Shapiro-Wilk test in order to determine if these results allow us to assert the existence of two fundamental units.

Conclusion

Many computations have been executed with a large set of parameters (initial temperature, slow decrease of temperature, starting configuration c_0). Neither the iterative deterministic method nor the simulated annealing method yielded any satisfactory results.

Our conclusion is that most of the weights correspond to multiples and sub-multiples of a fundamental unit of around 9.4 g. The problem is that there are still numerous exceptions, which form a highly non-homogeneous population. They mostly correspond to many various fundamental units and very few of them correspond to a single unit only.

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Weights and their raw material in Bronze Age Mesopotamia—a case study from Tall Bazi

Christoph Fink

Introduction

Generally, Mesopotamian weight stones are considered to be easily recognizable. There are thousands of carefully shaped weights in numerous museums—most frequently zoomorphic weights in the shape of a duck or a lion, in conical or sphendonoid shape. Thus, the visual appearance of Mesopotamian balance weights seems to be clear. However, this widely accepted idea about the common shape of weights has led to odd results. Just to take an arbitrary example: The ancient city of Tuttul (modern Tall Bi'a near Raqqa) was a 36 ha major city in the third and second millennium BC. Palaces, temples, houses, graves and fortifications have been excavated and several thousand inhabitants must have lived and worked there. However, only nine weight stones have been apparently found, six of which were published and two were weighed (Strommenger/Miglus 2010). Thousands of weight stones must have existed in this city in antiquity, since every person who traded, sold or bought goods, would have had to weigh silver for his or her economic transactions. Even if we accept the fact that some people took their weight-stones with them when they left the city, hundreds of balance-weights should have been found during the large-scale excavations.[1] This is not to blame the excavators of Tall Bi'a, but this striking rareness of weight stones can be observed at nearly all the excavated sites in the Near East—with the exception of those few sites where the excavators were especially interested in metrology.

This peculiar disproportion between the supposed number of weights in an ancient settlement and the number of weights that has been published in excavation reports is mainly due to the misconception of how balance weights must have looked like. In fact, the identification of an object as a weight constitutes the main problem in the research of ancient metrology. There have been different proposals of how to define objective standards, by which an item should be addressed as a weight. The most recent one has been formulated by Nicola Ialongo and Lorenz Rahmstorf and specifies six typical features. A weight can be identified as such if "it has a standardized shape", if it "is made of a hard and durable material", if "more similar objects appear together in a closed archaeological context", if "it does not show any systematic presence of usewear", if "individual objects can be ascribed to rational multiples of one or more unit-systems", and if the "deviation from the norm" is "within an acceptable margin of error" (Ialongo/Rahmstorf 2019: 108).[2] These are very wide criteria, but they seem to fit the reality of ancient weights and the customs of weighing much better than the preconceived regular shape, as it will be shown in the case of Tall Bazi.

Another problem for the metrology of the Ancient Near East concerns the question which weight system might have been used. For the Mesopotamian area, a mina of about 500 g is generally assumed, which—ac-

1 Another example is the site of Tall Munbaqa, ancient Yakaltum/Ekalte, which is contemporary and in many aspects similar to Tall Bazi. Most of the twelve recorded weights were found in the living quarter "Ibrahims Garten" of the lower town, and date to the Late Bronze Age. Just seven of them have been actually weighed. Most of them consist of haematite or goethite and some can be related to the Mesopotamian system of 8.3 g (Werner/Czichon 1998).

2 For additional criteria for weights see also Rahmstorf (2006: 9–10).

cording to mathematical traditions—was divided into 60 shekels with an ideal weight of approx. 8.3 g. In the western part of the Near East, the most common standard was based on a mina of 470 g, which is represented by inscribed weights from Tall Sweyhat and Ebla (Holland 1975: 75–76; Archi 1987: 58). The mina of 470 g can be additionally subdivided into three different weighing systems: in 60, 50 and 40 shekel the mina. This leads to a shekel of approx. 9.4 g, which was in use for example in Ugarit (Parise 1989: 333–334), another shekel of 7.8 g used in Ebla and a third shekel with 11.7 g dominant in the Anatolian region (Otten 1954–1956: 128–129). The names for these different systems have not yet been standardised in the literature. This paper follows the designations used by Enrico Ascalone and Luca Peyronel (2006) and therefore a shekel of 9.4 g is called "Levantine", and a shekel of 7.8 g is labelled "Syrian".

Case-study: Tall Bazi, Syria

Numerous iron oxide rocks were brought to light during the excavations at Tall Bazi. The excavators Berthold Einwag and Adelheid Otto entrusted me with their analysis, and I was able to study them in detail during the excavation campaigns at Bazi from 2004–2010. Some of the results presented here have been developed in my unpublished master's thesis, others have risen during the Metrologia project.[3]

Tall Bazi is located on the eastern bank of the Syrian Euphrates river, approximately 30 km to the east of the modern town of Manbij. The site was intermittently inhabited from the Early Bronze Age until the Roman period. The main feature of Tall Bazi is the 60 m high "Citadel". This natural mountain spur served as a stronghold during the entire period of the settlement's history. During the Early Bronze Age, the citadel—with its sophisticated fortifications and large public buildings (Einwag 2008)—was a part of the much bigger settlement (modern Tall Banat) and probably represented the administrative centre of this city (most recently Porter 2018).[4] After the destruction and abandonment of the Early Bronze Age settlement, a monumental *templum in antis* with associated structures was built on top of the citadel in the Middle Bronze Age and remained in use until the destruction of the site in the Late Bronze Age (Einwag/Otto 2018; 2019). The two domestic quarters of the lower town at the foot of the hill were excavated between 1993 and 1999, before the Tishreen dam was closed and the area was flooded by the barrier lake. The so-called "Nordstadt", the lower town to the north of the citadel, was occupied from the Middle Bronze to the Late Bronze Age. The "Weststadt" was situated between the citadel and the Euphrates and consisted of more than 70 houses.[5] This part of Tall Bazi was a subsequent extension of the settlement in the Late Bronze Age. The ground plans of the dwellings were standardized in floor plan and room layout and were similar in size.[6] At this stage, the settlement of Tall Bazi represented a medium-sized town with no administrative buildings in the lower town. Only part of the temple with its affiliated structures on top of the citadel was still in use. The settlement was finally destroyed and abandoned in the middle of the 14th century BC (Otto 2014a: 95; Einwag/Otto 2018: 174).

The geographical location reveals the importance of Tall Bazi during the Bronze Age. The site is located on the Euphrates, one of the major trade routes from North to South. Likewise, Tall Bazi was important for the East-West connection, from the Jazira plain to the Mediterranean coast, because the Euphrates is relatively slow and shallow there and thus allowed a fairly easy crossing. Still in recent times, the only way across the river in this region was a ferry boat between Banat-Bazi and Sandaliya, which was in use until 1999 and apparently had been used already by the travelling Max Freiherr von Oppenheim some 100 years earlier (Otto 2006: 288).

In this paper, we focus in particular on the Late Bronze Age I period, when Tall Bazi was a wealthy town within the Mitanni kingdom.[7] The inhabitants clearly profited from the flourishing economy and many seem to have been involved in trade and various crafts, as demonstrated by the different workshops for pottery and metal products which were found in the settlement (Otto 2006: 282). Additionally, Tall Bazi's economic wealth profited from a natural resource. Since the site was situated close to natural iron oxide sources, more precisely goethite, the in-

3 I thank Adelheid Otto and Berthold Einwag for having entrusted me with the study of the weights, and the members of the Metrologia team for the stimulating meetings. A few results of my master's thesis (Fink 2008) were published in the Festschrift Roaf (Fink 2012).

4 The Early Bronze Age Citadel of Bazi is presently the author's object of research as his doctoral thesis.

5 48 houses were excavated and around 22 could be traced in the course of a magnetometer survey (Einwag/Otto 2018: 156).

6 An in-depth description of the houses and their inventory can be found in Otto 2006; 2014a and Einwag/Otto 2018.

7 During the campaign in 2004, two cuneiform tablets were found in the temple. The texts stated that Tall Bazi belonged to the Mitanni Empire (Sallaberger et al. 2006; Einwag/Otto 2019: 167).

Fig. 1. Accumulation of raw material (*in situ*) on the floor of House 31

habitants of Tall Bazi owned a much-desired resource for cylinder seals and weights.[8] These conditions favoured the development of the settlement into a thriving trading town during the Early, Middle and Late Bronze Age.

Around 1350 BC, when the settlement was violently destroyed, probably by the Hittites, it was one of several collectively governed settlements in the Euphrates valley within the Mitanni kingdom. The Mitanni Great King exercised hegemony over collective-governance polities, but he resided far away in Waššukanni.[9]

As far as the settlement itself is concerned, it is important to keep in mind that it was completely destroyed by fire. Most of the material left behind in the temple on top of the citadel and in the fifty excavated houses of the lower town is indeed primary inventory, which was in use at the very moment of the final destruction of the city (Otto 2014a: 86–88). All the objects were part of a functioning system. This is one reason why the excavators and the teams working at the site collected and recorded even tiny stones that were lying on the floor of the rooms. These heaps of stones often consisted of a mixture of semi-precious reddish and whitish stones and blackish or brownish pieces of iron oxides (**Fig. 1**). The large amounts of semi-products, finished beads and polished stones indicate that they were collected nearby and either used by stone-cutters or traded (Otto 2006: 119).

Iron oxide rocks and its deposits

The Euphrates valley around Tall Bazi, as well as the entire Northern Syrian plateau, consists of limestone layers. This limestone contains mainly mineral conglomerates and flint rocks (van Loon 2001: 2.6–2.9), but iron oxide (or rather goethite) is the most frequent mineral, which can be found in the limestone heights bordering the Euphrates valley.

Goethite can occur naturally associated with haematite, but it is formed at lower temperatures and in sedimentary rock layers.[10] Both minerals look similar at first glance and are therefore often confused with each oth-

8 The proper chemical nomenclature for goethite (α-$Fe^{3+}O(OH)$) is "iron(III) oxide-hydroxide". For the sake of convenience, "iron oxide" is used as a generic term for minerals like haematite and goethite in this paper.

9 Waššukanni has not been located with certainty, however, it is generally assumed to be the site of Tell Fekheriye (Bonatz 2015: 26–27).

10 For a more detailed description of iron oxide rocks and its deposits in the Near East, see the recent publication of M. Melein (2018: 15).

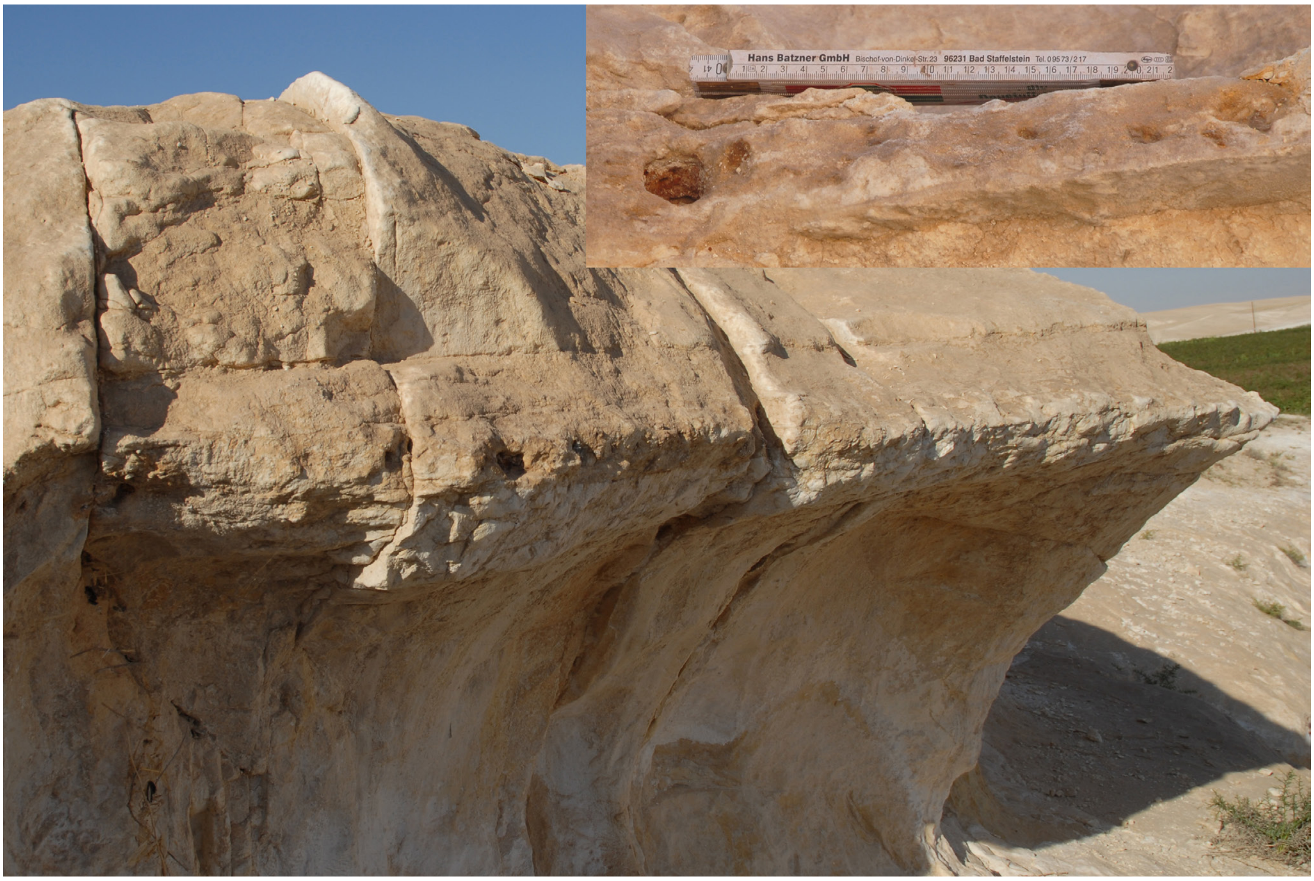

Fig. 2. Limestone outcrops in a wadi near Tall Bazi with inclusions of goethite

er.[11] Goethite's hardness ranges from 5 to 5.5 on the Mohs scale, thus goethite is somewhat softer than haematite. Today the material can be easily determined by the streak test. The colour of the streak of haematite is dark reddish, whereas the streak of goethite is auburn. Nodules of iron oxide rocks in its natural form can be found relatively often as inclusions in the wadis in the vicinity of Tall Bazi or just lying on the ground (**Fig. 2**). Because of these circumstances and mineralogical tests[12] it can be confirmed that the brownish and blackish stones lying on the floors of the Late Bronze Age houses were indeed of local origin.

Since sources of iron oxide are rare in the Near East, these resources may have been one reason for the economic wealth of the settlement. Goethite and haematite were the most common materials for balance weights and cylinder seals during the 2nd millennium BC in the Ancient Near East (Melein 2018). But, as D. Collon and P. R. S. Moorey noted, sintered quartz (respectively frit or faience) was increasingly used for mass-produced seals in the third quarter of the 2nd millennium BC (Collon 1987: 65; Moorey 1994: 76). This also applies to the cylinder seals from Tall Bazi. Of the 14 cylinder seals found during the excavation, only one is made of goethite and this exemplar dates to the Middle Bronze Age (Einwag/Otto 2019: 168 Fig. 13); the other cylinder seals are made of frit or limestone.[13]

Therefore, we assume that goethite was mainly used for the production of weights at Tall Bazi. The material goethite is thus an identifying feature of objects with an irregular form: they could be a weight stone or the raw material for such an object. The excavators of Munbaqa (Czichon/Werner 1998: no. 2639) suggested another purpose of these stones as gaming pieces. Their usage as tools seems less likely because of the shape and the relatively small size of these objects.

11 This can also be assumed for the Ancient Near East. The name for haematite in Akkadian is *šadanu* (Chambon 2006: 189), but there is no known Akkadian word for goethite.

12 These analyses were conducted by the mineralogist Prof. Ludwig Masch of LMU Munich. Additional analyses were made by M. Melein (2018) in her doctoral thesis.

13 Most of the faience cylinder seals are published in Otto 2006: 124.

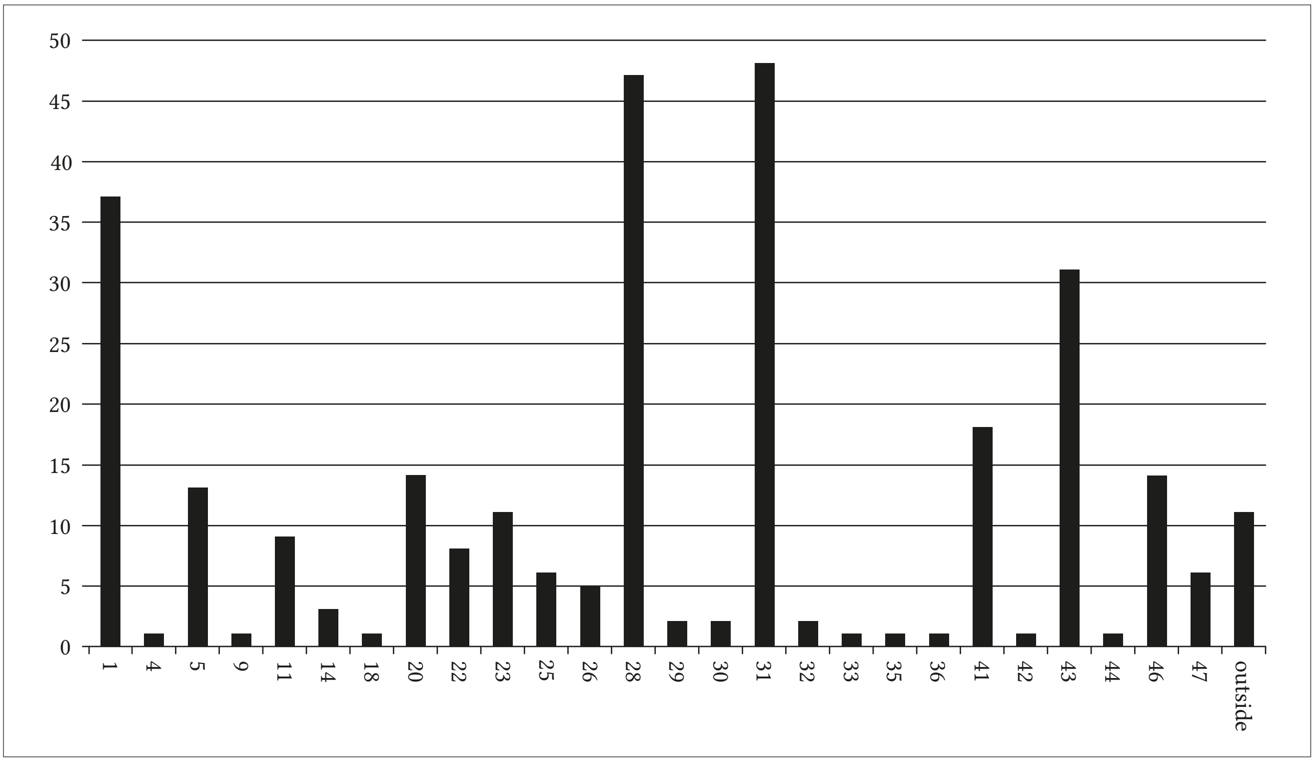

Fig. 3. Chart with the amount of goethite rocks in each house

Objects from iron oxide at Tall Bazi

Objects from iron oxide were found in 26 of the 48 excavated residential buildings of the Weststadt. Between five and fifteen weights were discovered in most houses. More than 30 iron oxide objects were found in four houses (Houses 1, 28, 31 and 43) (**Fig. 3**). In these houses, the iron oxide stones were found in heaps together with pebbles, shells and small limestones in the main room of the houses (Otto 2006: 119–122). Evidently, the local iron oxide rock was collected, brought to the houses and processed by at least four of the households. These houses were obviously engaged in the processing of stones, whereas the remaining households used these objects perhaps as weight stones or 'make-weights'.[14] The processing of iron oxides was presumably just a part-time job, as for instance the residents of Houses 1 and 31 produced also pottery (Otto 2006: 151. 202).

The objects on **Fig. 4** show five different stages of processing. **Fig. 4a** shows a natural goethite in cylindrical shape with a rusty surface. The second object (**Fig. 4b**) is less rusty and the nodules seem less pronounced. The third stage of processing shows a flattened surface (**Fig. 4c**), the fourth object is visibly cut and polished, but with still prominent nodules (**Fig. 4d**), while the last object (**Fig. 4e**) is highly polished, rather well shaped with many fine scratches visible on the surface.

One of the houses that revealed much less iron oxide objects is for instance House 26. It was equipped—like the other houses—with a long main room and four adjoining rooms. A collection of six different weights or possible weight stones was found in the area of the house altar of the main room. The objects had been kept in a small beaker together with beads and arcularia shells—the latter also connected with trading customs (Otto 2006: 129) (**Fig. 5a**). Although these objects were probably used as weights, they vary in form, material and even in their basic weighing systems. The decorated, perforated weight stone Bz 24/35:7 (**Fig. 5b**) is made of local goethite and weighs 9.3 g, which matches nearly 1 ideal Western or Levantine shekel (Otto 2008 and Otto, this volume). The sphendonoid weight Bz 24/35:17 consists of basalt and weighs 16.5 g, corresponding to 2 Mesopotamian shekels (**Fig. 5c**). Thus, on the one hand these stone objects were found together and can be linked with trade on account of their mass, their cochlea and their place of keeping. On the other hand, these pieces cannot be linked to one single weighing system and therefore do not form a set of weights.

14 The differences between 'make-weights', 'pebble' and 'precision' weights are discussed in Hafford (2012: 23).

Fig. 4. Different stages of processing of goethite rock

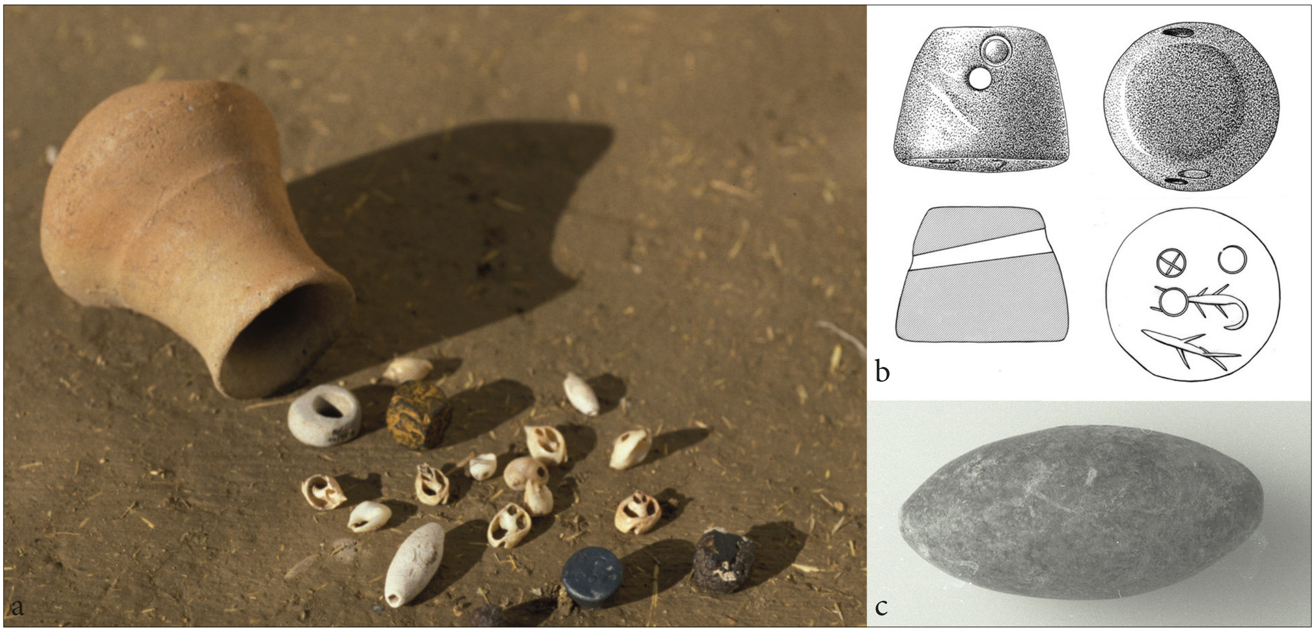

Fig. 5. a: Beaker with beads, arcularia and goethite objects found in House 26; b: Weight/stamp seal (goethite); c: Weight (granite)

The same can be stated for every other household of the Weststadt which kept weights.

No distinct set of weights was found in any house. The inhabitants who fled the settlement before the enemy's attack may have had time to take their most valuable possessions with them, as by the almost complete lack of silver and gold objects seems to indicate.

Since the iron oxide objects of irregular shape show various stages of processing, which usually require a great deal of time and effort, it can be assumed that these objects were not used as mere gaming pieces. In all likelihood the well-shaped and polished iron oxide objects were weight stones and several different metrological systems were simultaneously used in Tall Bazi. This is not surprising given Tall Bazi's location along the trade routes from North to South and East to West. As mentioned above, there is no evidence at the site that other objects than the weight stones were made of iron oxide. Thus, it is likely that all the iron oxides found in the excavations at Tall Bazi are finished or unfinished weight stones relating to the various known metrological systems used in Western Asia.

How can these presumable and perhaps unfinished weights be related to the weighing systems used in Tall Bazi, and which system was dominant or local?

Searching for the system

Altogether, there were about 450 items found during the excavations in Tall Bazi, which were possibly small weight stones or raw material. The mass of these stones varies between 0.8 g and 107 g and clusters around 7 g and 12 g. About 60 objects have been classified as actual weights, because of their material and shape (see **Fig. 10** and **Table 1**).

Approximately 300 stones from the Weststadt were made of iron oxide or rather the local goethite. For the

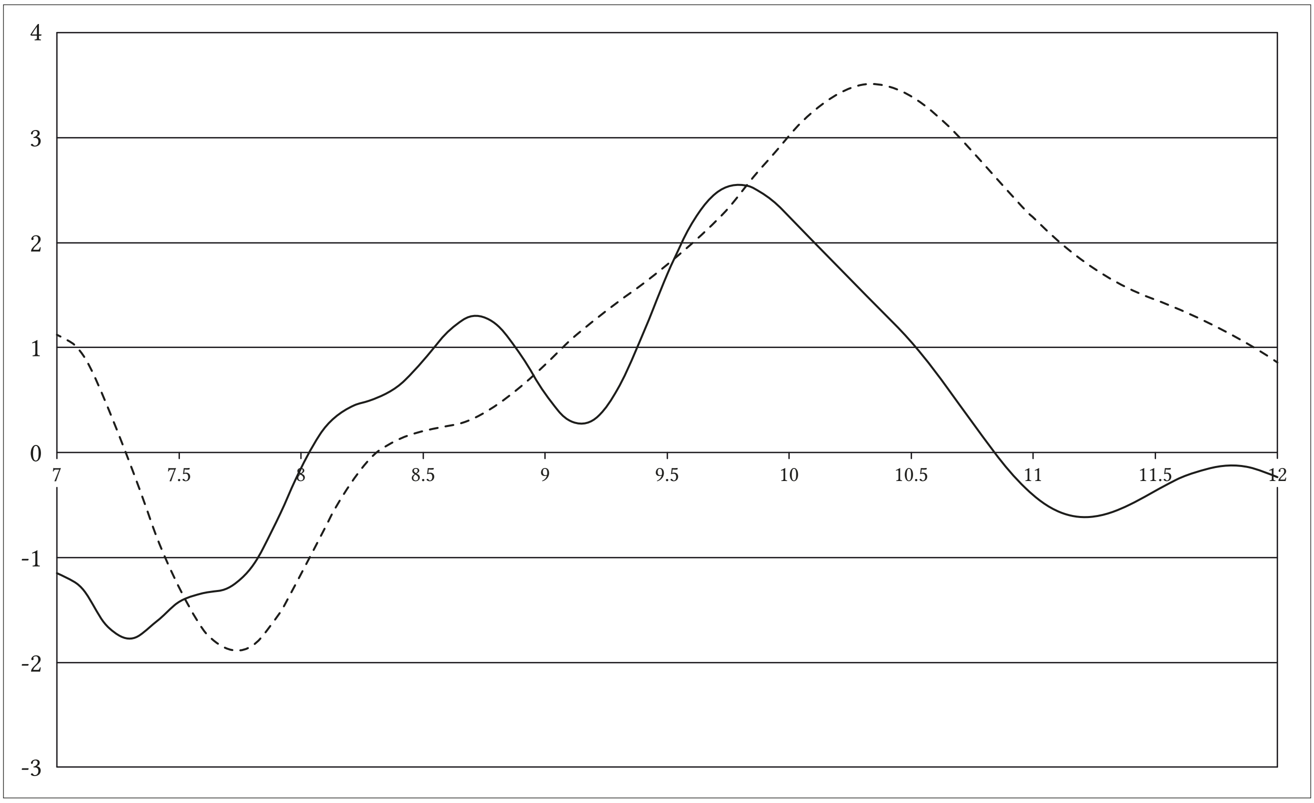

Fig. 6. Cosine Quantogram Analysis (q = gram) of goethite objects from the Weststadt. Solid line: users. Dashed line: producers

following evaluation we will focus on these iron oxide stones, because on the one hand, haematite and goethite were the predominant materials for weight stones in the Bronze Age and on the other hand, the context of the Weststadt narrows down the date for these objects to the Late Bronze Age. After sorting out the objects that were either broken or found in uncertain contexts, there were 225 presumable weights left, which were examined.

In order to analyse a large number of mathematically connected objects, the Kendall formula or the Cosine Quantogram Analysis offer a good possibility to evaluate them and to generate probable base units in a set of numbers. This formula—first described by the English mathematician D. G. Kendall (1974)—detects algorithmically constructed number series. The Kendall formula is based on the relation of cosine to 2π. From the whole equation arises the error term φ, which is highest when the actual basis-unit is reached (more detailed in K. Petrudo 1992: 71–75 and C. Pulak 1995: 307–317). Over the past three decades, the Kendall formula has become increasingly popular in archaeology and has been commonly used for examining weight assemblages.

Nevertheless, there are also a number of limitations to this method. For instance, this formula recognises just positive integers, which means that whole numbers like 1, 2, 3 and so on can be found as the base, but balance weights weighing one and a half shekel—as for example Chambon (2006: 97) notes for the Mari texts—cannot be identified. Another issue is the interpretation of the peaks. When can we assume that a high point is equivalent to a base unit and not just a peak of a random multiplier (Ialongo/Rahmstorf 2019: 116)? As to Tall Bazi, respectively any Syrian town in the Late Bronze Age, we already know the possible weighing systems which were used. Thus, we are not searching for a new base unit, but rather detecting the already known one.

A first breakdown of the whole corpus of possible weights from Tall Bazi did not produce significant recognisable peaks. Either the batch of possible weights was too small or it was simply not mathematically connected. But at least the splitting of the corpus in the already mentioned houses which used weights (“users”) and households which processed raw material (“producers”) makes some differences visible.

In **Fig. 6**, the application of the Kendall formula is presented. The dashed line represents the “producers” (n = 134) and the continuous line shows the graph for the “users” (n = 91). It can be recognised that in case of the weights from the producers’ houses the graph culminates at a lower level and within the range of an approximate of 10 g above basis unit. This could be explained by the presumable inaccuracy and by incomplete weights.

Fig. 7. a: Weight made of haematite (16.8 g); b: Weight made of volcanite (8.4 g); c: Weight made of haematite? (40+x g)

Fig. 8. a: Weight made of goethite (9.2 g); b: Weight made of goethite (9.1 g); c: Weight made of goethite (3.1 g)

Fig. 9. a: Weight made of goethite? (7.3 g); b: Weight made of goethite (11.8 g); c: Weight made of microgabbro (11.7 g)

The continuous graph indicates that in Tall Bazi two primary systems were used side by side, namely the Mesopotamian and the Levantine system.

Based on this knowledge, we can examine some definite weights that match these two systems. A clear difference in the weight assemblage of Tall Bazi in general is recognizable neither for the elaboration state nor for the allocation of shape to system or unit. However, at least a trend can be noted for both of these standards. **Fig. 7** shows a selection of weight stones following the Mesopotamian standard and corresponding in their shapes to the common sphendonoid form (see also **Fig. 10** and **Table 1**). In these cases, the material consists of foreign stones. It is also worth mentioning that two of them were found on the Citadel.

On the other hand, for the pieces of the Western or Levantine norm (**Fig. 8**), we can recognise that these weights are almost exclusively made of local stone, and the shape and processing is relatively coarse. Most of the exemplars of this system reveal the original shape of the nodule or are in the form of a truncated dome, hemisphere or dome shaped, similar to the weights found in Ebla (Ascalone/Peyronel 2006; Peyronel 2019: 73). Furthermore, it has to be considered that both systems seem to differ in their accuracy. At a superficial level, it seems to be the case that exemplars of the Mesopotamian shekel fit pretty well the base unit and especially the multiplier of it, whereas weight stones from the Levantine system cluster around 9.5 g. Or, to put it in a better way, there are many probable weights made of local goethite weighing between 9.0 and 10.0 g.[15]

An explanation could be the overall assumed inaccuracy of the used weights. A deviation of 5 % due to the inaccuracy of ancient scales would mean that a shekel of 8.4 g would have a tolerance range between 8.0 and 8.8 g (Hafford 2012: 38). This would, however, not explain the different margin of deviation in the various systems used. The reason for this circumstance could be simpler. It might be that just the very well made and precise weights were traded, whereas the locally produced and used weights were less accurate. This would strengthen the assumption that the Levantine system was the native weighing system in Tall Bazi.

Finally, another peculiarity has to be noted. The Mesopotamian and the Levantine systems are well represented in the corpus of weights from Tall Bazi. We can find very well-made exemplars of these standards in the assemblage and also the mathematical evaluation confirms this impression. But there are also objects which do not belong to the systems mentioned above. These items perfectly fit the criteria for weights—which means that these items are made of hard material, that they were found in domestic settings and have conventional shapes. **Fig. 9** shows some of these weights. These objects represent presumably the Anatolian (11.7 g) and Syrian (7.8 g) weighing systems. The weights can be made of local goethite but non-local materials also often occur. Weights with a different base unit are much rarer though and so they are not detected in the statistical and algorithmic evaluations.

Conclusions

It can be stated that mainly two weighing systems, the Mesopotamian and the Levantine one, were used in Tall Bazi side by side. The weight stones related to these two systems differ in shape and accuracy. The Levantine system was certainly more common. The shapes of the weights are less elaborated than the Mesopotamian ones and are often aligned to the original nodule structure.

15 This instance was already mentioned by E. Bordreuil (2006: 214); in Ugarit, the standard deviation is much higher for the Levantine system than for the others.

Fig. 10. Selection of weights from Tall Bazi

Table 1. Listed below are 66 objects from the excavations at Tall Bazi (No. Bz = find number), which are categorised as weights, based on their shapes, material, processing traces and find spot. The »ratio« describes the possible unit (shekel) of one of the four weight systems discussed in the text (Anatolian system = A, Levantine = L, Mesopotamian = M and Syrian = S). A mass number in square brackets refers to the incompleteness of the object (broken or chipped)

No. Bz	Area	Date	Material	Shape	Feature	Ratio	Mass	Fig.
48/20:1b	Citadel		goethite	cylindrical		1/4 S / 1/4 M?	1.9 g	Fig. 10
25/30:13a	Weststadt	LBA	goethite	cylindrical, irregular		1/4 L?	2.3 g	Fig. 10
51/23:227	Citadel	MBA/LBA	goethite	spherical, irregular		1/3 M	2.8 g	
25/30:13c	Weststadt	LBA	goethite	spherical, irregular		1/3 L	3.1 g	
47/24:43	Citadel		goethite	conical	perforated	1/3 L	3.1 g	Fig. 8c
48/29:76	Citadel		goethite	cylindrical, irregular		1/3 L?	3.4 g	Fig. 10
50/23:224	Citadel		goethite	irregular	with base	1/3 A / 1/2 S?	3.6 g	Fig. 10
29/36:4	Weststadt	LBA	goethite	cylindrical		1/3 A / 1/2 S?	3.9 g	Fig. 10
48/29:179	Citadel	MBA	goethite	cylindrical, irregular		1/2 M?	4.3 g	Fig. 10
29/31:21b	Weststadt	LBA	goethite	spherical		1/2 M / 1/2 L?	4.4 g	
31/39:23	Weststadt	LBA	goethite	spherical, irregular		1/2 L?	4.9 g	Fig. 10
50/20:112	Citadel		goethite	hemispheric,al irregular		1/2 L?	5 g	
48/29:162	Citadel		goethite	conical	with base	2/3 M	5.4 g	Fig. 10
25/30:2	Weststadt	LBA	goethite	spherical, irregular		2/3 M	5.6 g	
31/40:3b	Weststadt	LBA	goethite	hemispherical, irregular		1/2 A / 3/4 S?	5.8 g	
25/30:13b	Weststadt	LBA	goethite	spherical, irregular		1/2 A / 3/4 S?	5.9 g	
31/34:8	Weststadt	LBA	limestone	conical	with base	1/2 A / 3/4 S?	5.9 g	
29/32:23	Weststadt	LBA	goethite	cubical		2/3 L / 3/4 M?	[6.3 g]	
30/39:9	Weststadt	LBA	goethite?	cylindrical, irregular		1 S / 2/3 A?	7.3 g	Fig. 9a
30/40:12	Weststadt	LBA	goethite	spherical, irregular		1 S / 2/3 A?	7.5 g	Fig. 10
31/36:4	Weststadt	LBA	goethite	spherical		1 S / 2/3 A?	7.5 g	
50/24:15	Citadel		goethite	cubical		1 S	7.8 g	Fig. 10
21/26:22	Weststadt	LBA	goethite	cylindrical, irregular		1 M	8.1 g	Fig. 10
31/35:7	Weststadt	LBA	goethite	conical, irregular		1 M	8.3 g	Fig. 10
48/23:57	Citadel		volcanite	sphendonoid		1 M	8.4 g	Fig. 7b
21/26:10	Weststadt	LBA	goethite	cylindrical, irregular		1 M	8.5 g	Fig. 10
21/26:75	Weststadt	LBA	goethite	cylindric,al irregular		1 M	8.5 g	
50/23:72	Citadel	LBA	goethite	irregular		1 M	8.6 g	
24/35:20	Weststadt	LBA	goethite	spherical		1 M	8.8 g	
25/30:30a	Weststadt	LBA	goethite	irregular		1 L	9.1 g	
25/30:30b	Weststadt	LBA	goethite	cylindrical, irregular		1 L	9.1 g	Fig. 10
48/20:5	Citadel		goethite	conical		1 L	9.1 g	Fig. 8b
55/24:134	Citadel		goethite	conical, irregular		1 L	9.2 g	Fig. 8a
24/35:7	Weststadt	LBA	goethite	cone	perforated stamp seal	1 L	9.3 g	Fig. 5b
26/34:14e	Weststadt	LBA	goethite	cylindrical, irregular		1 L	9.3 g	
30/39:7	Weststadt	LBA	limestone	rectangular disc	marked	1 L	9.4 g	Fig. 10
21/26:57c	Weststadt	LBA	goethite	spherical		1 L?	9.7 g	Fig. 10

Table 1. (continued from previous page)

No. Bz	Area	Date	Material	Shape	Feature	Ratio	Mass	Fig.
21/27:26	Weststadt	LBA	goethite	spherical		1 L	9.8 g	
31/38:76	Weststadt	LBA	goethite	spherical, irregular		1 L?	10 g	
33/42:17	Weststadt	LBA	goethite	spherical, irregular	with base	1 L?	10 g	Fig. 10
21/26:57b	Weststadt	LBA	goethite	cubical		1 L?	10.1 g	Fig. 10
31/38:15	Weststadt	LBA	goethite	hemispherical		1 L?	10.2 g	Fig. 10
63/32:12	Nordstadt	LBA	goethite	spherical		1 L?	10.4 g	Fig. 10
25/31:8	Weststadt	LBA	goethite	conical, irregular		1 L?	10.6 g	
25/35:47	Weststadt	LBA	microgabbro	cylindrical, truncated	with base	1 A	11.7 g	Fig. 9c
33/39:1	Weststadt	LBA	goethite	cylindrical, irregular		1 A	11.8 g	Fig. 9b
51/23:248	Citadel		goethite	cylindrical, irregular		2 S?	14.2 g	Fig. 10
48/20:1a	Citadel		goethite	sphendonoid, irregular		2 S?	14.55 g	Fig. 10
29/31:3	Weststadt	LBA	haematite	zoomorphic	goose/duck	2 M	[16.0 g]	Fig. 10
24/35:17	Weststadt	LBA	granite	sphendonoid		2 M	16.5 g	Fig 5c
32/37:11d	Weststadt	LBA	goethite	cubical		2 M	16.6 g	
55/25:33	Citadel	MBA/LBA	haematite?	sphendonoid	with base	2 M	16.8 g	Fig. 7a
48/29:18	Citadel	MBA	goethite?	cylindrical?	with base	?	[17.2 g]	Fig. 10
55/24:163a	Citadel	LBA	goethite?	sphendonoid, truncated		2 M	17.2 g	Fig. 10
21/26:57a	Weststadt	LBA	sandstone	conical, truncated		2 M / 2 L?	17.3 g	Fig. 10
47/25:24	Citadel	EBA	goethite	sphendonoid		?	[18.9 g]	Fig. 10
31/40:3a	Weststadt	LBA	goethite	spherical		2 L?	20 g	
O:74	Surface		goethite	cylindrical		2 L?	20.7 g	Fig. 10
25/30:22	Weststadt	LBA	goethite	spherical, irregular		2 A / 3 S?	22 g	
53/24:57	Citadel		haematite?	sphendonoid	with base	2 A / 3 S?	22.9 g	Fig. 10
25/30:9	Weststadt	LBA	goethite?	sphendonoid, irregular		4 L / 5 S?	38.9 g	
30/39:2	Weststadt	LBA	haematite?	sphendonoid	with base	5 M?	[40.0 g]	Fig. 7c
33/42:20	Weststadt	LBA	goethite	spherical	with base	4 M / 5 L?	49.5 g	Fig. 10
25/31:17	Weststadt	LBA	goethite	spherical, irregular	with base	4 M / 5 L?	50.4 g	
60/35:5	Nordstadt	LBA	goethite	cylindrical, irregular		6 L	56 g	
30/40:7	Weststadt	LBA	basalt	sphendonoid		8 M?	[64.5 g]	Fig. 10

Almost all weights are made of local goethite and the accuracy of the weights is less high than that of the Mesopotamian pieces. This suggests that the Mesopotamian pieces were probably imported from outside. The material is frequently not the local goethite and the elaboration and accuracy of the objects is perceptibly higher than that of the weights of the Levantine system. Therefore, the Late Bronze Age indigenous weight assemblage of Tall Bazi belonged most likely to the Levantine System and was established in the town. But how do the pieces of the much less common Anatolian and Syrian systems fit in this context? There are only very few weights, so they cannot be evaluated in a statistical way. But their existence suggests trading and contacts in a wider scope and connections to the Anatolian region, which can also be supposed because of the location of Tall Bazi next to the upper Euphrates river with its associated trading routes.

It is worth noting that some of the Mesopotamian weight stones and more elaborated and accurate pieces from the Levantine system were found on the citadel of Tall Bazi and not in the residential town. Since the citadel was dominated by the large temple and a few other structures, which probably were all part of the sacred compound, this can be interpreted in several ways. Since the rightness of the weight stones was guaranteed by the gods, it can be assumed that—especially in a city like Tall Bazi which had no king but was collectively governed by the elders (Otto 2014b)—most of the official economic and financial transactions or those where foreign parties were involved took place in the temple area. Furthermore, it is not clear who established the standards and checked the accuracy of the weights. Was there a kind of office for weights and measures? This has been suggested for towns like Mari or Ekalte, where official weights of the palace and town were mentioned in texts (Chambon 2006: 97; Mayer 1990: 51)—even though it is not certain if there was an official set of weight stones or if these terms refer just to a metrological standard (Marti/Chambon 2019: 62). Or did every merchant possess his/her own weight set to be armed against deception? However, the missing accuracy and low elaboration of the objects seem to be related to the private context of the weights. The inaccuracy of weights of the everyday life was apparently a lesser problem for the inhabitants of the late Bronze Age than for us today.

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On some Middle Assyrian metrological points

John Nicholas Postgate[1]

To judge from their written output, Middle Assyrian scribes were very concerned to give precise metrological details of the grain they recorded, but these details are often obscure to us. An Old Babylonian document from Sippar cited by Veenhof (Goetze 1957 No. 21, in Veenhof 1985) mentions three variables which may have metrological implications:

- the condition of the grain—is it fresh or dry? This could affect the volume, it seems, because in the final phrase cited we are told that a proportion has not been deducted to allow for the loss from drying out.
- the identity of the measuring-container—in this case the b a r i g a / *parsiktum* (= 6 *sūtu*).
- the measuring technique—involving the implement *mešēqum*, known in English as a "strickle" (see below).

In addition, from other Old Babylonian texts we meet a fourth variable, that is, whether or not the product had been sieved (Veenhof 1985: 289–290).

Hence, in interpreting what the Assyrian scribes recorded there are at least these four variables which might be referred to:

1. The **condition of the substance** being measured,
2. The **stage of processing** (e. g. sieved or not),
3. The identity (and therefore capacity) of **the measuring vessel**,
4. The **technique** used when filling the vessel.

We will take these in turn as we look at the Middle Assyrian sources.

The condition of the grain—wet or dry?

In the Middle Assyrian texts I have not come across any clear examples of "dry" or "wet" applied to grain being measured (although we occasionally hear of "old" grain, e. g. MARV 3.4 rev. 3').

The processing stage

Sieving

Middle Assyrian scribes did not normally record whether grain had been sieved or not, or specify a proportion by which the volume was reduced in the process of sieving. The Middle Assyrian for "to sieve" is presumably *naḫālu*. This is not well attested as a verb but gives us *maḫḫulu*, "a sieve". Recently Freydank (2010: 63) has suggested restoring the word *naḫlu* "sieved" in a text from the Aššur Temple offerings archive (MARV 1.25). The word itself is unfortunately badly damaged and hence uncertain, and the text has other difficulties, but the proposal is undeniably attractive. If *naḫla* is correctly restored, it is the sole instance known to me in the Middle Assyrian corpus where reference is made to a metrological difference occasioned by the sieving process.

My reconstruction of what was happening here is as follows: a delivery of grain had arrived from Idu. A sample of 10 homers was sieved (perhaps because it was unusually contaminated), and the resulting amount of sieved grain noted as 84.5 % of the initial volume, with

1 This contribution reflects my paper at the Munich meeting, which was based on an article in the volume *Not Only History: Proceedings of the Conference in Honor of Mario Liverani Held in Sapienza-Università di Roma, Dipartimento di Scienze dell'Antichità, 20–21 April 2009* (edited by Gilda Bartoloni and Maria Giovanna Biga in collaboration with Armando Bramanti, Winona Lake 2016) pp. 219–241 (itself an expansion of the paper read by Adam Stone to the Barcelona Rencontre on my behalf in 2010). Given the evident relevance of the subject matter to the Munich meeting, it seemed appropriate to present here an abbreviated version covering the main points.

the "dust" when also measured coming to very slightly more than the expected 15.5 %. For the purposes of the accounting process, it was decided to fix the proportion of sieved grain recoverable at 84 %. Amounts of 10 homers of this grain, unsieved, were then issued to four of the receiving staff (probably all or most of them *alaḫḫinu* working for the Aššur Temple), and different amounts to two others, usually with an accompanying note of the 16 % loss to be allowed for when they in due course have to account for the amount they received. Thus, the opening lines (ll. 1–5) are there to give the basis for the subsequent calculations, and presumably each separate issue of the Idu grain was not sieved and re-measured, but the "deficit" purely calculated using these figures. This then is an example of the creation of a mathematical coefficient to be used in converting one observed measurement into another figure, a procedure which will also be encountered in the following sections.

"Release of the grainheaps"

In a letter from the Ubru archive (see Llop-Raduà 2010) we meet the verbal phrase *karu'a pašāru*, literally "to release the grain-heap": "within 5 days I shall come to release the grain-heap" (*anāku ka-ru-a a-na pa-ša-ri allaka* KAJ 316:6 = MARV 1.22:6). This procedure, and also the resultant product, would be referred to as *pišerti karu'e*, a phrase which qualifies barley (wr. ŠE) in a variety of texts (e. g. those from Dur-katlimmu and MARV 5.83 cited below), and has been discussed among others by Freydank (1994; 1997), Llop (2005: 46), and most recently by Röllig (2008: 20).[2] I agree broadly with Röllig's position, which is that the phrase refers to a physical (and administrative) stage in the crop-processing sequence, at which the grain has been piled into heaps, and is assigned to any interested parties, but I would insert after "heaps", the words "and is measured". This recognizes that the process of "releasing the heaps" is the stage at which the completed harvest, which has been grown and processed by the person actually cultivating the land, becomes a fungible commodity, ready for distribution among any persons with a claim on it. This could indeed include the tax-man, but there is surprisingly little evidence for agricultural taxation in the Middle Assyrian sources, and it seems likely that it would also be the moment where partition of the claims between joint cultivators, or even more frequently between landlord and tenant would be settled.[3] Equally, it is wise not to assume that the harvest was necessarily physically divided: this could perhaps have been the result, but it is also possible that the procedure needed simply the measurement of the entire crop in the presence of those with a claim on it, as well as possibly witnesses, and that the distribution need only have taken place "on paper". The amount due to each party could then be calculated mathematically as a proportion of the total, and there may often have been situations in which it was convenient to keep the grain together and merely record the amounts due to each party.[4]

That this was indeed the case follows mostly transparently from the Dur-katlimmu texts. In the most telling example (Röllig 2008: No. 89) the three words *pi-šèr-ti ka-ru-e ma-di-id* "measured in the release-of-the-heaps (state)", must belong closely together because the scribe has placed this single phrase as an afterthought on the left side of the tablet along with the date; but it is also clear that the same applies in the more regular formulation:

> 200 ANŠE 3BÁN ŠE *i+na* GIŠ.BÁN *ša ḫi-bur-ni* ***pi-šèr-ti ka-ru-e ma-di-id*** *te-li-<it>* BURU$_{14}$ *ša* 150 IKU 1 ANŠE 3BÁN 5 SÌLA ŠE.TA.ÀM *it-tal-ka* 3BÁN ŠE *ut-ru ša* ŠU PN. (Röllig 2008: No. 60:7–9).[5]

> "200.3 homers grain (measured) by the *sūtu* of the *ḫiburnu*, measured in the ›release-of-the-heaps (state)‹, harvest yield of 150 *iku*, it comes to 1.35 homers (per *iku*) (with) 0.3 homers over; in the charge of PN".

The point to stress here is that *madid* is part of the description of the grain: the scribe is not telling us **that** the grain "was measured"—this is surely self-evident; what he is recording is **in what condition** it was measured. Like *ḫiṣna* or *šiḫṭa* (see below), the phrase *pišerti karu'e* acts as an "internal accusative" or accusative of respect before *madid* "measured in the release-of-the-grain-heaps (state)". If this phrase were merely an administrative technicality, it would not come between the figure

2 In my "parent article" the meaning of *karu'u* in Assyrian and contemporary Babylonian texts is discussed further, but with the result that the meaning "grain heap" (which survives into Aramaic) is reaffirmed.

3 Similar procedures, sometimes involving the presence of a divine symbol, are well attested in the Old Babylonian period.

4 That there was a measuring procedure included at this stage is supported by the evidence of more than one Egyptian wall-painting and by a comparison with 20th Century AD Palestine as reported by Dalman 1933 among others.

5 The maths is a little wobbly—1.35 × 150 = 202.5. Many other examples from Dur-katlimmu in Röllig 2008, see also Llop 2006.

stating the volume of grain and the word *madid*, but outside this "metrological parenthesis".

The measuring vessel

Different sūtus

The Middle Assyrian homer contained 10 *sūtu*, and the *sūtu* contained 10 *qû* (Powell 1987–1990: 500–501). However, the *sūtu* itself could vary, and when recording amounts of grain the scribes were very diligent in specifying the measure in use, so we must conclude that it did make a significant difference. The list of variants of the *sūtu* (invariably written GIŠ.BÁN) has grown since Saporetti (1970) first addressed this issue (see also in particular Freydank 1992: 282):

- *eššutu*? (GIBIL) ["new"]
- *labertu* (SUMUN) ["old"]
- *rabītu* (GAL) ["big"]
- *ṣaḫartu* (TUR) ["small"; probably new in reign of Tukulti-Ninurta I]
- *ša* giš*allāni* ["of oak" Giricano]
- (*ša*) (*bēt*) *ḫiburni* [traditional norm]
- *ša endāte* ["of the impositions" cf. Llop-Raduà 2010: 352]
- *ša ginā'ē* ["of regular offerings"; Offerings Archive]
- *ša iškārāte* ["of work-assignments"] or *iškāri*
- *ša kablāte*meš ["with feet"]
- *ša kāri* ["of the quay"]
- *ša ki-zi-ti* ["of ..."]
- *ša kurummat ili* (ŠUKU-*at* DINGIR) ["of the god's ration"; Offerings Archive]
- *ša malāḫi* ["of the boatman"]
- *ša mār a-pi-e* ["baker's son", or PN?]
- *ša nakkamte* ["of the store-house"]
- *ša namḫirti* ["of commerce?"]
- (*ša pî*) GIŠ.5BÁN(-*ú*)-*te* [reading? cf. Freydank 1992: 301 "recht unklar")[6]
- *ša pirik ritte* [meaning?; Offerings Archive]
- *ša* PN
- *ša šibše* ["of grain-taxes"]

This list suggests a bewildering variety, but at any one time or place the situation may not have been too complicated: some terms define the social context or the purpose of the measuring, others simply refer to the physical characteristics of the vessel, and in the Aššur Temple offerings archive more than one term may be found describing a single *sūtu* vessel. Such combinations include:

GIŠ.BÁN *ḫi-bur-ni ša* ŠUKU DINGIR MARV 9.86:2
GIŠ.BÁN *ḫi-bur-ni pi-rík ri-te* MARV 3.60 (= Freydank 1992 No. 17):2–3
GIŠ.BÁN *ša* ŠUKU-*at* DINGIR *pi-rík ri-te* MARV 3.42 (= Freydank 1992 No.23):2–3
GIŠ.BÁN *ša* ŠUKU DINGIR *ša* É *na-kám-te* MARV 3.50 (= Freydank 1992 No. 26):4
GIŠ.BÁN *ša pi-i* 5BÁN-*ú-te ša gi-na-e* MARV 3.44 (= Freydank 1992 No. 21):2

It seems perfectly possible that the first three combinations listed here all refer to the same container, which could be described by any or all of the three categories *ḫiburni*, *kurummat ili*, and *pirik ritte*, referring to capacity, function, and a technical feature respectively. For the 5 *sūtu* vessel, see below.

Here I want to concentrate on a significant question expressed by Veenhof 1985: 302: "Another question is what ›by the b a r i g a of 60, 64, etc. s i l a‹ actually means. Does it imply the existence and use of measuring vessels of these sizes or is the reference only to units of measure used for accounting?" Or in other words, were these different *sūtu* physical containers used to carry out individual measurements, or are they merely intended to denote an abstract volume which is fixed in relation to other norms?

Conversions from one sūtu to another

Part of the answer comes from those cases where a scribe gives us a conversion from one *sūtu* to another, such as this passage:

60 ANŠE ŠE *i+na* GIŠ.BÁN TUR *a-na* 48 [AN]ŠE ŠE *a-na* GIŠ.BÁN *ḫi-bur-ni ta-u*[*r*]

"60 homers of grain in the small *sūtu* is converted to 48 homers of grain in the *ḫiburnu sūtu*".
MARV 1 (= VS.19) 1.i.54'–57' (cf. Freydank 1985; 1991)

The equivalence 60:48 gives the ratio small:*ḫiburni* as 1.25:1 (or 5/4). The same ratio for these two *sūtu* applies later in the same text with an equivalence 9:7.2 and in MARV 4.31 with 10.5:8.4. The text also mentions the "old *sūtu*", and it was largely on the basis of this text that I suggested that the "old *sūtu*" was a short way of referring to the "*sūtu* of the (*bēt*) *ḫiburni*", a suggestion which was tentatively accepted in Freydank 1991. Now however in Röllig 2008: No. 72, the equivalence 20.8:16.64 also gives ratio of 1.25:1

6 Cf. also GIŠ.BÁN 6BÁN-*te* (MARV 7.7:24).

but applies to old:*ḫiburnu*, indicating that it is the "little" and the "old *sūtu*" which had the same capacity. As the Munich paper by Chambon indicates (see Pommerening, Chambon and Marti in this volume), there are further complications introduced by the Dur-katlimmu texts, and I will not attempt to resolve the issues here.

These were not the only *sūtu* which needed converting: in MARV 9.112 we have the very similar ratio of 1:1.257 for the equivalence of 7 homers measured by the *sūtu* of Mar-apie with 8.8 *sūtu* by the "god's ration" *sūtu*.

Conversions from one measurement mode to another

The same usage of *tuāru* was noted by Freydank 2010 in the context of a few passages where we are given a similar conversion, from one mode of measurement to another. One example:

> 22' ŠU.NÍGIN 4532 ANŠE 5BÁN 8? SÌLA ŠE *pi-šèr-ti k*[*a-ru-e*] ... 24' *a-na* 4759 ANŠE 1BÁN 5 SÌLA ŠE *a-na ši-iḫ-ṭí ta-ur*

Here the ratio 4532.58:4759.15 gives *pišerti karu'e*:*šiḫṭi* ~ 1:1.05 (1.049987) (MARV 5.83:22'–25').

A similar conversion in MARV 3.10.13'–15' gives an equivalence of 210.5:221.505 for *pišerti karu'e*:*šiḫṭi*, which also gives a ratio of approximately 1:1.05 (1.0522803).

Thus, here too a smaller figure is described as converting into a larger, and the verb used is *tuāru*, either the D stative *ta'ur* ("it was converted" into) or the Gt *ittuar* "it has turned" into (MARV 9.95:26, amounts lost). As Freydank comments, these passages do not tell us whether the difference in volume is to be attributed to a change in the condition of the grain, or to a different measuring procedure: "Es bleibt zu fragen, ob es die Beschaffenheit der Gerste oder die Art des Messens ist, die zu der höheren Maßzahl führt ..." (Freydank 1994: 26). It is self-evident that where two stages in crop-processing are involved the earlier stage will tend to occupy more volume than the later, since the different processes—threshing, winnowing, pounding, sieving and other cleansing methods—are all aimed at removing components from the crop. However, the idea supported by me among others, that *šiḫṭu* and other terms used in these contexts refer to stages in the processing, is now called into question by the evidence of MARV 2.8 presented below. Instead it is more likely that all the scribes are doing is converting a volume recorded in one "mode" into the same volume when a different mode is used, using an accepted ratio, and that only one measurement took place.

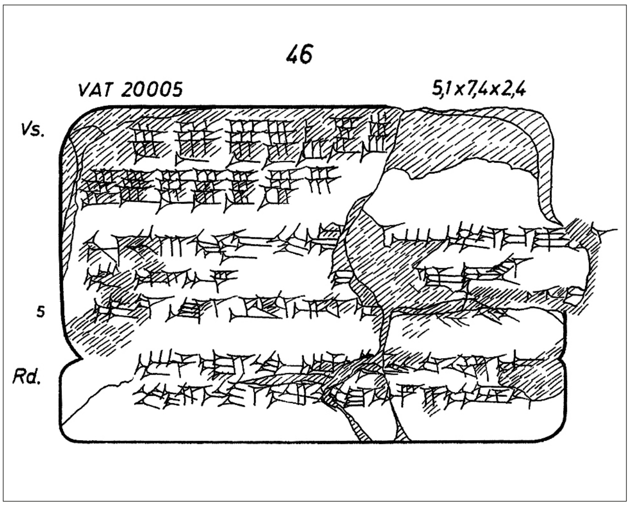

Fig. 1. MARV 7.46, Obverse (courtesy of Dr Helmut Freydank)

The measurement process(es)

Nevertheless, we should not ignore the existence of a variety of competing physical containers, some of which were surely used to carry out the measuring process on site. In Assyria one text which clearly demonstrates the physical use of one specific measuring-vessel is MARV 7.46 (**Fig. 1**).

Here the top of the obverse is taken up with groups of 10 wedges, formed of 3 rows of 3 crossed by a tenth wedge at the base. After the groups of ten comes a group of six wedges, and we can work out from the total of 83 homers in the third line that there must have been sixteen groups of ten in all, making a total 166, exactly twice 83. Proof that this is right comes from the end of the third line, where we read that the grain was measured "in the 5 *sūtu* measure": in other words, it was a container holding half a homer at a time, which must have been much more convenient than measuring large volumes with a vessel holding only 8 or 10 litres. Even these half-homer vessels were not very large—if we accept 1 *qû* = 0.8 litres for the sake of argument, the *sūtu* would contain 8 litres, equivalent to a cube of sides 20 cm, and the 5 *sūtu* measure would hold 40 litres giving a cube with sides of 34.2 cm. This is still perfectly manageable, and clearly measuring large amounts of grain with a 40 litre as opposed to an 8 litre vessel would have saved much time!

The measuring techniques

By "measuring technique" I mean how the container is filled. This may sound obvious and simple, but it has been a matter of contention and confusion through-

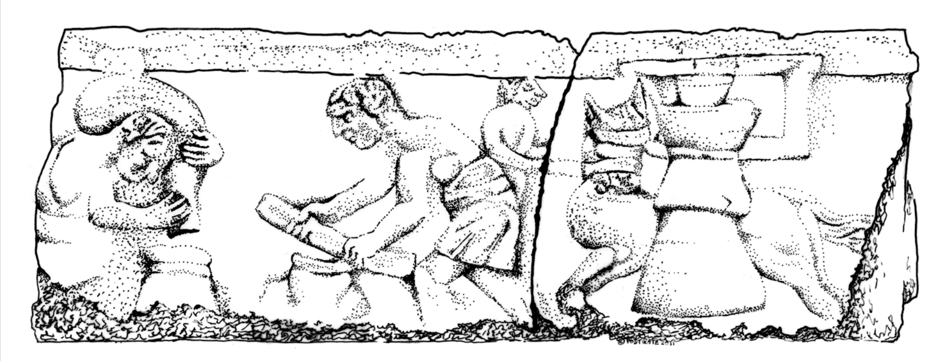

Fig. 2. Relief on sarcophagus from the Sepolcro degli Scipione (drawn by Elizabeth Postgate after Ciancio Rossetto 1973: Fig. 33).

out history (Kula 1986). How and when a container is deemed to be "full" is particularly variable. While there are two simple major alternatives—filling the container till the grain is horizontally flush with the rim, or heaping it up into the highest possible conical mound—there are plenty of minor variations. In the first case you fill the vessel to its rim and then smooth it flat, level with the rim. This could be carried out with the hand or with an implement known in English as a "strickle" and known from Old Babylonian sources where Wilcke (1983: 55–56. ad no. 2) translates *mēšequm* as "Glattstreich-Holz". For illustrations of this equipment one has to turn to Roman funerary reliefs (e. g. Moritz 1958: 90), where a strickle (*rutellum*) is shown next to measuring containers (*modii*). For the strickle in use see **Fig. 2**, also from a sarcophagus, where one measuring container is being filled from a sack, while a second one is being smoothed flat with the slightly curved strickle before the grain goes to the rotary mule-driven quern on the right.[7] While to the uninitiated it might seem that this was a foolproof method of achieving a consistent result, the evidence cited by Kula from Poland and France indicates that the precise nature of the strickle can make a significant difference, and this explains why the Old Babylonian scribes sometimes specified which strickle was being used, "fat" (*kabrum*), "medium" (*biruyum*), or "thin" (*raqqum*) (Veenhof 1985: 304).

The alternative technique is to heap as much as you possibly can onto the top of the vessel: this was reportedly the practice in Palestine in the 20th century AD, where the vessel was also shaken vigorously to allow the grain to settle (as described in Wilson 1906: 212). Already in 1st century AD Palestine we learn that the generous will give "good measure, pressed down, and shaken together, and running over" (Luke Ch. 6:38). It is plain that even after opting for one or the other of the two principal alternatives, there was room for variations which could be exploited by the unscrupulous. How much grain could be persuaded into the container could also be affected by the height from which it was poured—dropped-arm or shoulder height, for instance (Kula 1986: 47), and of course if the shape of a container is changed so that it is lower but wider, it will support a larger mound above the rim.[8]

To sum up, then, the possible variables to bear in mind in the next section include at least the following:

(1) flat or heaped
(2) proportions of measuring container
(3) type of strickle if used
(4) height from which poured
(5) compressed or not
(6) shaken or not
(7) running over or not.

Middle Assyrian terminology: ḫiṣnu, šiḫṭu and riḫṣu

The Old Babylonian *mešēqum* clause is absent from Middle Assyrian texts, but there are some phrases which must refer to measuring procedures. These principally involve the three words *ḫiṣnu*, *riḫṣu* and *šiḫṭu*. Although they all have clear metrological relevance, being found in what I have called "metrological parentheses", for each word it needs to be established whether it refers to the state of the grain, or to a measuring technique: a

7 From Ciancio Rossetto 1973: 46 Fig. 33, reference from Corbier 1984: 74. Very many thanks to Jonathan Barnes and Mark Jackson for their help in tracking down these two publications.

8 Such like variations are listed for Hellenistic times by Stroud 1998: 59.

decision is not easy and each term needs to be treated individually.

First, as already indicated, we may note that in virtually all cases the terms in question are found in the context of measurement. We do not meet them, or cognate forms, in other contexts where they might apply to a processing stage in the grain, e.g. sieving or crushing.[9] Of the three rather similar terms, two, *ḫiṣnu* and *šiḫṭu*, are found in identical contexts and seem to be mutually exclusive alternatives, while *riḫṣu* behaves differently and is discussed later, below. Both *ḫiṣnu* and *šiḫṭu* are found in the accusative governed by a following *madid* "measured". As already clear to Deller (1987), this is an accusative of state, and expresses the condition of the grain: "measured in the *ḫiṣnu*/*šiḫṭu* mode". The most informative context for *ḫiṣnu* remains MARV 2.20. The scribe uses the word in two different formulations: ŠE *ḫiṣna madid* the full phrase, or ŠE *ḫiṣnu*, which is merely an abbreviated variant. More recently *ḫiṣnu* has also turned up in the late Middle Assyrian texts from Giricano north of the upper Tigris, e. g. Giricano No. 1:1–4 8 ANŠE 7BÁN ŠE-*um*.MEŠ *i+na* GIŠ.BÁN *ša* ^{giš}*al-la-ni ri-iḫ-ṣu ḫi-iṣ-nu ša* PN (Radner 2004).

Unfortunately, its meaning still escapes us, but a connection with the verb *ḫaṣānu* "to protect" is indicated by MARV 2.8. This letter to the Offerings Overseer Izbu-lešir is about a delivery of sesame for the Aššur Temple and uses the verbs *raḫāṣu* and *ḫaṣānu* together in a way which obliges us to compare the coupling of *riḫṣu* with *ḫiṣnu* in Giricano 1 (above). The relevant lines read:

> ^{3} 6 ANŠE ŠE.GIŠ.IÀ *gi-na-a* ^{4} ^{1}*ḫu-ra-da-iu* ^{5} LÚ.MÁ.LAH$_{5}$ ^{6} *a-na* UGU EN-*ia* ^{7} *ul-te-bi-la* ^{8} 1 *qa a-ta-ḫa-az* ^{9} *i+na* GIŠ.BÁN *i-ra-ḫi-iṣ* ^{10} *la i-ḫa-ṣi-in* … (MARV 2.8:3–10).

My tentative translation of these lines would be: "I have made Huradayu the boatman transport to my lord 6 homers of sesame, regular offering. I have taken 1 *qû*, it was overflowing from the *sūtu*-vessel, it was not being contained(?)". Whether this is broadly correct or not, the passage undeniably associates the two verbs with the way the substance measured behaves in relation to a *sūtu* measuring-vessel, and hence with the technique of measurement, and this must mean that the cognate words *riḫṣu* and *ḫiṣnu* also refer to measuring technique (and not to a stage in crop processing). Since the substance measured here is sesame and not a cereal, we must resist the temptation to see these words as technical terms applying to the physical state of grain as suggested by Radner (2004: 76–78) and myself (Postgate 2006), and found e. g. in Jakob's most recent suggestion for *ḫiṣnu* of "grain still with its glumes (Spelzen)".[10]

Turning then to *šiḫṭu*, this term is found in similar contexts to *ḫiṣnu*, as noted above. In MARV 2.20, after the opening section where amounts of *ḫiṣnu* grain are reported, another part of the shipment is recorded in the shape of amounts of grain from four of the boatmen who are listed as bringing the grain in the first section, to an official who issued it "to the workforce who kept the boats":

> [x x (x)] 7 ANŠE 8BÁN ŠE *i+na* GIŠ.BÁN *ša ḫi-bur-ni ši-iḫ-*[*ṭ*]*a ma-di-id*

> "[Total] 7.8 homers of grain (measured) by the *ḫiburnu sūtu*, measured in the *šiḫṭu* (mode)" (MARV 2.20:25)

As with *ḫiṣnu*, the regular phrase *šiḫṭa madid* is replaced in some contexts by the single word *šiḫṭu* qualifying grain. Etymology is not helpful with this word, partly because here too there are two possible verbal stems: *šaḫāṭu* (a/u) "to draw off, strip off" and *šaḫāṭu* (i/i) "to jump", and partly because at Giricano (No. 8) the third radical appears not to be emphatic *ṭ* but a simple *t*. My suggestion in 2006 that the word referred to grain from which the husks had been stripped, is contradicted by my revised view of *ḫiṣnu*. A second reason for rejecting the idea that *šiḫṭu* refers to a processing stage of the crop is the fact that in MARV 5.83 and MARV 3.10 the figure for *šiḫṭu* is greater than that for *pišerti karu'e*. This would be improbable since any dehusking process would be expected to take place **after** the "releasing of the grain-heaps", and should surely reduce, not increase, the volume of the crop.

If instead the *šiḫṭu* amounts refer to the same volume of grain, as recalculated according to a conversion factor yielding the figure estimated for the *šiḫṭu* mode of measurement, this difficulty does not exist. That it was indeed a purely arithmetical procedure agrees with the fact that in MARV 5.83 the figure for the *šiḫṭu* mode is

9 It is true, though, that we do not have many texts dealing with grain processing.

10 Jakob 2009: 91, proposes "Getreide(, das noch) mit Spelzen (versehen ist)", which associates the "Grundbedeutung der Wurzel *ḫṣn* ("Schutz" u. a.)" with a state of the grain in which the seed and the glume are still together—presumably with the idea that the grain is protected by the glume. This sounds attractive but is contradicted by the evidence of MARV 2.8.

twice almost exactly 1.05 times the figure for *pišerti karu'e*, a result which would be unlikely if there were in fact two different measurements of the crop. In other words, the probability is that the grain was physically measured only once, at the "releasing of the grain heaps", and that the *šiḫṭu* value was derived by calculating 5 % and adding it to the initial figure.

riḫṣu

This usage of the word is so far only attested in two of the Giricano texts (cf. Radner 2004: 76–79). Consideration of MARV 2.8 appears to invalidate both Radner's and my proposals (2006) to reconstruct here some kind of washing or cleaning process. That passage seems to require us to understand both *riḫṣu* and *ḫiṣnu* as modes or techniques of measurement but since *ḫiṣnu* and *šiḫṭu* are in a complementary distribution, as seen most clearly in MARV 2.20 (above), they must refer to two mutually exclusive modes applying to the same aspect, whereas at Giricano No. 1 has *ri-iḫ-ṣu ḫi-iṣ-nu*, and No. 8 has r*i-iḫ-ṣu ši-iḫ-tú*, meaning that there must be two different aspects of measurement referred to. Having regard to the possibility drawn from its lexical value in other contexts that *raḫāṣu* in MARV 2.8 could mean "to overflow", it would be a neat solution if *riḫṣu* referred to a technique of filling to overflow, which could obviously be used where either of two different techniques (*ḫiṣnu* and *šiḫṭu*) applying to a different aspect had been employed. What that aspect might be eludes me and is not transparent from etymology: hardly shaken versus non-shaken, or loose versus compressed. A different route might be to assume that *raḫāṣu* referred instead to pouring the grain from an accepted height, in which case one of *ḫiṣnu* and *šiḫṭu* could refer to a *sūtu* filled only horizontally flush to the rim, and the other to a conically heaped container. Neither of these solutions is very convincing, and yet more uncertainty is introduced by the phrase *sikra madid*, which is attested in an Aššur Temple offerings text from the beginning of Tiglath-pileser I's reign:

> 30 ANŠE *i-na* GIŠ.5BÁN-*te-ma* ¹ÌR-ᵈ*gu-la* LÚ.ŠIM *si-ik-ra ma-di-id*.

> "30 homers (grain) also (measured) in the 5-*sūtu* container, Urad-Gula the brewer, measured in the sikru mode" (MARV 7.7:15)

I have no idea what *sikru* means here, though one must suspect a connection with *sekēru* "to block" which obviously could refer to some physical action in the measuring process.

Concluding summary

- "The release of the grain-heap" (*pišerti karu'e*) is used to define the state of the grain when measured at the threshing-floor and this can form part of a metrological statement.
- At a later stage in the crop-processing sequence there are two mutually exclusive measuring techniques referred to as *ḫiṣnu* and *šiḫṭu*. Their meaning remains uncertain (as does that of the once attested *sikru*). On some occasions the *šiḫṭu* mode yielded a figure 5 % higher than the volume recorded when the grain was in *pišerti karu'e* state.
- The term *riḫṣu* seems to refer to a yet another variable, possibly a technique of pouring the grain so that it overflows, which can be used in association with either of the others.
- In most cases where two different volumes are given, it is because the unit of measurement is different, not because the crop itself has been processed. The likelihood is that the grain was only physically measured once, and that the scribe obtained the second figure mathematically by using a known coefficient expressing the relative contents of the two metrological units or measuring techniques.

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The administration of Early Dynastic Šuruppak—new evidence from dry capacity systems

Sarah Clegg

Introduction

The Early Dynastic economic documents of Šuruppak come from three sources: illegal excavation, the 1902 Deutsche Orient-Gesellschaft excavation and the 1931 Pennsylvania Museum excavation (Martin 2001: 3). The findspots of the tablets excavated in 1931 are generally well recorded, with the majority coming from dumps. Establishing the findspots of the tablets from the 1902–1903 excavation is significantly more difficult, but in 1988 Martin managed to fix the findspots of about half the tablets excavated (Martin 2001: 103). These findspots clearly indicated that the tablets were scattered in archives across the city in around 20 different houses. These houses included, for example, the so-called ›Tablet House‹ XVh, which seems to have been an institution responsible for over a thousand men, and dealing with nearly 10,000 donkeys; House XVIIc-d, which contained tablets relating to thousands of workers, some of whom came from different cities; and House XVa-d, whose tablets relate mainly to land ownership (Martin 2001: 93). This led Martin to suggest that these households represented ›separate economic units‹ or households, centred around individual families (Martin 2001: 85. 178).

However, an analysis of the sealings of ED Šuruppak and the prosopography of the tablets led to a different conclusion: the houses were not separate households, but contained the archives from a single institution.[1] The officials and the workers of one household often appear in the texts of another, carrying out the same roles, and both the workers and overseers appear to be dependent on the ›payroll‹ of a single organisation, presumably the central administration of Šuruppak (Pomponio/Visicato 1994: 6). The significance of, and reason for, the division of the archives into separate houses is still unclear—Pomponio (1983: 14) suggested that they were divided according to city quarters, while Foster (2005: 87) has proposed that the archives were only in different households because “certain administrators carried out their official tasks in their own homes and kept their records there”. The divisions of the separate archives have increasingly been de-emphasised; in Visicato’s latest study of the bureaucracy of Šuruppak, the findspots of the tablets are scarcely mentioned (Visicato 2001: 67).

However, as this paper will show, an examination of dry capacity systems and their varying uses in different households gives a new, more nuanced picture of the central administration of ED Šuruppak and the importance of the households, and their economic relationships.

The systems

The city of Šuruppak has yielded 129 Early Dynastic tablets that document capacity measures. Two system names— ›lidga‹ and ›gur‹ —are attested in these texts.[2]

1 See Pomponio 1983 and 1987, for the prosopography of the tablets; Visicato 1995 and 1992, for the overall structure and hierarchy of the administration of Šuruppak; Matthews 1991, for the sealings. See Foster 2005, for a brief summary of this research.

2 There is not space here to discuss the complex relationship between the name of the largest unit and the name of the system. For the purposes of this paper, the names will be treated as interchangeable—thus ›gur‹ and ›lidga‹ will be treated as both system names and the name of the highest unit in their respective systems.

The names appear to map onto two separate systems (with certain caveats, discussed below).

The lidga

The ›lidga‹ is the best attested system name, and appears in 77 texts. One text contains calculations that demonstrate all the unit relationships of the system associated with this name:[3]

1) 11.0.1 5 še lid$_2$-ga	11.0.1 5 lidga of grain
2) 0.3.0 še	0.3.0 (lidga) of grain
3) 2.0.1 5 še	2.0.1 5 (lidga) of grain
4) 1.2.0 la$_2$ 0.0.1 5 še	1.2.0 minus 0.0.1 5 (lidga) of grain:
5) en-nam-zu$_5$-še$_3$	Ennamzuše
6) 3.0.3 munu$_4$-mu$_2$	3.0.3 (lidga of grain): the maltser
7) 1.2.1 5 lunga$_3$	1.2.1 5 (lidga of grain): the brewer

(= 18 lidga, 7 bariga, 6 ban, 15 sila minus 1 ban, 5 sila)

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8) an-še$_3$-gu$_2$ 20 še lid$_2$-ga	grand total: 20 lidga

P010023[4]

In this text, six quantities of grain are added together to produce a total of 20 lidga. The whole numbers of lidga in these six quantities add up to 18 lidga (11 + 0 + 2 + 1 + 3 + 1), meaning that the smaller units must all add up to make a total of 2 lidga. These smaller units consist of 7 bariga, 5 ban and 10 sila. Since the final quantity is a whole number of lidga, 10 sila must be the equivalent on 1 ban. This 1 ban added onto the 5 ban must be equal to 1 bariga, and the final 8 bariga must be equal to two lidga. The unit relationships of the system, therefore, must be:

sila→10→ban→6→bariga→4→lidga
240 sila per lidga[5]

This is the only calculation text using the term ›lidga‹ which gives the relationships between all the units, and thus the only text where the system is without doubt the 240 sila system given above and discussed extensively by Powell (1987–1990: 501). However, two further ›lidga‹ calculation texts give relationships between some of the units that make it likely, though not certain, that the system in use was the 240 sila system. The calculations in P010026 demonstrate the system used in that text had 4 bariga per lidga and 6 ban per bariga and in P010025 the calculations show that the system in use had 4 bariga per lidga.

It cannot be certain that every system called ›lidga‹ in the Šuruppak texts is the 240 sila system, since numerous systems were undoubtedly used that do not appear in calculation texts, and, in Mesopotamian metrology, multiple systems can appear under the same name (see Powell 1987–1990: 501). However, it is likely that in the extant texts the 240 sila system was the system that was mostly commonly referred to as ›lidga‹, since all three calculation texts suggest this system.

The gur (mah)

As well as the ›lidga‹, the system name ›gur‹ is also attested in the Šuruppak corpus, appearing in 61 texts.[6] In the majority of these texts (45) it is qualified as ›mah‹ (larger). The unit relationships of the system(s) appearing under this name are significantly less well understood than those appearing under the term ›lidga‹.

The clearest calculation text using the term gur (mah) shows an eight bariga gur, and is given below:

1) 11.2.0 še gur mah	**11.2.0 ›larger‹ gur of grain**:
2) ganun mah	the large storehouse
3) 6 še gur	**6 gur of grain**
4) 3½.2.0 ganun	**3½.2.0 (gur of grain)**: the storehouse
5) gur2-gur2	(obscure)
6) še-numun	seed

(= 20 ½ gur 4 bariga)

3 Texts such as this, which contain calculations that allow for the unit relationships of the system in use to be understood will be referred to throughout this paper as ›calculation texts‹.

4 All economic documents in this paper will be referenced by their numbers in the Cuneiform Digital Library Initiative Database (cdli.ucla.edu).

5 See Powell 1987–1990: 501, for more on this system. Powell claims that this system was used across Mesopotamia during the Early Dynastic period, but there is no evidence of it in any city but Šuruppak before the Sargonic period (see Clegg forthcoming a).

6 Pomponio and Visicato, claimed that the system name ›gur‹ was more common than the system name ›lidga‹ and suggested that this was caused by the fact that the gur was a newer system than the lidga and the latter was gradually being replaced by the former (Pomponio/Visicato 1994: 183). However, there is not a significant difference between the numbers of tablets using lidga and those using gur (mah) (77 to 61, respectively).

7) an-še3-gu2	grand total:
8) 21 še gur mah	21 ›larger‹ gur

P011012

In this text, three quantities of grain are added together to give a total of 21 ›larger‹ gur.[7] The whole numbers of gur in these three quantities add up to 20 gur, meaning the smaller units of 4 bariga and half a gur must add up to 1 gur. This shows that there were eight bariga per gur. This eight bariga gur (mah) is also potentially evidenced in text P010518, which records 4.4.0 gur of grain, and 4.5.0 gur of flour (lines 2 and 3 respectively). The unit relationships suggested by these quantities (≥ 5 bariga per gur and ≥ 6 bariga per gur) would both fit with an eight bariga gur.

In his 1953 publication concerning the capacity systems of Šuruppak, M. Lambert (1953: 206) claimed that the sila, ban, bariga, gur and ›granary‹ relationships of the 8 bariga gur were identifiable in one further text (TSŠ 50), which reads as follows:

1 gur$_7$ še	One ›granary‹ of barley
sila$_3$ 7	7 sila
1 lu$_2$ šu ba-ti	1 man was issued with
lu$_2$-bi	its men
45 42 51	164,571
3 še sila$_3$ šu-tag	3 sila of grain remains

This is a mathematical school exercise in which the student has worked out how many men could be given rations from a ›granary‹ of barley if each man received 7 sila of grain each.[8] A large unit with the name ›granary‹ is well attested in Old Babylonian texts, but appears only rarely in the third millennium. Based on the calculation in TSŠ 50, the ›granary‹ in this text contained 1,152,000 sila (164,571 × 7 + 3).

As mentioned above, Lambert used this text to suggest unit relationships for the 8 bariga gur, pointing out that the calculation would be correct if the 8 bariga gur system had the following unit relationships:

sila⟶10⟶ban⟶6⟶bariga⟶8⟶gur⟶40,0⟶ gur$_7$ (›granary‹)

On the strength of Lambert's article, these are still given as the unit relationships of the gur (mah) system in the Šuruppak texts.[9] It will be noted that the unit relationships envisaged by Lambert are the same as those of the 240 sila system discussed above, except in the number of bariga per gur. This has led to the 8 bariga system being treated as a variation on the 240 sila system, as opposed to a separate system in its own right.

However, there are two serious problems with Lambert's use of TSŠ 50 to determine the unit relationships of the 8 bariga gur system. Firstly, as mentioned above, the text is a school exercise. It is one of two exemplars dealing with the exact same problem, although the second (TSŠ 671) is riddled with errors (the standard discrete system and the area system, for example, are confused) (Powell 1976: 432). The main purpose of these texts was not to teach metrological relationships, but division by seven (Melville 2014: 519). As noted by Melville (2014: 518), even the categorisation of the ›granary‹ as a real-world metrological unit is uncertain, as opposed to a "fictitious unit created for the problem" or a "vague but real large unit given a precise size for calculational purposes".

Secondly, there is no evidence that the system being used in TSŠ 50 was the 8 bariga gur—no system name is given, and the only unit name is the ›sila‹, which is used in multiple systems. Finally, there is no evidence for the relationships of any units barring the one between the sila and the possibly fictitious ›granary‹.[10]

TSŠ 50, then, gives no evidence for the unit relationships of the 8 bariga gur. The unit relationships suggested by Lambert (above) and cited by several scholars since must, then, be abandoned.

However, the unit relationships of this system may be demonstrated in a further calculation text from Early Dynastic Šuruppak (P011041), which reads:

1) 1 5 še gur	**65 gur of grain**
2) 4 tag$_x$(LAK492)	**4 (gur of grain)** … :[11]

7 Since the obscure line 5 does not contain any numerals, it can almost certainly be ignored in these additions.

8 See e. g. Melville 2002 and 2014; Friberg 2005; Guitel 1963; Høyrup 1982.

9 See for example the references in note 8.

10 The lack of other unit relationships within this text is acknowledged by Melville (2014: 518). However, he claims that the metrological relationships of the ›gur mah‹ are evidenced in "numerous administrative documents" (though he does not provide references to any of these texts). Interestingly, he still suggests that the system being used in this mathematical text is the 8 bariga gur, despite noting the absence any of unit relationships or unit names that would indicate this.

11 The translation of "4 tag$_x$(LAK492)" as 4 (gur of grain) … is borne out by line 5 of this text, where the word ›še‹ (grain) is inserted before the "tag$_x$(LAK492)" and lines 10–11, where ›še gur‹ is written out fully.

3) pa$_4$-a$_2$-nu-kuš$_2$	Pa-anukuš
4) 30½ še libir	**30½ (gur) of old grain**
5) 2 še tag$_x$(LAK492)	**2 (gur) of grain** …:
6) si-du$_3$	Sidu
7) 1 42 še gur	**102 gur of grain**
8) ag$_2$	measured(?):
9) e$_2$-KA-nun	e-KA-nun
10) 1 47 gur še libir	**107 gur of old grain**
11) 2 tag$_x$(LAK492)	**2 (gur of grain)** …:
12) dub-hul-tar	Dubhultar
13) 12½.0.2 še KA-ni	**12½.0.2 (gur) of grain**
14) 6½.1.2 še gur	**6½.1.2 gur of grain**
15) 1½ še gur	**1½ gur of grain**
16) tag$_x$(LAK492) lugal-ki-tuš-du$_{10}$ … :	Lugal-kitušdu
17) 2 53 lugal-a$_2$-mah	**173 (gur of grain)**: Lugal-amah
18) 2 0 la$_2$ 3 še nam-mah	**117 (gur of grain)**: Nam-mah
19) 10½.1.2 gur	**10½.1.2 gur (of grain)**:
20) šeš-ama-na	Šeš-amana
	(= 633½ gur, 2 bariga, 6 ban)
21) šu-nigin$_2$ 634 še gur	**total: 634 gur of grain**

A total of 634 gur of grain is given. When the individual units in the quantities listed above are added up, they come to 633½ gur, 2 bariga and 6 ban. This means that 2 bariga and 6 ban must be equal to half a gur, which allows two possible sets of unit relationships:

sila(?)→?→ban→3→bariga→8→gur sila(?)→?→ban→6→bariga→6→gur

This means either that there is one system attested in both the gur (mah) calculation texts given above, which had 3 ban per bariga and 8 bariga per gur, or that there are two systems, one with 8 bariga per gur, and one with 6 ban per bariga and 6 bariga per gur. Although either option is technically possible, it seems most likely that both calculation texts record the same 8 bariga per gur system: if the system being used in P011041 really was a 6 bariga gur, it would be a remarkable coincidence that the calculations also allow for an 8 bariga gur.

One might be tempted to think the presence of multiple ›gur‹ systems in the extant texts from ED Šuruppak is suggested by the frequent use of the term ›gur mah‹ (›larger gur‹) implying the existence of at least two different ›gur‹ systems (one smaller and one larger). It is certainly noticeable that the calculation text which demonstrates the existence of the 8 bariga gur uses the term ›gur mah‹, while the text which could evidence either the 8 bariga gur or a 6 bariga gur uses the term ›gur‹, and never qualifies it with the word ›mah‹. This could mean that both the smaller and larger gur systems are attested in the surviving texts, with the (smaller) ›gur‹ system being the 6 bariga gur, and the ›larger‹ gur system being the 8 bariga gur. However, the distinction between the terms ›gur‹ and ›gur mah‹ is not entirely clear cut. In many texts, the terms ›gur‹ and ›gur mah‹ are used synonymously. For example, in P011012, given above, the same system is referred to as ›gur mah‹ (lines 1 and 8) and ›gur‹ (line 3). There is also no need to assume that both systems are attested in the surviving texts. It may be, for example, that the ›smaller‹ gur had fallen out of use by the ED III period. Furthermore, since it seems likely that all the texts using this name ›gur (mah)‹ come from the same archive (see below) it is also possible that the ›smaller‹ gur was used in a different archive.

All of this suggests (though certainly does not prove) that the two gur/gur mah calculation texts refer to the same system, which had the following unit relationships:

sila(?)→?→ban→3→bariga→8→gur

Absolute values and other systems

There are, then, two systems attested in the surviving Early Dynastic Šuruppak texts:

gur (mah) system:
sila(?)→?→ban→3→bariga→8→gur

lidga system:
sila→10→ban→6→bariga→4→lidga

It is impossible to discover the absolute values of these systems with the extant evidence—there are no surviving texts that allow for the calculation of, for example, yield rates or daily subsistence rations in sila.[12] Furthermore, these methods require the amounts to be converted into sila, something that cannot be done for the eight bariga gur system, where the number of sila per ban remains unknown.

It is doubtful that these two systems were the only systems used in Early Dynastic Šuruppak; calculation

12 Using yield rates, sowing rates and worker rations is also an extremely imprecise and error prone method of understanding sila size, see (Clegg forthcoming b).

texts are few and far between (in the case of Šuruppak, only five of the 129 texts that reference capacity systems are calculation texts). Furthermore, as Foster has shown, the surviving texts reference only a tiny portion of the population of ED Šuruppak, and thus, in all likelihood, only a tiny portion of the economic transactions that occurred (Foster 2005: 86). It is therefore extremely likely that further capacity systems were in use, but unattested in any of the surviving texts.

Table 1. Findspots of ED Shuruppak tablets attesting capacity systems (all findspots taken from Martin 2001).

Findspot	gur/gur mah	lidga
XVh ›Tablet house‹	13	
HJ and IJ House		2
XVIIc-d House		1
IXf-g House		1
XVli House		1
IXac House		1

The findspots

Table 1 shows the different names of capacity systems attested at Šuruppak and the known findspots of the texts referencing them. Since only nineteen tablets referencing capacity systems have known findspots, any conclusions drawn from this tablet must be provisional. However, a clear pattern of distribution is discernible.

This first thing to consider is that five of the six houses for which there is any evidence apparently shared a single capacity system, the lidga. One of these households, XVIIc-d House, seems to have been extremely important to the central administration—the tablets found in its archive reference thousands of men from other cities, and may contain reference to the palace (Martin 2001: 85). Standardisation of capacity systems was by no means a guarantee in a single organisation, and significant (and not always successful) effort had to be put into achieving and maintaining it.[13] That archives separated across five houses apparently shared a single capacity system suggests a high degree of centralisation in some aspects of the city bureaucracy of Šuruppak, and is further evidence that these archives were all part of a single, overarching organisation.

However, **Table 1** also suggests that in at least one household—House XVh—a different system, the ›gur (mah)‹ was used.[14] There are a number of potential reasons for this distribution.[15] It is possible, for example, that House XVh was at one time a separate institution that was assimilated into the larger city administration. It is also possible that it was established by the city administration but given some degree of autonomy in choosing which capacity systems were used. Finally, it could be that the gur (mah) systems were somehow more suited to the activities of the XVh House.[16] However, the fact that House XVh continued to use this separate system, and that there does not appear to be any overlap in the use of systems (the gur (mah) is not attested in other houses, and the lidga does not appear in House XVh) is suggestive of only one thing: that there were very few transactions between House XVh and the other houses. If transactions had been common, overlapping systems, shared systems or even an effort to change the systems of the XVh House to match those of other houses would be expected. This is especially interesting since the prosopography shows that, as with the other archives, workers and officials working in the XVh House also worked in others (Pomponio 1983: 141; Pomponio/Visicato 1994: 6). This suggests that shared workers cannot be taken as evidence that archives were otherwise economically interconnected.

It must also be noted that House XVh seems to have been a large, and important, institution, responsible for over a thousand men, and around 10,000 donkeys (Martin 2001: 85). That such a key institution was, to some extent, economically separated from the rest of the administration suggests a significant lack of centralisation in some areas of the city bureaucracy.

13 For more discussion of this see e. g. Kula 1986; Ashworth 2004.

14 It has been suggested that the gur/gur mah was a ›state‹ system, since it primarily appears in ration texts (Visicato 2001, 35). This idea was dismissed by Englund (2002: 126), who pointed out the lidga is also used for rations. However, Table 1 may explain why gur (mah) texts are so frequently ration texts: the activities of House XVh mainly centred around the loaning of donkeys, meaning that grain generally only appears in relation to rations given to its workers. The gur (mah), therefore, appears most frequently in rations texts not because the system was only used for rations, but because the household in which is attested only used grain for rations.

15 All the Fara archives appear to be contemporary, so chronological changes can be ruled out (see Pomponio 1987 and 1983: 141).

16 This third suggestion seems least likely, since the majority of texts dealing with capacity units in all households concern grain rations; there does not seem to have been a separate activity in the House XVh that used units of capacity.

Conclusion

Two systems are attested in the surviving documents from Early Dynastic Šuruppak. These systems had the following unit relationships:

sila→10→ban→6→bariga→4→lidga

sila(?)→?→ban→3→bariga→8→gur

These systems appear to map on to two distinct names—the lidga and the gur (mah) respectively. Analysis of the findspots of tablets using these system names suggests that different systems were used in different households. As discussed in the introduction to this paper, the separate findspots of the Šuruppak archives have increasingly been de-emphasised, while centralisation of the city bureaucracy has been stressed. The evidence presented here suggests that in some cases these ideas of centralisation are correct—of the six households for which there is any evidence, five appear to have shared the same measuring systems, suggesting a strong degree of economic centralisation and interconnectedness between them. However, as has also been shown, at least one other, large, important household may indeed represent one of Martin's ›separate economic units‹, albeit one with the same overseers and workers as other households, and controlled by the city administration. The archives may have all been part of a single institution, but the use of different systems in different archives suggests they were not all wholly integrated into one perfectly centralised bureaucracy. Furthermore, the fact that two of the households identified as the most important to the city administration (XVh House and XVIIc-d House) used different capacity systems suggests that limited economic relationships between some government institutions was a feature, not an exception, of the city administration of Early Dynastic Šuruppak.

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The materiality of capacity measures in Assyria

Florian Janoscha Kreppner – Fabian Sarga

1. Introduction

The aim of this paper is to shed new light on measures of capacity in Assyria, especially from the perspective of its material remains. The comprehensive overview of measures and weights of ancient Mesopotamia by Powell (1987–1990) shows clearly that the quality and quantity of archaeological data from Mesopotamia in general and Assyria in particular is severely limited. The archaeological data for ancient Egypt, by contrast, are much more comprehensive. For instance, containers have been preserved, whose function as measuring vessels is clearly established (Pommerening 2005). These are standardised vessels which, depending on their shape or material, are designed to measure liquid or dry capacities. A considerable number of measuring vessels from ancient Egypt bear both inscriptions indicating units and calibration markings.[1] There are also groups of equilibrated vessels whose capacity is mathematically related.[2] Measuring vessels from ancient Egypt were made from a variety of materials, often metal or stone. Unfortunately, archaeological excavations have not yet brought to light comparable and clearly identifiable measuring vessels in Assyria. Nevertheless, in order to investigate the capacity measures in Assyria, two approaches have been followed so far in previous studies in which the material remains of containers were consulted.[3] In the first approach, vessels or vessel fragments labelled with capacity measures were examined. If these vessels were intact to a reasonable degree, the capacity was calculated and correlated to the capacity measurement units mentioned in the inscription. This method was followed by Postgate (1978) for a jar from Tell al-Rimah and by Bösze (2010) for a rim fragment and a reconstructed vessel from Tell Chuera (see also Reculeau 2011: 121–128). In the second approach, ceramic assemblages were examined for size groups of certain vessel types. If size groups could be identified, it was checked whether they reflected a metric system. This approach has been followed for the Middle Assyrian period, from which extensive ceramic assemblages have been analysed and published, especially for Tell Sheikh Hamad (Pfälzner 1995: 243–244; 2007: 251; Chambon/Kreppner 2010) and Sabi Abyad (Duistermaat 2008: 408–418; 2015: 136–137).

In this paper we consider both approaches by discussing the vessels and sherds known so far from Assyria, which are labelled with capacity measures in the first section (**Table 1**). In the second part of the paper, the studies of size classes of the Middle Assyrian period are supplemented by a study of size groups of Neo-Assyrian pottery types. To this purpose, the documentation of Tell Sheikh Hamad ceramics and publications of Neo-Assyrian pottery from other archaeological sites were examined for vessels that are so complete (i. e. in the profile from the bottom to the rim) that the capacity could be calculated from their drawings. In this way, 199 vessels were assembled on which capacity measurements were carried out (**Table 2**). The question is raised whether size classes with regard to capacities can also be determined from the ceramic material of the Neo-Assyrian period and whether the data available are sufficient to draw conclusions on capacity measures.

1 Pommerening (2005: 350–353): Typ I: Gefäße mit Maßmarkierungen und Nennung der Maßeinheit.

2 Pommerening (2005: 354–363): Typ II: Gefäße mit Maßmarkierungen ohne Nennung der Maßeinheit sowie Gefäßgruppen mit auffälliger Volumenabhängigkeit.

3 Gaspa (2007; 2014) has followed another approach taking into account pictorial sources. He compared information on capacities and containers from written sources with pictorial representations, in particular from the Assyrian palace representations.

2. Pottery labelled with measurements of capacity

Archaeological excavations in the Near East long since brought to light inscriptions on ceramic vessels indicating a capacity measurement (Gelb 1982). However, many of these inscriptions were found on sherds of broken vessels or on vessels not completely preserved in the archaeological record. During the excavations of the 19th and early 20th century, only fragments with inscriptions used to be collected and documented, but not other possibly associated and fitting sherds, so that a reconstruction of these vessels was not possible and consequently the capacity of these vessels could not be determined (Powell 1987–1990: 501). The following section gives an overview of the new evidence of ceramic vessels from northern Mesopotamia labelled with capacity measurements. The functional context from which the specimen originate is discussed, followed by an examination of morphological vessel types and units of measurement. If the state of preservation permits, the capacity of the vessel is compared with the units mentioned in the inscription.

2.1 Middle Bronze Age Tell al-Rimah

The overview begins with the most frequently cited and so far most important reference piece of northern Mesopotamia, which was found in Tell al-Rimah (ancient Qatara/Karana?) and dates back to the 18th century BCE (Postgate 1978). Tell al-Rimah (**Fig. 1**) is located in northern Iraq in the Sinjar region about 65 km west of Mosul. This small trading city flourished in the late third and second millennium BCE. A large temple and part of the contemporary palace from the early second millennium BCE were excavated under the direction of D. Oates from 1961 to 1971 (Oates 1972). The large storage jar TR 5055 = IM 78658 has been reconstructed from sherds found in the palace on the floor of Room I. Rooms I and II both contained large storage jars and may have served as the domestic magazines of the palace. The dating of the jar usage to the reign of Hammurabi of Babylon is virtually assured by a number of tablets found in Room II. Below the rim of the jar, the measure of capacity "1 *emāru* 5 *sūtu* ⅓ *qû*, according to the *sūtu* of Šamaš" (Postgate 1978: 72), was incised in the pottery in two lines in vertical orientation after firing. The dimensions of the jar are

Fig. 1. Map showing archaeological sites mentioned in the text (© Tall Šēḫ Ḥamad Archiv, Berlin)

74.3 cm in height with an inner rim diameter of 33–34 cm and a maximum diameter of the body of 58.5 cm. The capacity of 121.3 litres has been measured after restoration by filling it with dry rice. Assuming the equivalence of 100 *qû* = 10 *sūtu* = 1 *emaru* to the measured capacity, Postgate yielded an equivalence of 0.80687 litres for the *qû* (Postgate 1978: 73; Reculeau 2011: 123). It was emphasised that this is only valid for the Old Babylonian *sūtu* of Šamaš at Tell al-Rimah. However, this jar is the first vessel from the second and first millennium BCE in northern Mesopotamia for which the actual capacity was related to the capacity measurements mentioned in the inscription, with the aim of converting the old capacity measures into to the modern metric system.

2.2 Late Bronze Age Tell Chuera and Tell Sheikh Hamad

More recently, inscribed pottery fragments from the western provinces of the Middle Assyrian state (**Fig. 1**) have become known from Harbe (modern Tell Chuera) and Dur-Katlimmu (modern Tell Sheikh Hamad) (Reculeau 2011: 122–127). In the Late Bronze Age Period Tell Chuera

Fig. 2. Aerial photo of Tell Sheikh Hamad/Dur-Katlimmu (G. Gerster 1997) with indications (© Tall Šēḫ Ḥamad Archiv, Berlin)

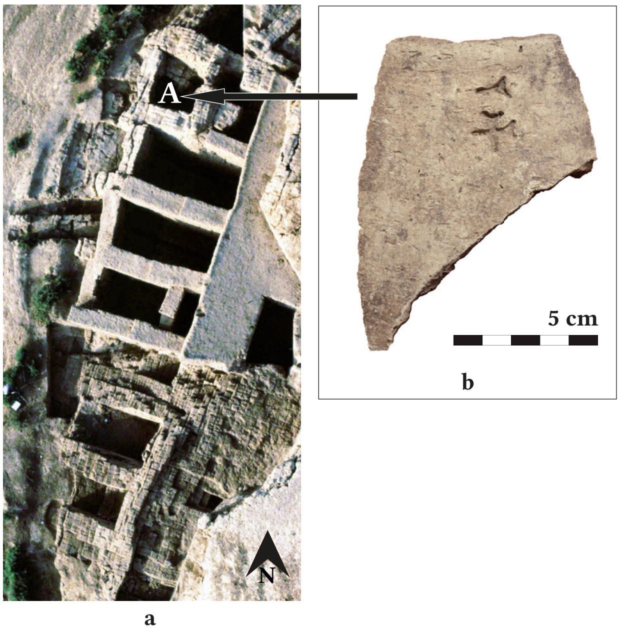

Fig. 3. a) Tell Sheikh Hamad, Building P on the western slope of the citadel with Room A; b) body sherd SH 80/1527/0631 with stamped cuneiform signs (© Tall Šēḫ Ḥamad Archiv, Berlin)

IIB (c. 1250–1100 BCE) only a small provincial town existed in the north-eastern part of the Tell (Area G) (Meyer 2016: 291–292; Klein 1995). The town was situated on an important east-west route between the Khabur and the Euphrates rivers and was the seat of a district governor. A large administrative building of several rooms, called Palace G, housed a small archive of clay tablets (Jakob 2009). Goods were also produced and stored in this building. The remains of an inscribed vessel rim (TCH03.G.06), which had been glued together from three pieces, were uncovered among the finds from Palace G. The cuneiform signs had been stamped on the vessel wall before firing. Unfortunately, large parts of the same vessel have not been preserved. An almost complete vessel (TCH03.G24) was found in the same room. Because of the comparable morphology of the rim fragment and the vessel, Bösze reconstructed the vessel shape of the labelled rim fragment graphically and calculated the capacity. The reconstructed height of the vessel is 40.5 cm, the rim diameter is 15 cm and the maximum width of the vessel is 30 cm. The capacity of the reconstructed vessel was measured with the software AutoCad® 2002. Filled up to the rim the capacity is 14.75 litres. However, it is methodically highly problematic to reconstruct vessel heights from rim fragments and thus to calculate their capacity. Therefore, it is questionable whether the labelled vessel actually had the reconstructed capacity. The inscription on the jar was read "1 GIŠ.BÁN (1 *sūtu*)" and Bösze concluded that the Middle Assyrian *sūtu* was 1.7 to 1.95 bigger than the one from Tell al-Rimah (Bösze 2010: 40).

Reculeau (2011: 126 Fig. 05.05) showed that the reading was problematic as well and proposed a new interpretation from a sherd[4] that was also stamped before firing and excavated in Building P of the Middle Assyrian provincial centre Dur-Katlimmu (modern Tell Sheikh Hamad), which is located on the eastern bank of the Khabur river in North-Eastern Syria (**Fig. 1** and **Fig. 2**). Dur-Katlimmu was connected with the capital Ashur via an east-west route across the steppe. According to the Tell Sheikh Hamad texts, it was the administrative centre of the newly established district and the seat of the governor (Cancik-Kirschbaum 1996: 19–25). It furnished the seat of a grand-vizier. Issues of political administration, development, and security of the western part of the Middle Assyrian state were controlled from Dur-Katlimmu (Kühne 2013: 474–476; 2016; 2021). Building P on the western slope of the citadel formed part of a Middle Assyrian governor's palace (**Fig. 3**). The excavated portion of the structure, a total area of approx. 200 sqm., consists of a series of storage rooms. The smallest of these rooms, Room A, contained an archive of cuneiform tablets found densely packed in a black ashy layer. The tablets had been stored alongside large quantities of pottery in an upper storey, which collapsed into Room A during a fire (Pfälzner 1995: 106–114). One body sherd SH80/1527/0631 (height: 11 cm, width: 8.3 cm, thickness: 1 cm) features two cuneiform signs stamped before firing. For the two pieces from Tell Chuera and Tell Sheikh Hamad, Reculeau proposes the following readings:

> "Cryptic as it might appear to us, a reading ›1 1/2‹ of both inscriptions (assuming a scribal error at Ḫuwēra), or ›1 1/2‹ for the Šēḫ Ḥamad one, and ›1/2 1‹ for the Ḫuwēra one, seems to be preferable in the present state of the documentation, even if I cannot decide whether this applies to quantities stored in the jars, or if they were identification marks of some sort. It appears that the reading of the inscription on the Ḫuwēra jar is very problematic and open to many interpretations. For the time being it should be stressed that the hypothesis of a Middle Assyrian *sūtu* of ca. 15 l is, at best, highly tentative, and that it should not be applied to convert the Middle Assyrian yields into the metric system." (Reculeau 2011: 127).

4 Reculeau referred to the piece as SH 80/1527/0457. Since this number has been assigned to several objects, the inscribed sherd obtained the new inventory number SH 80/1527/0631.

To summarise, the two pieces from Tell Chuera and Tell Sheikh Hamad were found in Middle Assyrian administrative contexts in provincial centres. It is not entirely certain that the inscriptions stamped on the vessels before firing indicate capacity measurements. Based on its fabric and morphology, at least the inscribed fragment from Tell Chuera was originally part of a bottle of the Middle Assyrian administrative pottery (Pfälzner 2007: 252–253). Unfortunately, due to reconstruction, the original capacity is not certain. The inscriptions are difficult to interpret in numerical values and units.

2.3 Bronze and Iron Age Ashur

Ashur (modern Qal'at Sherqat) used to be the religious and political nucleus of Assyria over times and was located on the western bank of the Tigris in the north of today's Iraq (**Fig. 1**). After the transfer of the seat of government in the 9th century BCE to the newly founded royal residence city of Nimrud, the city of Ashur with the Ashur temple remained the religious centre until the fall of the empire at the end of the 7th century BCE. 15 specimen with inscriptions of capacity measurements are known from Ashur. They were recovered during the excavations under Andrae from 1903 to 1914 and published by Pedersén (1997: 112–129) in the catalogue of inscribed objects from Ashur. Although there is an entry where approximately the pieces were found, these only give the square of the plan and sometimes another rough indication. **Table 1** shows the information from Pedersén's catalogue on the locations of the items.[5] The inscribed sherds originate from different urban and functional areas. The piece Ass 10433 was found outside the city walls, Ass 14034a+b comes from a residential area in trench dE8I (Miglus 1996: 218–219) and seven pieces were excavated in the Anu-Adad Temple.[6] However, it is not always possible to reconstruct an exact allocation to specific buildings or stratigraphic layers from this. As no photos and drawings of the fragments have been published so far, the morphological types as well as a chronological assignment cannot be determined more precisely.[7]

However, in the descriptions of the 15 inscribed fragments of clay vessels by Pedersén, the specification ›large‹ is given for 10 of them and ›thick-walled‹ for another one, which suggests that at least these 11 pieces were originally part of large storage vessels. There is a note on the way the inscription was applied for three pieces: ›stamped inscription‹ for Ass 3085, ›carved‹ for Ass 11105 and ›incised‹ for Ass 14034a+b. While the stamp could be applied only before firing, it is not possible without an autopsy to decide whether the other vessels were inscribed before or after firing. In seven of the 15 cases the inscriptions are broken off, which is the reason why the capacity information for these pieces is not complete. The signs ANŠE (7×), BÁN (8×) and SÌLA (2×) are used and also combined with one another. The numerical values are 1 (4×), 2 (1×), 3 (2×), 7 (1×) and 9 (4×), and once also a fraction is given: 1/2. So very different numerical values are indicated. It is noticeable that at least three pieces have non-integer values consisting of different units, probably even more because of the breaks.

2.4 Iron Age Nimrud

With a large-scale building programme, the Assyrian king Ashurnasirpal II established the new imperial capital Kalhu (today Nimrud) on the eastern bank of the Tigris about 35 km southeast of Mosul in Northern Iraq, which was inaugurated in 878 BCE (**Fig. 1**). The British excavations from 1949–1963 in the Northwest Palace and the Ninurta Temple on the citadel as well as at Fort Shalmaneser brought to light pottery inscribed with capacity measurements. The most imposing building on the citadel is the Northwest Palace, which is considered as the blueprint for later Assyrian palaces (Kertai 2015). Later on in the Neo-Assyrian period, when the capital was moved first to Dur-Sharrukin and then to Nineveh, the Northwest Palace was still in use, although its function had changed. During this later phase, rooms of the east wing of the entrance courtyard were used as storage rooms for the grain rations required by the palace offi-

5 In the article by Jakob-Rost (1991) on the inscriptions on smaller clay vessels from Ashur and Kar-Tukulti-Ninurta, she reads the inscription of her catalogue numbers 3740 as "1 BÁN SUMUM" and thus as an indication of a measure of capacity. Since Pedersén (1997) interprets the inscription as the indication of a personal name ("IPAP?-BAD"), the pieces Ass 10112, Ass 7694, Ass 9028 and Ass 15076 are not listed here.

6 Ass 5784, Ass 5990, Ass 7169, Ass 7218, Ass 7529a, Ass 7529b, Ass 7604; vgl. Werner 2016.

7 Julia Hänsel completed a Master's thesis at the University of Heidelberg in 2010, supervised by Peter Miglus with the title "Grosse assyrische Keramikgefäße mit Inschriften aus Assur und ihre Verwendung", which may contain more detailed information on the pieces relevant here but has not been published (URL: https://www.uni-heidelberg.de/fakultaeten/philosophie/zaw/ufg/informationen/abschlussarbeiten/magister_abgeschlossen.html, [11.09.2020]).

cials. For Room EB, the publication mentions an unspecified number of large pottery jars marked with their capacity of two homers (Mallowan 1966: 168), which were apparently used until the final sack of Nimrud at the end of the 7th century BCE. Since there are no exact details on either the inscriptions or the vessels themselves, it can only be stated here—on the basis of the rough description and the six vessels sketched in the plan—that the jars inscribed were quite large storage jars (Mallowan 1966: 167 Fig. 101).

Towards the south, in the service and living area of the Northwest Palace, a suite with the small Rooms JJ and HH could be reached from the south-eastern corner of the Central Courtyard Y via Passage P. The find context is documented by Wiseman and Kinnier-Wilson:

> "In room HH were found iron spears stacked against the east wall and a large storage jar inscribed with its capacity (Oates/Oates 2001: 62). The inscription ND 485 runs ›[1] homer, 2 *sûtu*, 5 *si*[*la*]‹." (Wiseman/Kinnier-Wilson 1951: 115).

Further evidence from the citadel was found in the Ninurta Temple, which was located north of the Northwest Palace. Mallowan describes the find situation as follows:

> "the remainder of the rooms south of the sanctuary were magazines, the largest of which, 8, 9, 11, and 13, were originally planned as a single chamber 32 metres in length and about 5 metres wide. Here a series of large terracotta jars was arranged in four rows, down the length of the room. Each jar was supported by a mud-brick bench and stood on a drip-stone which had once contained a bung at the bottom. The average capacity of each was about 300 litres (66 gallons); in the middle of the chamber there were two stone (gypsum) tanks inscribed with the name of the king. It is probable that all these receptacles were intended for the storage of olive oil, a commodity which was mentioned in a tablet from the adjacent area ZT9; some of them were inscribed with their capacity in terms of the homer and its subordinate measures the *sutu* and the *qa*." (Mallowan 1966: 91).

From the description as well as from a figure showing the find situation in Room 11 (Mallowan 1966: 92 Fig. 41), it is clearly recognisable that the vessels were permanently installed large storage vessels.

In the south-eastern corner of the lower town was a complex that served as a military palace with the royal armoury. It was named "Fort Shalmaneser" by the excavators. Around large courtyards, there were rooms with different functions. Even if only some of the rooms at the so-called south-western courtyard have been completely excavated, it can be stated that storage rooms were located there. Mallowan describes the Room SW 6 located in the north-eastern corner of the courtyard as follows:

> "sw6 was an extremely interesting room. It proved to be a wine cellar with serried ranks of big pottery containers set in mud-brick benches. Between them were narrow gangways just wide enough apart to enable a man to pass between and replenish or empty the pots as need be. The tops of many of the jars had been dislocated by a fall of the roof and their appearance on excavation was remarkably similar to that of excavated wine stores in the contemporary fortress of Karmir Blur, in ancient Urartu. Here, as in that fortress, many of the jars had been inscribed after baking. At Nimrud the capacity was reckoned in homers, *sûtu*, and *qa*.
> Two of these inscribed vases were reconstituted and filled with grain on the assumption, which may or may not be correct, that they were originally filled to the brim, and that the capacity marked on each corresponded with the measure of a full jar. One of them, ND6673, which stood 1.17 metres (3ft 8 in.) high when filled, was found to contain 303 litres. It is possible that this particular measurement may be a small fraction over the true capacity, because at one place in the belly of the vase a portion was missing, but the error can only be a small one. All the jars varied considerably in size …". (Mallowan 1966: 407–408, cf. Postgate 1978: 74).

For the finds from the Northwest Palace, the Temple of Ninurta and Fort Shalmaneser at Nimrud, it can be summarized that vessels inscribed with capacity measurements were excavated in highly official imperial buildings erected in the 9th century BCE. They were in use during the last occupation phase before the fall of the Assyrian Empire, when the seat of government had been relocated to Nineveh. The vessels are large storage jars and vary in size, some of which were fixed in the ground. The inscriptions indicate non-integer numerical values consisting of different units.

2.5 Iron Age Nineveh

Nineveh (ancient Ninua) is located on the eastern bank of the Tigris within present day Mosul in Northern Iraq

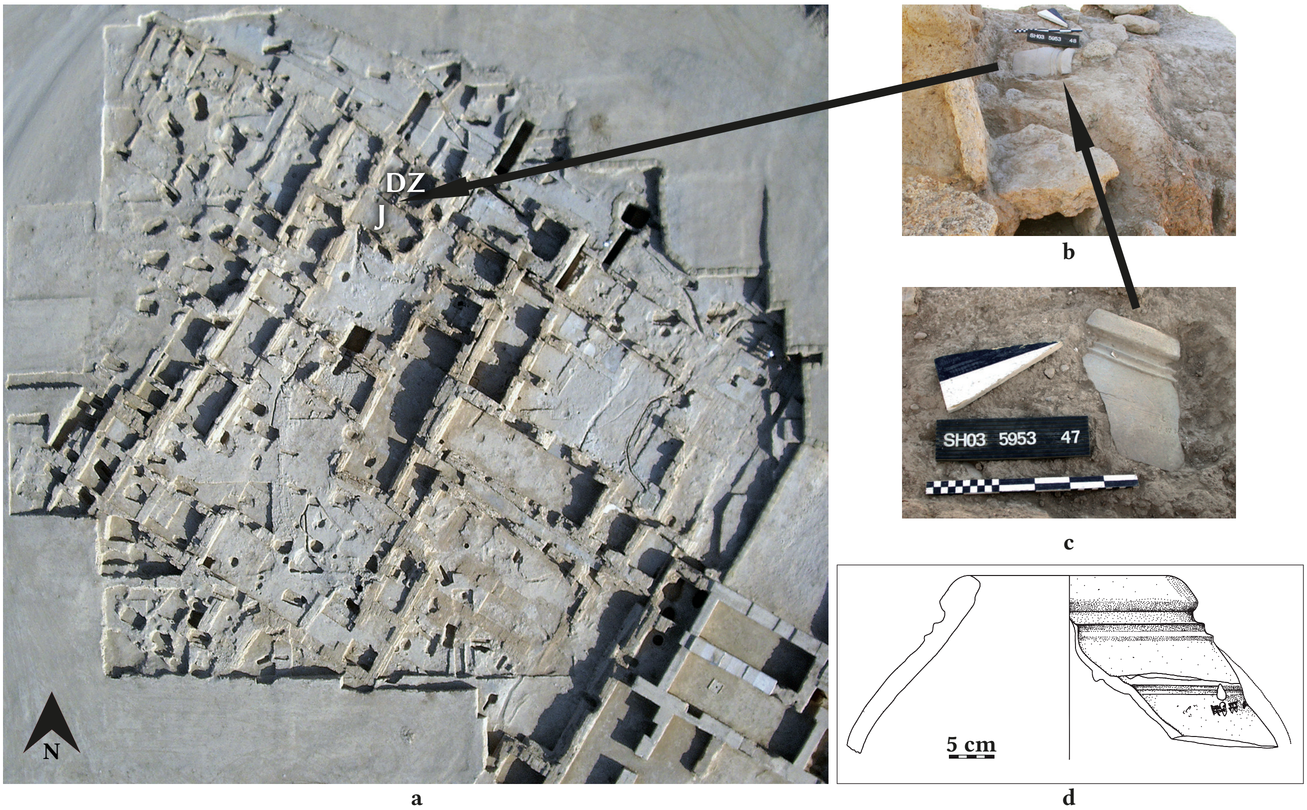

Fig. 4. a) Tell Sheikh Hamad, aerial photo of the Neo-Assyrian Residences; b) find context: the sherd was used to cover the drain; c) photo of the inscription; d) drawing of rim fragment SH 03/5953/0131 indicated with capacity measurement (© Tall Šēḫ Ḥamad Archiv, Berlin)

(**Fig. 1**). Nineveh was the royal capital of the Assyrian Empire in the 7^{th} century, until sacked by the Babylonians and Medes in 612 BCE. From Nineveh comes a body sherd K 14965 (length: 5.08 cm, width: 3.81 cm) with an inscription broken on both sides. The inscription reads 8 SÌLA (King 1914: 145).[8] No information is given as to which building or stratigraphic layer the piece was found in, so no statements can be made as to the functional context in which the inscribed vessel was once used. The thickness of the sherd indicates that it used to form part of a large storage vessel.

2.6 Iron Age Tell Sheikh Hamad

New data on the Neo-Assyrian imperial phase and the time immediately after the fall of the empire have been unearthed in the lower town of Dur-Katlimmu (modern Tell Sheikh Hamad). The settlement reached its maximum spatial extension of about 52 ha of intramural space in the Neo-Assyrian period from the 10^{th} to the 6^{th} century BCE (**Fig. 2**), through the addition of a lower town (Lower Town II) surrounded by a city wall and new suburbs (Kühne 2013; 2016). The significance of Dur-Katlimmu can be seen from its geostrategic position: the town was situated west of the Assyrian capitals and located—after its expansion to the west—at important traffic routes towards the western provinces. Dur-Katlimmu was an important garrison town with chariot troops and intelligence services (Radner 2002: 9–10).

In the centre of the lower town, houses 1–4 of different size occupying an area of 3500 sqm. were excavated (Pucci 2008). They were associated with upper-class housing (Kühne 2016). In House 1, two joining fragments of a large vessel were installed in the passage of Room J to Room DZ as a cover of a drain **(Fig. 4**; cf. Chambon/Kreppner 2010). While in the case of the finds discussed above either primary find contexts were described or no information was available, a secondary use of the inscribed sherd can be clearly identified here. The find was documented with the inventory number SH 03/5953/0131. The size of the fragment is 24 cm by 17 cm with a wall thickness of 2 cm. The inscription mentions the capacity measure "5-BÁN 5 *qa*" (Radner 2010: 182) and was en-

8 British Museum Collection Database: "K14965"; URL: www.britishmuseum.org/collection [29.08.2017].

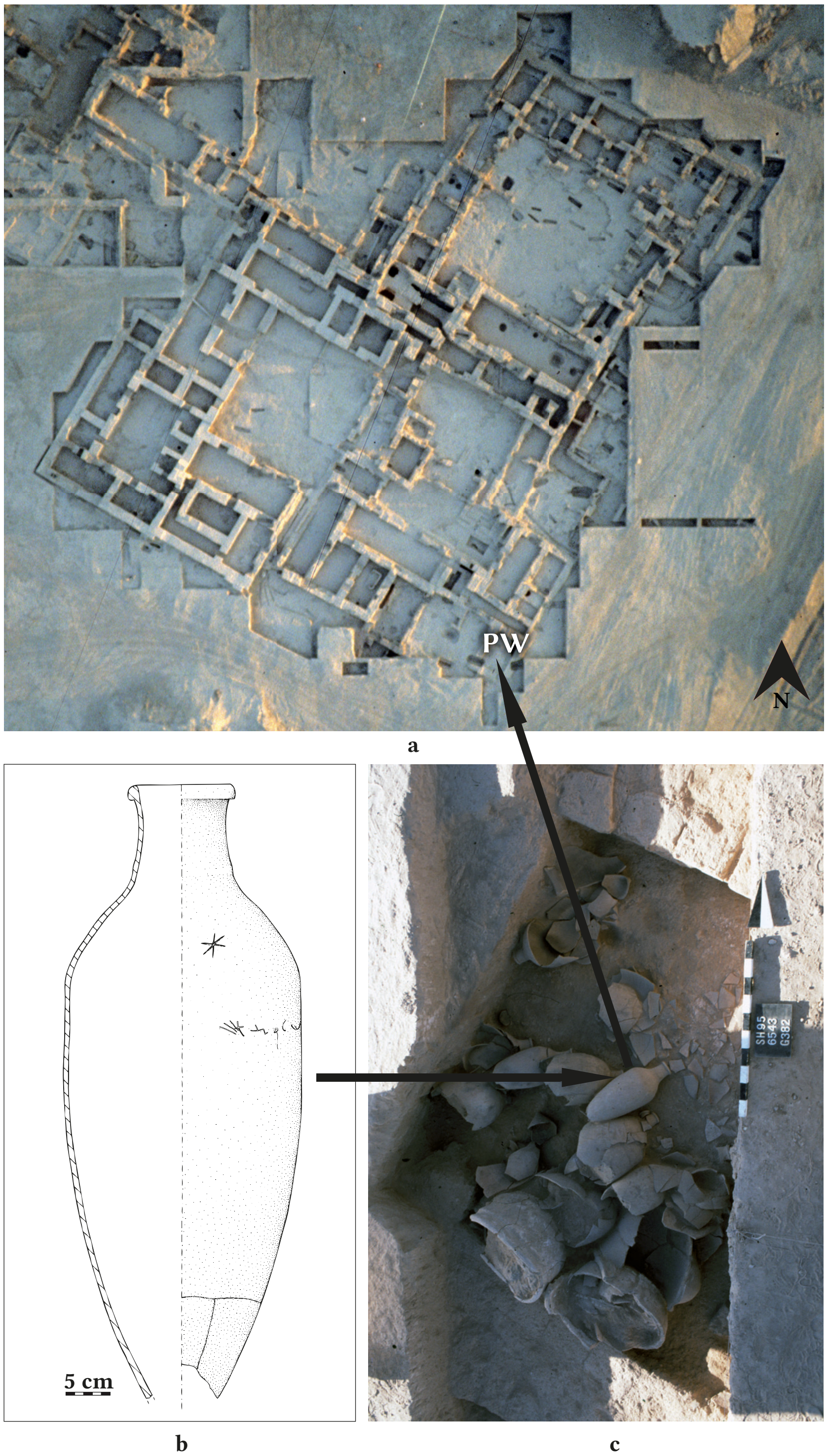

Fig. 5. a) Tell Sheikh Hamad, aerial photo of the Red House; b) drawing of jar SH 95/6543/0046; c) find context of the jar in Room PW (© Tall Šēḫ Ḥamad Archiv, Berlin)

graved in the surface after the firing only. The capacity associated with the vessel cannot be determined because only the rim fragment has been preserved. However, the morphological type as well as the thickness of the wall shows that the fragment was originally part of a large storage jar.

During the reign of Ashurbanipal (668–631/27? BCE), Šulmu-Šarri, the master of an archive found in the neighbouring so-called Red House (Radner 2002), gained the prominent economic and social position of a *ša-qurbūti*, which would seem to make him the most likely patron for the construction of the elite residence just east of houses 1–4. The start of the main occupation period can be dated to the third quarter of the 7th century BCE. Each of the youngest four clay tablets, deposited at the end of the main use period in Room XX, refers as a date to a year under the reign of the Babylonian king Nebuchadnezzar I (Kühne 1993). Consequently, they date the building's destruction to a period after the year 600 BCE (*terminus post quem*) and to the first half of the 6th century BCE, when Northern Mesopotamia was under Babylonian rule (612–539 BCE). The Red House, whose name derives from its red-coloured walls, thus spans this dramatic period of political transformation and allows insight into life in Northern Mesopotamia before and after the fall of the Neo-Assyrian Empire. The complete ground plan of the Red House has been unearthed (**Fig. 5**). The building covered an area of 5.200 sqm. and was composed of five courtyards and 90 rooms (Kreppner/Schmid 2013; Kreppner 2019). Several functional units could be distinguished, which include seven reception suites, five bathrooms, five staircases and several storage rooms. The storage room PW forms the southern edge of the building. The room inventory had been preserved and could be recovered during the excavation. The jar with the inventory number SH 95/6543/0046 (Kreppner 2006: 159. 206 Taf. 15,2; Rohde 2013: 351) has almost completely been preserved, only the base is missing. The jar bears a single-line incised inscription with a six-pointed star incised above and a secondary ink inscription (three characters) on the right in front of the incised inscription. Röllig emphasizes that the reading is not without problems. Probably, the first inscription was engraved before firing. It consists of two signs and three strokes. Röllig (2014: 235–236) interprets the incised signs as a Phoenician inscription and translates them as "3 *sūtu*". Later, after the firing, an Aramaic inscription was applied with ink on the right in front of the Phoenician inscription. Röllig translates the Aramaic inscription as the name "*Silim*" which may be interpreted as an indication of ownership. The vessel was found in a storage room in which a large number of large vessels were kept. In terms of fabric and morphology, this piece is very similar to jars from the same room and from the entire building (Kreppner 2006: Taf. 14,1) as well as to jars from other Neo-Assyrian sites (Curtis 1989: Fig. 36, No. 213 from Khirbet Qasrij). From the point of view of fabric and shape typology, the jar fits very well into the Neo-Assyrian/Northern Mesopotamian ceramic tradition. Unfortunately, no chemical-mineralogical analyses have been carried out on this vessel to verify the presumed local production. It would also be worthwhile to analyse the production technology of this jar with the *chaîne opératoire* approach and compare it with vessels of the same shape (Roux 2019). Perhaps through this method, differences in production technology could be identified and it could be examined whether potters trained in different pottery-making traditions could have made vessels according to local shape criteria on site in Dur-Katlimmu. It is certainly possible to imagine several different scenarios how the individual elements can be interpreted, such as a specific type of vessel, the Phoenician characters carved before firing, the property details added in ink later on in Aramaic script, and the kind of storage in the Red House of Dur-Katlimmu. For the examination of the capacity measurements in this contribution it seems important to point out that the materiality of this jar documents a complex biography. An unknown number of protagonists were involved leaving traces at different points in time. In contrast to the inscribed ceramic vessels discussed so far, Phoenician and Aramaic letters have been used instead of cuneiform signs. It is not yet possible to assess the extent to which this complex biography affects the value and meaning of the capacity measure.

However, this vessel has almost completely been preserved and has been published in photo and drawing, so that its capacity can be calculated. The dimensions of the vessel are 69.6 cm preserved height, 27 cm maximum diameter and 11 cm rim diameter. Although its base is missing, we have measured the capacity of the vessel from the drawing by using the method described below in the second part of this paper. The measurement was carried out for a maximum filling quantity up to the rim of the vessel and yielded a maximum capacity of 19.6 litres. However, an error can be expected in the measurement due to the missing bottom. If we now assume that the maximum filling quantity is indicated in the inscription with 3 *sūtu*, then 1 *sūtu* would correspond to 5.63 litres. As discussed, there are a number of uncertainties in understanding the indication of the capacity value of this vessel. It should be noted, however, that the *sūtu* has a completely different value compared to the vessels from Tell al-Rimah and Tell Chuera.

3. Measuring capacities

3.1 The Middle Assyrian evidence

Sites across the Northern Mesopotamian plains and neighbouring regions have yielded large quantities of Late Bronze Age pottery that have been associated with

Table 1. Pottery inscribed with measurements of capacity

Provenance	Excavation Number	Date	Context
Tell Rimah	TR 5055	Middle Bronze Age	Palace, Room I
Tell Chuera	TCH03.G.06	Late Bronze Age	Palace G
Tell Sheikh Hamad	SH80/1527/0457 (Reculeau), changed to SH80/1527/0631 in SH-database	Late Bronze Age	Citadel, Building P, Room A
Ashur	Ass 3085	Bronze or Iron Age (?)	»gE4I mušlašlu, auf dem Ostmassiv«
Ashur	Ass 5784	Bronze or Iron Age (?)	»eB6I unter dem Tümpel«, Anu-Adad-Tempel
Ashur	Ass 5990	Bronze or Iron Age (?)	»eA5IV bei der Nordecke der kleinen Zikkurrat«, Anu-Adad-Tempel
Ashur	Ass 7169	Bronze or Iron Age (?)	»eC5III an der nördlichen Stadtmauer, östlich der Schlucht, südlich des großen Fundaments«, Anu-Adad-Tempel
Ashur	Ass 7218	Bronze or Iron Age (?)	»eC5III westlich der Schlucht«, Anu-Adad-Tempel
Ashur	Ass 7529a	Bronze or Iron Age (?)	»eB5III im Schutt, dicht über dem Sandfels«, Anu-Adad-Tempel
Ashur	Ass 7529b	Bronze or Iron Age (?)	»eB5III im Schutt, dicht über dem Sandfels«, Anu-Adad-Tempel
Ashur	Ass 7604	Bronze or Iron Age (?)	»eA5III oberster Schutt«, Anu-Adad-Tempel
Ashur	Ass 9180	Bronze or Iron Age (?)	»dB6IV«
Ashur	Ass 9843	Bronze or Iron Age (?)	»cA5II Nordseite des Tals IV über dem Niveau des Asphaltpflasters«
Ashur	Ass 10433	Bronze or Iron Age (?)	»bA 7II Außenfront«
Ashur	Ass 11105	Bronze or Iron Age (?)	»Stadtgebiet«
Ashur	Ass 14034a+b	Bronze or Iron Age (?)	»dE8I 2. Suchgrabenschicht«
Ashur	Ass 17386	Bronze or Iron Age (?)	»i3/h3 Kasernenmauer, West«
Ashur	Ass 19212	Bronze or Iron Age (?)	»Stadtgebiet«
Nimrud	without number	Iron Age	Citadel, Ninurta temple, magazine Room 11
Nimrud	without number	Iron Age	Citadel, Northwest Palace, Room EB
Nimrud	ND 485	Iron Age	Citadel, Northwest Palace, Room HH
Nimrud	ND 6673	Iron Age	Fort Shalmaneser, Room SW6
Nineveh	K 14965	Iron Age	unknown
Tell Sheikh Hamad	SH03/5953/0131	Iron Age	Lower Town II, House 1
Tell Sheikh Hamad	SH95/6543/0046	Iron Age	Lower Town II, Red House

Table 1. (continued from previous page)

Morphological Type	Capacity	Indicated Capacity	Publication
storage jar, inscribed after firing	121.3 l	1 ANŠE 5 (BÁN) 1/3 SÌLA *i-na* GIŠ.BÁN ^{d}UTU	Postgate 1978
rim fragment of a Middle Assyrian standard bottle, stamped before firing	14.75 l ?	Bösze: 1 *sūtu*; Reculeau: DIŠ. MAŠ: 1 1/2	Bösze 2010; Reculeau 2011: 125–126
body sherd, stamped before firing		DIŠ.MAŠ: 1 1/2 ?	Reculeau 2011: 125–126
»Bruchstück eines Tongefäßes mit Stempelinschrift«		7 BÁN?	Pedersén 1997: 113
»Scherbe eines dickwandigen Tongefäßes«		1 ANŠE 7 BÁN[()]	Pedersén 1997: 114; Werner 2016: Kat.-Nr. 2053
»Randscherbe eines großen Gefäßes«		1 ANŠE	Pedersén 1997: 114; Werner 2016: Kat.-Nr. 2055
»Scherbe eines großen Tongefäßes«		… A]NŠE	Pedersén 1997: 115; Werner 2016: Kat.-Nr. 2066
»Randscherbe eines großen Tongefäßes«		…] 9 BÁN	Pedersén 1997: 115; Werner 2016: Kat.-Nr. 2068
»Randscherbe von großem Tongefäß«		9 BÁN	Pedersén 1997: 116; Werner 2016: Kat.-Nr. 2074
»Randscherbe von großem Tongefäß«		9 BÁN	Pedersén 1997: 116; Werner 2016: Kat.-Nr. 2075
»Randscherbe eines großen Tongefäßes«		1 ANŠE	Pedersén 1997: 116; Werner 2016: Kat.-Nr. 2076
»Scherbe eines großen Tongefäßes«		2 BÁN?	Pedersén 1997: 117
»Scherbe eines großen Tongefäßes«		1 ANŠE x?[	Pedersén 1997: 117
»Scherbe eines großen Tongefäßes«		…]x 3-BÁN 1 1/2 SÌLA?[	Pedersén 1997: 118
»Tongefäßscherbe mit eingeritzter Inschrift«		…]x SÌLA? […	Pedersén 1997: 119
»2 Scherben eines großen Tongefäßes mit eingeschnittener Inschrift«		3 ANŠE 1-BÁN	Pedersén 1997: 120; Miglus 1996: 217–218
»Tongefäßscherbe, beschriftet«		…]1? ANŠE? […	Pedersén 1997: 123
»Randscherbe eines Tongefäßes«		9-BÁN	Pedersén 1997: 127
large storage jars, permanently installed	avarage capacity 300 l	some of them were inscribed with their capacity in terms of the homer and its subordinate measures the *sūtu* and the *qa*	Oates 2001: 110; Mallowan 1966: 91
storage jars		two *homers*	Mallowan 1966: 168
fragment of a storage jar		[1] *homer*, 2 *sūtu*, 5 *si*[*la*]	Oates 2001: 62. 274
large storage jar, permanently installed, inscribed after firing	303 l	1 ANŠE 3 BÁN 7 SÌLA	Mallowan 1966: 107–108
body sherd		8 SÌLA	King 1914
rim fragment of a storage jar, inscribed after firing		5 BÁN 5 *q*[*a*	Chambon/Kreppner 2010; Radner 2010
storage jar inscribed before firing	19.6 l	3 *sūtu*	Röllig 2014; 2001; Kreppner 2006

Assyrian state control. At Middle Assyrian provincial centres in the Syrian Jazirah, as well as at sites in the Assyrian heartland such as Ashur and Kar-Tukulti-Ninurta (modern Tulul al-Aqr), specific bottles and carinated cups and bowls were produced in large quantities. In the light of these ceramic parallels, Pfälzner (2007: 250) proposed that Assyrian state administration brought a specific ceramic tradition and mode of production to the provinces. Evidence from Tell Sheikh Hamad (Pfälzner 1995; 2007) and Tell Sabi Abyad (Duistermaat 2008; 2015) indicate that simultaneously with the expansion of the Assyrian state to the west in the 13th century BCE, certain types of ceramics were introduced and that a direct relationship existed between these vessels and the Assyrian administration. Postgate characterises this type of pottery in his article ›the Debris of Government‹ as an "integral component of the package of Assyrian occupation, a package which also included tablets, another fairly durable component of material record" (Postgate 2010: 27).

From Room A of Building P in Tell Sheikh Hamad (**Fig. 3**), a total of 20 bowls and cups were recovered, the profiles of which had been preserved from the rim to the bottom and therefore the capacity could be calculated from the published drawings (Chambon/Kreppner 2010: 11–32; Kreppner 2015: 221–225). 15 of these are cups and five are bowls. For the cups, the calculated capacity of 14 containers is about 0.15 litres on average. One is larger and measures 0.58 litres. The five bowls have an average capacity of about 1.66 litres.

Tell Sabi Abyad represents an Assyrian *dunnu* (fortress) measuring 60 by 60 m, which was further protected by a moat and contained a series of dwellings and workshops (Akkermans 2016: 67–68). A thorough analysis of the pottery evidence from levels 3–6 (13th and 12th centuries BCE) shows that carinated bowls were present in a wide range of different functional contexts. Duistermaat (2008: 385) determined a group of small vessels with an average volume of 0.09 litres (between 0.03 and 1.14, average deviation: 24.1 %), a second group of medium-sized vessels with an average volume of 0.31 litres (between 0.13 and 0.60, average deviation 39.1 %), and a third group with an average volume of 1.05 litres (between 0.55 and 1.60, average deviation 27.3 %). Each class is about three times bigger than the smaller one below.

Although the three groups do not exactly correspond to the groups in Dur-Katlimmu, the group of small vessels in Tell Sabi Abyad and the group of cups from Dur-Katlimmu, the group of medium-sized vessels in Tell Sabi Abyad and the single piece from Dur-Katlimmu, as well as the group of large vessels from Tell Sabi Abyad and the bowls from Dur-Katlimmu seem to represent three size classes each at the two sites. Duistermaat interprets the size classes in Tell Sabi Abyad as follows:

> "the potters produced several types of vessels in roughly defined size classes: small, middle, and large. They were however not concerned with exact standard sizes or capacity volumes, nor did they use an external measuring system during production." (Duistermaat 2015: 136–137).

Taking into account the Tell Sabi Abyad evidence, Postgate proposes that the development of standardised ceramic assemblages was not an intentional imposition by a centralised state administration, but rather a response by the potters to the growing demand for certain functional types with specific volumetric requirements (Postgate 2010: 32). In summary, however, we may say that state organization is reflected in the size groups of certain types of ceramics in the Middle Assyrian period.

3.2 The Neo-Assyrian evidence

So far there have been no publications dealing in summary and in a systematic way with capacities of Neo-Assyrian vessels. This paper can be taken as another attempt to go in this direction. Within the framework of the Metrologia project, 448 measurements of complete profiles from the Assyrian heartland and a further 90 measurements of published and unpublished drawings from Tell Sheikh Hamad were carried out. The main basis for the pottery from the Neo-Assyrian heartland is taken from Hausleiter's publication of the Neo-Assyrian pottery corpus from the imperial capitals of Ashur, Nineveh and Nimrud and from the smaller settlements (Hausleiter 2010). Many of the contexts date to the 8th and 7th century and some to the so-called post-imperial period after the fall of Nineveh in 614 BCE (**Table 2**). This corresponds to the "Keramikstufen" "Neuassyrisch II" and "Neuassyrisch III" according to the definition by Hausleiter (2010: 14). Whether in general and—if so—to what extent the results can be transferred to the earlier phases of the Neo-Assyrian period is subject of the following discussion. At present this cannot be assessed satisfactorily due to the poor data situation, especially for the early phase of the Neo-Assyrian period.

By utilizing the available drawings of complete pottery profiles, the capacity of each vessel was measured with the Pot Utility Tool designed by Thalmann for the ARCANE Project. This diverges from the purely mathematical approach taken by Duistermaat (2008; see

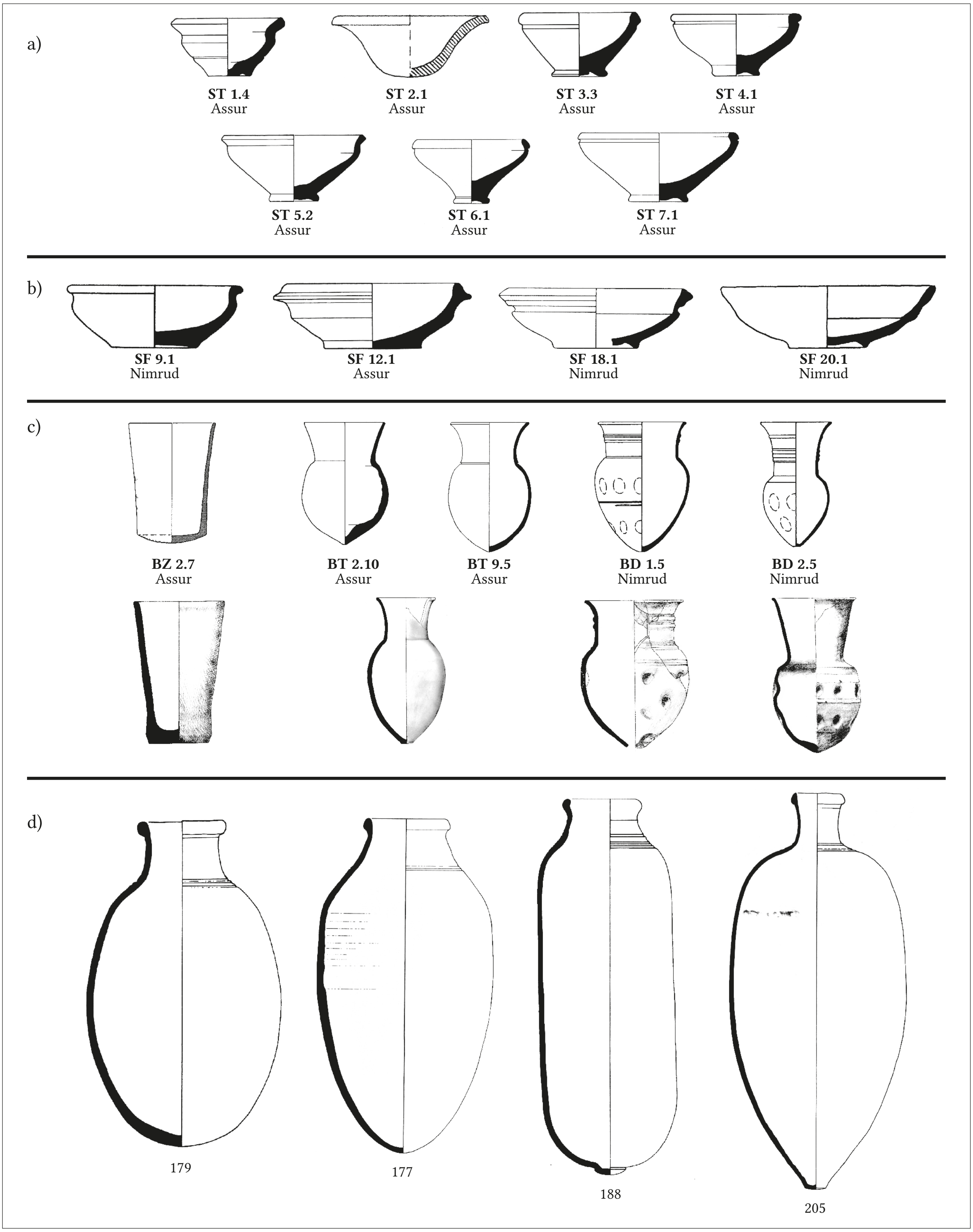

Fig. 6. The types of vessels discussed in this article, taken from Hausleiter 2010: Taf. 53. 55. 58–59. 64–66. 77. 82. 85–87 (a, b, c upper row), Curtis/Green 1997: Fig. 41–43 (d), as well as courtesy of the Tall Šēḫ Ḥamad project (c lower row, SH numbers from left to right: 87/5951/0273; 92/6151/0235; 03/5751/0686; 86/6153/0022; © Tall Šēḫ Ḥamad Archiv, Berlin). a) displays the bowls discussed in Fig. 7; b) the bowls discussed in Fig. 8; c) the beakers discussed in Fig. 9 and Fig. 10 and d) the storage jars discussed in Fig. 11 (Drawings not to scale)

above) for the study of the capacities of Middle Assyrian pottery from Tell Sabi Abyad. Of every vessel two measurements were taken: the maximum capacity (objective) and a capacity at the neck-line (subjective). Whenever in the following paragraphs a capacity measurement is indicated, it always describes the objective variant, that is, the maximum capacity (designated as "Volume in max. litres" in **Table 2**).

The 538 vessels measured are spread over a large number of very different vessel types, so that often only a few representatives are available for the individual types. Thus, a selection of four characteristic vessel type groups was therefore made, which will be discussed below and for which a total of 199 representatives are available. The number of individual specimen in the four vessel type groups made it necessary to define capacity ranges for their presentation in the graphs. The precisely measured values are documented in **Table 2**. The types used for statistical analyses in this paper comprise two groups of bowls, beakers and storage jars (**Fig. 6**) and are representative of about one third of our database. The contexts given in the following paragraphs are all based on information from Hausleiter (2010).

3.2.1 Bowls

The first example (**Fig. 7**) comprises data from Neo-Assyrian bowls that seem to be a continuation of Middle Assyrian types (see above; ST 1-7). The 44 data samples in this graph were all found in the Assyrian heartland. 41 vessels were found directly in Ashur most of them being associated with burial contexts. The other three vessels come from Nineveh, Nimrud and Qasrij Cliff. The vessel from Nimrud (ST 4.7) can be ascribed to a context in the elite houses near the Town Wall (T.W. 53).

The data presented in **Fig. 7** clearly shows that among the ST type bowls there is a high number of samples measuring between 0.01 and 0.10 litres and between 0.11 and 0.20 litres. Another—slightly smaller—number of samples measuring between 0.21 and 0.30 litres may become more important with a larger sample size. The smallest size group between 0.01 and 0.10 litres may be correlated to Duistermaat's (2008) size group of 0.09 litres, which is in evidence at Tell Sabi Abyad, as seven of the measurements in this group, or 58 % of the samples, lie between 0.08 and 0.1 litres. Similar to this, Pfälzner's (1995) size group of 0.15 litres at Middle Assyrian Dur-Katlimmu might be related to seven measurements from the size group of 0.11–0.20, which lie between 0.14 and 0.16 litres. This represents 41 % of the samples. Thus, a continuity in precise size groups can be postulated for small capacity volumes from the Middle Assyrian to the Neo-Assyrian vessel types, which are a continuation of the Middle Assyrian types.

The second example (**Fig. 8**) comprises data from Neo-Assyrian bowls that include newly established types (SF 9, SF 12, SF 18, SF 20) without any precursors in Middle Assyrian times. Of the 42 data samples presented in this table, 29 were found in Ashur—again predomi-

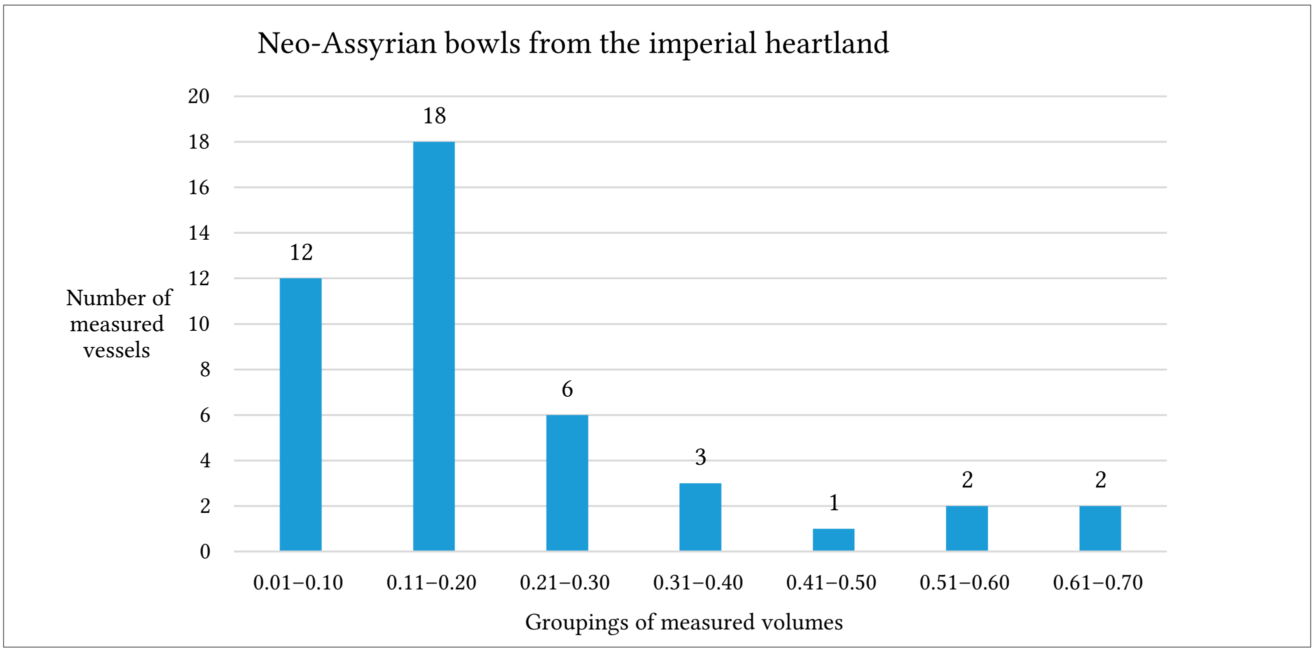

Fig. 7. Capacity measurements for the Neo-Assyrian bowls of type ST 1-7 from Ashur, Nineveh, Nimrud and Qasrij Cliff

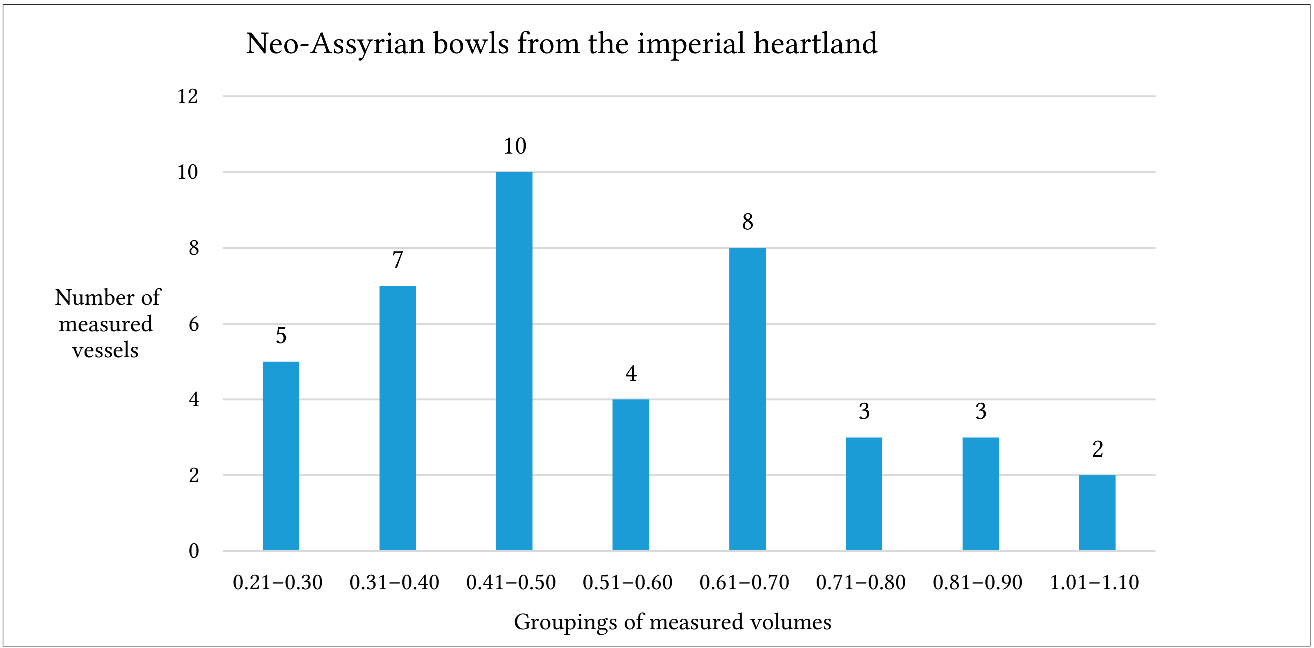

Fig. 8. Capacity measurements for the Neo-Assyrian bowls of type SF 9, 12, 18, 20 from Ashur, Nineveh, Nimrud and Qasrij Cliff

nantly in funerary contexts; 13 in Nimrud—the majority of which were found in the two contexts of either Fort Shalmaneser[9] or the Northwest Palace; and one in a chamber tomb in Humaidat.

In the case of these purely Neo-Assyrian types of bowls, size groups cannot be determined with a similar evidence as we have found for the continued types discussed above. The data that are most striking in this table are those for the samples measuring between 0.41 and 0.50 litres and for those measuring between 0.61 and 0.70 litres, with maybe two additional important sample sizes between 0.21 and 0.30 litres and 0.31 and 0.40 litres. However it must be stated that with regard to the data presented in **Fig. 8**, and with the exception of the group of 0.41–0.50 litres, the evidence for the other groups is far less significant than for the groups presented in **Fig. 7**. It is not sufficient to establish precise size classes. Within this 0.41–0.50 litres group there is a cluster of five samples holding between 0.43 and 0.45 litres, thus making up 50 % of this size group and maybe pointing to a size group of around 0.44/0.45 litres that may become clearer on the basis of a larger range of samples.

3.2.2 Beakers

For the third example discussed here, the types of vessels used were Neo-Assyrian beakers (types BZ, BT, BD). As opposed to the examples discussed in **Fig. 7** and **Fig. 8**, the measurements taken from vessels from the imperial heartland were contrasted with measurements obtained from Tell Sheikh Hamad. The objective was to evaluate whether the vessels from a regional centre were related to those from the imperial capitals not only in terms of typology but also in terms of their capacity measurements (see also Hunt 2015: 98–131). **Fig. 9** and **Fig. 10** will be discussed separately and then compared to each other. Of the 59 samples from the imperial heartland (**Fig. 9**) 31 were found in Ashur—again predominantly in funerary contexts—and 17 in Nimrud in varying citadel contexts (Fort Shalmaneser, Northwest Palace, Burnt Palace). Furthermore, two vessels were found in Khirbet Khatuniyeh, six in Tell al-Rimah—one of which was found in a grave context—two in Nineveh and one in Balawat in a temple context. The 29 examples from Tell Sheikh Hamad (**Fig. 10**) were found in House 4 of the Neo-Assyrian residences and in the Red House[10], an elite residence.

As becomes evident in **Fig. 9**, four significant data sets can be ascertained for the beakers, ranging between 0.11 and 0.50 litres, each with 0.9 litre steps. The samples

9 Some of the samples found in Fort Shalmaneser come from squatter occupations and can thus not be counted among elite contexts.

10 For the publication of the pottery from the Red House, see Kreppner 2006.

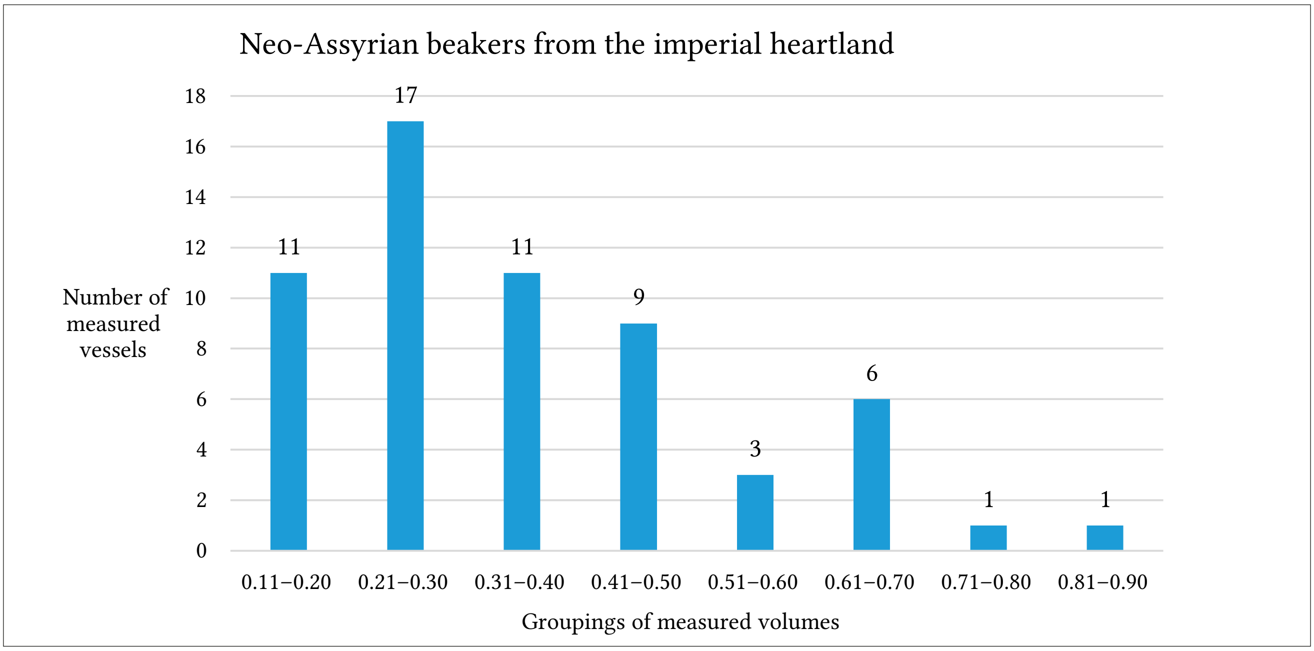

Fig. 9. Capacity measurements for the Neo-Assyrian beakers of types BZ 2, BT 2 & 9, and BD 1 & 2 from Ashur, Nineveh, Nimrud, Khirbet Khatuniyeh, Tell al-Rimah and Balawat

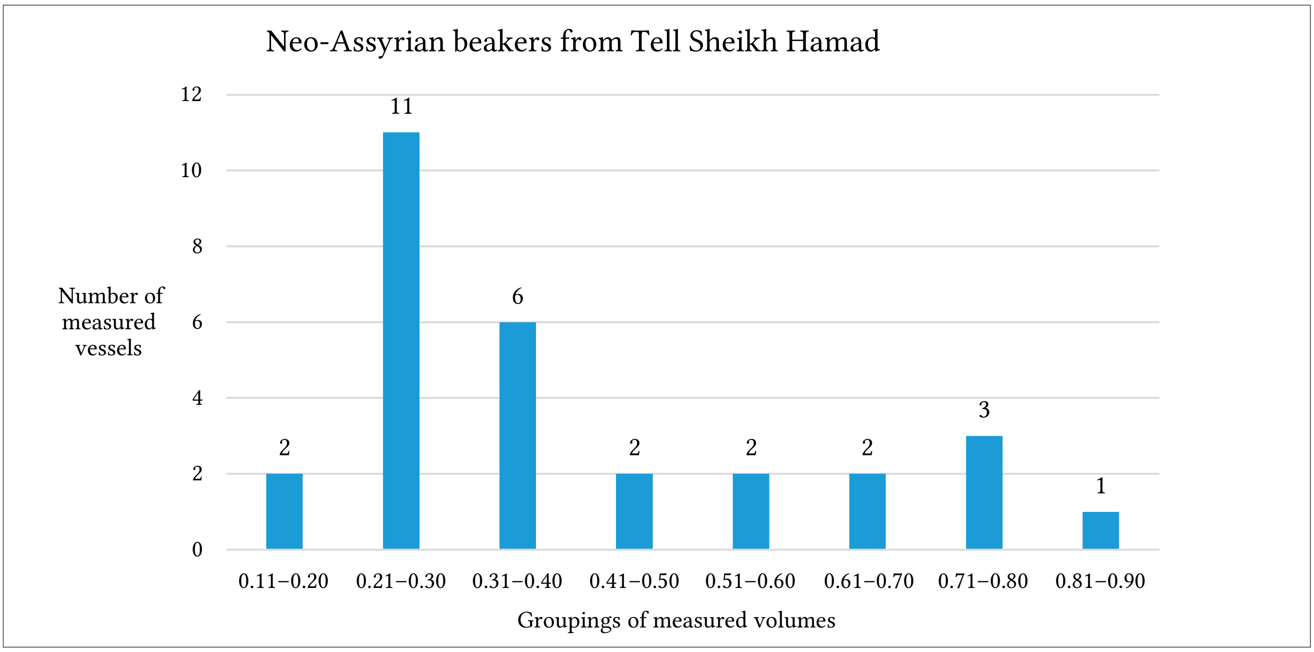

Fig. 10. Capacity measurements for the Neo-Assyrian beakers found in Tell Sheikh Ḥamad. Their types approximately correspond to the ones used in Fig. 9

measuring between 0.21 and 0.30 litres are the most pronounced ones. It should be noted that for the 0.11–0.20 litres 45 % of the samples (five samples) fall between 0.17 and 0.19 litres, while 53 % of the samples in the 0.21–0.30 litres group (nine samples) range from 0.26 to 0.28 litres. In the 0.31–0.40 litres group, 55 % of the samples (six samples) hold between 0.37 and 0.39 litres, while no such concentration can be found in the 0.41–0.50 litres group. This indicates that with increasing sample size there may be more precise size groups centred around the 0.18, 0.27 and 0.38 litres marks.

The data in **Fig. 10** immediately make obvious that for Tell Sheikh Hamad only two size groups may be determined. The samples measuring between 0.21 and 0.30

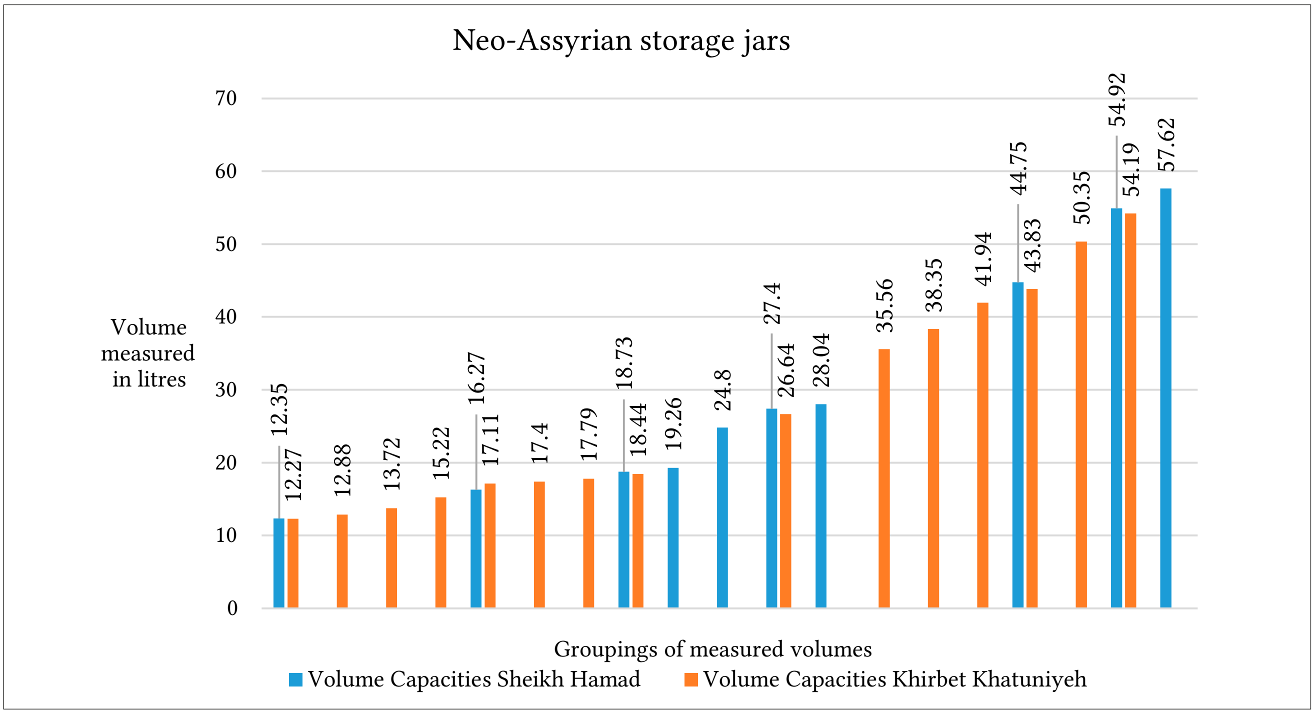

Fig. 11. Capacity measurements of storage jars from Tell Sheikh Ḥamad (blue) and Khirbet Khatuniyeh (red)

litres exhibit a concentration of measurements (55 % or six samples) ranging from 0.26 to 0.28 litres, while the samples measuring between 0.31 and 0.40 litres show a majority of measurements (67 % or four samples) between 0.33 and 0.34 litres. Thus it might again be stated that with increasing sample size more precise groupings around 0.27 and 0.33 litres might become possible. It is very interesting that both in the imperial heartland at the Tigris and in the region at the Khabur possible size group for beakers concentrated around 0.27 litres may be observed for the beakers. One could hypothesize, and it may be proven through the incorporation of a larger sample size, that this constitutes evidence for one (of presumably many) empire-wide standard capacity for beakers—regardless of type—around 0.27 litres.

3.2.3 Storage jars

Another objective of research were Neo-Assyrian storage jars, which should be more likely to exhibit standardized capacities due to their purpose as large storage vessels for whatever produce or goods **Fig. 11** lists capacity measurements from Tell Sheikh Hamad and Khirbet Khatuniyeh side by side.

Although one should assume that these jars were standardized, quite the opposite is true, as the data provided in **Fig. 11** prove. There is no congruence or exact correspondence of the storage jars from Tell Sheikh Hamad (TSH) and those from Khirbet Khatuniyeh (KK) (Curtis/Green 1997), although there is one close enough to be considered as an exact correspondence, with 12.35 litres (TSH) and 12.27 litres (KK). Others, however, vary far more, with capacities of 16.27 litres (TSH) and 17.11 litres (KK), 18.73 litres (TSH) and 18.44 litres (KK) as well as 54.92 litres (TSH) and 54.19 litres (KK). Thus, most of the measurements deviate too much from each other to allow the determination of something like size classes. It was not possible to find any inter-site size classes as it was for other pottery types. But if one looks only at the storage jars from Khirbet Khatuniyeh, a size class within the 12- and 17-litre-range might be found, provided that there will be further investigation and an expansion of the sample size, as three measurements from this site fall within these ranges.

4. Discussion

In the first part of this contribution, fragments or—more rarely—completely preserved ceramic vessels labelled with measures of capacity were discussed. Their dating covers a period of about 700 years from the 18^{th} to the 6^{th} century BCE. In the second part of the paper, the investigation of the size groups deals with the Middle and Neo-Assyrian periods from the 13^{th} to the $7^{th}/6^{th}$ century BCE. The area of investigation of both sections covers the heartland of Assyria on the Tigris in today's Northern Iraq and the Jazirah in Northern Mesopotamia up to the Euphrates in the west, situated in today's North-Eastern Syria. For both analyses, on account of this long period of time and the vast area, the data available is far too sparse to develop a comprehensive understanding and to produce conclusive results.

Only 25 vessels labelled with measures of capacity are available for examination (**Table 1**). These are distributed over time as follows: One piece comes from a Middle Bronze Age site (Tell Rimah), two pieces were excavated in Late Bronze Age contexts (Tell Chuera and Building P in Tell Sheikh Hamad), and seven pieces were found in Iron Age sites (Nimrud, Nineveh, the lower town of Tell Sheikh Hamad). The information published does not allow to definitely assign the 15 specimen from Ashur to one of the periods. The pieces from Tell Rimah, Tell Chuera, Building P in Tell Sheikh Hamad as well as from the Northwest Palace and Fort Shalmaneser in Nimrud were found in official and administrative contexts both in the core area and in provincial centres. With respect to temples, seven pieces from the Anu-Adad temple in Ashur and an unspecified number from the Ninurta Temple in Nimrud are documented. One jar was unearthed from a storage room of an elite residence in the lower town of Tell Sheikh Hamad. Another fragment was found in a secondary find position in one of the neighbouring houses, embedded in the floor. Although the original context of use cannot be determined with certainty, it is nevertheless likely that the vessel had previously been kept in a residential house in the lower town when it was still complete. For the other pieces, an exact archaeological contextualisation is not possible from the information published. However, it can be concluded that vessels labelled with measurements of capacity were in use in official administrative as well as religious contexts on citadels but also in elite private households in lower towns.

The state of preservation and documentation in published drawings allow clear statements about the morphology of the vessels only in two cases. The jar from Tell al-Rimah is a 74.3 cm high large storage vessel with a diameter of max. 58.5 cm, while the jar from the Red House of Tell Sheikh Hamad is smaller, with 69.6 cm in height and a width of max. 27 cm in diameter. Both were non-permanent fixtures in the ground. From the descriptions and from published photos or sketches of the archaeological record it can be concluded for Nimrud that in the Ninurta Temple and Fort Shalmaneser very large storage vessels labelled with measurements of capacity were permanently installed in the ground. Mobile inscribed storage vessels are documented for the Northwest Palace of Nimrud. For all other specimen it should be noted that these are only single fragments. One of them, the Tell Chuera rim fragment, has been reconstructed with the help of a vessel body from the same room as a bottle of the Middle Assyrian administrative pottery. The object descriptions of 11 of the 15 pieces from Ashur and the wall thicknesses of the pieces from Nineveh and House 1 of the lower town of Tell Sheikh Hamad suggest that they are fragments of storage vessels.

Four inscriptions were applied to the leather-hard clay before firing, three of them with a stamp (TCH03.G.06, SH80/1527/0457, Ass 3085) and one by carving (SH95/6543/0046). The labels of the three vessels TR 2055, ND 6673 and SH03/5953/0131, on the other hand, were carved into the pottery after firing. For the remaining inscriptions, it is uncertain whether they were created before or after firing. Cuneiform script was used on 24 of the 25 vessels, with the exception of vessel SH95/6543/0046, where the capacity was indicated in Phoenician alphabet script. In the cuneiform inscriptions the signs ANŠE, BÁN and SÌLA were used and also combined with each other in various constellations. Often the inscriptions are broken off, so that the numerical values and the different units of the individual inscriptions are not completely preserved. It is noticeable that the vessels very often bear non-integer numerical values.

The examination of the size classes of Middle and Neo-Assyrian vessels have revealed that for the Middle Assyrian period the state organization is reflected in the size categories of certain types of pottery, as is evident from the carinated cups and bowls from Dur-Katlimmu and Tell Sabi Abyad. As a short summary of the Neo-Assyrian evidence it can be stated that at least for the ST bowls presented in **Fig. 7**, a continuity from Middle Assyrian to Neo-Assyrian capacities seems to be evident in the small size groups of around 0.09 and 0.15 litres. However, it is far more difficult to determine precise size groups for decidedly Neo-Assyrian vessels—except for the small beakers, where standardized size groups around 0.27 litres as well as 0.33 litres could be hypothesized. There are indications that the purely Neo-Assyrian bowls analysed in **Fig. 8** might reveal a standardized size group of around 0.44/0.45 litres, given an expansion of the data set.

The difficult and inconsistent data situation results from the strongly varying find circumstances and data availability. For the Middle Assyrian vessels discussed, precise statements about their contexts can be made due to recent excavations and their exemplary state of publication. The contexts can be deemed decidedly administrative. For the Neo-Assyrian period we have a rather diffuse situation due to the different state of publication, since a large part of the corpus comes from older excavations. With Hausleiter's publication, a great variety of complete vessels was made available, but all these come from different sites and from very diverse contexts, including—but not limited to—graves, elite residences and village contexts. It may well be that the discrepancies between the Neo-Assyrian and the Middle Assyrian period stem partly from this diversity of contexts. So far, it has also been difficult to read volumetric size classes from the material of recent excavations in the lower town of Tell Sheikh Hamad (Chambon/Kreppner 2010; Kreppner 2015). The reason for this could be that the excavations did not reveal any particularly official administrative buildings, but rather elite residences in the lower town, whose ceramic inventory covered the various functional areas of private elite households. Nevertheless, it is important to note that, contrary to expectations, the phenomenon that Postgate (2010: 32) has identified for the size classes of the Middle Assyrian period—namely a reaction of the potters to the growing demand for certain types of functions with specific volumetric requirements—has not been reflected in the archaeological evidence to date in a comparable way for the Neo-Assyrian period.

5. Conclusions

To conclude, the discussions and results presented here will be used to reflect on whether the method of consulting pottery jars labelled with measurements of capacity is applicable for calculating, reconstructing, and transferring the Assyrian units to the modern metric system. In the region and time period investigated, the inscriptions have so far been found only on large ceramic vessels. As far as this can be judged from vessels often only preserved in fragments, none of the specimen featured calibration marks. On some examples, the labels were stamped or written in the leather-hard clay before firing. Other vessels were inscribed after firing. However, ceramic is an inappropriate material for measuring vessels which are intended to precisely determine a specific normalized measurement of capacity. This is because the material deforms during production, when clay becomes ceramic during the firing process. As there were no calibration marks on the specimen examined, it is unclear up to where the vessels should be filled to achieve the indicated measurement. In order to measure the capacity and to transfer the results to the modern metric system, modern scientists assume that the vessels should be filled up to the rim. But this is by no means certain. The inscriptions often give non-integer values consisting of various units and subunits, which is inconvenient for measuring vessels. It seems much more likely that these vessels marked with capacity measures were not used for measuring. Several scenarios are conceivable why capacity measures might have been written on these containers. For example, it might have been indicated how much should have been filled into or taken out of the vessel, or how much someone has filled in or taken out. In such cases, only part of the capacity would have been specified in the inscription and small, handy and normalized measuring vessels could have been used for the measuring process. A distinction should be made between whether vessels were labelled before or after firing. Although we do not know the reasons for choosing one or the other variant, we may assume that the different points in time of labelling could indicate dissimilar functions of the inscription. Measuring vessels as they are known from ancient Egypt, made of non-deformable material with calibration markings and related inscriptions indicating integer values, or sets of vessels equilibrated in capacity have not yet been found in archaeological excavations for the 2nd and 1st millennium BCE in Northern Mesopotamia. For the time being, the ceramic vessels discussed in this article had to be consulted. However, as has been shown, these are not suitable for calculating, reconstructing, and transferring the Assyrian measurements of capacity to our modern metric system.

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Table 2. Detailed list of measured capacities and find contexts

Fig.	Object-No.	Provenience	Details	Volume in litres	Volume in max. litres	Capacity in kg wheat	Capacity in kg barley	Period	Bibliography
7	ST 1.1	Assur	Ass. 11209d, VA Ass. 700	0.04	0.06	0.03	0.02	nA IIb	Hausleiter 2010: Pl. 64
7	ST 1.2	Assur	Ass. 10778c, VA Ass. 715	0.05	0.09	0.03	0.03	nA IIb/III	Hausleiter 2010: Pl. 64
7	ST 1.3	Assur	Ass. 11917g, VA Ass. 3429	0.07	0.10	0.05	0.04	nA II	Hausleiter 2010: Pl. 64
7	ST 1.4	Assur	Ass. 12295d, VA Ass. 713	0.06	0.10	0.04	0.04	nA II/III	Hausleiter 2010: Pl. 64
7	ST 1.5	Assur	Ass. 10231p, VA Ass. 710	0.05	0.09	0.04	0.03	nA	Hausleiter 2010: Pl. 64
7	ST 1.6	Assur	Ass. 11029h, VA Ass. 816	0.08	0.10	0.06	0.05	nA II	Hausleiter 2010: Pl. 64
7	ST 1.7	Assur	Ass. 7787 (Niche): Ass. 7814a	0.02	0.03	0.01	0.01	nA Iib	Hausleiter 2010: Pl. 64
7	ST 1.8	Assur	Ass. 10716e, VA Ass. 717	0.04	0.06	0.03	0.02	nA II	Hausleiter 2010: Pl. 64
7	ST 1.9	Assur	Ass. 8877b	0.05	0.07	0.04	0.03	nA II	Hausleiter 2010: Pl. 64
7	ST 1.10	Assur	Ass. 10911a, VA Ass. 701	0.05	0.08	0.04	0.03	nA II	Hausleiter 2010: Pl. 64
7	ST 1.11	Ninive	Ni 476, BM 1932-12-12,880 (WA 137277)	0.09	0.14	0.06	0.05	nA II	Hausleiter 2010: Pl. 64
7	ST 1.12	Assur	Ass. 11817f, VA Ass. 711	0.04	0.09	0.03	0.02	nA II	Hausleiter 2010: Pl. 64
7	ST 1.13	Assur	Ass. 11659f, VA Ass. 801	0.07	0.12	0.05	0.04	nA II	Hausleiter 2010: Pl. 64
7	ST 2.1	Assur	Ass. 21623y, VA Ass. 4396	0.13	0.20	0.10	0.08	mA/nA II	Hausleiter 2010: Pl. 64
7	ST 3.1	Assur	1990, A1-North 33,60–90 m (K. 9)	0.02	0.04	0.02	0.01	mA/nA II	Hausleiter 2010: Pl. 64
7	ST 3.2	Assur	1990, B-C, lower than 36 m (K. 110)	0.08	0.13	0.06	0.05	nA IIb/III	Hausleiter 2010: Pl. 64
7	ST 3.3	Assur	Ass. 11876b, VA Ass. 809	0.08	0.13	0.06	0.05	nA IIb/III	Hausleiter 2010: Pl. 64
7	ST 3.4	Assur	1990, A1-B1 Baulk, until 33.97 m (K. 91)	0.07	0.12	0.05	0.04	nA II	Hausleiter 2010: Pl. 64
7	ST 3.5	Assur	1990, C1-Southeast (level of upper stone pavement), 34 m (K. 58)	0.08	0.13	0.06	0.05	nA II	Hausleiter 2010: Pl. 64
7	ST 3.6	Assur	Ass. 10907h, VA Ass. 803	0.07	0.13	0.05	0.05	nA I/II	Hausleiter 2010: Pl. 64
7	ST 3.7	Assur	Ass. 11832c, VA Ass. 815	0.07	0.12	0.05	0.04	nA II	Hausleiter 2010: Pl. 64
7	ST 3.8	Assur	Ass. 11960k, VA Ass. 802	0.12	0.16	0.09	0.07	nA IIb	Hausleiter 2010: Pl. 64
7	ST 3.9	Assur	Ass. 11917f, VA Ass. 875	0.07	0.13	0.06	0.05	nA I/II	Hausleiter 2010: Pl. 64
7	ST 4.1	Assur	Ass. 12258i, VA Ass. 834	0.09	0.15	0.07	0.06	nA IIb	Hausleiter 2010: Pl. 65
7	ST 4.2	Assur	Ass. 10007k	0.10	0.16	0.07	0.06	nA II	Hausleiter 2010: Pl. 65
7	ST 4.3	Assur	Ass. 11659e, VA Ass. 797	0.09	0.14	0.07	0.06	nA II	Hausleiter 2010: Pl. 65
7	ST 4.4	Assur	Ass. 11917i, VA Ass. 870	0.08	0.15	0.06	0.05	nA I/II	Hausleiter 2010: Pl. 65
7	ST 4.5	Assur	Ass. 11251c, VA Ass. 957	0.11	0.2	0.08	0.07	nA IIb	Hausleiter 2010: Pl. 65
7	ST 4.6	Assur	Ass. 10907n, VA 790	0.07	0.13	0.05	0.04	nA I/II	Hausleiter 2010: Pl. 65
7	ST 4.7	Nimrud	B50, XII (see T.W. 53); BM 1992-3-2,75	0.13	0.21	0.10	0.08	nA IIb	Hausleiter 2010: Pl. 65
7	ST 4.8	Assur	Ass. 7881a	0.14	0.23	0.10	0.09	nA II	Hausleiter 2010: Pl. 65
7	ST 4.9	Assur	Ass. 11960b, VA Ass. 886	0.21	0.32	0.16	0.13	nA II/III	Hausleiter 2010: Pl. 65
7	ST 4.10	Assur	Ass. 10047a	0.09	0.16	0.06	0.05	nA II	Hausleiter 2010: Pl. 65
7	ST 4.11	Assur	Ass. 20782d, VA Ass. 879	0.19	0.26	0.14	0.12	nA II	Hausleiter 2010: Pl. 65
7	ST 5.1	Assur	Ass. 7881b	0.16	0.21	0.11	0.10	nA II	Hausleiter 2010: Pl. 65
7	ST 5.2	Assur	Ass, 12258h, VA Ass. 885	0.23	0.34	0.17	0.14	nA II	Hausleiter 2010: Pl. 65
7	ST 5.3	Qasrij Cliff	-	0.29	0.42	0.21	0.18	nA II	Hausleiter 2010: Pl. 65
7	ST 6.1	Assur	1990, B1-North, Grave S.4 (K. 64)	0.15	0.26	0.11	0.09	nA II	Hausleiter 2010: Pl. 65
7	ST 6.2	Assur	Ass. 10907m, VA Ass. 878	0.14	0.21	0.10	0.09	nA I/II	Hausleiter 2010: Pl. 65
7	ST 7.1	Assur	Ass. 11854c, VA Ass. 1509	0.29	0.53	0.22	0.18	nA II	Hausleiter 2010: Pl. 66

Table 2. (continued from previous page)

Fig.	Object-No.	Provenience	Details	Volume in litres	Volume in max. litres	Capacity in kg wheat	Capacity in kg barley	Period	Bibliography
7	ST 7.2	Assur	Ass. 14123r, VA Ass. 1515	0.29	0.53	0.21	0.18	nA II	Hausleiter 2010: Pl. 66
7	ST 7.3	Assur	Ass. 11286d, VA Ass. 1514	0.20	0.39	0.15	0.12	nA I/II	Hausleiter 2010: Pl. 66
7	ST 7.4	Assur	Ass. 10907l, VA Ass. 1505	0.34	0.69	0.25	0.21	nA I/II	Hausleiter 2010: Pl. 66
7	ST 7.5	Assur	Ass. 10907k, VA Ass. 1510	0.42	0.69	0.31	0.26	nA I/II	Hausleiter 2010: Pl. 66
8	SF 9.1	Nimrud	Fort Shalmaneser, SE 10, surface	0.18	0.23	0.13	0.11	nA II/III	Hausleiter 2010: Pl. 53
8	SF 9.2	Assur	Ass. 10879c, VA Ass. 884	0.19	0.23	0.14	0.12	nA IIb	Hausleiter 2010: Pl. 53
8	SF 9.3	Assur	Ass. 21623ac	0.38	0.43	0.28	0.24	nA II	Hausleiter 2010: Pl. 53
8	SF 9.5	Assur	Ass. 21623d	0.19	0.27	0.14	0.12	nA II	Hausleiter 2010: Pl. 53
8	SF 9.6	Assur	Ass. 13568a, VA Ass. 1494	0.29	0.41	0.21	0.18	nA IIb	Hausleiter 2010: Pl. 53
8	SF 9.7	Assur	Ass. 10590e, VA Ass. 921	0.16	0.23	0.12	0.10	nA II	Hausleiter 2010: Pl. 53
8	SF 9.8	Nimrud	NW-Palace, trench II, Fill; BM 1992-3-2,240	0.22	0.32	0.16	0.13	nA II	Hausleiter 2010: Pl. 53
8	SF 12.1	Assur	Ass. 10231, level I, Ass. 10231z, VA Ass. 892	0.16	0.24	0.12	0.10	nA IIb	Hausleiter 2010: Pl. 55
8	SF 12.2	Assur	Ass. 10870c	0.29	0.43	0.21	0.18	nA IIb/III	Hausleiter 2010: Pl. 55
8	SF 12.3	Assur	Ass. 10778a, VA Ass. 949	0.19	0.35	0.14	0.12	nA IIb/III	Hausleiter 2010: Pl. 55
8	SF 12.4	Assur	Ass. 10231, level I; Ass. 10231r, VA Ass. 950	0.2	0.32	0.15	0.12	nA II	Hausleiter 2010: Pl. 55
8	SF 12.5	Assur	Ass. 10911d	0.28	0.41	0.21	0.17	nA IIb/III	Hausleiter 2010: Pl. 55
8	SF 12.6	Assur	Ass. 10231, level I; Ass. 10231t, VA Ass. 952	0.25	0.44	0.19	0.16	nA IIa	Hausleiter 2010: Pl. 55
8	SF 12.7	Assur	Ass. 10911e	0.15	0.31	0.11	0.09	nA II	Hausleiter 2010: Pl. 55
8	SF 12.8	Nimrud	NW-Palast, trench II; ND 597, BM 1992-3-2,212	0.22	0.32	0.16	0.14	nA II	Hausleiter 2010: Pl. 55
8	SF 12.9	Assur	Ass. 22142h, VA Ass. 1490	0.2	0.45	0.15	0.12	nA IIb/III	Hausleiter 2010: Pl. 55
8	SF 12.10	Assur	Ass. 20117a, VA Ass. 924	0.3	0.49	0.22	0.18	nA II	Hausleiter 2010: Pl. 55
8	SF 12.11	Humaidat	Nr. 1001	0.43	0.64	0.32	0.26	nA II	Hausleiter 2010: Pl. 55
8	SF 12.12	Nimrud	B50, Room 19; BM 1992-3-2,244	0.23	0.47	0.17	0.14	nA II	Hausleiter 2010: Pl. 55
8	SF 12.13	Nimrud	Fort Shalmaneser, SE-Gate	0.51	0.68	0.38	0.32	nA III	Hausleiter 2010: Pl. 55
8	SF 18.1	Nimrud	Fort Shalmaneser SE 10, lower pavement	0.29	0.56	0.21	0.18	nA III	Hausleiter 2010: Pl. 58
8	SF 18.2	Nimrud	Fort Shalmaneser, Y, destroyed pavement	0.18	0.39	0.13	0.11	nA IIb/III	Hausleiter 2010: Pl. 58
8	SF 18.3	Nimrud	Fort Shalmaneser Y, pavement	0.25	0.47	0.18	0.15	nA IIb/III	Hausleiter 2010: Pl. 58
8	SF 18.4	Assur	Ass. 11748g1, VA Ass. 1495	0.31	0.63	0.23	0.19	nA II	Hausleiter 2010: Pl. 58
8	SF 18.5	Assur	Ass. 7787: Ass. 7793d	0.34	0.63	0.25	0.21	nA IIb	Hausleiter 2010: Pl. 58
8	SF 18.6	Assur	Ass. 10231m, VA Ass. 1455	0.46	0.75	0.34	0.28	nA II	Hausleiter 2010: Pl. 58
8	SF 18.7	Assur	Ass. 7794 in Ass. 7787, Ass. 7795a	0.46	0.75	0.34	0.28	nA IIb	Hausleiter 2010: Pl. 58
8	SF 18.8	Nimrud	NW-Palace, trench II; ND 608, BM 1992-3-2,57	0.31	0.6	0.23	0.19	nA II	Hausleiter 2010: Pl. 58
8	SF 20.1	Nimrud	Citadel	0.37	0.68	0.27	0.23	nA II	Hausleiter 2010: Pl. 59
8	SF 20.2	Nimrud	Fort Shalmaneser SE 18	0.48	0.83	0.36	0.30	nA II/III	Hausleiter 2010: Pl. 59
8	SF 20.3	Assur	Ass. 10590a, VA Ass. 1436	0.46	0.82	0.34	0.28	nA II	Hausleiter 2010: Pl. 59
8	SF 20.4	Assur	Ass. 10956a, VA Ass. 1397	0.21	0.38	0.15	0.13	nA II	Hausleiter 2010: Pl. 59
8	SF 20.5	Assur	Ass. 11748c, VA Ass. 1405	0.37	0.65	0.27	0.23	nA II	Hausleiter 2010: Pl. 59
8	SF 20.6	Assur	Ass. 10231, level I, Ass. 10231x, VA Ass. 1401	0.44	0.73	0.33	0.28	nA II	Hausleiter 2010: Pl. 59
8	SF 20.7	Assur	Ass. 11748e, VA Ass. 1407	0.25	0.45	0.19	0.16	nA II	Hausleiter 2010: Pl. 59
8	SF 20.8	Assur	Ass. 10888a	0.39	0.65	0.29	0.24	nA II	Hausleiter 2010: Pl. 59

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Fig.	Object-No.	Provenience	Details	Volume in litres	Volume in max. litres	Capacity in kg wheat	Capacity in kg barley	Period	Bibliography
8	SF 20.9	Nimrud	Citadel	0.46	0.9	0.34	0.28	nA II/III	Hausleiter 2010: Pl. 59
8	SF 20.10	Assur	Ass. 12047b, VA Ass. 1404	0.29	0.52	0.22	0.18	nA IIb	Hausleiter 2010: Pl. 59
8	SF 20.11	Assur	Ass. 10716h, VA Ass. 1403	0.35	0.63	0.26	0.21	nA II	Hausleiter 2010: Pl. 59
8	SF 20.12	Assur	Ass. 10231, level II; Ass. 10231n, VA Ass. 1402	0.33	0.58	0.21	0.21	nA II	Hausleiter 2010: Pl. 59
8	SF 20.13	Nimrud	A49 from deep pit of top level (see T.W. 53); ND 676, BM 1992-3-2,303	0.58	1.02	0.43	0.36	nA II/III	Hausleiter 2010: Pl. 59
8	SF 20.14	Assur	Ass. 7787: Ass. 7793i	0.65	1.10	0.48	0.40	nA II	Hausleiter 2010: Pl. 59
9	BZ 2.1	Tell Rimah	Area D, grave DG 16-66	0.16	0.17	0.12	0.10	nA II	Hausleiter 2010: Pl. 77
9	BZ 2.2	Tell Rimah	Area D (D 147)	0.13	0.17	0.09	0.08	nA II	Hausleiter 2010: Pl. 77
9	BZ 2.3	Assur	Ass. 11817a, VA Ass. 114	0.17	0.2	0.13	0.11	nA II	Hausleiter 2010: Pl. 77
9	BZ 2.4	Tell Rimah	Area C (C 97)	0.14	0.16	0.10	0.08	nA II	Hausleiter 2010: Pl. 77
9	BZ 2 B1	Nimrud	Fort Shalmaneser	0.15	0.16	0.11	0.09	nA II/III	Hausleiter 2010: Pl. 77
9	BZ 2.5	Assur	Ass. 13728h, VA Ass. 108	0.2	0.28	0.15	0.13	nA II	Hausleiter 2010: Pl. 77
9	BZ 2.6	Assur	Ass. 10462a	0.16	0.24	0.12	0.10	nA II	Hausleiter 2010: Pl. 77
9	BZ 2.7	Assur	Ass. 9866h, VA Ass. 531	0.31	0.43	0.23	0.19	nA II	Hausleiter 2010: Pl. 77
9	BZ 2.8	Assur	Ass. 11951a, VA Ass. 124	0.23	0.28	0.17	0.14	nA II	Hausleiter 2010: Pl. 77
9	BZ 2.9	Assur	Ass. 11960l, VA Ass. 122	0.28	0.38	0.21	0.18	nA II/III	Hausleiter 2010: Pl. 77
9	BZ 2.10	Tell Rimah	Area D (D 82)	0.51	0.62	0.38	0.32	nA II	Hausleiter 2010: Pl. 77
9	BZ 2.11	Tell Rimah	Area C (C 186)	0.59	0.64	0.44	0.37	nA II	Hausleiter 2010: Pl. 77
9	BZ 2.12	Assur	Ass. 11279d, VA Ass. 119	0.36	0.49	0.27	0.23	nA IIb	Hausleiter 2010: Pl. 77
9	BT 2.1	Assur	Ass. 21623i, VA Ass. 37	0.15	0.2	0.11	0.10	nA II	Hausleiter 2010: Pl. 82
9	BT 2.2	Nimrud	Burnt Palace, Ivory Floor; ND 1819, BM 1992-3-2,100	0.23	0.34	0.17	0.14	nA II	Hausleiter 2010: Pl. 82
9	BT 2.3	Tell Rimah	Area C (C 117)	0.18	0.27	0.13	0.11	nA II	Hausleiter 2010: Pl. 82
9	BT 2.4	Assur	Ass. 21623a, VA Ass. 31	0.20	0.26	0.15	0.12	nA II	Hausleiter 2010: Pl. 82
9	BT 2.5	Khirbet Khatuniyeh	Level 4	0.10	0.15	0.08	0.06	nA II	Hausleiter 2010: Pl. 82
9	BT 2.6	Nimrud	SEB 10, Pavement with Assur-etel-ilani bricks, 2 m beneath surface, against the northern wall, 1.1 m off the western wall; ND 5025, BM 1992-3-2,184	0.19	0.26	0.14	0.11	nA IIb	Hausleiter 2010: Pl. 82
9	BT 2.7	Assur	Ass. 10778e, VA Ass. 15	0.27	0.38	0.20	0.17	nA IIb	Hausleiter 2010: Pl. 82
9	BT 2.8	Assur	Ass. 10781n, VA Ass. 143	0.16	0.25	0.12	0.10	nA IIb	Hausleiter 2010: Pl. 82
9	BT 2.9	Assur	Ass. 10668c, VA Ass. 560	0.28	0.39	0.20	0.17	nA IIb	Hausleiter 2010: Pl. 82
9	BT 2.10	Assur	Ass. 10778d, VA Ass. 10	0.23	0.37	0.17	0.14	nA IIb	Hausleiter 2010: Pl. 82
9	BT 2.11	Assur	Ass. 11029f, VA Ass. 520	0.29	0.38	0.22	0.18	nA II	Hausleiter 2010: Pl. 82
9	BT 2.12	Assur	Ass. 11190k, VA Ass. 139	0.33	0.46	0.24	0.20	nA I/II	Hausleiter 2010: Pl. 82
9	BT 2.13	Assur	Ass. 14014a, VA Ass. 4290	0.33	0.52	0.24	0.20	nA II	Hausleiter 2010: Pl. 82
9	BT 9.1	Assur	Ass. 20117b, VA Ass. 171	0.21	0.31	0.15	0.13	nA II	Hausleiter 2010: Pl. 84
9	BT 9.2	Assur	Ass. 12054f, VA Ass. 12	0.32	0.43	0.24	0.20	nA IIb	Hausleiter 2010: Pl. 84
9	BT 9.3	Assur	Ass. 10744i, VA Ass. 146	0.33	0.47	0.25	0.21	nA II/III	Hausleiter 2010: Pl. 84
9	BT 9.4	Assur	Ass. 10797i, VA Ass. 13	0.29	0.41	0.21	0.18	nA II	Hausleiter 2010: Pl. 85
9	BT 9.5	Assur	Ass. 10097b, Assur-Gräbertafel Nr. 48	0.59	0.79	0.44	0.37	nA IIb	Hausleiter 2010: Pl. 85
9	BT 9.6	Assur	Ass. 10652a, VA Ass. 5	0.61	0.89	0.45	0.38	nA IIb	Hausleiter 2010: Pl. 85

Table 2. (continued from previous page)

Fig.	Object-No.	Provenience	Details	Volume in litres	Volume in max. litres	Capacity in kg wheat	Capacity in kg barley	Period	Bibliography
9	BT 9.7	Assur	Ass. 10097a, Assur-Gräbertafel Nr. 48	0.45	0.6	0.33	0.28	nA IIb	Hausleiter 2010: Pl. 85
9	BT 9.8	Assur	Ass. 11819d, VA Ass. 8	0.33	0.45	0.25	0.21	nA II	Hausleiter 2010: Pl. 85
9	BT 9.9	Assur	Ass. 11659g, VA Ass. 9	0.47	0.69	0.35	0.29	nA IIb	Hausleiter 2010: Pl. 85
9	BT 9.10	Assur	Ass. 10881b	0.23	0.41	0.17	0.14	nA II/III	Hausleiter 2010: Pl. 85
9	BT 9.11	Ninive	Ni 486, BM 1932-12-12,862, WA 137259	0.28	0.39	0.21	0.17	nA II	Hausleiter 2010: Pl. 85
9	BD 1.1	Assur	Ass. 22142g, VA Ass. 174	0.21	0.27	0.15	0.13	nA IIb/III	Hausleiter 2010: Pl. 86
9	BD 1.3	Nimrud	NW-Palace Z.T. 12; ND 1842	0.15	0.28	0.11	0.09	nA IIb	Hausleiter 2010: Pl. 86
9	BD 1.4	Assur	Ass. 8138a, VA Ass. 165	0.14	0.19	0.11	0.09	nA IIb	Hausleiter 2010: Pl. 86
9	BD 1.5	Nimrud	Fort Shalmaneser, C 1, 70–80 cm above the pavement	0.46	0.63	0.34	0.28	nA III	Hausleiter 2010: Pl. 86
9	BD 1.6	Assur	Ass. 10745a	0.50	0.65	0.37	0.31	nA IIb	Hausleiter 2010: Pl. 86
9	BD 1.7	Nimrud?	N 1882, WA 92885	0.23	0.32	0.17	0.14	nA IIb	Hausleiter 2010: Pl. 86
9	BD 1.8	Assur	Abschnitt 3, Ass.2000.D-175	0.16	0.22	0.12	0.10	nA IIb	Hausleiter 2010: Pl. 86
9	BD 1.10	Nimrud	Fort Shalmaneser	0.45	0.65	0.33	0.28	nA IIb/III	Hausleiter 2010: Pl. 86
9	BD 1.11	Khirbet Khatuniyeh	Level 4	0.16	0.26	0.12	0.10	nA IIb/III	Hausleiter 2010: Pl. 86
9	BD 1.12	Nimrud	NW-Palace, Z.T. 12; ND 1843	0.33	0.51	0.25	0.21	nA IIb	Hausleiter 2010: Pl. 86
9	BD 1.13	Nimrud	NW-Palace, Z.T. 12; ND 1838	0.16	0.29	0.12	0.10	nA II	Hausleiter 2010: Pl. 86
9	BD 1.14	Nimrud	NW-Palace, Z.T. 12; ND 1836	0.13	0.24	0.10	0.08	nA IIb	Hausleiter 2010: Pl. 86
9	BD 1.15	Nimrud	NW-Palace, Z.T. 12; ND 1945	0.30	0.48	0.23	0.19	nA IIb	Hausleiter 2010: Pl. 86
9	BD 2.1	Nimrud	Citadel	0.14	0.19	0.10	0.09	nA II	Hausleiter 2010: Pl. 87
9	BD 2.2	Nimrud	Citadel; N 36	0.16	0.23	0.12	0.10	nA II/III	Hausleiter 2010: Pl. 87
9	BD 2.3	Nimrud	Citadel; ND 503	0.18	0.32	0.13	0.11	nA II/III	Hausleiter 2010: Pl. 87
9	BD 2.4	Balawat	pavement of the SW shrine of Mahir; Bt 152, BM 1992-3-2,189	0.14	0.18	0.10	0.09	nA II	Hausleiter 2010: Pl. 87
9	BD 2.5	Nimrud	Fort Shalmaneser, C 2, above pavement; ND 7305, BM 1992-3-2,187	0.13	0.21	0.10	0.08	nA III	Hausleiter 2010: Pl. 87
9	BD 2.6	Ninive	BM 1932-12-12,897	0.17	0.26	0.13	0.11	nA II	Hausleiter 2010: Pl. 87
9	BD 2.7	Assur	Ass. 12712a, VA Ass. 542	0.27	0.34	0.20	0.16	nA II	Hausleiter 2010: Pl. 87
9	BD 2.8	Nimrud?	BM 1948-11-4,244	0.15	0.21	0.11	0.09	nA II	Hausleiter 2010: Pl. 87
9	BD 2.9	Nimrud	Fort Shalmaneser, S 10	0.10	0.13	0.08	0.07	nA III	Hausleiter 2010: Pl. 87
10	92/5755/0215	Tell Sheikh Hamad	Haus 3, FS 5755/040 : T 8; AZ_05_01/N_E	0.10	0.17	0.07	0.06	nA III	
10	84/9175/0175	Tell Sheikh Hamad	Gebäude F, T14, FS 9175/134	0.15	0.2	0.11	0.09	nA III	
10	78/1729/0012	Tell Sheikh Hamad	Grab 78/001, Grabbereich c. 20 cm unter der Oberfläche	0.16	0.24	0.12	0.10	mA	
10	92/6151/0046	Tell Sheikh Hamad	Haus 4, Raum RR, Phase 2b, FS 6151/135	0.24	0.25	0.18	0.15	nA II	Kreppner 2006: Taf. 6.7
10	00/6747/0143	Tell Sheikh Hamad	Rotes Haus, Raum IW, FS 6747/304, Ende 4. Nutzung	0.25	0.26	0.19	0.16	nA III	Kreppner 2006: Taf. 97.5
10	93/6147/0199	Tell Sheikh Hamad	Rotes Haus, Raum TZ, FS 6147/079, Ende 4. Nutzung	0.26	0.26	0.19	0.16	nA III	Kreppner 2006: Taf. 97.4
10	92/6151/0295	Tell Sheikh Hamad	Haus 4, Raum RR, Phase 2b, FS 6151/235	0.26	0.27	0.20	0.17	nA II	Kreppner 2006: Taf. 11.2
10	92/6151/0318	Tell Sheikh Hamad	Haus 4, Raum RR, Phase 2b, FS 6151/163	0.26	0.27	0.20	0.17	nA II	Kreppner 2006: Taf. 11.3
10	92/6151/0576	Tell Sheikh Hamad	Haus 4, Raum RR, Phase 2b, FS 6151/275	0.26	0.27	0.20	0.17	nA II	Kreppner 2006: Taf. 11.5
10	92/5949/0084	Tell Sheikh Hamad	Haus 1, Süd, Phase 2c–3b, Brandgrubengrab 92/086	0.20	0.28	0.15	0.13	nA III	
10	08/6153/0010	Tell Sheikh Hamad	FS 6153/737, Phase Ib, Abtiefen des T 26 auf Fußboden I 409	0.16	0.29	0.12	0.10	nA I	
10	84/9175/0175	Tell Sheikh Hamad	Gebäude F, Raum B, FS 9175/134	0.22	0.29	0.17	0.14	nA III	

Table 2. (continued from previous page)

Fig.	Object-No.	Provenience	Details	Volume in litres	Volume in max. litres	Capacity in kg wheat	Capacity in kg barley	Period	Bibliography
10	03/5953/0054	Tell Sheikh Hamad	Haus 1, Nord, Phase 2c, kleine Gefäßgrube in T 24 (Gefäß, fragmentiert)	0.17	0.3	0.12	0.10	nA II	
10	86/6153/0022	Tell Sheikh Hamad	FS 16; T 6; FS 6153/215	0.20	0.33	0.15	0.12	nA II	
10	87/5751/0026	Tell Sheikh Hamad	Haus 1, Süd, Phase 3b, T 12/14; Inst. 18; FS 5751/072	0.26	0.34	0.19	0.16	nA III	
10	95/6543/0094	Tell Sheikh Hamad	Rotes Haus, Fundbereich 4, Raum TX, Phase 4, FS 6543/045	0.33	0.34	0.25	0.21	nA III	Kreppner 2006: Taf. 97.6
10	86/8975/0157	Tell Sheikh Hamad	Gebäude F, FS 8975/073; Raum B, direkt auf Fußboden Inst. 14	0.27	0.34	0.20	0.16	nA III	
10	92/5755/0214	Tell Sheikh Hamad	Haus 3, Raum AZ, Phase 3c, FS 5755/040, AZ_05_01/N_E	0.3	0.36	0.22	0.19	nA III	
10	92/5755/0031	Tell Sheikh Hamad	Haus 3, Raum FX, Phase 2c, FS 5755/018 . Im Tannur I 4, Hof ZZ, FX_05_01/H_A	0.22	0.38	0.16	0.14	nA II	
10	03/5751/0689	Tell Sheikh Hamad	Haus 1, Süd, Raum FT, Phase 3b, FS 5751/533	0.35	0.43	0.26	0.22	nA III	
10	87/5951/0273	Tell Sheikh Hamad	Haus 1–4, Raum CC, Phase 3b, FS 179, FS 5951/179	0.38	0.43	0.28	0.24	nA III	
10	94/6551/0269	Tell Sheikh Hamad	Rotes Haus, Raum MX, Phase 8, FS 6551/052	0.54	0.54	0.40	0.34	nA III	Kreppner 2006: Taf. 110.1
10	95/6345/0339	Tell Sheikh Hamad	Rotes Haus, Raum UX, Phase 4, FS 6345/221	0.54	0.55	0.40	0.34	nA III	Kreppner 2006: Taf. 97.8
10	92/6151/0544	Tell Sheikh Hamad	Haus 4, Raum RR, Phase 2b, FS 6151/275	0.65	0.66	0.48	0.40	nA II	Kreppner 2006: Taf. 11.4
10	93/6147/0223	Tell Sheikh Hamad	Rotes Haus, Raum TZ, Phase 4, FS 6147/079	0.69	0.70	0.52	0.43	nA III	Kreppner 2006: Taf. 97.2
10	97/6543/0068	Tell Sheikh Hamad	Rotes Haus, Raum PW, Phase 4, FS 6543/101	0.74	0.75	0.55	0.46	nA III	Kreppner 2006: Taf. 97.7
10	97/6543/0043	Tell Sheikh Hamad	Rotes Haus, Raum PW, Phase 4, FS 6543/101	0.77	0.78	0.57	0.48	nA III	Kreppner 2006: Taf. 97.1
10	92/6151/0235	Tell Sheikh Hamad	Haus 4, Raum QQ, Phase 3b, FS 6151/194	0.65	0.79	0.48	0.40	nA III	
10	92/6151/0497	Tell Sheikh Hamad	Haus 4, Raum RR, Phase 2b, FS 6151/274	0.82	0.83	0.61	0.51	nA II	Kreppner 2006: Taf. 11.6
10	03/6153/0484	Tell Sheikh Hamad	Haus 4, Raum LT, FS 6153/352, Phase 3b	11.86	12.35	8.77	7.35	nA III	
10	86/8975/0098	Tell Sheikh Hamad	Gebäude F, Raum B, FS 8975/065	16.05	16.27	11.88	9.95	nA III	
10	95/6543/0048	Tell Sheikh Hamad	Rotes Haus, Raum PW, FS 6543/013, Ende 4. Nutzung	18.24	18.73	13.49	11.3	nA III	Kreppner 2006: Taf. 20.1
10	95/6543/0046	Tell Sheikh Hamad	Rotes Haus, Raum PW, FS 6543/013, Ende 4. Nutzung; phönizische Aufschrift mit Hohlmaßangabe 3 sūtu	18.67	19.26	13.82	11.5	nA III	Kreppner 2006: Taf. 15.2
10	95/6545/1187	Tell Sheikh Hamad	Rotes Haus, Raum JW, FS 6545/107, Ende 4. Nutzung	24.50	24.80	15.22	15.2	nA III	Kreppner 2006: Taf. 22.2
10	94/6345/0279	Tell Sheikh Hamad	Rotes Haus, Raum TX, FS 6345/098, Ende 4. Nutzung	27.00	27.40	20.00	16.78	nA III	Kreppner 2006: Taf. 22.1
10	95/6543/0151	Tell Sheikh Hamad	Rotes Haus, Raum PW, FS 6543/032, Ende 4. Nutzung	27.36	28.04	20.25	16.9	nA III	Kreppner 2006: Taf. 14.1
10	95/6543/0141	Tell Sheikh Hamad	Rotes Haus, Raum PW, FS 6543/032, Ende 4. Nutzung	44.10	44.75	32.63	27.3	nA III	Kreppner 2006: Taf. 17.1
10	95/6543/0162	Tell Sheikh Hamad	Rotes Haus, Raum PW, FS 6543/032, Ende 4. Nutzung	54.11	54.92	40.04	33.5	nA III	Kreppner 2006: Taf. 16.1
10	95/6543/0018/083	Tell Sheikh Hamad	Rotes Haus, Raum PW, FS 6543/032, Ende 4. Nutzung	54.03	57.62	39.98	33.5	nA III	Kreppner 2006: Taf. 14.2
10	179	Khirbet Khatuniyeh	Level 4 Building, Room 1	11.23	12.27	9.08	7.61	nA IIb	Curtis/Green 1997: Fig. 41
10	190	Khirbet Khatuniyeh	Level 4 Building, Room 2	12.45	12.88	9.53	7.98	nA IIb	Curtis/Green 1997: Fig. 42
10	188	Khirbet Khatuniyeh	Level 4 Building, Room 2	12.95	13.72	9.81	8.22	nA IIb	Curtis/Green 1997: Fig. 42
10	191	Khirbet Khatuniyeh	Level 4 Building, Room 1	14.86	15.22	11.26	9.44	nA IIb	Curtis/Green 1997: Fig. 42
10	183	Khirbet Khatuniyeh	Level 4 Building, Room 1	16.02	17.11	12.66	10.60	nA IIb	Curtis/Green 1997: Fig. 41
10	180	Khirbet Khatuniyeh	Level 4 Building, Room 1	17.07	17.40	13.79	11.50	nA IIb	Curtis/Green 1997: Fig. 41
10	185/186	Khirbet Khatuniyeh	Level 4 Building, Room 1	16.60	17.79	13.17	11.00	nA IIb	Curtis/Green 1997: Fig. 41
10	187	Khirbet Khatuniyeh	Level 4 Building, Room 1	17.98	18.44	13.65	11.40	nA IIb	Curtis/Green 1997: Fig. 40
10	177	Khirbet Khatuniyeh	Level 4 Building, Room 1	25.36	26.64	19.72	16.50	nA IIb	Curtis/Green 1997: Fig. 43
10	198	Khirbet Khatuniyeh	Level 4 Building, Room 1	35.38	35.56	26.32	22.00	nA IIb	Curtis/Green 1997: Fig. 43

Table 2. (continued from previous page)

Fig.	Object-No.	Provenience	Details	Volume in litres	Volume in max. litres	Capacity in kg wheat	Capacity in kg barley	Period	Bibliography
10	197	Khirbet Khatuniyeh	Level 4 Building, Room 1	37.86	38.35	28.38	23.70	nA IIb	Curtis/Green 1997: Fig. 45
10	205	Khirbet Khatuniyeh	Level 4 Building, Room 1	41.43	41.94	31.03	26.00	nA IIb	Curtis/Green 1997: Fig. 44
10	199/200	Khirbet Khatuniyeh	Level 4 Building, Room 1	42.09	43.83	32.44	27.10	nA IIb	Curtis/Green 1997: Fig. 43
10	196	Khirbet Khatuniyeh	Level 4 Building, Room 1	49.85	50.35	37.26	31.20	nA IIb	Curtis/Green 1997: Fig. 43
10	204	Khirbet Khatuniyeh	Level 4 Building, Room 1	53.48	54.19	40.10	33.60	nA IIb	Curtis/Green 1997: Fig. 44

Capacity measures in context II: New considerations on capacity units and their "standards" in Mesopotamia and Egypt

Tanja Pommerening, Grégory Chambon and Lionel Marti

1. Introduction

Within the framework of the METROLOGIA project, similar phenomena have been observed both in the Old Babylonian and in the Middle Assyrian epigraphic corpora: on the one hand, the way scribes reported capacity standards in the administrative texts, and on the other hand, the way modern scholars have interpreted these standards.

M. A. Powell's important synthesis on weights and measures in Mesopotamia postulated—as did many subsequent works based on it—that a variety of capacity standards for one and the same unit coexisted in everyday practice as reflected in various expressions in the administrative documentation, even though it was accepted that sometimes the same standard could be designated in different ways.[1] However, as K. Veenhof pointed out, followed by N. Postgate in this volume, it is actually difficult to know whether these expressions referred to physical containers of different standard volumes according to the offices using them at a material level, or to abstract volumes, fixed in relation to capacity standards for accounting at an abstract and purely functional level.[2] The difficulty in confirming or not one of these two hypotheses, which were based on the textual sources only, lies in the fact that the archaeological remains of measuring vessels are very scanty. In this respect, it is useful to look at Ancient Egypt, where cylindrical stone, leather and wooden standard vessels used for measuring crops from the time of the New Kingdom have been well preserved, and where also depictions of the measuring process of agricultural products still exist. In addition, there is valuable text material on derivations from standards.[3]

The first assumption for capacity measures in Mesopotamia, namely to postulate a number of different materialised capacity standards in everyday practice (i.e. the volume of *x* is different from the volume of *y*), is the most common one in Assyriology. Starting with such an assumption, the aim of the scholars is to reconstruct relative values between units within each measuring system and to identify absolute values by converting the ancient standards into modern standards (see the introduction to this volume). The implications of such a view for economic history go beyond purely quantitative evaluations. One might wonder, as some anthropologists do, whether the great diversity of capacity standards used in the same region and sometimes in the same locality reflects the fragmentation of political power or—conversely—whether the attempts to standardise systems of meas-

1 Powell 1990. Powell tried above all to establish a list of various designations of capacity measures, and to reconstruct the arithmetical relations between the capacity units.

2 The terms used for capacity measures are often ambiguous. For example, Z. Földi quite rightly stresses—in his study on the meaning of the term *sūtu* (written ^{giš}BÁN) in state/private business in Larsa Kingdom—that this administrative term, which he translates as "concession" (for the right of collecting the commodities purchased by individual entrepreneurs from the State), has a "logographic writing ^{giš}BÁN, [which] suggests that he has a strong connection with *sūtu* as a capacity measure (and measuring vessel)" (Földi 2014).

3 See for instance Pommerening 2005 and section 3.3 in this article.

urement for a large territory are due to the emergence of a strong and centralising power.[4] The Old Babylonian and Middle Assyrian periods provide good case studies regarding this issue, because of their cultural and political differences. The first period is characterised by a fragmented group of kingdoms with local specificities and shared socio-economic practices on an "inter-regional" scale, whereas the second period could be regarded as an empire that developed a strong religious and political ideology and a centralised administration controlling a whole system of redistribution centres for a vast territory. Most of the time, this perspective is transposed from our experience with the contemporary unified metric system in contrast to the great variety of measuring systems used for example in pre-revolutionary France or Great Britain prior to the establishment of the imperial system. According to this "metrotopology", the coexistence of different capacity standards in the same place would testify to trade or political contacts at regional level, disregarding the possibility that the units of measurement could have belonged to different unrelated metrological systems, each used in the same administration for different purposes, at local level.[5] Furthermore, this assumption takes it for granted that texts combining two different units of capacity in one phrase reflects a conversion between two capacity standards. However, if one puts the commodity transactions recorded in the texts back into their context, one could also assume that such combinations of capacity units could in some cases not be interpreted as expressions of a conversion, but rather as administrative information relating to management issues such as the type of grain procurement, the tracing of commodities in the administrative process and the type of offices involved in the transaction.[6]

This article aims to explore the relationships between capacity units (concept), measuring vessels (material object) and their incorporated capacity standards (social, economic and/or political agreement) based on Mesopotamian texts and Ancient Egyptian sources. By focusing more on administrative practices, and on qualitative rather than quantitative aspects, we suggest new ways to approach metrology in economic and social contexts. This study, which is the second of a two-part investigation (Capacity Measures in Context I and II[7]), is thus intended more as a constructive critique of traditional methods of interpretation in the field of metrology, rather than as background work on Mesopotamian economic realities.

4 See the important remarks of the anthropologist A. Testart in the foreword of Le Roux/Sellaton/Ivanoff 2004.

5 According to Eriksen 2007, the standardisation of units of measurement is one of the solutions to challenges posed by increasing mobility, growing interconnectedness of people and markets and intensified cultural contacts.

6 See Chambon/Marti 2017.

2. The issue of capacity standards

The following examples, from the Old Babylonian and the Middle Assyrian documentation respectively, provide an overview of the different ways of interpreting capacity standards in the cuneiform documentation.

The first document, an administrative text found in the ancient city of Mari (modern Tell Hariri) on the Middle Euphrates, was written by a scribe of the palace administration during the reign of King Zimrī-Lîm (18th century BC). It records the receipt of an amount of grain by a palace official called Ilu-kān.

ARM 11 85 (extract)

4 A.GÀR 9 GUR 5 SILA$_3$ *bu-rum*
2 *i-na* ^{giš}1 GUR *ki-ti*
nam-ha-ar-ti
4 ^{I}AN-*ka-an*
…

4 *ugārum* 9 *kur* 5 *qû* of *grain-burrum*
2 according to the (capacity measure) *kur kittum*
receipt
4 by Ilu-*kān*
…

The designation for capacity measures in the first line refers to the amount of grain-*burrum* (husked barley) that was received by the official; this amount could be calculated, estimated or measured.[8] The capacity units used belong to the local capacity system in Mari, with the following relationships between capacity units: 1 *ugārum*/A.GÀR = 1200 *qû*/SILA$_3$ and 1 *kur*/GUR = 120 *qû*/SILA$_3$. This designation "4 A.GÀR 9 GUR 5 SILA$_3$" corresponds to the record of an amount of grain, and thus to an accounting entry rather than to the mention of a materialised capacity standard. However, the designation in the second line "*ina* ^{giš}1 GUR *ki-ti*" seems at first glance to be more linked with the material background of the capacity measure, because the sign GUR for the *kur*-measure is: 1°) preceded

7 *Ibid.*

8 See the discussion by Chambon 2018: 46–56.

by the Akkadian preposition *ina*, with the meaning "in, on; according to"; 2°) written with the semantic indicator GIŠ for wooden objects, and 3°) followed by *kitti*, the feminine form of the Akkadian adjective *kinum*, which has the meaning "just, legitimate, correct", but also "normal, regular".

Two hypotheses may be envisaged. First, the second line could refer to a *measuring vessel* of one *kur* standardised according to the standard unit of the capacity system (the *qû*), i.e. a specific container that was repeatedly handled by pouring and filling the grain during the measuring procedure. This type of measuring tool must have had a cylindrical shape, according to the examples known in Egypt, made of wood or leather (see section 3.3)[9], or to the depictions of cylindrical measuring containers for grain on Late Akkadian seals (see CHAMBON and OTTO this volume, p. 8, Fig. 6). We have to assume that only a few vessels normalised to a standard existed and were available to administrations. This interpretation leads to the translation "4 *ugārum* 9 *kur* 5 *qû* of grain-*burrum* (measured) **according to** the (measuring vessel) *kur kittum* (used when measuring grain)". The material (wood or leather) of these measuring tools could explain why no archaeological evidence has survived so far in the wetter environment of Mesopotamia. However, this kind of vessels have survived in Ancient Egypt (see section 3.3).

The second hypothesis is that of a *physical container*, made of wood or braided plant material (reed, palm…) used to store or transport the grain, which instead leads to translate the passage as "4 *ugārum* 9 *kur* 5 *qû* of grain-*burrum* (stored or transported) **in** (containers) of the *kur kittum* type". This container could (but did not have to) have a standardised volume, which made it possible to calculate the quantity of grain stored or transported by simply counting the number of containers. For example, the older documentation from the Ur III period mentions containers *parsiktum*/BARIGA of standardised volume (of 60 *qû*, ca. 60 litres), which are used for both measuring and transporting barley.[10] Also this kind of vessel has survived in Ancient Egypt (see section 3.3). The matter of counting the number of containers with a standardised volume to obtain the overall quantity is also attested by some Middle-Assyrian documents. They bear marks of the counting of bags filled with grain and carried by donkeys (see POSTGATE in this volume p. 91). In an administrative text, for example, 86 bags full of grain, noted by 86 marks, correspond to the recorded total of 43 homers, i.e. the standardised load carried by a donkey (*emārum*/ANŠE, "homer" = 100 SILA$_3$, ca. 50 to 65 kg of grain).[11] This same principle of counting standardised containers can also be found in school texts of the Medio-Babylonian period. On CBS 11557 for example, the 50 marks written on one side of a lenticular tablet correspond to the 100 "big" *sūtu*-measure (^{giš}BÁN GAL) mentioned on the other side: the marks were certainly made during the counting of 50 vessels with a standardised volume of 2 "big" *sūtu*-measures. [12]

However, in the previous case of *ARM* 11 85, the first assumption of a *measuring vessel* of standard size used when measuring grain can hardly be retained for two main reasons. First, it is not possible to measure an amount of 5 *qû*, a submultiple of the *kur*, with a measuring vessel of one *kur* (= 120 *qû*), except if we consider that the expression "*i-na* ^{giš}1 GUR *ki-ti*" in the second line refers to a set of measuring vessels as a whole. Second, such a vessel would be too heavy (about 120 litres or 60 litres[13]) and not manageable in order to carry out the measuring process when repeatedly pouring and filling the grain. Thus, the second assumption of a *physical container* (of certainly a standardised volume) seems to be the most suitable (Compare this with the Khar ("Sack") in Ancient Egypt, cf. section 3.3). A parallel may be drawn with similar expressions written after amounts of foodstuffs in administrative texts, as in this receipt of oil in Mari, where "*ina* DUG *našpaki*" clearly refers to a jar (DUG) used to store sesame oil:

9 For the depiction of a set of capacity measures of various volumes in the tomb of Ḥsjj-Rʿ at Saqqara (reign of Djoser in the Third Dynasty), see POMMERENING 2005: 282–287.

10 See W. SALLABERGER 2022. G. Chambon thanks the author for showing him his manuscript before publication.

11 MARV 5 57. See remarks in FREYDANK / FELLER 2004: 12 and the text MARV 7 46, which is studied below.

12 BARTELMUS 2018: 11–13.

13 For the value of the *qû*/SILA$_3$ in modern litre, see CHAMBON 2011: 177–179 and RECULEAU 2018: 109 and the comments above. Chambon has suggested that the value of the *qû* in Mari (and maybe in the north-western regions as well) during the Old Babylonian period is ca. 0.5 litres (0.6 litres for Reculeau), which differs from the *qû* of the homer system (ca. 0.8 litres) used in northern regions and from the *qû* of the *kur* system (ca. 1 litre) used in southern regions. Containers of 120 litres and 60 litres full of barley would weigh 75 kg and 37.5 kg respectively. See for comparison the dimensions of the cylindrical tub from Kalhu discussed in the introduction of this volume: it has a capacity of about 40 litres and would weighs 25 kg when filled with barley, making it handled by one man.

ARM 21 114

	1 GUR Ì.GIŠ	1 *kur* of sesame oil
2	*i-na* DUG *na-aš-pa-ki*	***in*** a storage jar
	ša É Ì.SAG	of the 'warehouse of high quality oil'
4	ŠU.TI.A	receipt
	nu-úr-ì-lí	(by) Nūr-ilī
6	ITI *hi-bir*$_5$*-tim*	DATE
	U$_4$ 28-KAM	

But there is still a problem regarding the *ARM* 11 85 case: why is the expression "$^{\text{giš}}$1 GUR *ki-ti*" not in the plural form (i.e. not *kitti* but *kinātī*)? One would actually expect not 1 but 50 containers of 1 GUR each for the storage of the recorded amount of grain. Generally speaking, the capacity measures (Sumerian GUR, BÁN, BARIGA…) in the expressions "*ina* $^{\text{giš}}$ + [capacity measure]" are never written in the plural form in the Old Babylonian documentation.[14] Does it mean that the scribes paid more attention to the kind of storage containers than to their number? One can also argue that the two hypotheses (a standardised capacity measuring vessel or a physical container in which an exact amount has been measured into) are not mutually exclusive. The (standardised or not) containers could contain the grain measured with the capacity standard to which the metrological expression refers and could become, by metonymy, the so-called "*kur kittum*" containers (noted in the singular because it refers to the capacity standard) or vica versa. Such metonymy shows also up in Ancient Egyptian measurement lexemes: so the hin-measure could be a designation for a vessel without standard as well as for an exact capacity unit and this unit was incorporated into bigger measuring vessels showing markings of the hin measure.[15] More generally, the notions of "(material) container", and "volume (concept)" were highly intertwined in the Mesopotamian and Egyptian conception of "measure". For example, the names of certain vessels and containers, mentioned in particular in lexical lists, are confused with the capacity unit corresponding to their capacity. In the Old Babylonian documentation from Alalah (level VII), the determinative GIŠ for wooden object may or may not have been used before the *parīsu* capacity measure in the same contexts, which again underlines the proximity between the measure concept and the material aspect.[16]

One can see here the limits of an interpretation which would be based only on textual content, with a philological approach. Understanding the context of the operations that involve measuring practices as well as administrative activities, when possible, is of great help. In this respect, the actual function of administrative documents has to be precisely considered. They are not intended to be accurate and factual records of reality.[17] They are not descriptive but informative. They were written within the framework of accounting and bookkeeping practices in order to manage foodstuffs as well as to participate in a memorisation of networks, useful for setting up and controlling the fiscal regime[18] and for clearing up the responsibilities of each person in this system. As already stressed, the text *ARM* 11 85 belongs to an archive found in the palace of Mari which concerns the management of grain by an official named Ilu-kān.[19] In this documentation, three different measures are mentioned: the "*kur* of the market" (*mahīrtim*), the "*kur* of the *šibšum*-due" (*šibši*(*m*)) and the "normal kur" (*kitti*(*m*)). The fact that these three capacity measures are mentioned sometimes together in the same text, where the total grain quantities are calculated at the end without evidence of any conversion (i.e. simply the sum of all quantities recorded on the document, regardless of the associated capacity measure), shows that they are very likely not standard capacity measures of different but of the same size.[20] Some evidence clearly indicates that the "*kur* of the *šibšum*-due" is used when the grain delivered to the palace comes from the payment of this tax.[21] Therefore, it could be assumed that each of the three metrological expressions refers mainly to an administrative information[22] concerning the origin of the delivered grain within the fiscal regime of Mari.[23] In particular, the grain

14 See the examples mentioned by VEENHOF 1985.

15 For the *hin*-measure and vessel, see POMMERENING 2005, 195-224; for the *ds* jug, p. 91-98; for the *hin*-measure being a marked part of a measuring vessel, see POMMERENING 2010.

16 ZEEB 1991: 200.

17 G. CHAMBON, Pourquoi écrire et tenir des comptes ? Étude de la comptabilité dans le Palais de Mari au 18[ième] siècle av. J.-C., in E. BORDREUIL – V. MATOIAN – J. TAVERNIER (eds.), Administration et pratiques comptables au Proche-Orient (PIOL), Leuven (in print).

18 For this notion, see CHAMBON 2020.

19 CHAMBON 2018.

20 See for example FM 15 103.

21 See for example FM 15 75 and the remarks in CHAMBON 2018: 57.

22 CHAMBON suggested that the expressions respectively refer to the grain from commercial activities, the grain from the *šibšum*-dues on cultivated land paid by landowners and the grain from the *biltum*-dues managed directly by the palace administration. The first and the third expressions need further investigation.

23 For a discussion on the fiscal regime in the Mari kingdom, see CHAMBON 2020.

from the *šibšum*-dues on cultivated land paid by landowners (grain related to the "*kur* of the *šibšum*-due") and the grain from the *biltum*-dues managed directly by the palace administration (the grain related to the "normal *kur*"?) have to be distinguished for administrative purposes; it was therefore most likely stored in two separate groups of containers which were immediately recognisable.

It seems that this was also the case with the so called "(capacity) measure of the god Marduk" in the Old Babylonian documentation from lower Mesopotamia (see an example above). The mention of this capacity measure in administrative texts allowed accountants to distinguish the activities of the royal administration of Babylon (whose tutelary god is Marduk) from those of the local authorities and to know exactly who was responsible for the receipt or delivery of goods in the economic system of the kingdom.[24] The difference of function of this capacity measure and the contemporary "(capacity) measure of the god Šamaš" needs further investigation.

The Middle-Assyrian documentation presents a parallel situation to that described for the Old-Babylonian period. The capacity units are organised according to the system of *emāru*. The basic unit is the *sūtu*/BÁN, which has as multiple the *emāru*/ANŠE and as subdivision the *qû*/SILA₃. An intermediate unit considering the graphic constraints was used: the *parsiktu* of 6 *sūtu*. The *sūtu* of 10 *qû* has a capacity of approximately 8-9 litres[25], i.e. around 5 kg of barley. This size is ideal for a measuring vessel, which can be easily handled, even with the weight of the vessel. That is certainly why a measuring unit around 10 litres can be found in others countries, especially in Egypt (see section 3.3 below).

The usual starting point for a study of Ancient Near Eastern administrative terminology is to remember the ambiguity of the terms available to us, in the form of ideograms as well as in syllabic form.

The case of the Akkadian *sūtu*/BÁN illustrates perfectly this situation, because according to the dictionaries, this term refers to:[26]

- "a vessel";
- "a measuring vessel of a standard capacity and its volume" which can be divided in "size; capacity, by a local standard, other specifications, not specified";
- "a measure of area based on the quantity of grain necessary for seeding".

According to the administrative documentation, the material of the *sūtu* varies greatly: it could be a wooden object, a ceramic, a metallic object or a stone object.[27] It is also characterised by a wide variety of functions depending on the context; but does the term *sūtu* refer to a capacity measuring vessel, a (standardised or not) container or an accounting device?

In many cases, grain volumes are expressed according to the following formula: (volume) *i+na* GIŠ.BÁN + [designation], which is traditionally translated as "(volume) according to the *sūtu* of [designation]".

One of the interests of the Middle Assyrian documentation is to provide a very large number of variants for the expressions with *sūtu*.[28] Without going into detail, these variants could be divided into three categories: those related to material aspects (old, small, big, new), those related to volume issues (volume of 1 *sūtu*, or of 5 *sūtu* etc.) and those related to administrative procedures (*ša šibše* "of the *šibšu*-tax", *ša iškārī* "of work-assignments", *bīt hiburni*,[29] *kurummat ili* "god ration", *ginā'ē* "regular offerings" etc.) or to individuals.[30] The latter cases are rarer, and always document people in connection with the flow of grain.

The phenomenon is not limited to the texts from Aššur. In the texts from Tell Rimah[31], there are the *sūtu* of the *hiburni*[32] and the old *sūtu*[33]; in Sabi Abyad the *sūtu* of the *hiburni*[34]; in Tell Taban the *sūtu ša iškāru*[35]; in Tell Cheikh Ḫamad the *sūtu ša iškāru*[36], the old *sūtu*[37], the small *sūtu*[38] and the *sūtu ša hiburni*[39]; in Tell Billa[40] the

24 See the study of this capacity measure in Nicolas 2021.

25 See the various values for the *qû* in Reculeau 2018.

26 See for example CAD S, p. 420a.

27 See CAD S/sūtu.

28 See for example Postgate 2016: 227 and his article in this volume.

29 This last case is very interesting because we know that it refers to a building adjacent to the temple of Aššur, and that the *hiburni* had a stock of grain, which it managed.

30 For example, the *sūtu* of Rūqī-lāmur (MARV 6 88: 24), of Urad-Aššur (MARV 7 7: 17), de Uppu?-x (MARV 8 3: 3'), of Šuzub-[ND] (MARV 8 74: 5) and of Mār-apie (MARV 9 112: 4). The fact that in MARV 6 88:24-25 the user of the *sūtu* is involved in the transaction makes it possible to propose to read in MARV 7 7: 18 (at the beginning of the line) mìr-*aš-šur*, based on l. 17. It would be necessary to collate the text, but the copy suggests this reading.

31 On the texts of Tell Rimah, see Postgate 2013: 260–268.

32 For example, TR 115 (Saggs 1968: pl. LXXI) et 3007 (Saggs 1968: pl. LIX).

33 For example, TR 2903 (Saggs 1968: 171-172, pl. LIV), 2910 (Saggs 1968: 173, pl. LVI) ou 3013 (Saggs 1968: pl. LX ; Wiseman 1968: 181).

34 For example T 98-33 (Wiggerman 2000: 205).

35 T05A-151: 4 (Shibata 2012: 494-495).

36 For example BATSH 4/1 1: 5.

37 For example BATSH 9 74: 1 ; 87: 2 etc.

38 For example BATSH 9 75: 19, 28.

39 For example BATSH 9 75: 20; 85: 7, etc.

40 On the texts of see Postgate 2013: 268–278.

old *sūtu*[41] and the *sūtu ša hiburni*[42], in Giricano the *sūtu ša allāni* "of the oak"[43], or in Tell Chuera the small *sūtu*[44] and the old *sūtu*.[45]

The relationship between the type of management and the *sūtu* capacity measure is sometimes explicit, as in this text:[46]

"1 homer of seed of lens, belonging to the *šibšu*-tax, according to the *sūtu* which is also of the tax-*šibšu*, under the responsibility of Būr-nāṣir, to sow 5 *ikû* of fields belonging to the palace…"

The fact that the same variant of the *sūtu* is found in the documentation from several sites, means that it is part of a much larger administrative system than the local systems. Most of these *sūtu* can be found in the texts of the *ginā'ū* offering archive, and/or in administrative procedures related to the palace. In contrast, the *sūtu* "of the oak" was found only in the documentation from Giricano, which does not mention any other known *sūtu* type.

The idea that the designation of the *sûtu* would be related to the identification of the service that carried out the measuring procedure, or is responsible for the transport or delivery of the grain, could explain the occasional occurrence of *sūtu* without designation. Indeed, the fact that accountants sometimes have to indicate which office manages the measurement procedures or the grain flow means that this is not obvious to the reader of the administrative text.

3. Measuring

3.1 Some cases of measuring procedures and accounting devices during the Old Babylonian period

Information on measuring practices can be obtained mainly from Old Babylonian letters rather than from administrative documents. Indeed, epistolary correspondence between individuals or officials is full of information about daily activities with an emphasis on logistical or administrative problems encountered that need to be resolved. For example, the letter H.E. 118, of unknown origin, reports on the difference between an expected quantity of grain and the actual result of measuring it:[47]

"Speak to my lord: thus says Sîn-bēl-aplim: may Sîn, Šamaš and Ezinu for my sake keep you alive forever! As for the 24 *kur* [1 *kur* = 300 *qû*] of barley which ordered me to check by means of the 3 *sūtu*-measure [1 *sūtu* = 10 *qû*], he [the expert in measuring practices] checked (that there were only) 18 *kur* of barley by means of the 3 *sūtu*-measure. He did not find a *sūtu* per *ṣimdu* [1 *ṣimdu* = 30 *qû*] (that he measured). I had said to you (then), 'You shall receive, by the "chief" (of the trade expedition) one (additional) *sūtu* per *ṣimdu*; I shall supply the (amount of) barley.' He verified (the content of) the *kur* of barley by means of the 3 *sūtu*-measure while we were downstream".

Sîn-bēl-aplim, a merchant, writes to another person about a quantity of 24 *kur* of barley, which was to be transported along the river. After receiving the barley, he carried out a counter-measure (Akkadian verb *šunnûm*) to check the actual quantity using a measuring standard *ṣimdu* (= 30 *qû*); it then turned out to be only 18 kur, a quarter less than the expected total of barley. The sender of the letter points out that 10 qû per 30 qû is missing, i.e. a quarter of the expected quantity, with the expression "he did not find a sūtu [= 10 qû] per ṣimdu [= 30 qû]". This difference can be explained by a fraud or a loss of part of the cargo rather than by the use of different capacity standards. In any case, Sîn-bēl-aplim explains to the recipient of the letter that he is committed to ensuring that all the grain will be delivered, by making up for the shortfall himself. One of the key characters in this operation is simply designated by the third person "he"; this is the specialist who is responsible for checking that the measurements are carried out correctly and for reporting any losses. It is particularly interesting to note that this specialist uses a measuring vessel of 30 *qû*, which would weigh about 19 kg when filled with barley, and therefore easily handled by one man.

Specific expressions for capacity measures have also been used in letters in measurement contexts. In the Old Babylonian letter AbB 14, 51,[48] certainly from Sippar, a person named Iškur-Mansum (the chief merchant of Sippar?) relates a problematic case involving Warad-Ilišu, probably a priest:

41 For example texts 1: 7 (Finkelstein 1953: 122), 29: 3, 35: 2 (Finkelstein 1953: 130), etc.

42 For example text 42: 5 (Finkelstein 1953: 131).

43 For example texts 1: 2 (Radner 2004: 64), 8: 3 (Radner 2004: 87), and the comment of Radner 2004: 76.

44 For example texts 22: 5, 7 (Jakob 2009: 60), 24: 3 (Jakob 2009: 62), etc.

45 For example text 24: 6 (Jakob 2009: 62).

46 KAJ 134: 2-9. See Jakob 2003: 16. See also the discussion of the *sūtu*-measure of the *šibšum*-due in the Mari documentation above.

47 Chambon 2011: 166–167.

48 N°ARCHIBAB T12475.

“If he [Warad-Ilišu] raises protest, let smooth flat (by hand or with a strickle) each *sūtu*-measure of Šamaš by quantities of ⅓ *qû*. If he has given it according to the *sūtu*-measure of Marduk, I myself, upon arrival, will give …”.

This extract, although only partly clear, provides interesting information about measuring techniques. First, as suggested by WILCKE and VEENHOF, the measuring process may have sometimes involved the use of a wooden strickle (Akkadian *mešēqum*), with which the grain was smoothed flat (Akkadian verb *šêqum*), levelled with the rim, as it is well known later for the medieval and modern period,[49] and as it also can be shown in depictions of measuring grain in Ancient Egypt (see section 3.3). Secondly, Warad-Ilišu seems to have two options for delivering an unspecified commodity; either according to the *sūtu*-measure of Šamaš or according to the *sūtu*-measure of Marduk. The second option seems to be better for Iškur-Mansum, while the first option is associated with a protest situation. One might then think that the problem lies in the use of two capacity standards of different size. According to Veenhof, the *sūtu*-measure of Marduk is smaller than the *sūtu*-measure of Šamaš, in fact by 10 %. The difference per *kur* (= 300 *qû*) accordingly is 3 *sūtu* (= 30 *qû*), i.e. 1 *kur* (= 300 *qû*) according to the *sūtu*-measure of Šamaš is equal to 1 *kur* 30 *qû* (= 330 *qû*) according to the *sūtu*-measure of Marduk. This could explain why each *sūtu*-measure (= 10 *qû*) of Šamaš must be “smoothed flat” by removing quantities of ⅓ *qû*, because 1 *sūtu*-measure of Šamaš is equal to 1 *sūtu*-measure of Marduk + ⅓ *qû*. So Iškur-Mansum would like the quantity of goods to be converted into the standardised system of the *sūtu*-measure of Marduk. But does it really refer to a difference of size between two capacity standards? Or could it not be an indication of a fixed exchange rate for commodity flows in the Babylonian kingdom depending either on the royal administration (*sūtu*-measure of Marduk) or on the administration of the Šamaš temple (*sūtu*-measure of Šamaš)?

The cuneiform administrative documentation only rarely mentions the verb *madādu*, “to measure”. An Old Babylonian text from Larsa, belonging to the archives of Šamaš-hazir, the *šassukkum*-manager of the royal agricultural fields of the king Hammurabi, offers some interesting information:

TCL 11 165 [AO 8407] [50]

Obv. 12 GUR AN-*pi*$_4$-^{d}UTU ^{giš}BA.AN
2 ⸢10+X⸣ GUR É ^{d}UTU ^{giš}BA.RÍ.GA(!) GI.NA
⸢25⸣ GUR 1 BÁN MU.TÚM É KIŠIB.BA
4 ^{I}*zi-nu-ú* KI.1
ša i-na ^{giš}BANEŠ *im-ma-du*
6 24 GUR 5 BÁN MU.TÚM É KIŠIB.BA
^{I}*zi-nu-ú* KI.2
8 *ša* ⸢*i*⸣*-na* ^{giš}BA.RÍ.GA MU.TÚM
im-ma-ad-du
Rev.10 ITI NE.NE.GAR
MU ÈŠ.⸢NUN⸣.NA$^{(ki)}$
12 ⸢A GAL.GAL.LA⸣ BA.GUL

Obv. 12 *kur* (delivered from?) Annum-pī-Šamaš (in) *sūtu* (or *pānu*)-measure[51]
2 10+x *kur* (delivered from?) the temple of Šamaš in “normal”[52] *parsiktu*-measure
25 *kur* 1 *sūtu* received by the *bīt kunukkim*
4 by Zinû, for the first time,
which were measured according to the *ṣimdu*-measure
6 24 *kur* 5 *sūtu* received by the *bīt kunukkim*
by Zinû, for the second time,
8 which were measured according to the *parsiktu*-measure of receipt.
Rev.10 Month V
Year Hammu-rabi 38

This text is an administrative note reporting on a problem concerning the result of measuring an amount of an unspecified commodity (grain?). Four different capacity measures are actually mentioned. As the administrative terminology is always concise and precise, without superficial information, any indication given by the scribe in the text is important for administrative purposes. Two commodity deliveries, respectively by Annum-pī-Šamaš and the temple of Šamaš, are related to two capacity

49 See the papers by CHAMBON/OTTO and POSTGATE in this volume.

50 N°ARCHIBAB T20351. This text was studied by Baptiste Fiette in his work on Šamaš-hazir’s documentation (FIETTE 2018: 283, 284, 300, 317).

51 Most of the time, ^{giš}BA.AN was considered as the Akkadian spelling of ^{giš}BÁN for *sūtu*-measure, but several examples in the Mari documentation (CHAMBON 2011: 67: a *pānu*-measure = 50 SILA$_3$ in Mari) as well as in the documentation from Southern Mesopotamia (see for example YBC 4265, mentioned below, l. 5: ^{giš}*pá-an* 3 BÁN ^{d}[AMAR.UTU$^{?}$], “the *pānu*-measure of 3 *sūtu*”) concern a *pānu*-measure, which must be considered as a container of variable volume.

52 The Sumerian GI.NA is equivalent to the Akkadian *kittum* (see above).

measures, the *sūtu*-measure (= 10 *qû*) and the "normal" *parsiktu*-measure (= 60 *qû*). These two quantities were then added together to be stored in the warehouse *bīt kunukkim*. But, as B. FIETTE pointed out, the total quantity to be reported depends on the capacity measure standard used: it is 25 *kur* 1 *sūtu* (= 7,510 *qû*) when measured for the first time according to the *ṣimdu*-measure (= 30 *qû*), which seems to be specific to Šamaš-hazir's office[53], and 24 *kur* 5 *sūtu* (= 7,250 *qû*) when measured for the second time according to the *parsiktu* of the receipt (= 60 *qû*). Thus, the last two capacity measures are clearly standardised measuring vessels used to control the exact volume of goods. But what about the function of the capacity measures associated with the two commodity deliveries, reported in the first lines?

It is unclear whether these refer to the containers in which the commodity was transported and delivered[54] or to the standardised measuring vessels in which it was previously measured. This interpretative ambiguity concerns several documents mentioning capacity measures just after quantities, without any reference to a measuring or transport procedure, like "140 ŠE GUR ^{giš}BA.RI$_2$.GA", which could be translated as "140 *kur* of barley according to the *parsiktu*-measure" or "140 GUR-measures of barley (stored or transported) in *parsiktu*-containers".[55] Sometimes, the size of these capacity measures is specified. In particular, K. VEENHOF listed three different sizes for the *parsiktu*-measure larger than the 60 *qû* standard (*parsiktum*-measures of 64 *qû*, 66 ⅓ *qû* and 70 *qû*) in the Old Babylonian documentation, asking an important question: "Does it imply the existence and use of measuring vessels of these sizes or is the reference only to units of measure used for accounting?"[56] Or, in N. POSTGATE's words in this book, "were these different [...] physical containers used to carry out individual measurements, or are they merely intended to denote an abstract volume which is fixed in relation to other norms?"

We have already discussed the case of the *parsiktu*-measure (BA.RÍ.GA) of 66 ⅓ *qû* mentioned in a business contract concerning the trade of barley (YBC 4265[57]), which in fact seems to reflect a levy carried out by the royal administration in the context of the taxation of goods in transit in the kingdom of Larsa.[58] In order to anticipate this levy, the rate of which is ⅒ of the commodity, an additional quantity of barley is added to the initial quantity of 31,500 *qû* of barley transported, which enables to obtain 35,000 *qû* of barley including tax (35,000 – ⅒ × 35,000 = 31,500). The accountants indicate this administrative operation by the sentence: "in (each) *kur*, 33 ⅓ *qû* 'turn into' a *ṣimdu*-measure (= 30 *qû*) of Marduk", which means that each time barley was measured with a measuring vessel of 30 *qû*, 3 ⅓ *qû* had to be added. Thus, each transport container did not contain 60 *qû* but in fact 66 ⅔ *qû*; this is the result of a calculation made by accountants for measuring processes rather than the volume of an unusual capacity standard. To sum up, there was only one kind of measuring vessel (of 30 *qû*), and the transport containers, which usually contained 60 *qû* each, had to be filled with 66 ⅔ *qû*, in order to include the tax payable.

A key text, YOS 12 203[59], studied by K. VEENHOF in this important work on the term SAG.ÍL.(LA) in accounting texts, records amounts of barley related to the use of *parsiktu*-measures of 64 *qû* and 70 *qû*.

YOS 12 203

3,600 GUR ^{giš}BA.RÍ.GA 0,1.1
2. 600 GUR SAG.ÍL *ša* 1 GUR 0,0.5
280$^{!}$[60] GUR *ne-eh-lum* ša 1 GUR 0,0.2
____
4. 4,480[61] GUR ^{giš}BA.RÍ.GA ^{d}AMAR.UTU
SAG.NÌ.GA ŠÀ.BI.TA
____
6. 300 GUR É.A-*li-di-*⸢*iš*⸣
240 GUR ^{d}UTU AN
8. 240 GUR *i-na*-BALA-[šu]
780 GUR ^{giš}BA.RÍ.GA 0,1.[1]
10. 130 GUR SAG.ÍL *ša* [1 GUR 0,0.5]
____
412 GUR *ni-id-na-*⸢*at*-30⸣
12. 183 GUR ERÍN *ya-ku-nu-um*
300 *še-ep-iš*$_8$*-tár* RÁ.GAB
14. 895 GUR ^{giš}BA.RÍ.GA 0,1.0.4 SILA$_3$

53 The grain loan contract *OECT* 15 118 (N° ARCHIBAB T20347) mentions "Šamaš-hazir's *ṣimdu*-measure". See FIETTE 2018: 291.

54 But it is difficult to imagine the use of 360 *sūtu*-containers for the delivery of the 12 *kur*-measures, if we consider ^{giš}BA.AN as a *sūtu*-measure (see above).

55 See AbB 12, 20, N°ARCHIBAB T13738.

56 VEENHOF 1985: 302.

57 N°ARCHIBAB T2518.

58 CHAMBON/MARTI 2017: 71-72.

59 YBC 7079. G. Chambon thanks B. Foster and K. Wagensonner for providing him with the photo of the text, and J.-M. Durand and R. De Boer for their suggestions.

60 Each GEŠ (4 GEŠ for 4 × 60) looks like a GEŠ×U (600: see the previous line), but the latter interpretation makes no sense in view of the following total l. 4.

61 The sign ŠE must be interpreted as 40 because the total 4,480 GUR (l.4) corresponds to the sum of 4269 GUR (l.35) + 211 GUR (l.36).

59 GUR SAG.ÍL *ša* 1 GUR 0,0.2

---

16. 1,864 GUR 3 (BA.RÍ.GA) 2 BÁN $^{\text{giš}}$BA.RÍ.GA $^{\text{d}}$AMAR.UTU
MU.DU *na-*⸢*at-ba*⸣*-kum*

---

18. 784 (GUR) 3 (BA.RÍ.GA) 2 BÁN DUMU$^{\text{meš}}$ SÚ.BIR$_4$ GÚ-EDEN$^{\text{ki}}$
67 (GUR SÚ.BIR$_4$ BÀD *ha-am-mu-ra-bi*/$^{\text{ki}}$
T.20 40 GUR SÚ.BIR$_4$ ZU.NI.LÁ
891 GUR 3 (BA.RÍ.GA)[62]
R. 22 ŠE.BA SU.BIR$_4$ BÀD DIDLI

---

39 (GUR) DUMU-KI SIPA U$_8$ UDU$^{\text{há}}$
24. 40 GUR *a-píl*-KI SIPA
12 (GUR) 1 (BA.RÍ.GA) *a-wi-il*-É.A
26. 91 (GUR) 1 (BA.RÍ.GA) ŠE.BA SIPA$^{\text{meš}}$

---

432 (GUR) 2 (BA.RÍ.GA) ŠÀ *ya-ah-su-uk*/AN
28. 52 (GUR) ŠÀ URU *ša-mi-rum*
734 (GUR) ŠÀ ŠEN$^{\text{ki}}$
30. 1218 GUR 2 (BA.RÍ.GA) $^{\text{giš}}$BA.RÍ.GA 0,1.1
203 (GUR) 2 BÁN SAG.ÍL *ša* ⸢1 GUR 0,0.5$^{!}$⸣
32. 1421 (GUR) 2 BÁN
$^{\text{giš}}$BA.RÍ.GA $^{\text{d}}$A[MAR.UTU]
34. *ṭe*$_4$*-hu-um*

4269 GUR $^{\text{giš}}$BA.RÍ.G[A $^{\text{d}}$AMAR.UTU]
36. LÁ.NI 211 GUR KI DINGIR-la-[X X]
1887 GUR *še-am*(!) NÌ.TUR.TUR
38. ÍB.TAG$_4$ 124 GUR

ITI ŠE.GUR$_{10}$.KU$_5$ U$_4$ 11.KAM
40. MU ALAM.ŠÙD.DÈ

3,600 *kur* in the *parsiktu* of 70 *qû*
2. 600 *kur* (which corresponds to) the "difference assessed" according to an estimated rate of 50 *qû* for 1 *kur*.
280 *kur* (estimated loss after) sifting according to an estimated rate of 20 *qû* for 1 *kur*.

---

4. 4,480 *kur* in *parsiktum* of (the god) Marduk = capital, from which,

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6. 300 *kur* (from$^?$) Ea-līdiš
240 *kur* (from$^?$) Šamaš-ilum
8. 240 *kur* (from$^?$) Ina-palêšu
(total =) 780 *kur* in *parsiktu* of 70 *qû*
10. 130 GUR (which corresponds to) the "difference assessed" according to an estimated rate of 50 *qû* for 1 *kur*

---

412 *kur* (from$^?$) Nidnat-Sîn
12. 180 *kur* (from$^?$) the working team led by Yakūnum
300 *kur* (from$^?$) Šep-Ištar the conveyor
14. (total =) 895 *kur* in *parsiktu* of 64 *qû*
59 *kur* (which corresponds to) the "difference assessed" according to an estimated rate of 20 *qû* for 1 *kur*

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16. (total =) 1,864 *kur* 3 *parsiktu* 2 *sūtu* in *parsiktu* of (the god) Marduk
delivery to the granary

---

18. 784 *kur* 3 *parsiktu* 2 *sūtu* (for$^?$) the Subarians of the Gu-eden
67 *kur* (for$^?$) the Subarians of Dūr-Hammurabi
T.20 40 *kur* (for$^?$) the Subarians of the city of ZU.NI.LÁ (city of Kasallu?)
(Total =) 891 *kur* 3 *parsiktu*
R. 22 Barley rations for the Subarians of the fortresses

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39 *kur* (for$^?$) Mâr-erṣetim, shepherd of sheep.
24. 40 *kur* (for$^?$) Apil-erṣetim, shepherd
12 *kur* 1 *parsiktu* Awil-Ea
26. (Total =) 91 *kur* 1 *parsiktu* rations of the shepherds

---

432 *kur* 2 *parsiktu* from Yahsuk-El
28. 52 *kur* from the city of Šamirum
734 *kur* from the city of ŠEN
30. 1218 *kur* 2 *parsiktu* in *parsiktu* of 70 *qû*
203 *kur* 2 *sūtu* (which corresponds to) the "difference assessed" according to an estimated rate of 50 *qû* for 1 *kur*
32. (Total =) 1421 *kur* 2 *sūtu*
in *parsiktu* of (the god) Marduk
34. added$^?$

(Total =) 4269 *kur* in *parsiktu* of (the god) Marduk
36. arrears = 211 *kur* from Ilum-la-[…]
1888 *kur* of barley of minor crops
38. Remaining: 124 *kur*

DATE

This barley account begins with the mention of a "capital" (SAG.NÌ.GA) of 4480 *kur* of barley, which consists of a total of three entries: a round quantity of 3,600 *kur* of barley in (or according to) a *parsiktu*-measure of 70 *qû*, to which

62 2 BÁN of the l.18 are missing in this subtotal.

was added a "SAG.ÌL(.LA)" of 600 gur-measures of barley at a rate of 50 *qû* per *kur*, and 280 *kur* of barley, called "*nehlum*", at a rate of 20 *qû* per *kur*. Then, the text consists of nine paragraphs separated by rulings and followed by a date (Month 12/the 11th day/Samsu-iluna 6) which Veenhof considers as series of expenditures from (l.5: ŠÀ.BI.TA) this capital. He then states that the term SAG.ÌL(.LA), which he translates as "difference assessed", "occurs whenever the bariga-measure [= *parsiktu*-measure] used as measure of the account is different from the one in which deliveries and expenditures had been made and recorded".[63] These *parsiktu*-measures of 64 *qû* and 70 *qû* would therefore be atypical compared to the usual standard of 60 *qû*, designated as the "measure of Marduk".

In detail, some quantities of barley are either referred to as delivery (MU.DU) to the granary (l. 16-17: total of the subtotals on l.9,10,14,15[64]) by an individual, by the working team led by Yakūnum, and the person responsible for conveying the grain (RÁ.GAB) respectively, or as rations (ŠE.BA) distributed to Subarians (l. 22) or to herdsmen (l. 26). Another paragraph (l.27-34) seems to concerns amounts of barley which were "added" (?) from (ŠÀ) the holdings of an individual and two cities. The total of the subtotals l.16, 21, 26, 32 is given l.35 (with 2 *kur* more).

Therefore, the capital includes quantities of barley brought in for storage as well as quantities which were (or more likely were intended to be) delivered as rations. This idea of future operations from an expected amount is underlined by the mention of arrears (LÁ.NI) at the end of the text; the 4,269 *kur* of barley theoretically already available (l. 35) are 211 gur-measures (l. 36) short of the expected capital (4,269 + 211 = 4,480 *qû*, l.4). One can guess from the round quantity (3,600 *kur*) that this capital had been estimated before. Therefore, accountants seek to anticipate the actual quantities that will be available in stock. As in the case of the text YBC 4265, with the parsiktum-measure of 66 ⅓ *qû* discussed above, the "atypical" *parsiktu*-measures of 70 and 64 *qû* seem to be in fact accounting devices, with the aim of including anticipated losses or taxes (or other accounting procedures) in the capital, rather than a means of assessing the difference between two standardised measuring vessels. Moreover, these "atypical" measures are mentioned each time the grain is brought in (l. 9, 10, 14, 15, 30, 31), not when it is distributed. The main objective of accountants is to ensure that the quantities of barley in stock are those expected when rations are to be distributed. They therefore have to anticipate the difference between the quantities needed and the quantities actually delivered to the granaries. The quantities actually available are certified by the expression "in *parsiktu* of Marduk".

It is difficult to know what type of loss or tax the mention of SAG.ÌL(.LA)[65] refers to. It corresponds to a rate of ⅙, i.e. 50 *qû* per *kur* (= 300 *qû*) or to a rate of 1⁄15, i.e. 20 *qû* per *kur* (see below). As N. Postgate reminds us in this book, there are two alternatives when filling a container with grain: "filling the container till the grain is horizontally flush with the rim, or heaping it up into the highest possible conical mound". The first alternative was certainly the one chosen during transport, so as not to lose grain. By filling the containers with one sixth more than their volume, which is what the *parsiktum*-measures of 70 *qû* refer to, could this include the amount of grain of the conical mound that will appear if the grain is measured when receiving it with standard 60 *qû* containers?

What does the rate of 20 *qû* per *kur* refer to? We follow Veenhof's interpretation of the term *nehlum* as "sifting" (l. 3)[66]. Veenhof was surprised that "(the effect of) sifting is not deducted but has to be added to the capital". But if we consider that establishing the capital takes into account anticipated operations (taxes, losses, sifting etc.), it is understandable that the accountants have added in advance to the capital the assessed loss of volume after sifting, which is estimated at 20 *qû* per *kur* (ca. 6,66 %). For the same reason, the raw barley, which appears to come directly from the threshing floor after harvest, was transported in containers filled with 64 *qû* of grain (l.14) and not with 60 *qû* as usual, thus including the 6.66% estimated loss after sifting.

The case studies on metrological phrases such as "according to/in the parsiktum-measure of x *qû*", can provide the beginning of an answer to Veenhof's and Postgate's question about the distinction between physical containers or abstract volumes, fixed in relation to capacity standards in accounting: it is actually both. The physical containers for transportation are filled with grain in an unusual way compared to the capacity standard of 60 *qû*, in order to include the anticipated opera-

63 Veenhof 1985: 288.

64 This total exceeds the sum of the subtotals by only 200 silà: this probably corresponds to the actual (not accounting) quantity measured.

65 Is SAG.ÍL.LA Sumerian or Akkadian loanword? See the remarks in Veenhof 1985: 293-294.

66 Our hypothesis of a "prélèvement lié à un héritage ou un transfert de biens", based on the Old Babylonian documentation from Mari, seems more tenous (Chambon/Marti 2017: 74). The published account by Stol 1984: 170, n°28, quoted by Veenhof, mentions an amount of barley which still requires a "sifting" before the actual amount can be determined (N°ARCHIBAB T2715).

tions. Here, the capacity standards take on the function as accounting indications.

3.2 The capacity measure unit and the container: some middle-Assyrian cases

As illustrated previously, part of the problem in interpreting the capacity units and their standards stems from the ambiguity of the ancient terminology, which at first glance does not necessarily allow us to distinguish between volume, measurement unit[67] and container. The Middle-Assyrian documentation illustrates this fact well, but allows us to go further. According to this documentation, huge quantities of grain circulated in Assyrian-dominated areas. Barley was sometimes stored for several years, redistributed, lent, integrated into complex economic networks such as that of the regular offerings to the temple of Assur. The texts, however, do not seem to provide information on the issue of transport, the measuring procedures, control, or storage.

The issue of grain transport and management is strangely absent in the texts, which only punctually refer to stages of its activities such as the calculation of the volume of grain after harvesting or its delivery in the various storage places. Were, for example, cereals usually packed in standard-sized containers or not? While it seems obvious that the liquids were transported in jars,[68] which were mentioned quite often in our texts, what about grain? In very rare cases, jars full of cereals were mentioned in texts, in particular for sesame.[69]

On the other hand, when the grain for the regular offerings arrived at Assur,[70] receipt documents sometimes contained very interesting written forms. For example:[71]

	[10] ⌜10⌝ ⌜10⌝ ⌜10⌝ ⌜10⌝ ⌜10⌝ ⌜10⌝ ⌜10⌝ [10] [10]	166
2	⌜10⌝ ⌜10⌝ ⌜10⌝ ⌜10⌝ ⌜10⌝ ⌜10⌝ 6	
	PAP 83 ANŠE ŠE-⌜*um*-MEŠ⌝ *i+na* GIŠ.5BÁN-*te*	Total: 83 homers of barley, in the "5 *sūtu*"
4	⌜*i+na* é⌝ *aš-šur m*[*a-d*]*i-id*	measured in Aššur temple

Following the same principle as in the Middle-Assyrian text presented above (VAT 19924), the mention of the figure 166, noted by repetition of the mark for "ten" and 6 times "one" in the first lines,[72] is twice the recorded total of 83 homers, (1 homer corresponds to the standardised load carried by a donkey). It refers either to 166 bags or baskets of 5 *sūtu* capacity each, half of the emāru-measure (of 10 *sūtu* = 100 *qû*), which were carried on each side of a donkey and were counted here [73], or less likely to a measuring vessel of 5 *sūtu* used 166 times in the measuring procedure[74].

What does the expression "measured in the temple of Aššur" mean? The use of the verb *madādu* "to measure" is rare in administrative texts dealing with amounts of grain, as in the case of the Old Babylonian documentation. It is mentioned in texts of receipts of this type, with half homer.[75] Half a homer is easily carried by one man, as it weighs about 30 kg when filled with grain.[76]

Therefore, one could wonder whether the expression *i+na* GIŠ.BÁN (see above) should not sometimes be understood literally as "(transported) in a *sūtu* vessel/container". In the case seen above, the volume of the container corresponds exactly to ½ homer.[77]

This assumption is supported by a fragmentary text, which mentions:[78]

[23]3 ANŠE ŠE *i+na* GIŠ.BÁN *š*[*a*	"3 homers of barley in *sûtu*-containers of [
[24]1 ANŠE *i+na* DUG.BÁN *ša* [	1 homer in *sûtu*-jars of [
[25]5 BÁN ŠE *i+na* 5BÁN-*te a-n*[*a*	5 *sûtu* of barley in 5 *sûtu*-containers for ["

This text refers to three types of packaging for grain: in *sūtu*-containers (i.e. containers with a capacity of 1 *sūtu*), in *sûtu*-jars (i.e. jars with a capacity of 1 *sūtu*) and in 5 *sūtu*-container (i.e. containers, certainly woven wicker baskets, with a capacity of 5 *sūtu*).[79]

This is also the case according to MARV 10 86, which recorded sesame received in jars.[80]

67 See Postgate 2016: 232–239.

68 See for example MARV 5 5: 4, 7, 20, 22 in which "honey" was delivered in DUG.BÁN, and DUG.ŠAB.

69 See for example MARV 10 98.

70 See Postgate 2013: 89-146.

71 MARV 7 46. See Freydank / Feller 2004: 12 and Maul 2013: 566–567.

72 Each "ten" is marked by a circle: see Freydank/Feller 2006: 10. See also Gaspa 2011: 233–259.

73 Maul 2013: 566.

74 Postgate 2016: 231–232.

75 For example, in MARV 9 16, but without indication of location.

76 See for example Reculeau 2018: 105.

77 Maul 2013: 566.

78 MARV 7 88: 23-25.

79 Note the absence of the determinative GIŠ in line 25.

80 It is certainly necessary to reverse the face and the reverse side of this text.

ŠE Ì.MEŠ URU *ku-liš-hi-na-áš*	Sesame from the city of Kulišhinaš
{^{m}*aš-šur*-⸢IBILA$^{?}$⸣}.⸢KAM⸣	

⸢16⸣ DUG.ŠAB.MEŠ	16 šappu-jars

The jars are certainly of a standard size.[81] In this text concerning receipts of barley, the system of the mark for ½ homer is also used.[82]

The following extract of a letter mentions sesame transported by a boatman:[83]

6	6 ANŠE 1 (*paršiktu*) GIŠ.Ì.ŠE *i+na* DUG.1*bán*	6 homers 6 *sūtu* of sesame in jar(s) of 1 *sūtu*

The transport was done in jars of 1 *sūtu*-volume each, so 66 jars were needed.

The text MARV 8 46[84] probably also mentions another type of packaging. It lists 10 barley receipts, the total of which mentions that the "*sūtu* of *pirik ritte*", whose meaning is unknown[85], was used. This certainly indicates that the grain was measured on receipt. Much of the grain received was transported by ships. The smallest amount is 117 *qû*, and all the others have multiple volumes (by two: 235 *qû* or by three: 352 *qû*) except for the last amount of 320 *qû*. Do these volumes reflect standardised containers in the ships, which were emptied and measured on arrival? These containers could be jars with a capacity of at least 117 *qû* (i.e. 120 *qû*?).

Another text, MARV 7 7, is particularly interesting:

^{1}⸢20*[86] ANŠE ŠE-*um*-MEŠ⸣ *i+na* GIŠ.5BÁN-*te* ^{2}*pa-ni-ú i+na* É *aš-šur ma-di-id* ^{3}LÚ.LUNGA.MEŠ *it-ta*-⸢*ṣu*⸣ ^{4}*i+na* ITI *a-bu*-MAN.MEŠ-*ni* U$_4$ 15-KÁM *li-me* ^{5m}GIŠKIM.IBILA.É.ŠÁR MAN ⸢KUR⸣ *aš-šur* ^{6}40 ANŠE *i+na* GIŠ.5BÁN-*te*-⸢*ma*⸣ *ma-di-id* ^{7}{x} ⸢^{m}⸣KAR-^{d}30 ^{m}*aš-šur-dan-ni-ni* ^{8}*im-ta-ad-du* ^{9}*i-na* ITI KIMIN-*ma* U$_4$ 18-KÁM ^{10}⸢*li-me* KIMIN-*ma*⸣ ^{11}31 ANŠE 5BÁN *i+na* GIŠ.5BÁN-*te-ma* ^{12m}ÌR-^{d}*gu-la* ^{m}KAR-^{d}30 ^{13}*i+na* ŠÀ-⸢*be*⸣ *i-ta-aṣ-ṣu* ^{14}30 ANŠE *i+na* GIŠ.5BÁN-*te-ma* ^{m}ÌR-^{d}*gu-la* ^{15}LÚ.LUNGA *si-ik-ra ma-di-id* ^{16}*i+na* ⸢ITI KIMIN-*ma* U$_4$ 26-KÁM *li-me* KIMIN-*ma*⸣ ^{17}3 ⸢ANŠE⸣ *i+na* GIŠ.BÁN *ša* ^{m}ÌR-*aš-šur a-láh-hi-ni* ^{18m} ⸢ÌR$^{?}$-*aš*$^{?}$-*šur*?⸣[87] ^{m}*ha-at-ta-ia* ^{19}⸢7⸣ ANŠE 1 (*paršiktu*) 2BÁN *i+na* GIŠ.BÁN *ša* ⸢*pi*⸣-*i* ^{20}GIŠ.5BÁN-*ú-te a*-⸢*na*⸣ É-*te* $^{21tr.}$1 (*paršiktu*) 1BÁN *i+na* GIŠ.BÁN *ša pi-i* GIŠ.5BÁN-*te*-⸢*ma*⸣ ^{22md}UTU-*ar-ni*-DU$_8$ $^{23tlg.}$PAP 1 ME 21 ANŠE 5BÁN *ina* GIŠ.5BÁN-*te* ^{24}11 ANŠE 5BÁN *ina* GIŠ-BÁN-1-*te*

In this text, quantities of barley are related to the three following phrases:

- *ina* GIŠ.5BÁN-*te* "according to/in the 5 *sūtu*-measure/container"; these quantities of barley were either measured (*madādum* l. 2, 6 and 15) or taken out (*waṣum* l. 3 and 13).
- *ina* GIŠ.BÁN ša PN "according to/in the *sūtu*-measure/container used by [personal name]".
- *ina* GIŠ.BÁN *ša pī* 5BÁN-*te* "according to/in the *sūtu*-measure/container used to fill/complete[88] the 5 *sūtu*-measure/container".

At the end of the text, the total of barley is divided into two categories: 1°) "(amount of barley) *ina* GIŠ.5BÁN-*te*" which corresponds to the sum of the quantities received "*ina* GIŠ.5BÁN-*te*", and 2°) "(amount of barley) *ina* GIŠ.BÁN-1-*te*", which corresponds to the sum of the quantities received *ina* GIŠ.BÁN *ša* (personal name) and *ina* GIŠ.BÁN *ša pī* 5BÁN-*te*. The sum of all the entries corresponds to the

81 The text MARV 3 9: 23-26 mentions jars where the volume of the products is not specified in three cases, according to the formula x jar, belonging to y (l. 26-27). In one case, the scribe mentioned: ⸢x⸣ DUG.ŠAB.MEŠ 4BÁN 2 SILA$_3$ *a-na ma-da-di*, ⸢*ša*⸣ ^{md}NUSKU-*ia ša* UGU ⸢*e*⸣-*kal*⸣-*li* : "x *šappu*-jars (whose volume is) 4 *sūtu* 2 *qû*, for measuring, of the palace overseer (...)".

82 The text should be collated.

83 MARV 10 90, published Ridder 2013: 140.

84 ^{1}3 ANŠE 5BÁN 2 SILA$_3$ *ša* ^{m}*aš-šur*-NUMUN.NÍG.BA ^{2}⸢DUMU ^{d}AMAR.UTU-*ia* ^{m}ŠEŠ-*la-mur* ⸢*ma-hi-ir*⸣ ^{3}⸢3 ANŠE 5BÁN⸣ 2 SILA$_3$ ⸢*ša* ^{m}DUMU-*ṣíl-lí-ia*⸣ ^{4}DUMU ^{d}*a-šur*-KAR ^{m}DUMU-*ṣíl-lí-ia ma-hi-ir* ^{5}2 ANŠE 3BÁN 5 SILA$_3$ *ša* ^{m}*ba-at-qi* ^{6}DUMU ⸢*a*⸣-*bi-la-mur* ^{m}*aš-šur*-SUM-*na* ^{7}1 ANŠE 1*bán* 7 SILA$_3$ ^{m}*aš-šur*-MU-SUM-⸢*na*⸣ ^{8}1 [A]NŠE 1BÁN 7 SILA$_3$ ^{md}*a-šur-ták-lak* ^{9}1 ANŠE 1BÁN 7 SILA$_3$ ^{m}DUMU-*ṣíl-lí*-⸢*ia*⸣ ^{10}PAP 3 ANŠE 5BÁN 1 SILA$_3$ ⸢*ša*⸣ GIŠ.MÁ *ša* ^{m}⸢XX⸣-*ba-ṣa-ni* ^{11}DUMU ⸢*aš-šur*⸣-*ba-is*-⸢*su-ni*⸣ ⸢*ma-ah-ru*⸣ $^{12\ tr.}$⸢1 ANŠE 1BÁN⸣ 7 SILA$_3$ ^{m}*aš-šur*-MU.SUM-*na* ^{13}⸢1 ANŠE 1BÁN⸣ 7 SILA$_3$ ^{m}ŠEŠ-*la-mur* ^{14}⸢1 ANŠE 1BÁN 7⸣ SILA$_3$ ^{m}DUMU-*ṣíl-lí*-⸢*ia*⸣ ^{15rev}PAP 3 ANŠE 5BÁN 1 SILA$_3$ *ša* ⸢GIŠ-MÁ *ša* ⸢^{m}X X X X X⸣ ^{16}DUMU ^{d}IŠKUR-MU-KAM *ma-ah-ru* ^{17}3 ANŠE 5BÁN 2 SILA$_3$ *ša* ^{m}*aš-šur-šeš*-SUM-⸢*na*⸣ ^{18}DUMU ^{d}AMAR.UTU-*ia* ^{m}DUMU-*ṣíl-lí-ia ma-hi-ir* ^{19}3 ANŠE 5BÁN 2 SILA$_3$ *ša* ^{m}*aš-šur*-SUM.MU-MEŠ ^{20}DUMU *li-še-ru* ^{m}*aš-šur-ták-lak ma*-⸢*hi-ir*⸣ ^{21}2 ANŠE 3BÁN 5 SILA$_3$ *ša* GIŠ.MÁ *ša* ^{m}⸢^{d}UTU.MU.KAM⸣ ^{22md}*a-šur*-MU.SUM-*na ma-hi-ir* ^{23}3 ANŠE 5BÁN 2 SILA$_3$ *ša* GIŠ.⸢MÁ *ni-nu*$^{?}$-*a*⸣-*ia* ^{24}⸢DUMU⸣ ^{d}UTU.⸢ERIN$_2$⸣.TÁH ^{m}DUMU-[*ṣíl*]-⸢l*í-ia*⸣ *ma-hi*-⸢*ir*⸣ ^{25}⸢3⸣ ANŠE 2BÁN *ša* GIŠ.MÁ *ša* ^{m}⸢*aš-šur*⸣-⸢X X X X X⸣ $^{26tr.md}$*a-šur*-MU.⸢SUM-*na*⸣ *ma-hi*-⸢*ir*⸣ $^{27tlg.}$⸢PAP 3⸣2 ANŠE 5BÁN ŠE-*um*-MEŠ ^{28}⸢*i+na*⸣ GIŠ.BÁN *ša pi-rík rit-te mah*-⸢*ru*⸣ ^{29}ITI *kal-mar-tu* U$_4$ 25-KÁM *li-m*[*u*] ^{30m}*sà-kip-šu-nu*.

85 *pirik ritte* means "across the hand". See POSTGATE, this volume.

86 The copy has ⸢80⸣. However, for the addition to be correct, 60 must be removed. The vertical sign could have been mistaken for the beginning of a line. The collation shows that this proposal is correct. L. Marti thanks S. Maul for allowing him to verify this reading on the photographs of texts from Aššur.

87 For this reading proposal see note 29.

88 The expression *ša pī* 5BÁN-*te*, literally "of/from the mouth of 5 *sūtu*" is difficult to understand. In the Old Babylonian documentation from Mari, it might have meant "to complete/fill the volume of a container". CHAMBON 2009: 34-35.

sum of the two totals. These totals are divided by 50 *qû* (5 *sūtu*) and 10 *qû* (1 *sūtu*) respectively.

Do the metrological phrases refer to different measuring-vessels (*sūtu*-measures) or to two different types of packaging (*sūtu*-container)? The use of the verb *madādum* "to measure" with the GIŠ.5BÁN-*te* might suggest at first sight that we are dealing with a measuring-vessel of 50 *qû* (= 5 BÁN, i.e. 5 *sūtu*). But the fact that some quantities of grain mentioned in other texts with "*ina* GIŠ.5BÁN-*te*" are not divisible by 50 qû (5 *sūtu*) leads to the second hypothesis in this case (i.e. 5 *sūtu*-container).[89] Furthermore, the scribe twice specified (l. 19 and 21) that the *sūtu*-container (GIŠ.BÁN) was used to fill in or complete the 5 *sūtu*-container. Therefore, it can be assumed that the term GIŠ.BÁN actually refers both to a standardised container and a measuring vessel of 10 *qû*, which could easily be handled by one person. It was also related to individuals (l. 17, 18 and 22), who certainly were the users (or the owners) of this type of vessel. The term GIŠ.5BÁN-*te* rather refers to a "container (which contains) 50 *qû* (of grain)" which was filled with a measuring vessel of 10 *qû*. It is certainly related to the bag/basket of 5 *sūtu* capacity (half of the *emāru*-measure) carried on both sides of donkeys, as discussed above. Both measuring vessels and containers are actually used to determine the amount of grain; the first one by measuring directly the amount of grain, the second one by counting the number of standardised containers.

This interpretation would make it possible to understand the mention in MARV 8 74[90] of:

32 ANŠE *i+na* G[IŠ].BÁN *ša* ᵐ*kar*-[DN] ⌜*ša pi-i*⌝ 5BÁN-*te*

"32 homers (of grain measured) according to the *sūtu* used by Kar-[…] to fill containers of 5 *sūtu*".

An amount of 32 homers of grain was measured with the measuring vessel of 10 *qû* (1 *sūtu*) used by the individual Kar-[…], in order to package it in containers filled with a standardised volume of 50 *qû* (5 *sūtu*).

In very rare texts, it is stated that the *sūtu*-container actually contains 13 *qû* rather than the usual 10 *qû* with the mention GIŠ.BÁN *ša* 1BÁN 3 $SILA_3$.[91] In the case of MARV 6 88, which records 3 *homers* (300 $SILA_3$) of grain measured by such a measuring vessel of 13 *qû*, it is possible that the measuring process was carried out 23 times (23 × 13 = 299 *qû* is very close to 300 *qû*).

The text MARV 8 3, also mentions two measuring vessels of 13 *qû*:[92]

l. 8' [amount of grain] *i+na* GIŠ.BÁN *ša* 1BÁN 3 $SILA_3$
l. 14' [amount of grain] *i+na*] GIŠ.BÁN *ša* 1BÁN 3* $SILA_3$ *hi*-⌜*iṣ*⌝-*nu*

Postgate's suggestion that the term *hiṣnu*[93] refers to the measuring practice seems quite likely. This reinforces the idea that the GIŠ.BÁN plays the role of a measuring-vessel. Perhaps the grain was measured using two different methods (i.e. the usual method and the *hiṣnu*-method).

To sum up, the issues of measuring procedures, the use of a measuring vessel and packaging are closely related. Once a liquid is poured into a jar, it does not need to be measured until it is used, so the jars had to be of standardised capacity or the scribes had to carefully record the exact volume of product in each jar. However, cereals, especially in view of their transport and storage conditions, must be measured at least every time they leave a storage place and/or change packaging.

3.3 *Capacity units, standards, measuring vessels and physical containers: evidence from Ancient Egypt*

With regard to the analysis of Ancient Near Eastern sources, Egyptology is lucky to be able to draw on a large number of iconographical sources, which offer an idea of how the measuring vessels looked like, how, when and what they were used for, and how administration was involved. In addition, some measuring vessels from archaeological contexts enable us to reconstruct capacity standards. Texts that provide information about manipulations in measuring and deviations in measurements also allow us to confirm that differently crafted measuring vessels could indeed lead to deviations from a regular norm. This information will help to reflect the assumptions formulated above.

As in Mesopotamia a number of names of measuring vessels and measuring units are known, and very often there is no distinction between the name of a vessel type, a measuring unit and the measuring vessel itself. A central term is *jp.t* (etymologically "that which counts"),

89 See for example MARV 6 81: 5-6: 1 ME 70 ANŠE 1 (*paršiktu*) 1BÁN, ⌜*i+na*⌝ GIŠ.5BÁN-*te-ma*.

90 MARV 8 74: 8', 14'.

91 MARV 6 88: 26. We should certainly add MARV 8 3: 8', 14' by reading *i+na* GIŠ.BÁN *ša* 1BÁN 3* $SILA_3$.

92 MARV 8 8 3:

93 See for example RADNER 2004: p. 76, FREYDANK 2010, POSTGATE 2016: 235–238 and Postgate's contribution in this book.

which had been the name for a cylindrical vessel type that was used for measuring grain and other silo goods since the time of Old Kingdom (approx. 2700-2200 BC).[94] At the time of the New Kingdom (approx. 1550-1070 BC), the designation was transferred to the standardised unit of grain measurement as well, which formerly was called *ḥkꜣ.t* (etymologically "that which rules"). During this time, the classifier written behind the word *jp.t* changed (not regularly) from the cylindrical vessel to a material sign (wood), which perhaps helped to reduce the confusion between the *jp.t*-unit (concept) and the *jp.t*-measuring vessel (object). Textual, archaeological and pictorial sources show, that wood was the main material used to construct the cylindrical measuring vessels. In addition, vessels made of stone (for instance a standard measuring vessel kept in the Karnak temple) or leather have been found in excavations as well.[95]

The terms of the grain measure units related to the *jp.t*-vessels changed in the course of time. During Old Kingdom (approx. 2700-2200 BC) and Middle Kingdom (approx. 1990-1760 BC), the main unit of grain measure was called hekat (*ḥkꜣ.t*). In Middle Kingdom, a single hekat (around 5 litres) and a double hekat (around 10 litres) can be found; at the beginning of New Kingdom a fourfold hekat (around 20 litres) emerges, which since the time of Thutmosis III., had been called *jp.t* (oipe) in correlation with the name of the cylindrical measuring vessel. The *sūtu* capacity measure is therefore comparable to about half an oipe, i.e. a double hekat. The oipe unit was connected to the hekat by the following relation: 1 oipe = 4 hekat. At the end of the Middle Kingdom, a systematic correlation was also established between the hekat and the so-called hin-measure: 1 hekat = 10 hin; thus in the New Kingdom we have: 1 oipe = 40 hin. The hin has a volume of around 0,5 litres and a decimal correlation to the hekat. As we have vessels from archaeological contexts, we can say that there exists also an actual volume equivalent. The decimal equivalent is also obvious with the *sūtu* and the *qû*.[96]

The Egyptian hin-measure was also applied for liquids and especially served to control the volume of the oipe-measure used during grain administration. This will be shown by some examples below.

Depictions from the process of grain management have been found in decorated tombs since the time of the Old Kingdom. They symbolise the perpetual supply of harvested goods and show the tomb owner as an supervisor of the harvest, the grain processing, the measuring and storage of the goods in silos or also during the removal of grain and other goods from the silos for further use (sowing, bread and beer preparation, payment). In these depictions—as it was also in reality according to the content of the texts—the emphasis was always on correct counting and measuring, so that a large number of measuring scenes have been handed down. In the late Old and especially in the Middle Kingdom, the tomb owner could also be supplied with three-dimensional models of granaries (**Fig. 1**). Those models included always at least one statuette of a grain measurer holding a measuring vessel. This again shows the important emphasis on correct procedures in counting and measuring.

Fig. 1: Wooden model of a granary with two grain measurers on the floor, an overseer, four workmen transporting bags ("khar") on the roofs and filling them into the holes, and a scribe who notes the amount of bags. Kopenhagen, Ny Carlsberg Glyptothèque, AEIN 1630; 12th dynasty (time of Amenemhet I)[97]

The depiction (Fig. 2) from the tomb of the Kaiemnefer shows a grain measurer during the process of measuring (*ḫꜣj.t*) in front of the silos that are devoted to *pḫꜣ*-grain

94 For the *jp.t* (oipe), see Pommerening 2005, 51-62. Compare also our own terminology, Pommerening 2005, 8f.

95 Standard measure from the time of Thutmosis III: Cairo, JdE 36925 (SR 11476), see Pommerening 2005, 363f. and fig. 6 here; vessels made of leather and found in pan graves: London, British Museum, EA 63195, see Pommerening 2005, 365f.

96 The *sūtu*-measure had certainly a capacity of about 5 litres (in Mari) and 10 litres (in southern Mesopotamia), just like the single hekat and the double hekat: see above.

97 Cf. Pommerening 2005, 345 (Mo09); for the tablet and its inscription see p. 346f. (Mo12).

crop (*šnw.t pḫ3*). The overseer (*jry jḫ.t*) standing behind him is supervising the process while counting.[98]

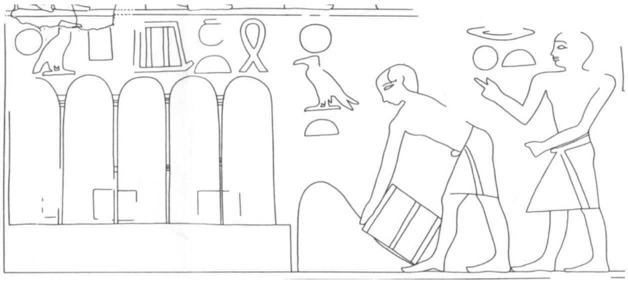

Fig. 2: Measuring scene from the tomb of Kaiemnefer; Boston, Museum of Fine Arts, 04.1761, 5th dynasty (time of Niuserre)

Measuring grain and other crops is shown in scenes from the beginnings of tomb decoration. The process of measuring is called *jp* "to count" or *ḫ3j.t* "to measure". In the two-dimensional representation, the measuring vessel is shown rectangular with three thicker lines in the middle and on the upper and lower rim. The three-dimensional models show cylindrical vessels with three circles around. This is the first evidence of cooper-work.[99] The conventions of Ancient Egyptian iconography with showing important things in a bigger scale than others do not allow to reconstruct the volumes of these measuring vessels by relating them to the assumed size of a measurer. But the scenes show the handling of the measuring vessels by one man, which gives an idea of their actual size in an indirect way. None of the grain measuring vessels is held or pulled through the grain by only one hand. As a rule, the measurer stands with one leg before the other leaned forward before the heap of crops, which he has to measure. He grips the measuring vessel with one hand on the upper and the other hand on the lower side for pulling it through the heap, or the vessel is placed on the feet, and the measurer shovels the crops into the vessel with his hands. The hands in **Fig. 1** and **2** demonstrate that the vessel is levelled and not heaped up. The seeds usually fill the vessel till the grain is horizontally flush with the rim. Only in one case heaps are shown, which are explicitly mentioned as overflowing measures, which was incorrect according to the texts[100]. The transport of those vessels is shown especially in marked scenes, where the buyers bring their own measuring vessels with them on their shoulders[101] and the vessels appear to be more than half the length of the carriers' shoulders. All in all, by considering the iconographical sources we can assume an usual vessel volume of 10 to 20 litres. This volume corresponds to a netto weight of barley of 6,73 or 13,46 kg respectively and seems practical from an ergonomically point of view and in comparison to our modern tools.[102]

The measured material was filled into bags/sacks after having been measured with the measuring vessel.

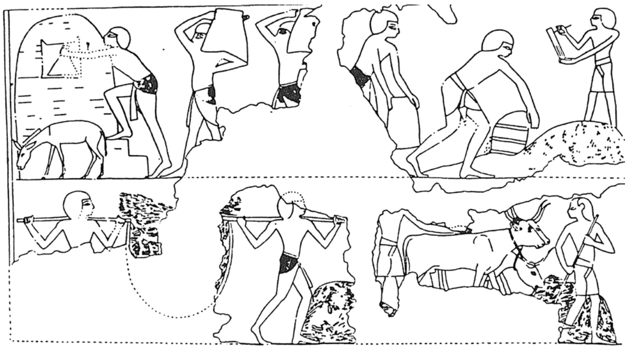

Fig. 3: Measuring scene from the tomb of Iakhmes, Thebes, El-Chocha, TT 241. 18th dynasty, time of Thutmosis III[103]

Normally the bags/sacks were used for transporting the measured harvesting goods to the silos (Fig. 1 and 2). As the number of bags was counted, they became a unit of measurement of their own (khar-measure; German "Sack"), just by being used as storage and transport tool (see **Fig. 3**). This was certainly the case with the BARIGA from the Old Babylonian period and the GIŠ.5BÁN from the Middle Assyrian period, as we have discussed above. The correlation between the volume of the bags and the number of hekat or oipe in it was fix. Usually, the bags were filled with 10 hekat or double hekat during the Old and Middle Kingdom (48 litres, 96 litres) respectively. During the New Kingdom, 1 khar was equivalent to 4 oipe.[104] Only in the case of variations to this fixed arithmetic relationship, we find specific mentions in the texts. On the verso of a wooden scribe's palette with cups for red and black ink from the time of Thutmosis III for example,[105] the scribe left some notes about deliveries from a foreigner. It is clear from the text that the sack that arrived was not equivalent to the standard sack in this time, which was four 4-fold hekat (= 16 hekat sack = 4 oipe sack = about 80 litres). Therefore, the scribe uses

98 Cf. Pommerening 2005, 291 (D07).
99 Cf. Stülpnagel 2013, 7-12.
100 See Pommerening 2005, 329 (D71).
101 See Pommerening 2005, 308-312 (D31-D35).
102 For further information see Pommerening 2005, 16-21, 281-347.
103 See Pommerening 2005, 323 (D58).
104 See Pommerening 2005, 12.
105 See Helck 1992, 41-44; cf. Pommerening 2005, 143 (T5.042).

an equation, saying that barley came up in 3.5-fold hekat sacks (= about 70 litres), and converts the amount of these sacks into the standardised sacks of four 4-fold hekat (= 4 oipe sacks) and from there into oipe:

barley (*jt*) 3 ½-fold-hekat-sack – 5 (about 350 litres)
makes (*jr n*) 4-fold-hekat-sack 4 (and) 1 oipe (about 340 litres)
emmer (*bd.t*) 3 ½-fold-hekat-sack – 25 (about 1750 litres)
makes (*jr n*) 4-fold-hekat-sack 22 (and) 2 oipe (about 1800 litres)
makes (*jr n*) emmer 90 oipe (about 1800 litres) and barley 17 oipe (about 340 litres).

Since the scribe calculates the content using the approximate size of the existing sack as being a 3 ½-fold-hekat-sack, rounding errors occur. This also shows that it was not a question of one oipe more or less as a delivery result. Furthermore, in this case there was no exact re-measurement of the entire content, but a calculation, resulting in the standard-measures of 4-fold-hekat-sacks (= sacks of 4 oipe; about 80 litres) and oipe.

The sack of 4 oipe was the usual packaging and reckoning unit. The sack itself was regularly normed by the volumes filled into it with standardised measuring vessels and not by its original volume (see below).

But there is also evidence of sacks that were described as measuring vessels in Egyptian texts. A drawing from the Old Kingdom and one from the Middle Kingdom suggest that there were also standardised sacks that were considered as units of measurement in their own right (**Fig. 4** and **5**). They are waist-high and probably correspond to the khar volume that was common in the Old or Middle Kingdom, namely 10 or 20 hekat (48 or 96 litres).

Fig. 4: Drawing from the tomb of Niachchnum/Chnumhotep, 5th dynasty, time of Niuserre; left hand an inscription "to measure figs" (*ḫꜣj.t dꜣb*)[106]

Fig. 5: Outside the coffin of Kawit showing full sacks before silos, 11th dynasty, time of Mentuhotep-Nebhetepre[107]

It now remains to be seen how the measuring vessels depicted in the iconography correlate with the mentioned units of one- two- and fourfold hekat (the last one is the oipe). One could assume that the volume of the corn measuring unit is exactly 1:1 the volume of the vessels depicted in the scenes. If so, the vessels in the New Kingdom would be four times bigger than the vessels in the Old Kingdom, because the standard unit in the Old Kingdom was the hekat with 4,8 litres and the standard in the New Kingdom was the 4-fold hekat (called oipe) with 19,2 litres. Due to the depictions, the measuring vessel could have had a volume of 10 litres during the Old and Middle Kingdom and therefore the double of the unit hekat. Meanwhile we know from texts that the corn measuring units hekat and oipe were divided in a dyadic way down to $\frac{1}{64}$ hekat or $\frac{1}{64}$ oipe (this is shown by a special system of grain measuring numbers), so we could ask for the existence of these smaller vessels as well. Indeed, we have discovered a depiction of a set of vessels in dyadic range in the tomb of Hesire dating around 2700 BC. Besides we have at least a few measuring vessels from archaeological context that deliver the typical volumes of the corn measuring system: 1 oipe (= 4 hekat), $\frac{1}{16}$ oipe (= ¼ hekat), $\frac{1}{32}$ oipe (= ⅛ hekat), and $\frac{1}{64}$ oipe (= $\frac{1}{16}$ hekat).[108] Particularly helpful in the questions of standards is a measuring vessel with the volume of 1 oipe (around 20 litres), bearing the inscription of Thutmosis III and found in the Karnak temple (**Fig. 6**). As this vessel is made of stone, it must have been a normative measuring vessel, and as the oipe was the standard measure during the time of Thutmosis III, we have a definitive correlation. Due to its weight, this vessel was probably not

106 See Pommerening 2005, 317 (D37).

107 See Pommerening 2005, 317 (D45).

108 See Pommerening 2005, 363-369.

used for daily measuring activities; for those works the use of standardised leather vessels or wooden cylinders as depicted seem reasonable. A leather vessel with a volume of around 19 litres from 1700 BC has survived in a tomb. On the basis of the depictions it seems likely that the volume of the cylinders used for measuring grain during the Old and New Kingdom did not change in the way that 5 litres used to be the standard during the Old Kingdom and 20 litre vessels 1000 years later. Most important was that there existed a defined correlation between the volume of the vessel, the volume of the standard unit, and its subdivisions and multiples.

In the context of corn measures, the dyadic numbers can build new bases for multiples. For example subunit of the oipe, the dja, started to be a new unit, which in turn was subdivided into smaller parts dyadically (up to ¹⁄₁₂₈), and also built multiples. The parts and the whole measure were integrated in one and the same vessel, comparable to our kitchen measuring cups.

Fig. 6: Measure of stone from Karnak temple with inscription of Thutmosis III, volume of 19.2 litres (which is 1 oipe)[109]

According to the iconography and the texts, the measuring vessels and corresponding grain measuring units were used in temple and state administration as well as in private trade. Moreover, the vessels were used to measure multiples of the hekat, and since Thutmosis III of the oipe.

In the texts, the measuring vessels can be named by different terms: *jp.t n pr*[110] “oipe of the house” is the name of a vessel which was placed in the house of an official, *jp.t n šnw*[111] was the “oipe of the granary”—granaries could be part of a temple or of a pharaonic domain. The measuring vessel of the granary could be named more precisely as *tꜣ jp.t tꜣ šnw.t Jmn* “Measuring vessel of the granary of Amun”. According to the New Kingdom texts, all these vessels theoretically had the volume of an oipe (which is 40 hin), but due to manufacturing defects and deliberate modifications, there could be differences in size between the vessels. These were measured by the smaller unit hin (around 0.5 litres).

The following short example illustrates that the unit oipe was the main measuring unit of the New Kingdom and the main volume of the usual measuring vessels used by the administration, and that measuring vessels of this type could be stored in different places but normally should have had the same amount of volume. This is a letter from a woman to her husband, in which she describes her problems with the delivery of an exact amount of grain to the granary of Amun.[112]

(rto 4) *sḏm=j md.t* (5) *nbj.hꜣb =k n=j ḥr=w*	I heard all concerns that you sent to me concerning this.
pꜣ ḏd j.jr=k tꜣ md.t n pꜣy 162 *2 *n ẖꜣr bd.t* (6) *j.ḏd=k*	Your saying concerned these 162 khar *2 (oipe) emmer, to which you said:
jm ḥn sš Pn-tꜣ-ḥw.t-nḫ.t	“Arrange, that the scribe *Pn-tꜣ-ḥw.t-nḫ.t*, comes
mtw=f šsp=w jrm nꜣ ḥn.tjw	and that he together with his superiors receives these (162 khar *2 (oipe) emmer).
(7) *mtw=w tm jtḥ=w m wʿ(.t) jp.t ʿꜣ.tj.n=k*	and that they do not measure with a big measuring vessel” That is what you said.
tꜣy=k šʿ.t spr.tj r pꜣ nty ṯꜣ.tj jm (8) *jw=f (ḥr) wḏ(.t) sš Sꜣry jrm pꜣ ẖꜣy*	Your letter arrived to the place where the Wesir was and he charged the scribe *Sꜣry* together with the measurer.
jw=f (ḥr) dj.t jw.t=w jw jnj=w wʿ jp.t	And he arranged, that they came, bringing with them a measuring vessel,

109 See Pommerening 2005, 363f. (M09).

110 Urk. IV, 2152,18–2153,2; Urk. IV, 2153,6–11.

111 pGenf D191 rto 9 (LRL 57,7-58,2).

112 pGenf D191, rto 4-12 (LRL, 57,7–58,2), cf. Pommerening 2005, 42f.

jw=s{t}(9) *ꜥꜣ r jp.t tꜣ šnw.t wꜥ hnw*	which was 1 hin bigger than the measuring vessel of the granary.
jw=j (ḥr) šm.t r ḥꜥw=j jw=j (ḥr) dj.t šsp nꜣ jt jw=j jm	And I went there for myself and I arranged the reception of the barley, being there myself.
(10) *jw=w (ḥr) jry(.t) ẖꜣr 146 *3 m tꜣy jp.t*	And they made 146 khar *3 (oipe) with this measuring vessel.
jw pꜣy ms-ḫr (ḥr) ḏd jrm pꜣ wḥꜥ	And this workman and the fisher said:
150 ẖꜣr n jt (11) *pꜣ ḫꜣy=n n=n m tꜣ jp.t tꜣ šnw.t Jmn j.n=w*	"150 khar of barley was what we for ourselves have measured with the measuring vessel of the granary of Amun". That is what they said.
jw=j (ḥr) ṯnf nꜣ jp.t jw=j (ḥr) ḏd n=n	And I checked the measuring vessels (by measuring) and I said to them:
(12) *pꜣy=j ṯnf m-dj=j*	"My checking by measuring is helping me,
jw=j (ḥr) gm(.t) nꜣ jt m pꜣ nty nb.t s.t jm j.n=j n=w…	because I found all the barley at this place which should be here." That is what I said to them.

The amount of 146,75 Khar is around 10 % smaller than the intended amount of 162 khar *2 (oipe). Therefore the vessel which was brought by the measurer was indeed too big: it had a volume which was 10 % bigger than that of the oipe, i.e. 44 hin instead of 40 hin.

What is interesting in this case is that the woman claims that the measure was 1 hin bigger than the measuring vessel of the granary which they had. This means that the amount was converted into hekat-measures. Remember the relationship: 1 oipe = 4 hekat = 40 hin or 1 hekat = 10 hin. Furthermore, this text shows—and there are others—that the hin-measure was used to check the bigger grain measure.

In any case, this should demonstrate that a precise name by place or owner of a measuring vessel was important to know, as with this knowledge it was possible to express the deviations from a standard.[113]

4. Conclusion

While Old Babylonian letters can sometimes describe concrete problems in measuring processes, as they mention the parties involved in commercial transactions, administrative texts are intended to record accounting information in a concise way. Accountants are not interested in measuring activities themselves, but in their present or future outcome (facts and figures) within the flow of commodities and the fiscal regime. In this respect, metrological expressions with capacity standards mainly refer to accounting devices, which aim to inform about the origins of commodities or anticipated operations rather than about actual measuring practices that would involve different standards of capacity measures. In particular, the study of the different "unusual" capacity measures (volume bigger or smaller than the usual capacity standard) in the Old Babylonian texts should be continued. But rather than systematically considering such capacity measures as measuring vessels, whose differences in volume with this of the capacity standards would lead to conversions, it is interesting to ask why scribes mention them in administrative texts. It seems that some of the terminology is actually process-oriented.

This does not mean that there were no capacity standards in everyday life. In this respect, we learn a lot from the Egyptian example. In Egypt, there existed some volume standards of stone, which perhaps also could have survived in the Near East. Thus, there actually existed an idea of comparable norms. Furthermore, the Middle Assyrian documentation shows that the issues of capacity norms, measuring procedures and packaging are closely related, as can be also shown from the Egyptian examples. In particular, grain could be transported and delivered in containers of ca 50-60 liters, which themselves had a standardised volume or which had be filled with a standardised volume. This is entirely comparable to what the Egyptian sources show us. In this way, accountants only have to count the containers to find out the total volume of grain, rather than doing many measuring operations with a standard capacity measuring vessel. If we look at the *palettes* the scribes hold in their hands in the small models, it is obvious that they only count the sacks which arrive on the roof. The way of reckoning the basis units is only for comparison. On the other hand, Middle Assyrian documentation and also Egyptian texts provide a large number of variants for the *sūtu*/ GIŠ.BÁN, and the *jp.t*-vessel, which refers both to a standardised container and a measuring vessel of 10 *qû* resp. 40 hin.

113 For more examples see Pommerening 2005, 40-45. i.e. another oipe-measure, which should include a volume of 40 hin, was checked and contained only a volume of 38 hin, see p. 42.

List of abbreviations

AbB 12	=	van Soldt 1990
AbB 14	=	Veenhof 2005
ARM 11	=	Burke 1963
ARM 21	=	Durand 1983
BATSH 4	=	Cancik-Kischbaum 1996
BATSH 9	=	Rölling 2008
FM 15	=	Chambon 2018
KAJ	=	Ebeling 1927
MARV 3	=	Freydank 1994
MARV 5	=	Freydank/Feller 2004
MARV 6	=	Freydank/Feller 2005
MARV 7	=	Freydank/Feller 2006
MARV 8	=	Freydank/Feller 2007
MARV 9	=	Freydank/Feller 2010
MARV 10	=	Freydank/Prechel 2011
OECT 15	=	Dalley 2005
YOS 12	=	Feigin 1979

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Metrology in action. Hacksilver and scale weights in Western Asia during the 3rd millennium BCE

Luca Peyronel

Introduction

The study of Early Bronze Age economies in ancient Western Asia is strongly dependent on data gathered from written sources. Regardless of the differences in regional trajectories of the socio-economic structures that emerged from archaeological evidence, Near Eastern economic history has usually been traced according to a long-term perspective. It followed the rise and development of the Mesopotamian city-states, regional kingdoms, and empires, epitomising the dependence on the textual reconstruction (van der Spek *et al.* 2018; Alivernini/Mynářová 2021), which for a long time had been influenced by the different models of the formalist and structuralist approach (Silver 1985; Powell 1999; Renger 2004). It is only during the past two decades that new research ventures off the beaten paths have allowed the reconstruction of a more nuanced picture, which also takes into account the archaeological analyses of specific periods and cultural contexts, aiming at highlighting local strategies and a more detailed description of the economic and exchange systems (Warburton 2016; Rahmstorf/Stratford 2019; Rahmstorf *et al.* 2021). At the same time, the long-standing debate on the concept of ancient globalisation has been resumed, enriched by a wealth of data gained from the scientific analyses of materials and organic remains (such as DNA and provenance studies), profiling the impact of interactions on a broader scale, and delineating the rise of an intertwined world in which technologies, economic tools and administrative devices were diffused over the whole Near East and also beyond during the 3rd millennium BC (Jablonka 2014; Wilkinson *et al.* 2011; Wilkinson 2014).

The circulation of metals gained crucial importance within the overall system, and the reconstruction of the procurement, production and consumption cycle shed light on local specificities, shared practices, and cultural behaviour. Operationally, it depended on the exchange systems and was regulated by shifting mobility patterns, agencies and political control in a progressive trend towards commodification. A separation between the base (copper, tin, lead) and precious metals (silver, gold/electrum) and their techno-system packages seems to be correlated with the rise of socio-economic complexity during the Late Chalcolithic period, when alloying techniques and technological improvements, such as cupellation, developed. Such a distinction and the practical and 'cultural' spheres of metals use are vividly represented throughout the cuneiform literature, especially in the Sumerian debate poem 'Copper and Silver', in which the rhetorical fiction of a dispute between them served to emphasise their complementarity in Mesopotamian society (Peyronel 2019a: 76-77). The development of metrological and commensuration systems was part of this general changing framework of socio-economic relations, on which the administrative and centralised structures had a strong impact. In this respect, the emergence of the specific economic role of silver is a phenomenon that should be investigated in relation to the development of a 'global' exchange network. The use of silver as currency can be recognised in the cuneiform records, but it was not exclusive to the Sumerian world. Archaeological evidence shows that silver bullions and sets of scale weights appeared in the same period in Western Asia, and they were correlated with standardised metrological values (Rahmstorf 2016).

However, the very beginning of this process still needs to be made clear because of the unsatisfactory publication of several important sites. The recent reappraisal of archaeological investigations into various urban areas of Southern and Northern Mesopotamia as well as the explorations carried out in many 5th to 3rd millennium settlements in Turkey, together with a large amount of evidence from important centres of the Northern Levant (Ebla *in primis*), enable a substantial advance on the knowledge of early Near Eastern silver metallurgy and metrology.

The necessity of a multivariate analysis of silver use, which combines epigraphic and archaeological data, quantitative/statistical methods for metrological evaluation, and scientific analyses of silver pieces was the starting premise of the research project 'Silver Circulation in Ancient Near East' (SCANE), carried out by the University of Milan under the coordination of the Author (Peyronel 2018a; 2019a). The first phase of research was devoted to the analysis of the 2nd millennium BC evidence: a wealth of information on both scale weights and silver hoards is available for the Middle and Late Bronze Ages, allowing the testing of statistical methods and the refinement of the data collection criteria. Currently, the project focuses on the Early Bronze Age, and a first survey of the materials is here presented together with a preliminary evaluation of silver use as it emerged from available documentation.

Hacksilver in Syria and Mesopotamia during the 3rd millennium

Silver (Ag) occurs as native metal and in ores (Bachmann 1993; Hauptmann 2020, 74-85). The former is very rare in Western Asia, and since the very beginning polymetallic argentiferous ores were also exploited. The main silver ores are the sulphides and the chlorides, from which the precious metal can be easily smelted, and the silver-lead ores (especially galena, a lead sulphide, and cerussite, a lead carbonate) that usually contain the metal in a low percentage. The latter needs the process of cupellation to separate and extract silver, which allows the precious metal remaining apart, with the lead reacting and forming a waste slag (PbO) named litharge (Moorey 1994: 232-236; Hauptmann 2020, 286-293). The main sources of silver in South-Western Asia are located in the Taurus Mountains range of Anatolia: in the Keban mining district (Elaziğ Province, Turkey) on the upper Euphrates, lead-silver ores have been exploited since the 4th millennium BCE, as testified by the smelting site of Fatmalı-Kaleçik (Hess *et al.* 1998). In south Central Anatolia, the Bolkardağ valley also gave unequivocal evidence of polymetallic ores associated with 3rd millennium mining and smelting sites (Yener 1986; 2021); further west, the Aegean coastal region is characterised by various silver ores especially clustered around Çanakkale and Izmir (de Jesus 1980).

It is almost certain that most of the silver reached the Northern Levant and Mesopotamia from Anatolia, where 'the silver mountain' cited in the Mesopotamian cuneiform inscriptions must be placed. However, numerous silver-bearing deposits are also reported for the Iranian plateau. Some of them (e.g., Nakhlakh) are near the surface and might have been easily accessible for early metal extraction (Stöllner *et al.* 2004).

A precise identification of silver sources through chemical analyses is prevented by the complex process of refining and producing the metal, which alters the trace elements. Useful information can be gathered only from the isotopic composition of the lead content, if present, which remained constant from ore to artefact (Pernicka 2014). According to the lead's fingerprint, it is possible to indicate the compatibility of silver coming from archaeological contexts with one or more silver-lead ores without any certainty on their exclusive provenance. For instance, isotope analyses carried out on eleven objects from the ED III Royal Cemetery of Ur seem to indicate that silver originated from both Iranian and Anatolian multiple sources (Salzmann 2019, 89-107).

A systematic study cataloguing silver artefacts from the pre- and protohistoric periods in Western Asia has not yet been carried out. However, a general survey of the metal chronological distribution shows that in the 6th–5th millennium BC, the earliest evidence are isolated small finds (beads) in native silver. A wider presence of artefacts is attested for the Late Chalcolithic 3-5 (4th millennium BC), and it would have been related to the diffusion of the cupellation technology, although silver obtained through cupellation cannot be unequivocally identified in the absence of processing by-products. Silver findings (ornaments, sheets, small vessels) are spread from Central and South-Eastern Anatolia (Fatmalı Höyük, Korucutepe, Arslantepe), Syria (Brak, Hamoukar, Habuba Kabira), the Levant (mostly from Byblos, but also isolated specimen from Tell esh-Shuna, Tell el-Farah N, Bab edh-Dhra'), Mesopotamia (Uruk), and Iran (Tepe Sialk, Arisman, Susa, Hissar Tepe), which shows the concentration of silver and litharge slags in the regions where silver-lead ores are located (Anatolia and Iran) (Prag 1978; Philip/Rehren 1996; Helwing 2014). Besides Uruk itself, the concentration of silver items has been pointed out and considered evidence supporting the commercial 'model' of the Uruk phenomenon (Algaze 2008). The Late Uruk enclave of Habuba Kabira on the Middle Euphrates constitutes another exception: here, the smelted metal was imported probably from the North (Pernicka *et al.* 1998). These 4th millennium silver items are mainly small personal ornaments and jewellery pieces, while small containers, inlays and figurines are attested for the last part of the period (especially Late Chalcolithic 5), together with alloyed copper-silver objects (Helwing 2014; 2019).

The reasons why this metal began to be appreciated throughout entire Middle Asia and the Mediterranean should be related to a combination of factors: the presence of multiple sources of silver-bearing ores and their location near the copper-bearing ones makes silver procurement and exploitation relatively easy; the metal's physical properties—once smelted and refined, silver is a soft metal with a shiny white appearance; the pale grey/white colour of the metal, with the possibility of combination with gold (yellow) and copper (reddish-brown) permit the manufacture of polychromatic precious decorative items (Sherratt 2018).

During the 3rd millennium BC, a fundamental change in silver use is attested, undoubtedly tied to the socio-economic developments of the urban complex societies. The substantial increase of the metal in Syria and Mesopotamia during the Early Dynastic period were related to a new economic function assumed by the precious metal, which started to be used as a standard of equivalence and means of payment in the process of commodification related to the urban revolution (Rahmstorf 2016). Silver probably assumed this role precisely because it was relatively accessible from multiple sources and, at the same time, rare in comparison with other goods and materials, making the practice of exchanges through its use as a standard of value a very convenient choice. Thus, the circulation of silver by weight for commercial purposes was advantageous since a large number of trading activities could be performed with a small quantity of metal. Moreover, silver is an 'impracticable metal' since it cannot be employed in manufacturing implements, tools and weapons unlike copper and other metals. A similar process characterised gold in Egypt during the Old Kingdom, where it was used as a means of equivalence and as a metrological standard, since it was easier available than silver.

The condition of rarity was but of the reasons for the advent of the hacksilver economy in Mesopotamia, and the first appearance of silver bullions in the mid-3rd millennium BC is a clear manifestation of this structural change, also revealing that silver has become the primary raw material to store economic value. Silver processed into regular shapes (bun ingots, rings, and coils), rough-cut pieces and scraps of metal (hacksilver) to be hoarded, recycled and/or exchanged are attested both for private and public contexts (Peyronel 2010; Ialongo *et al.* 2018). At the same time, the finding of early 3rd millennium balance pans and scale weights from the Aegean to the Indus Valley undoubtedly indicate the spread of the notion of weight and commensuration through direct contacts and the exchange of commodities (Ialongo *et al.* 2021). Within the Bronze Age 'global' network of interactions, weighing procedures might be considered as part of a wider 'institutionalised' package of technologies and administrative tools (such as seals and sealings), variously operating into the different economic structures (Rahmstorf 2011).

The epigraphic cuneiform sources confirmed the different stages of silver exploitation and the key role of the precious metal in ancient Western Asian economies (Bartash 2019). The Sumerian sign for silver (ku$_3$-babbar) means 'the white/bright metal', while its Akkadian counterpart, appearing in the Akkadian period, *kaspum*, derives from the verb *kasāpum*, which means 'to break into pieces' and it is derived from the economic use and circulation of silver.

Pictograms referring to metals and metalworking activities have been attested since the advent of writing in the mid-to-late 4th millennium Archaic tablets of Uruk (Eanna IVa and III). The presence of the sign KU$_3$ in these texts, which resembles half a coil, should indicate, amongst other, the substantive 'shining/precious metal', and a direct identification with silver has been suggested (Monaco/Pomponio 2009; Krispjin 2016). However, a generic meaning for metal seems more probable, and it would be related to copper or copper alloys (Bartash 2019: 178-180). During the ED I-II, silver did not appear in the Archaic texts of Ur (Lecompte 2013). It is only from the ED IIIa onwards that cuneiform documents (Fara texts, ancient *kudurrus*) unequivocally attest the Sumerian sign for silver in relation to the metal's use as a measure of value and account's unit (Milano 2004). During this early period, however, the metal most used in economic transactions was copper (counted in minas), while silver first appeared on specific (ceremonial?) occasions and as an addition to the main exchange's operation, and then replaced copper to become the only metal that fulfilled the functions of a medium of exchange and payment, a reserve of wealth and standard of equivalence in the late 3rd millennium BC. Looking at the epigraphic documentation of the Early Bronze Age, the development of silver use appears quite clear: the Fara texts (ED IIIa) include several sales of land tenures and houses in which a quantity of copper usually indicates the 'price' (and also the 'addition'), and silver is only rarely used in relation with a 'gift' added to the economic transaction (Martin 1988). In the so-called ancient *kudurrus*, a script-bearing stone with inscriptions regarding land tenure administration and the exchange of properties, dating from the end of the 4th millennium BC down to the Akkadian period, we can note a striking difference between the early (JN-ED I-II) and late documents (ED III-Akkadian). The latter ones are characterised by the presence of silver and its use in connection with numerals that suggest an indication of purchase payment (Gelb *et al.* 1991; Milano 2008). The corpus of Old Akkadian administrative and legal texts also allows to recognise an increase in the economic use of silver (e.g., in the so-called Manishtusu obelisk, and in various sales documents from Nippur, Isin, and Adab) (Monaco/Pomponio 2009). Outside Mesopotamia, a wealth of information on the exchange and use of silver come from the Ebla texts, dating back to the 24th century BC, where the cuneiform texts of the royal archives clearly show the intersection of the gift system with the circulation of silver as a means of payment in a redistributive pattern (Archi 1985; 2003; 2011; Peyronel 2014a). Silver and gold objects of standard weights (plates or disks, daggers, bracelets, and pendants, from 10 to 60 shekels) circulated according to redistributive procedures and were the traditional method of wealth accumulation. Instead, silver vessels—rarely present among precious goods exchanged within the kingdom—mostly correlated with the foreign ceremonial and gift exchange system. Notwithstanding the different circuits, all these precious items were recorded indicating their weights (or 'value') in silver.

At the time of the Ur III empire, the strong bureaucratic and administrative organisation of the kingdom resulted in the standardisation of weights and measures and in the emergence of a fixed system in which silver and barley eventually became the only standards of reference to express the value and price of other goods (Garfinkle 2008; Mander/Notizia 2009) and to indicate the rates of interest in the loan contracts (Garfinkle 2004). At the end of the 3rd millennium BC, a series of texts from Ur, Lagash, Puzrish-Dagan, recorded the manufacture and distribution of precious metal standardised objects named in Sumerian ḪAR (Akkadian *šewirum*), which literally means 'ring' (Michalowski 1978; Paoletti 2008: 150-152 with references). The Drehem Treasure Archive presents lists with silver ḪAR that high-ranking individuals and members of the crown 'received as gift' by the crown on specific occasions (e.g., marriages or births, celebrations of military victories) or during social events, such as religious festivals. The weights of the rings are specified, ranging from one to ten shekels, and the Ur metal texts—which contained notations on metalworking—recorded the overwhelming prevalence of rings corresponding to five shekels. The rings were in fact always weighted rather than counted, thus giving the possibility to check with precision the silver quantity. As attested in the earlier documentation from Ebla, the Neo-Sumerian evidence suggests that silver circulation, now in the recurrent ring-shape, allowed internal wealth redistribution, in a system strongly embedded in social and ideological spheres. It has been rightly noticed that the term ḪAR might not only denote rings, but also coils and spirals frequently found in the silver hoards (Powell 1978) together with a variety of other silver pieces, including length of rods and wires, ingots, sheets, and scrap metal fragments (Peyronel 2010).

The archaeological evidence testifies to the large amount of silver that reached Mesopotamian centres after the mid-3rd millennium BC. The precious metal was used to manufacture prestige items, such as vessels, composite sculptures, pieces of jewellery and decorative parts of composite artefacts, including animal and anthropomorphic miniature figurines, as the ones found in the funerary assemblage of the Royal Cemetery of Ur (Zettler/Horne 1998). One of the biggest single silver artefacts is the extraordinary Enmetena vase, retrieved at Tello/Girsu and now in the Louvre (Heuzey 1895; Chevalier 1996): it is 35 cm high and has a copper-footed support in the shape of four lion's paws. Its ovoid body is engraved with four large lion-headed eagles grasping alternatively couples of lions and ibexes surmounted by a row of crouched cows, and a cylindrical neck bearing at the rim the votive dedicatory inscription to the god Ningirsu by the Ensi of Lagash (**Fig. 2**). A similar range of manufactured items is documented for Tell Mardikh/Ebla in Northern Syria, at Tell Brak/Nagar on the upper Khabur, and at Tell Hariri/Mari on the middle Euphrates, showing the same silver use in the wealth economies of the northern regional powers. The emergence of political entities in Anatolia in the very same period is characterised by the presence of citadels and by the evidence of strong interactions with both the Aegean and Syria-Mesopotamia (Bachhuber 2015). With regard to metallurgy, a distinctive occurrence of prestige metal objects including often items obtained by alloying silver, copper, and gold, is attested for the EB I-III. The phenomenon is epitomised by the rich burial offerings of the so-called 'royal tombs' of Alaca Höyük and by the 'treasures' of Troy II-III, where also several silver objects and ingots were found.

Contemporary with the spread of prestige silver items in entire South-Western Asia is the appearance of silver bullions. The hoarding of silver pieces was intended to conceal the precious metal that had assumed an exchange value in the ancient economies. From this time onwards, silver by weight was used in the Near East and Eastern Mediterranean until the introduction of coinage, and even when the first silver coins appeared they

Fig. 1: Map of Western Asia with indication of the main sites mentioned in the text (by V. Oselini, Base map: ESRI World Physical Map, March 2019. WGS84).

Fig. 2: Silver vase of Enmetena from Tello/Girsu. Département des Antiquités orientales, Louvre (courtesy of Musée du Louvre).

were exchanged according to the weighing practice in the same manner as the other pieces of silver (Peyronel 2010; 2014a; 2019; Thompson 2003).

A hoard's classification based on the content led to a distinction between hoards containing only silver pieces, hoards with silver plus other various precious items, and hoards with silver, precious items, handicrafts and administrative/economic tools. This sub-division has proved useful in recognising regional differences and trends from the long-term diachronic perspective (Peyronel 2010). Context and type of containers add further information for understanding the hoarding practice, and allow the investigation into the relation between the owners and the silver bullion, thus revealing the depositional dynamics (Bjorkman 1994). To examine the economic function of silver, these 'utilitarian' hoards are our primary archaeological source. They may clearly be distinguished from foundation deposits in which precious objects, including those made of silver, had a completely different meaning (Ellis 1968).

Early Bronze silver bullions have been reported only for two Syro-Mesopotamian sites: Khafaja/Tutub in the Diyala valley and Tell Chuera in the Syrian Jazirah. By contrast, hoards containing hacksilver and silver items, together with other materials and objects, are more widely distributed, with evidence from Mesopotamia to Anatolia (Tell Taya, Khafaja/Tutub, Tell Asmar/Eshnunna, Tell Agrab, Tell Brak/Nagar, Tell Hariri/Mari, Troy, Mahmatlar, Eskiyapar) (Peyronel 2010; Bachhuber 2018) (**Fig. 1**). All the silver hoards come from household contexts, namely private buildings where the silver used to be hidden below a floor, and the silver pieces were contained in a small jar. Mixed hoards are usually associated with domestic architecture but come also from public buildings (temples and palaces). Most hoards from Mesopotamia were retrieved in urban centres in the Diyala valley, with a paucity of data for the southernmost alluvium, although the lack of published information could bias our reconstruction.

Among the hoards found at Tell Asmar/Eshnunna, inside small jars hidden below the floors of houses (XX, XXXIII, XXXIV, XXXVIII) dating to the Akkadian period (Levels V-IVa), several contained silver pieces (Delougaz 1952; Bjorkman 1994). Their inventory is briefly described in the reports, without any details or photographs of the pieces, preventing a detailed analysis. However, the available information allows us to point out the association between hacksilver and cylinder seals, semi-precious stone beads and, in one context also, balance weights.

House XX is associated with a silver hoard found below the floor of room L.19:1, which is only briefly described in the excavation report, mentioning silver ornaments and a large filigree disc (Delougaz 1952, pl. 187; Delougaz et al. 1967, 169; Bjorkman 1994, 619, Asmar #02).

Two hoards were retrieved below the main room (H18:4) of House XXXIII (Delougaz *et al.* 1967: 177, 226-227, pl. 28; Bjorkman 1994, 621, Asmar #04): one contained c. 110 pieces, mostly hacksilver (2 coils, 2 rings, 42 beads, 1 frog-shaped amulet, fragments of wires and sheets) and semi-precious stone beads (lapis lazuli, carnelian, agate), and the other one cylinder seals, balance weights, beads, and small copper tools, apparently without silver pieces.

A small jar filled with silver and other precious small finds (Delougaz *et al.* 1967: 223, pl. 28; Bjorkman 1994, 632, Asmar #16) was hidden below the floor in the entrance room of House XXXIV. The silver inventory included 12 silver coils, 2 'lumps' (probably ingots), 1 ring, 4 ornaments and 1 frog-shaped amulet, associated with 6 carnelian beads, a gold bead, and a lapis lazuli cylinder seal with silver caps (Frankfort 1955: n. 644).

M.A. Powell published a photograph with three groups of silver pieces, specifying that they came from domestic contexts of Tell Asmar (Powell 1978: 230, pl. IIIA-B), although we cannot precisely identify them. They include several fragmented rings and coils, cut pieces of wires, small bars, folded sheets, lumps, and some small ingots.

A spectacular hoard comes from the Northern Palace (Level Va), wrapped in a textile, and hidden below the floor of a peripheral room of the building (E16:16) (Delougaz *et al.* 1967: pl. 37; Bjorkman 1994, 624, Asmar #07). It consists of more than three hundred precious ornaments, mostly silver and semi-precious stone beads, lapis lazuli and silver amulets (lion-headed eagles, bulls, frogs, and lion) (Frankfort 1934: 35-36, figs. 28-29; Delougaz *et al.* 1967: 190, 245). The silver inventory also includes some scrap silver (sheets and fragments of rings) and a large filigree disc of 11 cm in diameter.

A hoard exclusively consisting of hacksilver was found at Khafaja/Tutub, buried beneath the floor of the main room (Room 1) of a house (S 41:1) dating back to the Akkadian period and located immediately east of the Temple of Sin X (Delougaz *et al.* 1967: 17, 45. pl. 16; Bjorkman 1994: 534, Khafaja #19; Peyronel 2010, 929, fig. 1: A1). The precious material was found inside a small pot (Delougaz 1952: Pl. 107a, 183) sealed with bitumen, and included 4 coils, 15 biconical beads, 2 small 'cones', 15 rings/coils, 13 sheets, 1 thick folded bar, 9 sheet's pieces and c. 30 scraps. No data are available on the specimen' total weight and individual masses, although the materials are currently under study by W. B. Hafford (see vimeo.com/436797333) (**Fig. 3**).

More than one hundred spirals/coils of silver allegedly from Khafaja and now kept in the Museum of the

Fig. 3: Silver items from a hoard found below room 1 of house S 41:1 at Khafaja/Tutub (38-10-82). University of Pennsylvania Museum of Archaeology and Anthropology (after vimeo.com/436797333).

Oriental Institute of the University of Chicago were acquired by H. Frankfort in Baghdad from A. D. Messayeh in 1930 (Powell 1978). If their provenance is correct, it cannot be excluded that they come from a unique silver hoard/cache from a public building (due to the quantity, a domestic context seems to be excluded) and, considering the settlement history of the site, they might date from between the second half of the 3rd and the beginning of the 2nd millennium BC. However, silver bullions discovered in controlled excavations are always made of a mixture of silver pieces and never only by rings/coils. The metrological data and the description of the specimen published by M. A. Powell show that most of the coils display masses between 0.5 g and 34.5 g, thus ranging between 1 shekels' fraction and 4 Mesopotamian shekels maximum (Peyronel 2010, 933-934, fig. 12; 2019a, 77). The only heavier coils are A9546 (61.65 g = 8 shekels?), A9547 (a complete spiral of 75.4 g = 9 shekels), A 9544 (a whole spiral of 241 g = 30 shekels or half a mina), A 9547 (a spiral cut at one end of 470 g = 60 shekels or 1 mina), and A 9543 (a complete coil of 492.5 g = 60 shekels or 1 mina). It is interesting to note that the specimen' weights do not match those reported in the cuneiform records dating to the Ur III period that attested the manufacture and distribution of 'rings', which mainly were standardised according to the weight/value of 5 shekels (8.4 g x 5 = c. 42 g).

Evidence of hacksilver associated with sacred buildings in the 3rd millennium BC is scarce and comes from Tell Agrab in the Diyala valley, where a 'visible' hoard with rings/coils and hacksilver was retrieved in a long room/corridor of the Shara Temple dating back to the ED II (L 13:3; Delougaz/Lloyd 1942: 250, 272-273). The items listed in the report include silver wires, rings/coils, ornaments, beads and an enigmatic 'gold weight' (Bjorkman 1994, 606, Agrab #19).

Two silver hoards from the Akkadian period were discovered at Tell Taya during the excavations carried out by the British School of Archaeology between 1967 and 1973. One hoard (Reade 1973: 165, Pl. 67a; Peyronel 2010, 929, fig. 1: A3), whose total weight is not registered, includes 5–6 irregular flat and bun-shaped ingots, c. 10 coils/rings, some biconical beads of silver together with gold beads and sheets, and some small stone beads. It comes from a filling layer without relation to architectural structures in the Gatehouse area, and according to the excavators, the vessel in which the silver used to be kept was probably thrown away when the area was levelled during phase VII. It might date from the previous period of occupation (Level VIII).

A second hoard from Level VIII was found in a pot sealed with a clay stopper and buried under the floor of a private house located west of the temple (Reade 1968: 248; Bjorkman 1994, 673, Taya #01; Peyronel 2010, Tab. 1: B6). It includes 38 complete rings/coils and several fractioned spirals/rings, 5 biconical beads, 8 flat ingots, 20 irregular lumps and numerous scraps of silver, together with two gold beads and several semi-precious stone beads.

Moving to the west, 3rd millennium silver hoards are attested for the Jazirah at Tell Brak/Nagar and Tell Chuera.

The evidence from Tell Brak is particularly rich, with four hoards retrieved hidden below the floors of private dwellings dating back to the late Akkadian period. A small hoard of hacksilver came from a house in Area ER (beneath Room 6) and was kept in a goblet of Metallic Ware, sealed by a clay stopper. It included 1 thick twisted rod, 1 disc, 9 rings, 43 beads, fragments of twisted wire, some pendants of silver, together with some gold ornaments and 1 lapis lazuli bull amulet (Mallowan 1947: 74, 176-177, pls. 15:2, 33-34; Bjorkman 1994, 645, Brak #03). A small jar—buried below the floor of the last refurbishment of a dwelling in Area CH (Room 12)—contained silver pieces (1 ring, 1 twisted rod, several folded/distorted strips and beads), together with 4 interlaced copper (or copper-silver alloy) rings, gold and semiprecious stone (agate, carnelian, lapis lazuli) beads, gold coil pendants, and 2 ellipsoidal hematite scale weights (masses not indicated) (Mallowan 1947: 74, 177-178, pls. 15:2, 35; Bjorkman 1994, 643, Brak #01). Probably related to very poorly preserved remains of a private building located east of Area CH was a small jar filled with gold ornaments (earrings, rings, beads) and two thick silver rings (4.5 cm in diameter).

A fourth hoard was found in a two-room building—perhaps part of a larger compound—located in Area HS3, below the floor in baked bricks of Room 2, interpreted as a bathroom. In this case, the silver and other precious items were kept in a perishable bag sealed by a cretula with a seal impression, and placed within a jar, which was also sealed by clay and covered by a bowl (Matthews 2003: 203-208, figs. 6.14-19,58,62-65). The rich assemblage of the hoard included several pieces of hacksilver: 3 ingots (2 disc-shaped and 1 elongated one), 2 fragmentary pendants and 12 folded sheets (scrap metal), a thin rod, a large torque with one hooked end, 8 rings/coils, 11 small rings, 4 folded rods (**Fig. 4**). It also contained 4 copper/bronze small rings and some precious ornaments: an Imdugud pendant/amulet made of lapis lazuli and gold foil, a sheet gold pendant/amulet with two rampant crossing lions, a silver equid figurine, a jasper pendant, 2 gold beads, several carnelian beads, 2 small lapis lazuli pendants/amulets.

Fig. 4: Silver items from a hoard found below room 2 of a two-room building in Area HS at Tell Brak/Nagar (after Matthews 2003: figs. 6.18-19).

silver objects used as currency. Unfortunately, the short description in the report neither mentions the total amount of silver nor the masses of individual items.

Along the Middle Euphrates, more than one hundred silver scrap items and small pieces of rings/coils were contained in a bottle found in the filling layer of a dwelling at Tell Munbaqat (MBQ 29/29-137), possibly dating to the late 3rd millennium BC (Machule *et al.* 1989, 76-77, Pls. 5.1 e 11, 12; Bjorkman 1994, 570 Mumbaqat #4). The hoard comprised many small fragments of rings or lengths of rod/wire, resulting from multiple splitting operations, together with cut pieces of ingots and small lumps. Three silver ingots (a bar of 78 g, a flat disc of 62 g, and a lump) originate from another hoard found in the so-called 'Steinbau 1', also dating to the late Akkadian/Ur III period (Czichon and Werner 1998, 179, 182 pls. 128-129).

The lack of silver hoards at Tell Hariri-Mari 'Ville II' is strange, considering the large extension of the excavations of the 3rd millennium settlement. In the well-known 'Trésor d'Ur' from the Pre-Sargonic Palace of Mari, only two silver rings/coils are present out of the unique collection of precious objects (more than one hundred separate objects, including a lapis lazuli Anzu pendant, several cylinder seals, copper and ivory statuettes, pins, semi-precious beads among which the one inscribed with the name of Mesanepada, ruler of Ur) (Parrot 1968; Bjorkman 1994, 550, Mari #01). It was contained in a jar covered by two bowls buried in a pit at the foot of the eastern pillar of Courtyard XXVII, which belongs to the palatial temple sector. The 'treasure' has been widely discussed, and it was considered either as a 'true' hoard hidden to be recovered or as a votive or foundation deposit (see Bjorkman 1994, 77-88 for a review of the different hypotheses). According to Margueron (2004, 212-215), it might have been buried only after the end of the ED palace, thus in association with the Pre-Sargonic Palace '0' dating to the Akkadian period. However, most of the scholars agree with a dating before the destruction of the Pre-Sargonic Palace 1.

Ritual closure deposits containing silver pieces together with jewellery and copper/bronze objects are attested for the courtyards (FS 48 and SS 8) of the monumental cultic compounds in Area FS and SS (Oates *et al.* 2001: 44, 233-235, 243-246, figs. 50-51, 265). The precious items from Area FS were grouped into various perishable containers (in leather and cloth bags and baskets) in the filling over the floor, surrounded by copper/bronze tools placed upright. One of these metal collections comprised 137 silver beads, 9 silver rods/ingots, a length of silver chain, a silver disc, and some gold pieces of jewellery and semi-precious beads. Several silver rings/coils were found in the deliberately deposited mass of metal objects (c. 5.5 kg) in the temple courtyard 8 in Area SS.

A silver bullion from Tell Chuera was found in a small jar beneath the floor of Room 5 in House A, which dates back to the ED III-Akkadian Period (Moortgat 1960: 7-8, Pls 11-12; Bjorkman 1994, 666, Chuera #12; Peyronel 2010, 929, fig. 1: A2). It contained 10 larger irregular lumps/ingots, 20 coils/rings and c. 50 scrap items and lumps. The hoard was composed only of hacksilver with the usual array of

In Anatolia, silver had been exploited from various ores since the early periods of metalworking. Sophisticated silver objects and vessels appeared in rich deposits and funerary assemblages during the 3rd millennium BC (e.g. at Troy and Alacahöyük). At the same time, the presence of hacksilver and ingots is documented for a few sites (Bachhuber 2015). The precious metal was circulated by means of items different from those attested for Mesopotamia and Syria.

At Troy, six so-called tongue-shaped silver ingots ('Zungenbarren')—i.e. rods or bars with one rounded and one concave end—come from 'Treasure A' (Schliemann 1881: 470-472 no. 787-792; Bobokhyan 2006, 87-88, fig. 1.7, tab. 5a). Their standardised shapes and masses (ranging between 170.8 g and 189.2 g) suggest a manufacture roughly following metrological values related to the 20-multiple of the Mesopotamian (8.5-8.7 g) or the Levantine (9.1-9.4 g) shekel-units. A series of 16 elongated gold/electrum rods weighing c. 10-11 g (c. 10 cm in length), with regularly spaced multiple notches, discovered in 'Treasure F' have also been considered as a kind of 'ingot', either assuming the notches were metrological signs or splitting marks to obtain small metal pieces of the same size (Götze 1902, 342, 361-362; Rahmstorf 2022, 197-201). L. Breglia (1958) pointed out that both the silver bar ingots and the gold/electrum rods can be related to a weight unit ranging between 5 and 5.9 g, while more recently, a unit of 5-5.5 g has been proposed as the only standard for the gold/electrum bars (Bobokhyan 2006, 88-90, tab. 5b).

18 silver ingots have been retrieved by the villagers, probably in a unique hoard at Mahmatlar near Alaca Höyük (Kosay/Akok 1950). 17 of them are bun shaped, with masses clustering around the value of a mina (from 416 to 494 g), and one is an exceptional ingot of 4 kg and 630 g, corresponding to c. 10 'western' mina of c. 470 g.

Two hoards from Eskiyapar (Özgüç/Temizer 1993) were found buried in pits beneath the floor of a domestic structure dating to the late Early Bronze III period. They contained silver and gold vessels and pieces of jewellery but no hacksilver or ingots.

The practice of hoarding silver in the shape of ingots, rings/coils and scrap metal items was widespread in Mesopotamia and Syria and appeared sporadically also in Anatolia, while it seemed to be absent in the Southern Levant and on the Iranian plateau during the second half of the mid-3rd millennium BC. However, the picture is based on data gathered from publications and a complete survey of the museum collections is needed to analyse the silver circulation comprehensively. A specifically morpho-functional and metrological analysis of the silver found in 3rd millennium hoards is also made difficult by the almost complete lack of information regarding masses and technical characteristics (such as manufacture signs, cutting marks). Furthermore, metallurgical analyses have been carried out only on a few hacksilver samples, privileging another kind of finished objects. To fill this serious documentary gap, a systematic survey in the museum's collections is currently in progress as a part of the SCANE project by the University of Milan, and a programme of compositional analyses on a large sample of silver materials is also scheduled (Peyronel 2018).

Even with this incomplete information, it is possible to point out the following observations: (1) In Syria-Mesopotamia, few hoards contained scrap silver items only. However, hacksilver was a recurrent component of the material assemblage, often together with limited amounts of gold. The practice changed in the later periods when a higher number of silver bullions was documented for the whole Near East. (2) Silver circulated as a currency in the same shapes as attested for the 2nd millennium BC in Mesopotamia and the Levant: pieces of rods, bars, lengths of wires, irregular ingots/lumps, rings, sheets, and fragments of jewellery to be recycled. (3) Rings/coils make their appearance in mid-3rd millennium BC in Syro-Mesopotamian hoards before the earliest epigraphic documentation of ḪAR/*sewirum*, which dates to the Akkadian period. (4) Bun and bar ingots occurred in Anatolian hoards and deposits, which also contained precious silver and gold objects, such as vessels and jewellery, but no hacksilver and rings/coils. (5) Silver was associated with scale weights only in one hoard from Tell Brak (two specimen). (6) Clay stoppers and sealings are attested for Mesopotamian hoards, showing the same practice as in the following periods.

Silver by weight: The 3rd millennium scale weights in Western Asia

The presence of 3rd millennium silver hoards indicates the circulation of precious metals in the various regions of Western Asia, with the first attestations coeval to the earliest occurrence of the scale sets of weights. The archaeological and epigraphic evidence thus points to a direct relation between the introduction of silver as a means of payment and standard of equivalence and the sudden diffusion of balances and weights according to codified and shared metrological systems during the Early Dynastic III period (c. 2600-2300 BC).

The evidence on proper balance weights in the 4th and early 3rd millennium BC is in fact still to be determined. A handful of potential weights from uncertain stratigraphic contexts have been associated with Late Chalcolithic phases only at Tepe Gawra and Uruk (Hafford 2019; Rahmstorf 2014; 2022, 344-345).

Among the thousands of weights discovered in Southern Mesopotamian sites before the introduction of stratigraphic methods of excavation, only a limited number can be definitely dated before the end of the 3rd millennium BC, while only a few weights associated with 3rd millennium levels have been published from recent archaeological investigations (Powell 1979; Karwiese 1990; Rahmstorf 2022, 328-346). It is therefore quite difficult to trace the development of weight systems and weighing practices in the Early Bronze Age before the Ur III period. It is only in the latter period that the documentation includes several marked and inscribed royal weights showing the process of standardisation of measures and the widespread bureaucratic use of metrological instruments (Hafford 2012; Peyronel 2012).

In the recent comprehensive study of EBA weights of Europe, Western and South Asia by L. Rahmstorf (2022), less than two hundred allegedly weights coming from Southern Mesopotamian sites date back to the epoch spanning the ED II and the late Akkadian period. The most important groups come from the Diyala region: 57 specimen from Tell Asmar/Eshnunna, and 49 from Khafaja/Tutub (Meyer 1981; Rahmstorf 2022: 328-333), with the earliest ones dating to the ED II period (c. 2700-2600 BC), according to the associated building levels. Among the large corpus of Nippur (324 weights: Unger 2018; Hafford 2005), only 45 come from reliable 3rd millennium contexts. The most interesting group has been retrieved in Area WF, where a transitional ED III/Akkadian phase has been singled out (McMahon 2006: pl. 165). 26 weights belonging to one or more scale sets, come from a foundation deposit (a broken jar base atop a baked brick) together with some large shell beads. It is one of the few well-dated assemblages of weights from a 3rd millennium context in lower Mesopotamia: notwithstanding masses are indicated only at the nearest gram, it seems probable that most of the specimen belong to sub-multiples and multiples of the Mesopotamian shekel of c. 8.4 g (with ratios of ½, 1, 2, 4, 5, 10).

Only 20 potential weights from the old excavations at the large ED II-III urban site of Fara/Shuruppak have been published (not illustrated: Unger 2018, Tab. V; see now Rahmstorf 2022: 339-342 and this volume). Fara is undoubtedly a key site for the study of the development of weight systems (and early administrative practices) in Mesopotamia, and the renewed archaeological research by the German expedition headed by A. Otto would allow gathering new important metrological evidence.

No balance weights unequivocally dated to the ED/Akkad period from Tell Muqayyar/Ur can be identified among the hundreds of specimen recently studied by Hafford (2012), and the few 3rd millennium weights published from Tello/Girsu and al-Hiba/Lagash date back to the post-Akkadian periods. The earliest 'royal' weight is a limestone sphendonoid weighing 119.3 g with the inscription '15 shekels, for Ningirsu, Uruinimgina king of Girsu', thus indicating the metrological value, the dedication to the deity and the name of the ruler of the 1st dynasty of Lagash (c. 2400 BC). It was bought on the antiquities market at the beginning of the 20th century, and the place of discovery is unknown, although a provenance from Tello is probable (Scheil 1912; Peyronel 2012: 11-12, fig. 1). The 15 units of 7.95 g can be considered to be either Mesopotamian shekels (-0.4 g of a shekel value of c. 8.3–8.4 g) or 'Syrian' shekels (+0.15 g of c. 7.8 g).

Archaeological evidence indicates the presence of multiple metrological systems since the first appearance of scale weights in Mesopotamia. Most of the specimen can be related to the Mesopotamian sexagesimal system (shekel of c. 8.4 g and mina of c. 504 g), showing that it was adopted in the main urban centres by the public institutions. However, a certain degree of variation in the values is indicated by the masses, probably because of the political fragmentation in the ED period, suggesting that metrological standards were not fixed and regulated at regional level. The 'Western' system (mina of c. 470 g reckoned at 60 'Syrian' units of c. 7.8 g, 50 'Levantine' units of c. 9.4 g and 40 'Anatolian' units of 11.7 g) was also widely used during the Early Dynastic period (especially the 'Levantine' units related with the shekel of 9.4 g). The early presence of metrological interaction spheres might be considered as the practical result of the affirmation of silver circulation and globalised network of exchanges in Western Asia. During the Akkadian period, archaeological evidence shows a trend towards standardisation and the almost exclusive adoption of the Mesopotamian system, as indicated by marked weights, although some exemplars belonging to the 'Western' system are also attested.

In Northern Mesopotamia, the Jezirah and the Northern Levant, various balance sets were found in stratified contexts facilitating a more detailed evaluation of the weight systems during the Early Bronze III-IV period (c. 2700-2000 BC, corresponding to the different regional periodisation of ENL, EME/EUE, EJZ, ETG of the ARCANE chronology, https://www.arcane.uni-tuebingen.de).

The most significant number of specimen from a single building occurs at Tell Mardikh/Ebla (Ascalone/Peyronel 2006, 80–121, 179–207; Peyronel 2019a, 68–70; 2019b; Rahmstorf 2022, 276–293) (**Fig. 5**), where the administrative documents from the royal archives also offer the paramount opportunity to combine archaeological and textual information (Archi 1987, 67–83; Chambon 2011, 58–61). 50 out of 79 Early Bronze balance weights retrieved up to the 2005 excavation season come from the destruction level marking the end of the EB IVA town (c. 2400–2300 BC). 47 specimen were found scattered in different sectors of the Royal Palace G, with a significant concentration in the so-called Administrative Quarter and the Southern Unit of the Central Complex. They are mainly iron oxides, sphendonoids and sub-spherical weights with masses between 1 g and 150 g. Heavier exemplars have also been retrieved, including a scale set of marked exemplars kept in the small archive at the corner of the Audience Courtyard. A specific class of limestone conical weights horizontally pierced atop with masses corresponding to a double mina (local and in one inscribed exemplar foreign) is unequivocally associated with raw lapis lazuli in the palace (Peyronel 2011; 2019b). The remains of a wooden beam near one specimen in the 'treasury' at the back of the throne room, where also c. 23 kg of lapis lazuli was retrieved scattered on the floor, testify to the presence of a scale for weighing the semi-precious stone (**Fig. 6**).

The metrological analysis of the Eblaite weights and the information gathered from the cuneiform documents have shown that the palace administration used the 'Western' system with a mina of c. 470 g reckoned at 60 units of c. 7.8 g. However, the sub-regional standards of c. 9.4 and c. 11.7 g were also attested for the palace. Moreover, a group of weights seems to be related to a c. 6.6 g unit and its 10-multiple of c. 66 g, possibly a weighing system for wool/textiles characterised by a mina of c. 660–670 g (Peyronel 2014b). The lack of weights related to the 'Mesopotamian' system is striking at Ebla, especially considering that the 'Western' system was documented by numerous exemplars in Northern and Southern Mesopotamian sites dating to the ED III period. The co-existence of Mesopotamian and Levantine standards in the Syrian Euphrates valley is instead testified by the weights from Tell Sweyhat—with an inscribed (1 ma-na) limestone weight of 472.2 g dating to the 23^{rd} century BC (Holland 1975; 2006: 231 fig. 163:2, pl. 123b–c.) (**Fig. 7**). In this respect, the lack of information on Early

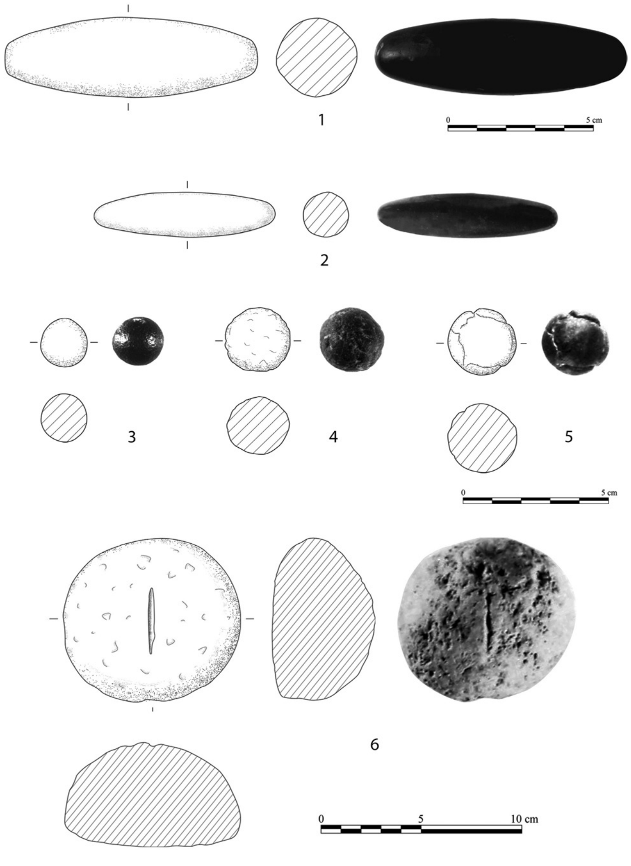

Fig. 5: Scale weights from the Royal Palace G at Tell Mardikh/Ebla (after Ascalone/Peyronel 2006: cat. nos. 15-16 (1-2), 29-31 (3-5), 48 (6).

Fig. 6: Limestone conical weight from room L.2982 of the Royal Palace G at Tell Mardikh/Ebla (after Peyronel 2019b).

Fig. 7: Limestone inscribed weight from Tell Sweyhat (after Holland 2006: fig. 163:2, pl. 123).

Bronze/Early Dynastic balance weights from Tell Hariri/Mari poses a serious obstacle to the overall reconstruction, preventing to verify the situation in a crucial area at the intersection between the Mesopotamian and Levantine metrological spheres (Ascalone/Peyronel 2006, 354–355; Rahmstorf 2022, 314–315).

The Eblaite weights can be usefully compared with those from Tell Brak/Nagar and Tell Beydar/Nabada in the Upper Khabur, a region under the control of the regional kingdom of Nagar, which had strong political and economic relations with Ebla (Milano 2004; Ascalone/Peyronel 2006: 292–295; Rahmstorf 2022: 305–311). The occurrence of weights with metrological marks at Beydar testifies to the adoption of the 'Western' system before the Akkadian conquest. In contrast, a hematite weight of 25.3 g with three parallel incisions (3 'Mesopotamian' shekels of 8.34 g) from the late 3rd millennium BC at Tell Brak (Phase M) may indicate that the Mesopotamian system was introduced during the Akkadian control.

The only available data on balance weights in Northern Mesopotamia comes from Tepe Gawra (Ascalone/Peyronel 2006: 297–306; Rahmstorf 2022: 305–311). 25 specimen have been assigned to Levels VII-IV, roughly dating to the period spanning the period from the 26th century to the end of the 3rd millennium. The predominance of weights (17) related to the Mesopotamian standard ensured that this was the metrological system used at the site in the mid-3rd millennium. At the same time, some exemplars related to the 'Western' units suggest the existence of metrological interactions with the Jezirah and Northern Levant.

Unfortunately, out of 54 weights from Qala't Sherqat/Ashur kept in Istanbul Museum, only the few inscribed ones can be dated (to the 2nd and 1st millennium BC), preventing the study of the metrology in a diachronic perspective in the Assyrian capital (Ascalone/Peyronel 2006: 423–430).

In Anatolia, groups of specimen dating to the Early Bronze II–III have been retrieved at several sites, including Hisarlik/Troy, Çukuriçi Höyük, Demircihüyük, Bozöyük, Aphrodisias, Alişar Höyük, Gözlü Kule/Tarsus (Rahmstorf 2022: 214-257). The metrological evidence has been scrutinised during the past years, and it has been pointed to the presence of metrological solid interactions in the wide region stretching from the coast to the central and south-eastern plateau. The revision of materials from former excavations, such as the weights from Troy, Tarsus and Alişar (Bobokhyan 2006; 2009), as well as recent discoveries of assemblages in specialised metallurgical sites, such as Çukuriçi Höyük, definitely dating to the first half of the 3rd millennium BC (Horejs 2009; 2016), indicate the early development of weighing procedures in Anatolia, interrelated with Syro-Mesopotamia on the one hand and with the Aegean on the other, as the co-occurrence of spool-shaped weights testifies by barrel-shaped specimen. Although it is still unclear when the 'local' unit based on a shekel of c. 11.7 g and linked with the 'Western' system (mina of c. 470 g) was introduced, evidence shows the crucial role of the region at the intersection of different metrological spheres in the affirmation of an interregional network of exchanges already in the first half of the 3rd millennium BC (Peyronel 2018b).

Conclusions

The 3rd millennium in Western Asia witnessed the development of long-distance exchanges, the diffusion of technologies and administrative devices, and the advent of commodification reflected by the widespread distribution of raw materials (metals *in primis*), imported items, sealings, and scale weights. It was at the apogee of this 'archaic globalisation', around the middle of the 3rd millennium BC, that the economic function of silver—used as a standard of equivalence, means of exchange and storing of wealth—made its first appearance and became within a short time firmly established in the Levant, Anatolia and Mesopotamia. During the same period, weight units and metrological systems were elaborated from the Indus Valley to the Aegean, together with commensuration and equivalence systems. The distribution of weights and silver hoards highlights this process and indicates the strong interactions that led to overlapping metrological systems.

The research conducted within the European project coordinated by L. Rahmstorf on 3rd millennium balance weights from Western Asia, the Aegean, and the Indus Valley (Rahmstorf 2022; Ascalone 2022) has clearly demonstrated the importance of a methodological approach that combines the scrutiny of the archaeological contexts and the quantitative/statistical analysis of the groups of scale weights.

The objective of the project 'Silver Circulation in the Ancient Near East' (SCANE) of the University of Milan is to investigate/ examine the silver function in the ancient economies of Western Asia, carrying on a multivariate analysis of silver bullions during the Bronze Age. A systematic study of silver during the 3rd millennium BC is currently hampered by the incomplete documentation of the published material. The analysis of 2nd millennium hoards, and in particular a Middle Bronze silver bullion from Ebla, have in fact demonstrated the importance of a morphometric and metrological analysis of the silver pieces to shed light on the practice of weighing the metal. The Ebla silver hoard was found in a jar buried beneath a floor of a poorly preserved house, and it contained 172 silver objects weighing 5043.5 g (c. 10 Mesopotamian minas), including complete or fragmented ingots of different sorts (bars/rods, disc- and bun-shaped, with masses ranging from 1.3 g to 285 g), coils/rings, thick lengths of wire and rod, several small rings, thin sheets, several irregular lumps of different sizes and a biconical bead (Peyronel 2019a: 78–81). The chemical composition of 13 pieces (2 rods, 4 elongated bar ingots, 6 discoid ingots and the bead) has been determined using a portable XRF spectrometer, showing that all the samples are made from silver alloyed with copper, and trace amounts of gold and lead are always very low (Au max 0.5 % and Pb max 1.3 %). The silver dataset has been compared with contemporary groups of weights (Ebla: 94, Kültepe: 162, Larsa: 67, Nippur: 132, and Ur: 327 specimen), testing the statistical properties of fragmented silver as a form of bullion currency: Cosine Quantogram Analysis (CQA) and Frequency Distribution Analysis (FDA) were performed on the different datasets, giving interesting results (Ialongo et al. 2018). The statistical-quantitative tests applied to silver and scale weights have shown that the masses of silver pieces and scale weights behave statistically in the same way and, therefore, that the practice of metal fragmentation was (aimed at obtaining) intended to obtain predetermined quantities (and values). Silver by weight, as an economic and financial instrument accepted in the whole Near East, easily transportable, and with a convenient value-to-weight ratio, is therefore also predestined as a means of circulation in the form of recurring quantities, which would have been easily (re)-convertible into the weight units adopted by the various economic/administrative systems. This convergence of values would also have facilitated interregional and long-distance exchanges in an effective compromise between the commercial practices and the administrative needs of the public organisations. The actual validity of this reconstruction, also in the 3rd millennium BC, will have to be carefully verified by enlarging the sample of silver datasets. Undoubtedly, this first application has shown the necessity of a rigorous method of silver analysis. Furthermore, a holistic approach to interpret the complex economic world of the pre-monetary Near Eastern cultures makes the careful use of archaeological data alongside epigraphic information indispensable.

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Balance weights from the recent excavations at Ur, 2015-2019

William B. Hafford, Berthold Einwag and Adelheid Otto

New US/Iraqi excavations at the ancient city of Ur began in 2015 under the direction of Elizabeth Stone of SUNY Stony Brook, William Hafford being in charge of Area 4.[1] A team from LMU Munich led by Adelheid Otto joined in 2017.[2] Five new excavation areas (Areas 1–5) were opened in the southern portion of the site, each delivering weight stones; an additional goose or duck weight from the surface is further included in this study (**Fig. 1**).

Since the American and German teams worked hand in hand in the excavations, the authors of this article had many discussions about the weight stones in the excavation house and during lunch breaks in the AH Area. William Hafford was asked to include the weights of the German excavation Area 5 in his general study of Ur weights, which continues his research on the weights from Ur (Hafford 2012). In this article Adelheid Otto and Berthold Einwag contribute the information about the context of the weights in Area 5, while William Hafford discusses the contexts of weights in Areas 1-4 and conducts the analysis of all weights from Areas 1-5. The description of all the weights can be found in Table 1 (see below).

Note: Since this article was finalized, the authors had the opportunity to conduct another season in the name of Penn Museum Philadelphia at Ur in October-November 2022, under direction of Steve Tinney and W.B. Hafford. Two more excavation units were opened by the Penn Museum team, and the excavations in Area 5 were enlarged. However, only a few more weights were found in this season and they do not change the overall analysis in this article. Adding them would have delayed this publication further; therefore, they will be published later in a report on that season.

Balance Weights from Areas 1-4 at Ur
(W.B. Hafford)

Weight stones for use on balance scales have been found in every area of the recent excavations. Forty-six examples were found in Areas 1-4 as follows:

Area	Examples
1	5
2	9
3	22
4	10

Areas 1 and 2 were excavated solely in the 2015 season and were both located within AH, a domestic zone previously excavated by Leonard Woolley in his 1930/31 season.[3] The houses he uncovered appear from the tablets

1 Foreign excavations in Iraq were halted in the 1980s-2000s but began returning in the 2010s with the assistance of Iraqi archaeologists. The largest excavations at Ur had been conducted by a joint expedition of the University of Pennsylvania Museum and the British Museum from 1922-1934. For general information on the return of US/Iraqi excavations at Ur, see Stone and Zimansky 2016, and Hafford 2017. The authors thank Elizabeth Stone and Paul Zimansky warmly.

2 Until the final report is complete, the reader may refer to a summary of the results of Area 5 in Otto 2019, 2022 and 2023. The Gerda Henkel Foundation has to be thanked for their support of the German team's three seasons.

3 Woolley directed the large-scale excavations at Ur in the 1920s and 30s. The volume that included his excavations in Isin-Larsa/Old Babylonian domestic areas (Woolley/Mallowan 1976, edited by T.C. Mitchell) was published many years after his death, utilizing his original manuscript from the 1950s and his field notes from the 1930s.

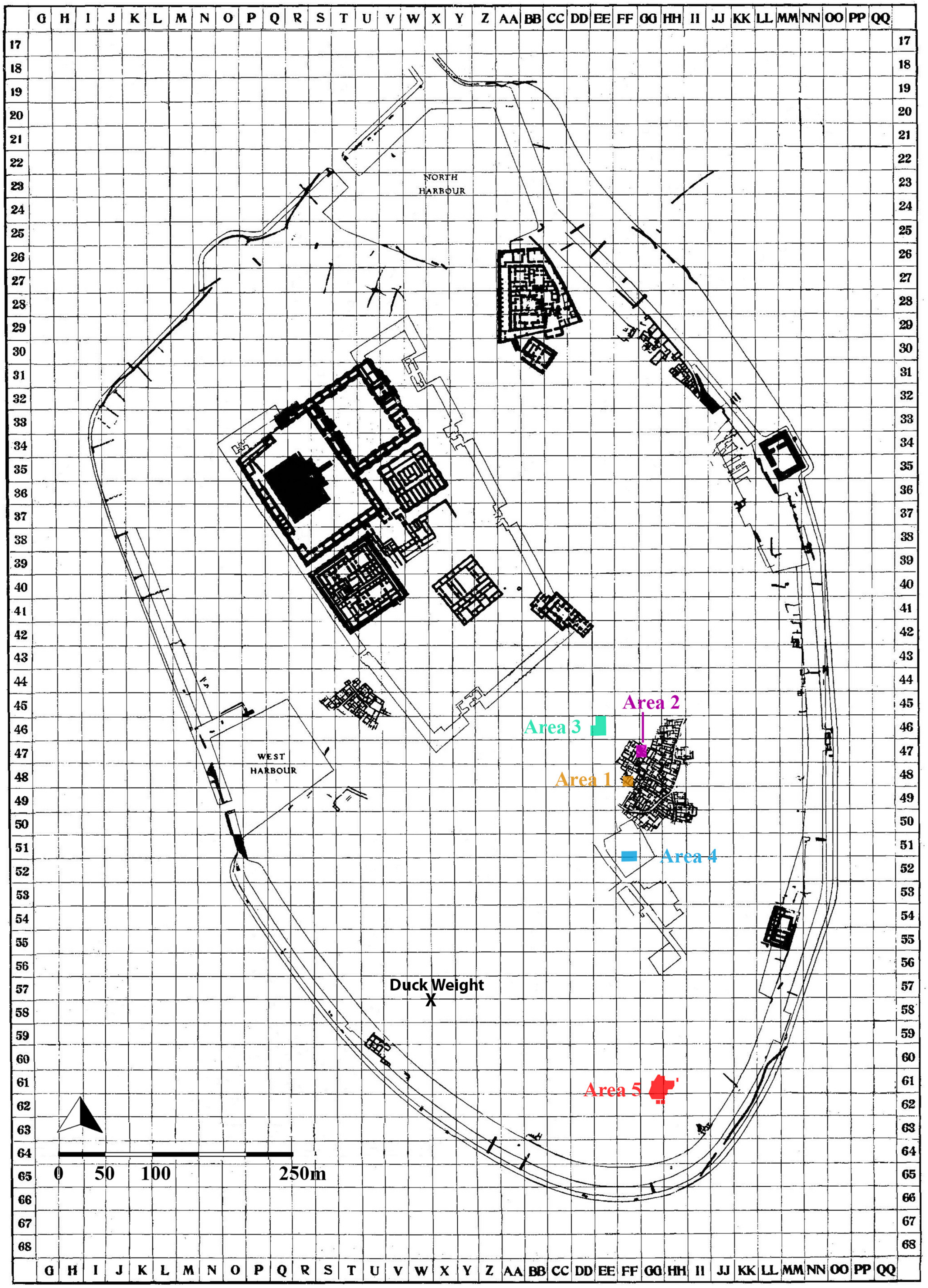

Fig. 1: Location of Areas 1–5 Excavation Units and the large Duck Weight on Woolley's Grid plan of Ur (on base map by Woolley/Mallowan 1976: Pl. 116)

found within them to have largely been occupied by merchants or others dealing with commodities and loans or payments in silver (Van de Mieroop 1992a: 126). Woolley uncovered more than 50 houses in AH, stretching across more than 7,000 square meters (Woolley/Mallowan 1976: 10; Zettler/Hafford 2015: 379). However, he only excavated down to the best-preserved floors of the Old Babylonian period in most cases. Re-excavating some of his rooms not only resulted in a better understanding of what he saw, but also allowed further excavation beneath the floors he uncovered.

Woolley named the streets in the large domestic areas he uncovered (AH and EM) as if they were in an English town.[4] He then numbered the houses by their entrances to the street with odd numbers on one side and even on the other (see **Fig. 2** for the position of SUNY unit areas in comparison to Woolley's Area AH). The SUNY trenches inside Area AH equate to Woolley's named houses as follows:

Area 1 = 10×10m unit covering: No. 1 Baker's Square, Rooms 4-7. Excavation uncovered Woolley's floors in all of these rooms and went beneath to investigate Woolley's statement that the baked brick walls of the Isin-Larsa/Old Babylonian period rested atop mudbrick walls of the Ur III period (Woolley/Mallowan 1976: xvi, 13–14). Mudbrick walls were found, as were a few Ur III artifacts, but in mixed context. The walls could potentially be early Isin rather than Ur III.

Area 2 = 10×15m unit covering: No. 1 Niche Lane Room 2 and parts of Rooms 1 & 3; No. 3 Niche Lane Rooms 1-5; portions of No. 5 Niche Lane Room 1, No 1 Boundary St. Room 7, and No. 2 Niche Lane Room 2. The majority of the deeper excavation occurred beneath Niche Lane itself, where some mudbrick walls were found along with a great deal of packing, and eventually a number of Akkadian period tablets. In both Areas 1 and 2 there were no proven Ur III domestic spaces.

Areas 3 and 4 were both established for comparison purposes outside of, but not overly far from, Woolley's Area AH. They were begun in 2015, then continued and expanded in 2017 and 2019.

Area 3 = 10×10m unit approximately 30 meters northwest of Woolley's Area AH. It was expanded southwards another 10×10m and westwards from that a further 5×10m in 2017, and these extensions were continued in 2019. It revealed a large baked brick house containing cuneiform tablets that identify its owner as Abisum, a General (UGULA MAR.TU) in the time of Hammurabi and Samsu-iluna (Charpin 2019; Stone *et al.* 2021). His name appears on at least 14 tablets, dated from Hammurabi year 36 through Samsu-iluna year 11.[5] In the northern 10×10 this building is particularly well preserved to its pavement and was left in place, while the much more disturbed southern 10×10 was taken below the Old Babylonian level. Once again, no proven Ur III domestic space was discovered.

Area 4 = 10×5m unit located approximately 20 meters south of Area AH. It was arranged to fall within Woolley's Area NH House 7 courtyard (Room 3). It was expanded southwards 10×5m and westwards 5×10 in 2017. Woolley did not dig deeply in Area NH. He noted the tops of late house walls visible on the surface and cleaned these for mapping purposes. In some cases, he dug down around 50cm to reveal more of the architecture and floors, but he did not dig beneath the Neo-Babylonian/Persian occupation. These late houses were larger than the Old Babylonian ones; thus, the SUNY Area 4 trench, even with its expansions, was contained within the courtyard of this building. The area beneath the courtyard revealed a long sequence of occupation including substantial baked brick walls of the Old Babylonian period. Under those walls were mud *tauf* (or *pisé*) walls that date to the early Isin period. Beneath these walls were many Ur III tablets in mixed fill context, but no associated architecture.

Note: The Ur III level was finally reached in the 2022 season, at a depth of 6.5m below surface, but without any find of weight stones.

Balance weights in Area 1

Weight finds in Area 1 were relatively limited (**Fig. 3**, orange square). Initial excavation cleared soil that had washed in during the 80+ years since Woolley left. Nearly two meters of wash had almost completely filled this structure, leaving only the tops of the baked brick walls barely visible. Much of the soil was run-off from

4 Some (e.g., Van de Mieroop 1992b: 122) say these street names correspond to streets in Oxford, where Woolley attended university. Few names actually match with Oxford streets, however, and more matches are found in the city of Bath, where Woolley purchased a house in 1920. Nevertheless, no city matches completely with all of the street names assigned to those at Ur and several, such as Niche Lane, Bazaar Alley, and Store Street, were clearly named for characteristics Woolley saw in the ancient streets themselves.

5 Notably in the 11th year of his reign, Samsu-iluna is said to have destroyed the walls of Ur after a revolt of the southern cities, and no Old Babylonian tablets here are dated later than that year. Written materials do not appear again at Ur until around the time of Kurigalzu, a few hundred years later.

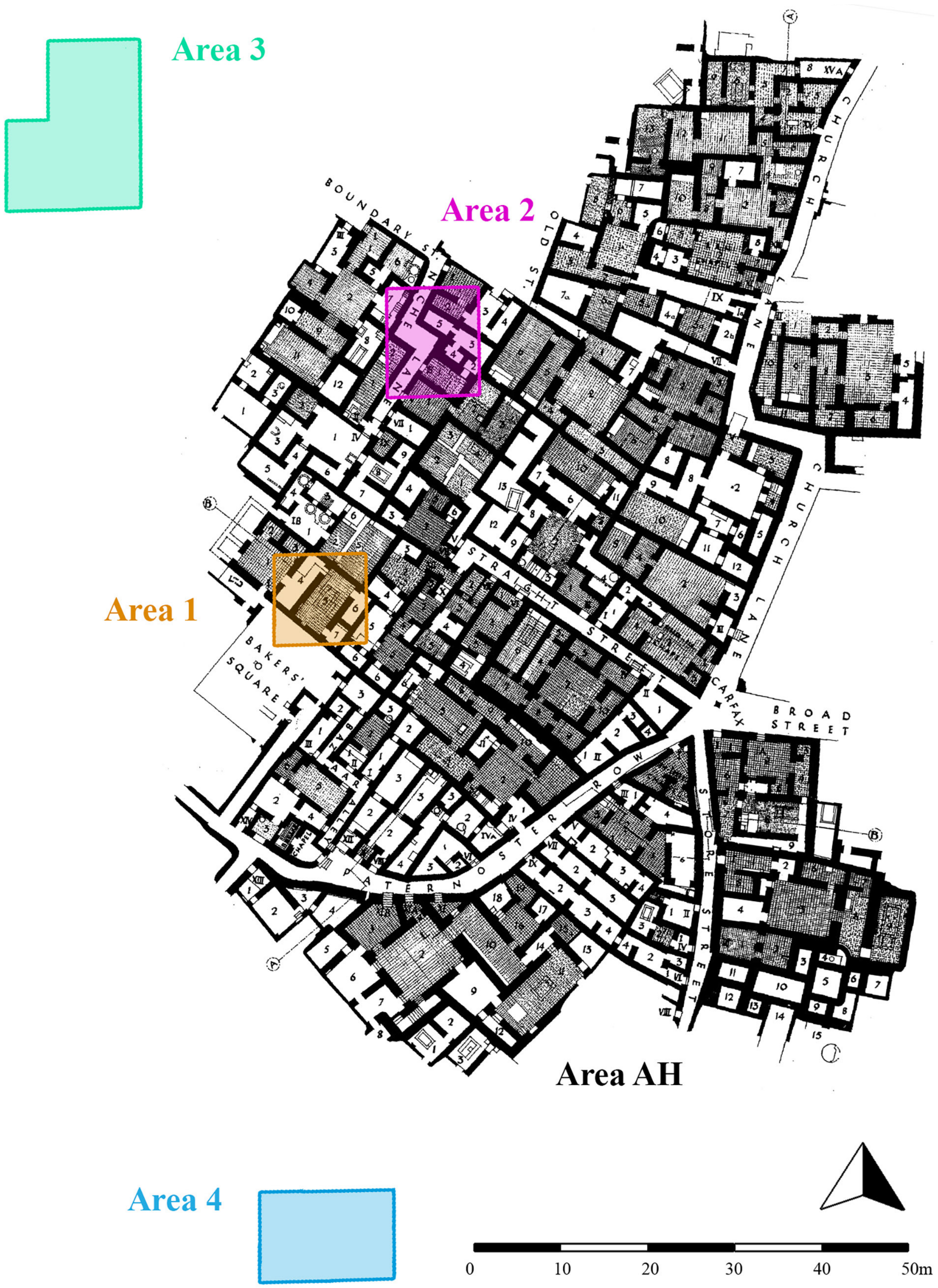

Fig. 2: SUNY excavation units in relation to Woolley's Area AH (on base map by Woolley/Mallowan 1976: Pl. 124)

Fig. 3: SUNY excavation units shown with location of weight finds (on drone photo by B. Einwag)

nearby backdirt piles left over from the old excavations. Woolley dug at such speed that he revealed his 53 houses in under three months; in the process he did not collect pot sherds and missed some small finds. Therefore, there were many artifacts from his excavations that had washed back in, now out of context.

Woolley's floors were eventually located and ancient contexts established. In some cases, such as in his Room 7, Woolley had stopped at an upper clay floor, beneath which was a partially paved floor he never saw.[6] A broken hematite weight (**530**) was found in association with this paved floor. This weight, along with various shells, beads, and a bronze ring found near the floor, may show use of the space as a storeroom for valuables. The room was located just off of the domestic chapel (Room 5) and many infant burials were found beneath its paved floor.

One possible weight (**72**) was found in Woolley's Room 4, to the west of the domestic chapel. This room was quite disturbed, with the northern portion of its dividing wall to the west largely missing or in a state of collapse. The possible weight is not shaped but its material and mass would make for potential use as a pebble weight. Such a use cannot be confirmed, nor can its context, as it was found near the level of Woolley's floor and could possibly have washed in.

Room 5 was the domestic chapel for No. 1 Baker's Square and beneath it was a large, brick-built, corbel-vaulted tomb. Woolley revealed the entrance to this tomb but did not excavate it, as the door blocking was missing, indicating it had been looted in antiquity. The emplacement of the tomb disturbed the lower levels badly, but in the southern portion of the room, beyond the tomb, the earlier room beneath was partially preserved. Three confirmed weights (**970**, **973**, and **1058**; **Fig. 4**) were found scattered in the fill just beneath what was likely the floor associated with this earlier room. On the floor were a number of yellow, rectangular baked bricks (the form used in the Old Babylonian walls) and a fine yellow powder lay across most of the area between them. It is possible that this was a working surface formed during the creation of the brick tomb, and thus associated with the later period of the upper building. Its elevation at the bottom of the lower mudbrick walls makes it likely that it was the original floor of the earlier room, partially reused in making the tomb. The appearance of a pivot stone beneath this surface and in line with the mudbrick wall to the west lends credence to the idea that this was indeed a floor, though no clear doorway could be seen in the mudbrick above the pivot stone. The weights were found beneath the surface but above the level of the pivot stone. It is not clear whether they had originally been used on the surface—which also revealed a partial shell ring and several cut shells, possibly indicating a manufacturing process—or were simply part of the packing beneath the floor. There were a number of Ur III artifacts in the packing beneath this floor; thus, if the weights were part of the mixed fill they might date to the Ur III period. There were no definite Ur III artifacts above the level of the yellow powder/partial baked brick floor in the southern portion of the room, but an Ur III tablet was found in the cut for the tomb in the north and Ur III bricks were reused to create a partial retaining wall for this cut in the northeast.

Fig. 4: Weights 970, 973, and 1058 from Area 1 (photos by Paul Zimansky)

6 Woolley drew a plan of the domestic quarter AH based on the preserved floors he uncovered, but recognized he had varying floor levels. About this he states: "…it is true to say that the quarter, as excavated, falls entirely within the limits of the Larsa period, all the houses, etc. shown having existed between 2025 and 1763 B.C. Actually some of them were founded, in their present form, before that period, but if so they were rebuilt during it on identical lines; others were changed during the period and their varying phases cannot be co-ordinated with any precision" (Woolley/Mallowan 1976: 14). It appears from the SUNY excavations that Woolley's floor levels may have been from various phases in the latter half of this period, with walls below on the same lines from the earlier half.

In all cases in Area 1, mudbrick walls were found beneath the baked brick walls Woolley had revealed. These walls tended to be wider than those above, serving as a very stable foundation. Woolley believed such walls to be Ur III in date, but this assumption was based solely on their position beneath the walls he designated Isin-Larsa/Old Babylonian. Woolley did not closely investigate the mudbrick walls, though at times he did partially expose them in order to dig graves beneath the floors associated with the baked brick walls.

Balance weights in Area 2

Seven weights and two possible weights were found in Area 2 (**Fig. 3**, purple square). This area covered parts of many houses that had been revealed by Woolley, as well as parts of Niche Lane, the narrow street running between them. The street was named for a feature in the outer wall of one of the houses, and this niche was partly revealed in clearing the northern portion of Area 2. The floors were relatively near the modern ground surface and most were left in place. One of the sphendonoid (ovoid) weights (**1953**) was found very near the surface and might have been part of the post-Woolley wash; it was not likely in its original position and cannot be accurately associated with any of the houses of Niche Lane.

Fig. 5: Weights 1962a, 1962b, and 1962c from Area 2 (photos by P. Zimansky)

A group of two sphendonoid weights (**1962a**, **1962b**) and one possible cylindrical weight (**1962c**) (**Fig. 5**) were found together associated with the baked brick pavement of No. 5 Niche Lane, Room 1. They were very near a low baked brick podium in the northern corner of the room that Woolley did not describe or indicate on his plan map; it might be that this part of the room was not completely uncovered or well investigated in his time. In fact, Woolley says little of No. 5 Niche Lane, stating that it had "no proper house-plan, nor was it possible to assign any particular character to the building" (Woolley/Mallowan 1976: 123). Too little of this house was revealed in SUNY Area 2 to say more, but the find of three weights together might indicate commerce as one aspect in which the house owners were involved, as was clearly the case in many of the other houses along Niche Lane.

Woolley found many tablets in No. 3 Niche Lane, all of which date to the time of Rim-Sîn of Larsa and belong to the archive of a man named Dumuzi-gamil (Woolley/Mallowan 1976: 122). The tablets are administrative in nature and many deal with loans of silver (Van de Mieroop 1992: 126–128). Weights would seem likely in such a mercantile household, but Woolley does not report any from this house. Then again, he did not often report findspots of artifacts from domestic spaces unless they were found in graves beneath the floors. Woolley's field notes show five graves beneath the floors of this house, but many more were discovered in SUNY excavations. One of these graves, beneath Room 5, produced a sphendonoid weight (**307**). The grave was that of an infant, which is somewhat surprising as most infant burials have no grave goods and are placed within pots or bowls. This one, however, was in a brick-lined grave and the body had a clay bead and a shell ring at its neck and shoulder. The weight was found at the edge of the small brick-lined grave after the bones were removed. It may have entered the context with the fill rather than as an intentional grave good, or it may indicate the status or profession of the child's family.

A fine, though slightly chipped, hematite sphendonoid (**900**) was found well beneath Woolley contexts in No. 2 Niche Lane, Room 2. Woolley reported this building as a domestic chapel that had been oddly sealed off from any house, standing on its own in its latest occupation with a door in Room 1 onto Niche Lane (Woolley/Mallowan 1976: 121).[7] There had been a door in an earlier phase of Room 2 onto the street, and this was uncovered in the SUNY Area 2 excavations. Broken remains of burials

7 There is a possibility that this building served as a more public chapel at one point in time (Van de Mieroop 1992b).

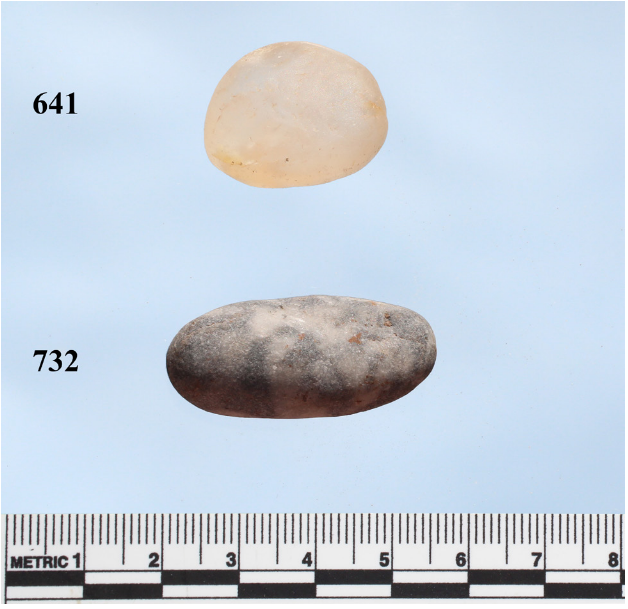

Fig. 6: Weights 641 and 732 from Area 2 (photos by P. Zimansky)

were found around the base of the baked brick walls as if perhaps discarded there by Woolley, and below was mixed fill that included the sphendonoid weight.

Mudbrick walls were noted beneath the baked brick walls in many places in Area 2, but not as uniformly as those in Area 1. This is likely due to the varied nature of the many structures of Area 2 and their frequent remodeling, as opposed to the single house in Area 1. Because the upper walls were left in place during the SUNY excavations, the spaces available for deeper excavation were limited in size, and only a few room spaces were taken down below the indication of mudbrick walls. The largest space available (about 4.5 × 2 meters) was that in the turn of Niche Lane itself, but this was still too small an area to give a clear sense of deeper architecture. Some weights were found in this deep excavation area, however.

Weight **317** was found just below the level of the street attained by Woolley. Much deeper, well below any indication of mudbrick walls, a partially paved surface was reached. The pavement led to a drain, which might indicate that it had once been part of a central courtyard, but no walls were clear at this depth. Nevertheless, whatever buildings existed here were not built on the same plan as those much farther above. A possible weight (**641**) was found just above the level of the deep baked brick surface, and a confirmed weight (**732**) was found almost on it (see **Fig. 6** for both). Somewhat beneath this level, eighteen Old Akkadian tablets were uncovered, mostly dealing with accounting and administration.

Balance weights in Area 3

Area 3 was the largest horizontal area excavated by SUNY, covering 250 square meters at the surface, and it produced the largest number of weights (**Fig. 3**, green square). Disturbed remains of intrusive burials showed that there had once been Neo-Babylonian or Persian housing here, but no walls of these buildings remained on the surface. In fact, erosion has removed all but traces of the latest occupation across most of Ur.

Beneath the surface soil and the remains of late burials was a large house built with substantial use of baked brick, very similar to houses in Woolley's Area AH and surely part of the same overall domestic area of the Isin-Larsa/Old Babylonian period. The house courtyard and many of the surrounding rooms fell within the original 10x10m unit placed in 2015. Cuneiform tablets found in the house belong to the archives of a man named Abisum, whose title shows that he held the position of General (UGULA MAR.TU) in the later years of Hammurabi and early years of Samsu-iluna (Charpin 2019: 26–28). His house might then be expected to be large and generally well outfitted, which appears to have been the case (Stone *et al.* 2021: 186–190). Though the entire house has not been revealed and some portions are badly damaged, the courtyard is well paved and there are two staircases. Houses with staircases to the roof (or possibly a second story)[8] are common, but two off of the same courtyard have not been previously observed at Ur.

Because the architecture was well preserved, it was left in place and a second 10×10m unit was opened immediately to the south where the pavement and walls had been badly disturbed or were missing entirely. This area would more readily allow for exploration of earlier levels.

Late weights (found above the level of the Old Babylonian house of Abisum):

A broken possible weight (**909**), a rock crystal cylinder, was found near the surface and cannot be confirmed as to weight standard or to context. A small hematite weight (**150**) was found in a large burning feature identified as a pit, but that was perhaps an oven. It was created in a late level (likely Kassite), and the intense heat discolored the soil down to the pavement of the Old Babylonian house beneath (near the southern staircase). The weight was found in a soil sample taken from inside the

8 The debate on whether there was a second story on the typical Mesopotamian house is extensive (e.g., Stone 1981: 30; Miglus 1999: 65, 75; and **Brusasco** 1999/2000: 87).

burning feature, and thus it is from a later period than that of the main house.

Old Babylonian weights (found on or just beneath the pavement of the house of Abisum):
A likely weight (**551**) was found outside and lower than the late burning feature (**Fig. 7a**). This weight sat just above the paved floor of the Old Babylonian house near the southern staircase. It is an oval-plan, flattened-base, domed stone that may be a grinding tool, but is different from the sub-cubical and sub-spherical grinders commonly found.[9] In this case, the shape is much more akin to a duck weight without a head carved on the back. It was never weighed, however, and its possibility as a balance weight cannot be confirmed. A confirmed weight (**559**) was found in the same general area, however, between paving bricks near the southern stairs. It was reported in the field notes as hematite, but was apparently never weighed or photographed. The pavement continued somewhat into the south 10×10m unit opened in 2017. When this pavement was removed, a beautifully polished, sphendonoid hematite weight (**1786**) was found beneath (**Fig. 7b**). A sub-cubical grinding stone was also found here along with many fragments of stone, possibly indicating that stone-working had been an activity conducted in the area.

The soil in the upper portion of the southern 10×10 was mixed, both by late disturbance (possibly caused by Kassites searching for baked brick for use in building their houses) and by Old Babylonian burials that had cut through earlier deposits. Across the upper portion of this area a few late mudbrick walls were found, forming no clear house outline, but perhaps connecting stubs of baked brick walls that were still visible at the time to form new living spaces. These walls were not well preserved and were removed after mapping.[10]

Fig. 7: Weights 551 and 1786 from Area 3 (photos by P. Zimansky)

Fig. 8: Weights 2155, 2549, and 2578 from Area 3 (photos by P. Zimansky)

Two weights (**2155**, **2549**) and one possible weight (**2578**) were found in the mixed fill just beneath the level of these high partial walls (see **Fig. 8** for all three weights). Broken weight 2155 was found not far from one of the upper mudbrick walls and near a brick pile. It was likely to have been dug up in the process of robbing bricks and discarded as part of the disturbed soil. This soil also contained many broken pots, a few broken shell rings, bits of bronze, and a bead, all of which might indicate storage or perhaps disturbed burials. As this material was cleared,

9 Many of these rounded-corner, near cubical objects were examined and weighed in the course of the three seasons. They do not indicate standardization, instead falling randomly in the range of 100–200 grams. They appear to have been stones that were used for grinding and when one area flattened out, a new area was used, ultimately resulting in a sub-spherical or near-cubical appearance.

10 The ground surface in the Isin-Larsa/Old Babylonian period may have been higher to the south-southeast of Area 3, as some baked brick walls with older mudbrick beneath enter the southeast portion at a higher elevation than those in the north and west. Furthermore, a baked brick tomb (Feature 75) found in this southeast area was notably higher in elevation than the main one for Abisum's house (Feature 71). This would imply a higher floor level for the room that would have stood over that tomb, though no floor was noted and Feature 75 was badly damaged/looted.

Fig. 9: Weight 2111, in the form and mass unit of the Indus Valley (photo by P. Zimansky)

Fig. 10: Weights 2998, 3043a, 3043b, and 3106 from Area 3 (photos by P. Zimansky)

many burials indeed began to appear. Among the burials were found scattered items, including tablets dating to the early Isin and Old Babylonian periods. Weight 2549 and possible weight 2578 were part of this general mixed fill. The possible weight is roughly ovoid in shape but unworked. Natural stones or pebbles were sometimes used as 'make-weights' (Hafford 2005: 354), but the mixed nature of the context does not allow us to confirm that this one was actually used in this manner.

The complete layout of the house of Abisum is not known. In the southern portion, the walls are mostly missing, but the find of a brick-built, corbel-vaulted tomb in this area indicates it was the location of the domestic chapel.[11] Many of the tablets from Abisum's archives were found near this tomb, and some had fallen into it when the roof was damaged in a looting event after the abandonment of the house (Stone *et al.* 2021: 187–188). The concentration of tablets indicates probable storage of the archive in or near the domestic chapel. Woolley noted that this was often the case: "Opening out of the chapel, usually behind the altar, there was often a very small chamber which one was tempted to call the vestry; in it we commonly found a large number of tablets" (Woolley/Mallowan 1976: 30).

A cubical Indus Valley weight (**2111**, **Fig. 9**) was found above the tomb near the disturbed floor level of what had been the domestic chapel. This find is particularly interesting in its clearly foreign origin. The weight is one of only a few confirmed Indus weights found in Mesopotamia (Ratnagar 1981: 186). The archives of Abisum indicate that he was often involved in commercial endeavors; yet, none clearly show importation from the Harappan civilization. However, a typical red-slipped Bahrain pot is another proof for his commercial relation across the Gulf (Stone *et al.* 2021: 187–188). Because of the disturbed or destroyed nature of the house floors in this area, we cannot confirm that the weight was used in the Abisum household, but there is a possibility that it was, as other weights (though all of Mesopotamian origin) were found in good contexts in the house overall. In fact, one confirmed weight (**2998**) was found in the fill surrounding the tomb, and two more (**3043a**, **3043b**) and a possible weight (**3106**) were found to the west of it near a partial paving (see **Fig. 10** for all four weights). It is tempting to see these weights as part of a group once stored together with the archives in a small room off of the domestic chapel. The area above and around the tomb was badly disturbed, however. A suspension weight (**2384**) was also found in the general area of the disturbed upper zone of the domestic chapel floor. It is not a common form for a balance weight and was not weighed; thus, whether or not it conformed to a weight standard cannot be shown.

11 See photo of the house in Stone *et al.* 2021: Fig. 12. Domestic chapels frequently have a vaulted family tomb beneath the floor, but such tombs are occasionally found beneath other rooms (Woolley/Mallowan 1976: 363–364).

The domestic chapel was typically the most secluded of rooms in a house, and often existed at the farthest extent along a back wall (Woolley/Mallowan 1976: 29; Crawford 1991: 101). We might, therefore, suspect that the southern wall of Abisum's house would be just south of the corbel-vaulted tomb. Though some partial baked brick walls survived to the southwest, possibly indicating the entrance to another house, no walls delimiting the domestic chapel were found. There is some indication that they were robbed of their bricks by later occupation, however, a process that likely caused the overall disturbance in this area.

In the southeastern extent of Area 3, beyond where the southern wall of Abisum's house might have existed, another brick-built tomb (Feature 75) was found. It sat at a somewhat higher elevation than the tomb (Feature 71) of Abisum's domestic chapel, and was much more badly destroyed by looting. The roof of this tomb was missing and only six courses of baked brick walls remained. The elevation of this grave, combined with the fact that most houses do not possess more than one brick-built tomb, leads to the conclusion that this was part of a separate house located to the southeast of Abisum's. This tomb was the location of the largest grouping of weights, with five (**3124**, **3231**, **3242a**, **3242b**, and probably **1801**) associated with it (see **Fig. 11** for four of these weights)[12]. Weights 3242a&b were found together in the southern portion of the tomb with 3231 very close by. Outside the tomb was found 3124, and in cleaning at the beginning of the next season, 1801 was found at the eastern baulk at the edge of this context. These latter two weights may not be directly associated with the grave but are in the same fill context and it is likely that they were scattered during the looting of the tomb. This leads to the strong possibility that all five were originally a group used together and buried with the person or persons in the grave.[13] In fact, they are all hematite sphendonoids of similar manufacture and the four that were weighed make an excellent sequence of standard fractions: ¼, ½, ⅔, and 1 shekel. Even more impressive is that they all calculate almost perfectly to a shekel of 8.4 grams (within half of a percent) showing that they were made to the exact same standard with a high degree of accuracy.[14]

Fig. 11: Weights 3124, 3242a, 3242b, and 1801 from Area 3 (photos by P. Zimansky)

Earlier weights (well below floor levels of the Old Babylonian house of Abisum):

Just as seen in the other trenches, mudbrick walls were found beneath the baked brick walls in Area 3. These date either in the Isin or the Ur III period.[15] One partial weight (**1439**) was found beneath a largely robbed-out baked brick wall west of the main tomb context (Fea-

12 Most were found at the very end of the 2017 season and one was never weighed or photographed.

13 Disarticulated bones, including parts of four skulls, were found in the eastern portion of the tomb. Such shifting of remains to one end is typical procedure for a family tomb beneath a domestic chapel and is strong evidence that Feature 75 was part of a house separate from that of Abisum, which had its own family tomb (Feature 71). The latest burial would have been complete in the center of the tomb, but in the case of Feature 75 it was likely destroyed or removed during the severe looting episode when many of its bricks were also removed.

14 Weights across Mesopotamia tend to fall within a normal curve showing 5% either side of the 8.4 gram mark; i.e., they vary from 8.0 to 8.8 grams as the calculated shekel with the majority clustering between 8.2 and 8.6 grams (e.g., see Hafford 2012: 37). Although some of this variance might be due to specific regional interpretation of the standard, the vast majority of it is due to inaccuracy in ancient scales. It appears that ancient hand balance scale tolerance was at about this level of 5%. The extreme precision of this particular group at half of a percent variance is unusual and likely means that they were made and used together.

15 There is not a great deal of difference in pottery from the Ur III into the early Isin period. The lack of Ur III tablets or other artifacts that are more firmly datable to the Ur III period in good contexts within the levels of the mudbrick walls, combined with the presence of some of these markers in packed fill beneath them is the basis of the possibility that the mudbrick walls may date to the early Isin period.

ture 71). The soil directly beneath the remains of the wall would not have been disturbed by later digging and a small portion of mudbrick was also found here, as well as the impression of a large reed mat, indicating the weight was associated with this lower occupational level. The weight was broken but it may have been reused, as the primary break had been intentionally smoothed.

Reed mat impressions were relatively common at this depth, perhaps indicating a floor or building level (reed mats were often placed at intervals between mud courses of walls or platforms). Beneath, mud bricks were quite common and in one area appeared to have formed a kind of paved floor. Exactly what this heavy brick context represents is not yet clear. At approximately the top of this general context of mud bricks and reed mat impressions, to the east of Feature 71 and west of where Feature 75 had been, weight **4560** was found. The context would equate to a level at or just beneath the level of the lowest mudbrick walls. The weight might thus be equivalent in period to 1439; however, its context is not clear and it may be associated with whatever the major mudbrick construction beneath represents.

Much deeper down—some five meters below ground surface—in a narrowing space between mudbrick features in the southeast of Area 3, a small spherical stone (**4655**) was found that could potentially have been a weight. At this depth, and in such a small space, the stratigraphic level is difficult to interpret, but some of the broken pottery here is Early Dynastic. No other weights or possible weights were found at this depth and this one cannot be confirmed.

Balance weights in Area 4

Area 4 is located in Woolley's Area NH to the south of Area AH (**Fig. 3**, blue square). This is where Woolley identified the best-preserved late housing on the mound. The homes of the Neo-Babylonian and Persian occupants were the last constructions to be erected on the site prior to final abandonment.[16] These structures were thus exposed for millennia and, because they were made entirely of mudbrick, they have eroded almost completely away. Even the best-preserved examples typically consist of only two or three courses of mudbrick.

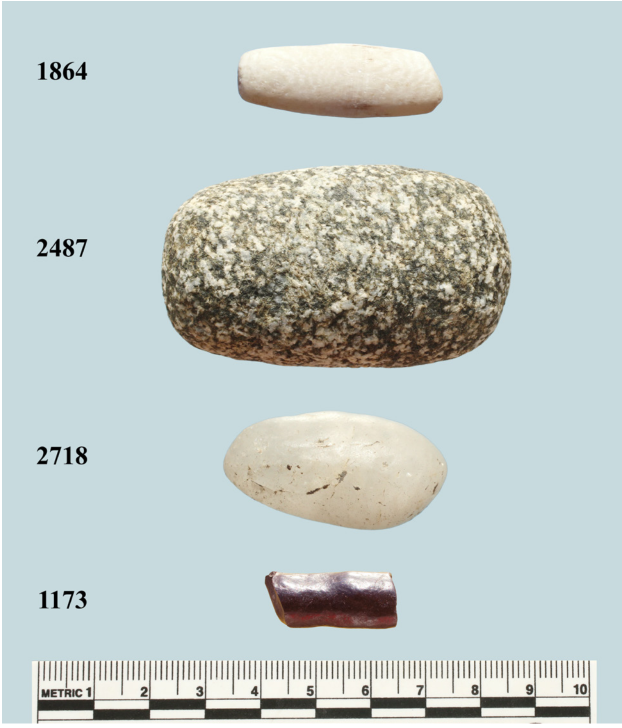

Fig. 12: Weights 1864, 2487, 2718, and 1173 from Area 4 (photos by P. Zimansky)

The goal of Area 4 excavations, however, was not to investigate late housing specifically, but to establish a sequence in the area and compare it to the other SUNY trenches in and around Area AH. Therefore, the unit was designed to fall within the large courtyard of NH House 7. Only small portions of the surrounding Neo-Babylonian walls were encountered and the unit reached a depth of just over six meters below modern ground surface. Another meter of depth was achieved in a small area of the unit in 2022. A large portion of the upper levels of this unit were badly disturbed by very large rubbish pits. In other words, House 7 had been built atop a large trash dump.[17] The largest of the rubbish pits, measuring almost eight meters in diameter, sat directly beneath the courtyard. It narrowed as it went deeper, cutting through building remains of earlier periods and eventually encountering other rubbish pits of earlier periods. Such pits had been common here, punctuated with periods of house building, for some 1,000 years.

16 The latest dated object found at the site was a tablet from the time of Philip Arrhidaeus (Philip III of Macedon), elder half brother of Alexander the Great (Woolley 1962: xi, 48). He was born in 359 BCE and reigned as king of Macedon from 323 until his death in 317/316 BCE.

17 Woolley (1962: 48) believed House 7 was one of the earliest of his Area NH because he found 70 tablets dating to the time of Nabonidus (ca. 620 BCE) here. House 6 immediately to the north, however, was perhaps the latest in the area. It produced many tablets of Artaxerxes, as well as the latest tablet from the entire site (ca. 317 BCE).

Weights and possible weights were found in the area, but many come from the pits and cannot be associated with their use spaces. For example, weight **1864** (**Fig. 12a**) was found near the top of the large Neo-Babylonian trash pit beneath the courtyard. It is a broken quartzite sphendonoid, with a flattened oval section not typical of earlier weights, and it was likely in use later than the Old Babylonian period, but the construction of the pit does not date the find. It is also broken and cannot be used to determine weight standard.

A large ovoid weight (**2487**) (**Fig. 12b**) is more securely dated to the Neo-Babylonian period, however. It was found just above a broken pavement at the northwestern end of the House 7 courtyard. Woolley had explored this area, digging down along the northern wall of the courtyard, but his exploration trench only reached down some 50 cm and extended only partly along the northern wall. Where it ended, the remains of a pavement made of broken baked bricks began. Just beyond the pavement in the area where the weight was found, there sat a heavily used fire pit and so the primary context seems to have been one of food preparation.

A possible weight (**2718**) (**Fig. 12c**) was found near the mostly destroyed remains of a wall corner that dates stratigraphically to the Kassite period. The walls had been cut through by the major rubbish pit from above and most of its bricks were robbed out at this time. The stone is an unworked quartz pebble, however, and though it is a good shape and possible fraction of the known shekel, it cannot be confirmed as a weight. Another possible weight (**1173**) (**Fig. 12d**) also comes from the Kassite stratigraphic levels, very near a fire pit that had a nearly complete Kassite goblet at its edge. The object is a goethite lump in roughly cylindrical form, in shape close to a nodule[18]. This dense material was rarely wasted and this stone might have been used as a pebble weight, but it also has a partial drill hole in one end, showing that there may have been an attempt to make it into a cylinder seal.

The Old Babylonian period, represented mainly by substantial baked brick walls, is clearest mostly in the southeast corner of Area 4. The large Neo-Babylonian pit did not strike this corner and the walls were so substantial that the modern excavation left them in place. The structure apparently fronted on a large open space that may have become a street in the latest phase, but most of the walls of this phase were destroyed by the Neo-Babylonian pit. The open area had three packed clay surfaces approximately 10 cm above one another. The two highest had Old Babylonian rubbish pits cut from them, the one to the south extended beyond the excavation unit; the other had around a five meter maximum diameter and covered a large part of the central unit, damaging many of the lower mud walls.

No complete Old Babylonian rooms were excavated, but a partial room with paved floor was uncovered along the eastern baulk. On the floor of this room was found a possible weight (**2746**), a polished dark green cylinder with one side displaying a prominent lip. This makes the object seem more like a jar stopper or labret than a weight, but it weighs in at three shekels and may have been used in a balance pan.

Below the Old Babylonian level in places where the rubbish pits had not struck were found many mud walls. These were not mudbrick walls, but were packed mud (*tauf or pisé*) with reed mats separating large courses approximately every 35 cm of height. In the fill around the upper ranges of these walls in the northeastern portion of the unit, many chipped and ground stone pieces were found. Among these stones was a possible weight (**2641**). It is a near-cylinder that may be an unfinished cylinder seal, but it also could have been used as a weight at 4 shekels. The context here appears to be packing below the exterior surface in use in the Old Babylonian period. Stone-working likely occurred somewhere in the area.

Burials of the Old Babylonian period were commonly found alongside the lower mud walls. One of the burials contained a rock crystal pebble (**2740**), but no confirmed weights were found with it and it may have been included as a curiosity or attractive stone to complement the many beads that were found in this grave.

The *tauf* walls were built on three courses of baked brick to protect them from rising damp. Several of the walls were badly damaged by the Old Babylonian rubbish pit, but it reached its lowest point around the top of the baked brick foundations. Most of four rooms of the *tauf* house was uncovered. No clearly Ur III artifacts were found in this building, but many Ur III tablets were found beneath it. Even this level of packing cannot be securely dated in the Ur III, however, as some of the tablets found within it date into the Isin period. These tablets (along with a cylinder seal mentioning Iddin-Dagan) establish a *terminus post quem* for the building, which must be early Isin or later in date.

Weight **4532** (**Fig. 13a**) was found in the burned roof fall above the final floor of the southernmost room of the Isin building. A relatively crude quartzite, it is none-

18 Similarly shaped goethite nodules, half-products and finished weight stones were found at sites in the Syrian Euphrates valley where goethite deposits occur in the limestone hills bordering the valley, see Otto 2006: 119–122, Fink 2012 and Fink this volume; Melein 2018.

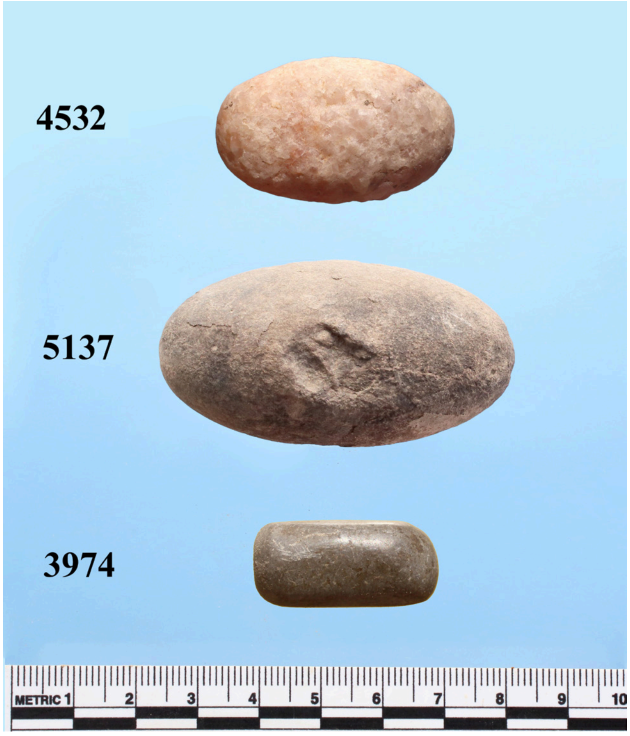

Fig. 13: Weights 4532, 5137, and 3974 from Area 4 (photos by P. Zimansky)

theless a clear 3-shekel ovoid weight. Another weight (**5137**) (**Fig. 13b**), made of a rather porous (and likely heat treated) limestone, was found well below the Isin floors of the eastern room. The soil here held many objects but no architecture. It was occasionally disturbed by burials from the Isin building above, but this weight was part of the packing below the floor. In this same general packing material beneath the northern room was found another weight (**3974**) (**Fig. 13c**). Though made of a better material and well-polished, it was of a less typical shape, known as 'loaf' for its more rectangular plan and its vague resemblance to a loaf of bread. Unfortunately, this object was never weighed.

Balance weights from Area 5 at Ur

(A. Otto and B. Einwag)

Twenty-one objects that can be related to weighing procedures were found in Area 5. This area is situated close to the southern edge of the South Mound near the city wall—an area never investigated before (see **Fig. 1**). A team from LMU Munich was allowed to work in this area during two campaigns in 2017 and 2019 as part of the new excavation project at Ur (2015–2019) directed by Elizabeth Stone,[19] and in the third campaign in 2022 under the direction of W.B. Hafford. However, the third campaign delivered only one good Ur III weight stone, **8089**, which has been included here.

The weight stones in context

The LMU Munich team had chosen Area 5 for two main reasons. One was to examine if the Old Babylonian households at the periphery of the main mound differed from the houses in the city center, especially in the domestic areas AH, EM and EH excavated by Woolley and re-investigated since 2015, and if the differences would point to socially or economically diverging neighborhoods. The other goal was to reach Ur III period levels, which seemed easier to accomplish here in the sloping areas on the outskirts of the city than in the much higher city center.

One Old Babylonian house and part of the underlying Ur III structures were excavated in Area 5 (**Fig. 14**). The house, covering an area of 236 sqm, was exceptionally large and consisted of 16 rooms arranged around a courtyard. Only very shallow remains of later periods were encountered in this area, which is situated at the edge of one of the main wadis and marked by severe erosion. The two uppermost levels consist of intrusive Late Babylonian and Persian tombs and shallow mudbrick remains of a Neo-Babylonian building. The Kassite presence resulted mainly in the robbery of several walls of the Old Babylonian house, which seem to have been exploited by the Kassite inhabitants as a source for baked bricks.

The house was erected in the Isin-Larsa period, sometime between 1865 and 1850 BCE during the reign of Nûr-Adad of Larsa (Otto 2023), and shows three main phases. In the beginning (Phase 1), it was inhabited by a certain Sîn-nādā, who was the priest and later the manager of the Ningal temple, and by his wife Nuṭṭuptum. Several texts and sealings found in various rooms of the house tell us that the couple had been involved in the management of the Ningal temple. Sîn-nādā, who is named

19 We thank Prof. Elizabeth Stone und Prof. Paul Zimansky (State University of New York at Stony Brook), who generously allowed us to participate in the Ur project. Our thanks go to his Excellency the late Dr. Abd-el Amir Hamdani, minister for culture; the Director General of the Iraqi Department of Antiquities SBAH, Qais Rasheed; and the representatives of the local antiquities service (SBAH) of Nasriyah. The LMU team was directed by Adelheid Otto and Berthold Einwag and included archaeologists, anthropologists, philologists and geophysicists, to whom our sincere thanks are due.

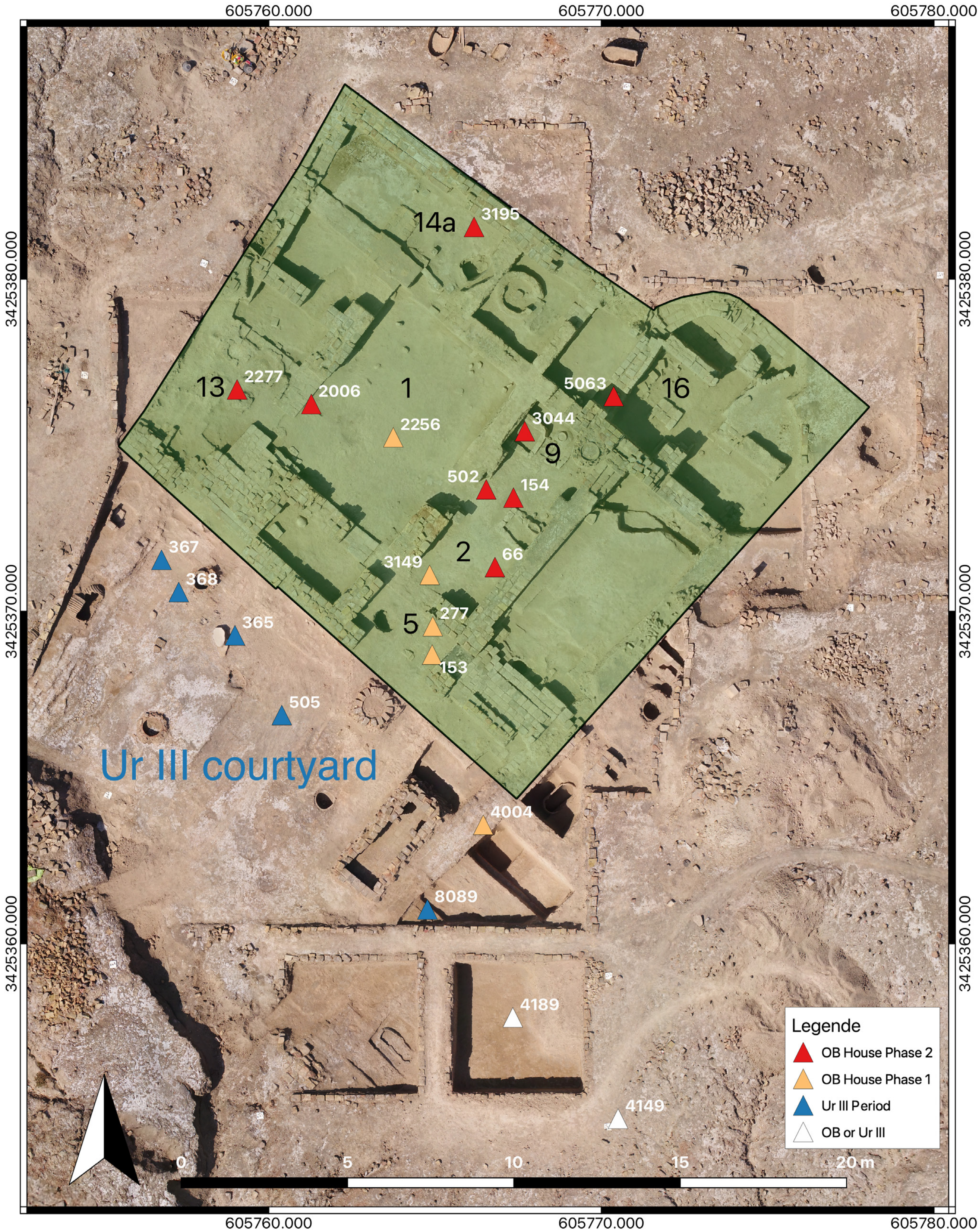

Fig. 14: LMU Area 5 shown on drone photo with location of weight finds (B. Einwag)

servant of the Larsa kings Sîn-eribam and Ṣilli-Adad in his two seals, was clearly a member of the urban elite during the Larsa period before Warad-Sîn mounted the throne (Otto 2019). Phase 1 came to a sudden end after about 20–25 years only, at the time of the Larsa king Ṣilli-Adad who reigned only for 9 months in 1835 BCE. We think that this was caused by the take-over of the new dynasty of Kudur-mabuk's sons Warad-Sîn and Rim-Sîn, and that Sîn-nādā, who was a high-ranking official in service of the old dynasty, had to leave his home or disappeared in another way.

Fig. 15: Weights 3149, 2256, 277 and 153 from Area 5, Sîn-nādā's house (Phase 1) (photos by P. Zimansky)

The house of Sîn-nādā and Nuṭṭuptum was built directly on the stumps of Ur III buildings, which had been levelled for the erection of this house. Apparently, the area here had been abandoned after the fall of Ur around 2000 BCE and had not been re-inhabited until 150 years later—a situation different from that in AH and EM where the occupation seems to have been restarted quite shortly after the fall of Ur (Otto 2023).

In Phase 2, the house underwent some changes and the floor was raised considerably (in some rooms up to 0.8 m) with the help of an artificial fill. The owner of this house is not known by name, but a few tablets and sealings in best Old Babylonian style (Otto 2021) indicate that the house was in use from c. 1834–1770/60, i.e. during the reigns of Warad-Sîn and Rīm-Sîn of Larsa.

The last occupation of the house in Phase 3 (probably from c. 1770/60 until Ur's temporary abandonment after Samsu-iluna's 11th regnal year) was marked by another elevation of the floors and change in room functions. But this phase was preserved only in the northwestern corner of the house and has not delivered any weights.

Isin-Larsa balance weights in the house inhabited by Sîn-nādā and Nuṭṭuptum

Four of the five balance-weights from Phase 1 (**Fig. 14**, yellow triangles) were found in the house of Sîn-nādā and Nuṭṭuptum and may be attributed to their economic household activities. One hematite weight (**3149**) was lying on the floor in the southwestern corner of the Reception Room 2 (**Fig. 15a**). It had once been a superbly crafted, very regularly shaped and highly polished sphendonoid weight, but it was broken. Thereupon, the edges of its fracture surface had been ground down so that it again exactly corresponded to the Babylonian system of 8.4g, but now it weighed only 2 shekels. Since it seems to be exactly half of a sphendonoid weight stone, it should have originally weighed 4 Babylonian shekels.

The fragment of a small weight stone (**2256**) was found roughly in the middle of Courtyard 1 above the mud floor (**Fig. 15b**). Probably it was discarded here after it had broken. Originally, this balance stone from hematite was sphendonoid with flattened bottom side. Today, less than half of it has been preserved, the remaining fragment weighing 1.7g. Therefore, it may be assumed that the complete weight stone once had weighed around 4.2g, corresponding to half a Babylonian shekel; but since it cannot be proven, its unit was not included in the statistics presented here.

Two stones (**Fig. 15 c**, **d**) were found in the heap of waste in Room 5, which consists mainly of sherds, animal bones and ashes mixed with tablets, tablet cases and sealed labels. It can be disputed if these stones were indeed weights. One (**277**) was a smooth, but unworked quartzite pebble of 36.0g; the other one (**153**) was a flat loaf of banded light-grey marble with rounded corners, the four sides of which were artificially flattened. Its mass of 34.4g corresponds to 4 Babylonian shekels. Although this shape and material is not very frequent, similar weight stones existed in Northern Mesopotamia (Otto 2006: 120–121, Fig. 62,4). Since many of the sealed labels found associated in Room 5 concern the delivery of draff and other goods to Nuṭṭuptum, these weights were possibly part of the economic transactions for which the

Lady of the house was responsible. They seem to have taken place in Room 5 and in the open area south of it, which was accessible from the house by a doorway. There was still a large open area in Old Babylonian times, where the Ur III courtyard had existed.

Another weight (**4004**), which was found on the surface outside the house above the levelled Ur III walls,[20] can also have been related to the economic transactions taking place in this area. It is an irregularly formed goethite nodule showing traces of flattening and polishing on one side and falling with 8.7g still within the tolerable range of 1 Babylonian shekel.

Old Babylonian balance weights in the house of Phase 2

Eight balance weights were found in the Old Babylonian House, Phase 2 (**Fig. 14**, red triangles). Two small sphendonoid hematite stones were found in Entrance Room 14a (**3195**) and in Courtyard 1 (**2006**). **2006** (**Fig. 16a**) is a tiny, but perfectly shaped weight with a length of 1.25cm, diameter of 0.5cm and mass of 0.9g, i.e. ⅒ Babylonian shekel. **3195** (**Fig. 16b**) is slightly larger and weighs 2.6g, i.e. ⅓ Babylonian shekel. The production process is clearly visible: after the sphendonoid object with a flattened base had been cut and polished, both small ends were ground less carefully so that the desired mass was achieved. Perhaps both small weight stones formed part of a larger set.

The highest concentration of weight-stones is clearly in the elongated double-room (Rooms 2+9), which was equipped with a hearth and a grinding installation in Phase 2. Four weights were found in this room (**66**, **154**, **502**, **3044**) (**Fig. 17 a-d**). **66** is a perfectly sphendonoid, well smoothed goethite of chocolate-brown color, corresponding to ⅔ Babylonian shekels. **154** is a less well-polished sphendonoid goethite, where the impurities of the nodule appear in several places,[21] but with a mass of 4.2g it corresponds exactly to ½ Babylonian shekel. **502** was lying close to 154 near the wide door opening to the courtyard. It is a lentoid limestone artefact, which at first sight seems like a natural pebble; however, it shows traces of scratching and polishing and, with its mass of 8.6g, it corresponds to one Babylonian shekel.

Possibly not a balance-weight but a suspension weight of different purpose is **3044**. The flat, oval limestone pebble was pierced from two sides; its mass is 158.3g including the accretion of crystals. Probably the object was a whet-stone or connected to textile work rather than to weighing procedures.

Only one object possibly being a balance-weight was found in the northeastern wing of the house, in the doorway leading from Room 17 to Room 16 (**5063**) (**Fig. 18a**). It is a tiny disc-shaped serpentinite of only 0.8cm diameter, possibly representing a very small weight stone of ¹⁄₁₆ Babylonian shekel.

The attribution of weight **2277** to Phase 2 is probable but not completely beyond doubt, since it was found in an Old Babylonian pit that was intrusive in the Phase 1 level of Room 13 (then a large kitchen). No floor of Phase 2 has been preserved and the room's function in Phase 2 is not evident, but the pit fill probably belongs to Phase 2. **2277** (**Fig. 18b**) was a formerly sphendonoid hematite balance weight broken in antiquity and possibly therefore discarded.

Ur III Balance Weights

The Isin-Larsa house was built directly on top of the Ur III level in such a way that the more than 1m wide mudbrick walls of the Ur III structures were levelled and served as a solid foundation for the slightly narrower Isin–Larsa baked brick walls. Only a fairly limited area of this Ur III level was excavated in 2017 and 2019, mainly consisting of a level area that was clearly an open courtyard. It was bordered on the southeastern side by several rooms, which contained little material. The more astonishing was the enlargement of the area in 2022, where the building turned out to be much larger and associated with the delivery of goods and the planning of building activities (not visible on the 2019 aerial photo of **Fig. 14**).

In 2017, only a part of the northwestern area of the courtyard was excavated. Nevertheless, the objects on the floor were significant and clearly related to the weighing and processing of goods. A grinding installation made of basalt, carinated bowls and other pottery and three weight stones were found in close proximity; the fourth weight lay only 2 meters further to the east (**Fig. 14**, blue triangles). Two of them were pendant weights, one was of cylindrical shape and one an unfinished goose-weight.

The larger one of the pierced pendant weights (**365**) (**Fig. 19a**) was found broken vertically, still weighing 350.9g (for the reconstruction of the original shape see

20 The aerial photo of Fig. 14 is a bit misleading, because it shows the Ur III mudbrick walls below the Old Babylonian level where the weight was found.

21 Goethite nodules often appear in cylindrical, oval or sausage-like form in the limestone hillsides along the Euphrates valley, see Fink 2012 and this volume.

Fig. 16: Weights 2006 and 3195 from Area 5, Old Babylonian House (Phase 2) (photos by P. Zimansky)

below and **Fig. 25**). The pear-shaped, carefully polished limestone artefact is pierced at the narrow upper end (the cylindrical perforations from both sides meeting almost precisely) and enlarges continuously towards the rounded bottom. It fits well in one hand and can be easily handled. W.B. Hafford suggests that it could have been used for weighing wool. A similarly shaped pierced limestone weight with the mass of a double mina was found in the Royal Palace G at Ebla with the remains of a wooden scale beam and 23kg lapis lazuli testifying to its function for weighing precious stone (Peyronel this volume: 163). A similar function cannot entirely be excluded at Ur, since the nearby Ur III tablet concerns the delivery of precious Carnelian from Meluhha (see below).

367 (**Fig. 19b**) is a flat, roughly rectangular stone with rounded edges and corners. It is pierced near one end by conical piercing from both sides meeting in the middle. It weighs still 191.1g, but is slightly chipped. Its material (corund) and form resembles whetstones; therefore, it more probably represents a whetstone rather than a weight stone.

By far the largest weight stone found on the Ur III courtyard was **368** (**Fig. 19c**). This massive dome-like limestone cube was fairly smooth on the upper and lower end, but still showed traces of the manufacturing process by picking. Its mass of 4907.2 g corresponds fairly well to 10 mina or 600 Babylonian shekels, which must have been somewhere between 8.2 and 8.4g if we add the loss by chipping.

Fig. 17: Weights 66, 154, 502 and 3044 from Area 5, Old Babylonian House (Phase 2) (photos by P. Zimansky)

Quite similar in shape was weight stone **8089** of olivine-gabbro the form of which is between dome-like and cubical (**Fig. 19d**). The roughly cylindrical object has flat upper and lower sides and cut edges. The traces of polishing are visible on many places and testify of the efforts to make it a precise weight. Its mass of 171.0g corresponds to exactly 20 shekels of 8.4g. Notably it was found in the Ur III building near a carnelian bead, flint tools and a tablet mentioning the merchandise of carnelian from

Fig. 18: Weights 5063 and 2277 from Area 5, Old Babylonian House (Phase 2) (photos by P. Zimansky)

Meluhha indicating economic processes. It has to be emphasized that if we had not weighed every single artefact found in Area 5, this object would certainly have been classified as "working stone". We hope that weighing will become a standard action in future excavations in the Near East.

When the Ur III area was enlarged in 2019, another saddle mill, several broken female terracotta figurines, a golden bead, a cylinder seal and pottery were found on the same floor. Additionally, the base of a rectangular reed container covered with bitumen was lying near weight 365. This could be the bottom of a basket used for carrying or measuring grain or other goods in the same area where the weighing of goods took place. Unfortunately, the capacity of the container cannot be reconstructed.

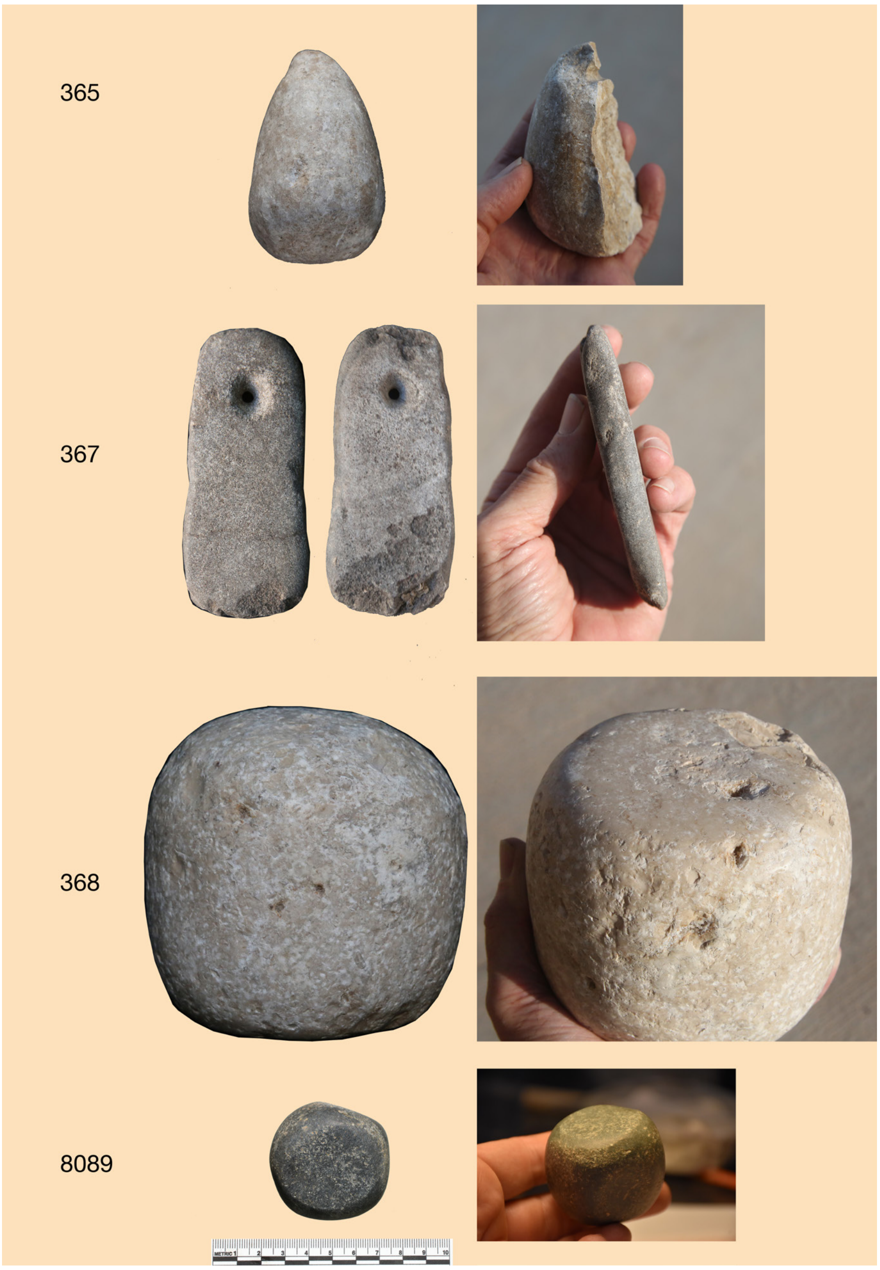

Fig. 19: Weights 365, 367, 368 and 8089 from Area 5, Ur III level (photos by P. Zimansky and W.B. Hafford)

In the debris approx. 40 cm above the floor an unfinished goose-weight (or 'duck-weight') of limestone (**505**) was found (**Fig. 20**). Its surface has been left rough and shows regular marks of picking with a pointed tool. Probably the object of still 43.9g was never finished because it broke during the manufacturing process and was then discarded. This indicates that goose-weights were not only used here during the Ur III period, but were also produced on this open space or in a nearby building. Since goose-weights came up in the Ur III period only and were used as the officially accepted referential weights for weighing procedures under control of the state authorities (see chapter Otto/Chambon on goose-weights, in this volume), this might be an additional indication of the function of this area in the Ur III period. We assume that goods were brought in from the nearby city gate to this open place, where they were weighed, measured, stored, distributed and processed.

Balance weights from Area 5, surface

Three certain or assumed weights were found in less assured contexts (**Fig. 14**, white triangles). Objects **015** and **4149** were found on the surface in Area 5. We attribute them nevertheless to the Ur III or Old Babylonian period, because Ur III and Old Babylonian walls, washed free by erosion, were visible on the surface where 015 was found (not indicated in Fig. 14, but found approx. 8m southeast of 4149), and the potsherds near 4149 were Old Babylonian.

Object **015** (**Fig. 21a**) is outstanding among other potential weights from Ur: it is a roughly cylindrical object, one side being slightly concave and the other rather straight; one small side is more convex than the other, which is flat enough to make the object stand. Even more outstanding is the material: white crystalline marble with large red speckles. Its mass of 21.1g can correspond to 2.5 Babylonian shekels, and its form and material find their closest equivalent in the spool-shaped balance weights of Aegean-Anatolian type, which are widely attested in the third millennium (Rahmstorf 2022: 21–264, Taf. 1–15), although it cannot be totally excluded that the object is rather an unfinished bead. If this interpretation were right, Ur would be the only site so far, where weight stones from the Aegean, Syrian, Babylonian and Indus areas were found in contexts of the late third and early second millennium.

4149 (**Fig. 21b**) is a perfectly shaped sphendonoid weight from hematite with a mass of 2.8g, i.e. precisely corresponding to ⅓ Babylonian shekel of 8.4g. Weight **4189** (**Fig. 21c**) is another complete sphendonoid hematite; however, its two ends are irregularly shaped and differently polished. It seems that a broken larger weight stone had been recycled and ground at the shorter end in order to be used as a smaller weight. Since all iron oxide stones had to be imported to Babylonia from Syria or Anatolia (Melein 2018), the recycling of broken balance weights was a common practice. 4189 was found in a large Old Babylonian trash pit intrusive in the Ur III levels, and which contained mixed Old Babylonian and Ur III material.

Fig. 20: Unfinished goose weight 505 (photos by P. Zimansky)

To sum up, 13 of the weight stones were found in Isin-Larsa / Old Babylonian and five in Ur III levels, three more can be attributed to the Old Babylonian or Ur III period.

The stratigraphy and date of the relevant phases can be summarized as follows: Area 5 served as an economic area for the delivery, weighing and handling of goods and the planning of building activities during the Ur III period (5 weights). After a *hiatus* of approx. 150 years, a new house was built on top of the Ur III walls. This house contained in Phase 1 (Isin-Larsa period, c. 1860–1835) 5 weights; in Phase 2 (Old Babylonian period, c. 1834–1770/60), when it was inhabited by a new owner, 8 weights.

The most remarkable result is the distinct difference in material and shape between the Ur III and Isin-Larsa/Old Babylonian weight stones. The confirmed Ur III weight stones are either domed, goose-shaped or suspension weights from limestone, marble and olivine-gabbro.

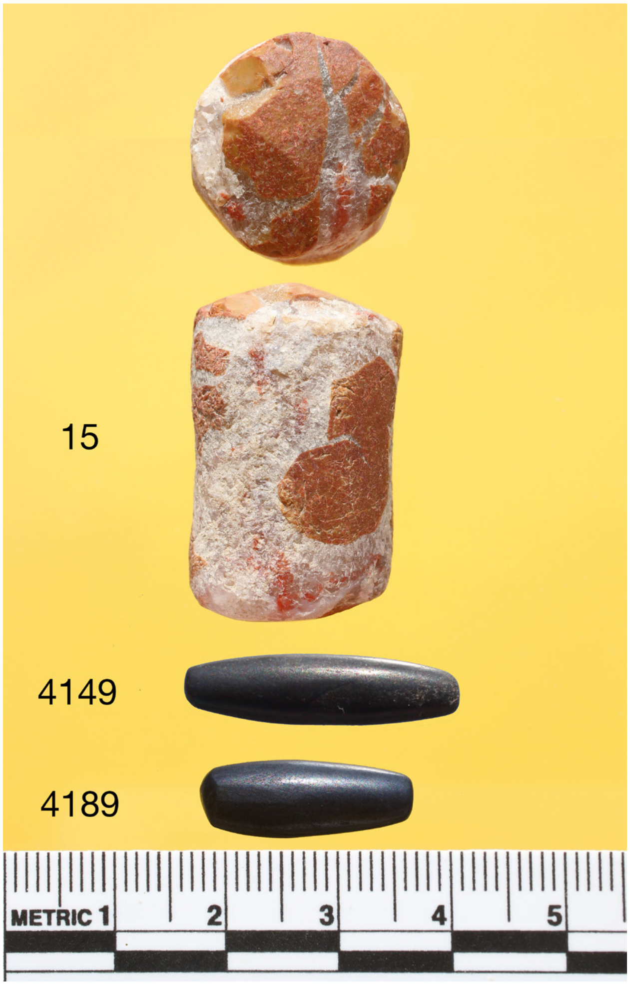

Fig. 21: Weights 015, 4149 and 4189 from Area 5, surface (photos by P. Zimansky)

Fig. 22: Large goose weight 509 and weight 510 from surface of the South Mound (photos by P. Zimansky)

By contrast, the Isin-Larsa weight stones do not differ from the Old Babylonian ones in shape or material; nearly all the carefully shaped ones—mostly of sphendonoid form—consist of iron oxide varieties.

A large goose-weight from the surface of the South Mound

The guardian of the site, Daif, drew our attention to an enigmatic object on the surface of the western part of the South Mound (see **Fig. 1**) in the 2019 campaign. Where Iraqi colleagues had excavated parts of a baked brick building in the late 1990s[22], the large goose-weight **509 (Fig. 22a)** lay in the area of rooms and walls, and only about 50cm away the similarly large sphendonoid stone **510** (**Fig. 22b**). It is not absolutely certain that both stones had always been lying there, but tourists or other people could also have deposited them there; however, the very fact that the less spectacular stone 510 lay near the goose-weight seems to indicate that both originally had been deposited there or nearby.

In the geophysical prospection conducted by Jörg Fassbinder (LMU Munich) in 2019, the magnetometer image shows in this area a large, multi-roomed building of baked bricks, much larger than a dwelling house. We suspect that it is an official building of the Ur III or Old Babylonian period.

509 is a large goose-weight ('duck-weight') from gabbro. It measures 19.5cm in length, 13.5cm in width and 12.0 cm in height. With its mass of 4836.7g it corresponds to 6 *mana* or 600 shekels of 8.06g. It is slightly chipped, so that a former unit of approximately 8.2g could have been achieved. Its form is rather massive and broad, if seen from above, while the neck and head are fairly small. It is similar in shape to the much smaller basalt weight U.6502 (mass 244.2g, i.e. 30 shekel of 8.14g) which was a surface find by Woolley (Hafford 2012, 29, Fig. 4f; http://www.ur-online.org/subject/5724).

510 is an oval (or roughly sphendonoid) weight from reddish granite with a mass of 2197.0g. Its measurements are 16.6cm by 11.5cm by 8.2cm. Both ends are broken, therefore we assume that it could have originally weighed around 2500g corresponding to 5 *mana*. It is not certainly a weight stone, but due to the fact that it is fairly similar in shape and size to the goose-weight and was found close to it, we interpret it as a weight.

Analysis of all weights from recent excavations

(W.B. Hafford)

The data from the weights reported in their contexts above have been gathered together (see Appendix). They have then been analyzed in several different ways in order to discuss their mathematical relations and, thus, the systems of weight mensuration that were in use over the periods represented by the excavations.

The scales available at the excavation in 2015 had a precision of only 1 gram; therefore, all weight measurements made in that year are less than ideal, actually falling up to half a gram on either side of their reading. The smaller the weight, the more significant an error this will be in determining the potential base shekel. The following seasons had used scales of 0.1-gram precision and occasional access to 0.01-gram precision scales; nevertheless, objects from Areas 1-4 were not consistently weighed, meaning that not all weights could be analyzed numerically.

22 The results of the excavation still await publication.

Analysis of likely multiples and fractions has been conducted for all known masses of complete objects, i.e., if a weight measures 16.5 grams it is very likely to have represented 2 shekels of 8.25 grams, as the known southern Mesopotamian shekel ranges around 8.3-8.4 grams. Similarly, if a weight is 4.2 grams, it is very likely to have been used to measure ½ of the 8.4-gram unit. Interpreting multiples and fractions in this way is by no means a foolproof method, but it is a good starting point so long as only sensible numbers (ones that fit well in a base 60 mathematical system) are attempted.

A graph of the resulting potential base shekel weights for the recently excavated Ur weights appears in **Fig. 23**. This chart shows the overwhelming presence of the 8.4-gram southern Mesopotamian shekel (within 5% tolerance either side). However, some weights fall outside of this range. For example, one weight is recorded at a base of 13.7 grams. This weight (**2111**) is very important in that it is clearly foreign in origin. It is a well-made chert cube that weighs 27.4 grams. The material and form exactly match those in use in the Harappan civilization of the Indus River Valley, whose weight system is known to have been based on 13.63 grams (Ratnagar 1981: 184).[23] If it were not in a recognizably foreign shape, this weight might have been calculated to be 3 x 9.13 grams rather than 2 x 13.7 grams.

Five weights calculate between 8.8 and 9.4 grams, above the expected range of the southern Mesopotamian shekel. These might represent the northern Mesopotamian shekel of 9.4 grams, but they require a closer look. If the system is represented, there should be a range equally around the mean, but only one of these five pieces hits the standard while the other four are quite low at around 9.0. The single 9.4 calculated unit comes from a weight found in Area 1, beneath the lower occupation floor. It is a well-made hematite sphendonoid (**973**) that weighs 47 grams. It was found in 2015 and thus might be as high as 47.5 or as low as 46.5 (owing to scale resolution, any number in this range would result in a readout of 47), but as this is clearly a 5-shekel multiple, it is not as problematic as if it were a much smaller weight. Dividing by five places its represented shekel firmly between 9.3 and 9.5, and makes this weight very likely to have been calibrated to the northern standard. Interestingly, another weight found in the same context (**970**) and of similar manufacture might also have been calibrated to this standard. It is much smaller, however, and the lack of precision on the scale makes it very difficult to know the intended shekel in this case. It weighed only 3 grams on the 1-gram precision scales and thus actually weighs somewhere between 2.5 and 3.5 grams. That means that the shekel represented by this ⅓ fraction could have been anywhere from 7.5 to 10.5, covering a wide range around both the southern and northern shekels. Nevertheless, it is possible that both 973 and 970 from the same context were set to the northern standard.

The remaining three weights that calculate between 8.9 and 9.0 base shekel are all somewhat problematic. One was actually broken in antiquity but was included in mathematical analysis because the broken end was polished down, indicating a likely attempt to reuse it as a weight at a new fraction. The process of recalibrating a broken weight may not have been overly precise; such objects would be used out of necessity, much the way pebbles that fit generally into the system can be used to fill out a set of weights. Another example weighs only 0.9 grams. This is likely a ⅒ fraction, not a terribly common one in the system, but it actually could weigh 0.85-0.95 grams and could thus have been intended to represent either the southern or northern standards. The final example is a pebble weight, that is, a natural stone that is roughly ovoid in shape that might have been used to fill out a set but that is not confirmed. It weighs 36.0 grams and could be 4 shekels of 9.0 grams, but this is by no means clear.

Thus, a 9.4-gram standard is only clearly indicated by one weight in the recent excavations. A few others might support this usage, but cannot be confirmed. A similar result was found in the much larger set of examples from Woolley's excavations (Hafford 2012: 43). Here the 9.4-gram standard is indicated in a small number of the overall weights, but curiously there have been no single unit 9.4 gram weights found anywhere on the site, in contrast to a large number of unit 8.4 gram examples.

A few weights in the graph also fall below the expected southern Mesopotamian shekel range. They span from 7.5-8.0 grams and could potentially indicate the low 7.8-gram standard noted at Ebla (Ascalone/Peyronel 2000: 115).[24] Like the weights plotting high on the graph, most of these low weights may be called into question. Of the five that graph in the 7.9-8.0 bin, for example, four calculate to 8.0—the lower end of tolerance for the 8.4 standard—and three of these were measured in 2015 to low precision. The other is an unconfirmed disk weight. The final weight in this bin is unlikely to have been a

23 Zaccagnini (2019: 50) also links a 13.4-gram shekel to the 'Dilmun' mina, which he believes is 1340 grams, representing 100 of these shekels.

24 Zaccagnini (2019: 74) calls this the Karkemish shekel and places it at 7.83 grams.

weight at all. It is a flat rectangular suspension piece (3044) that is the standard form for a whetstone or suspension weight.

Three weights plot in the 7.5-7.9 range, which is correct for the Eblaite shekel. One of these, however—calculating at 7.5 grams—is a natural pebble that is not likely to have actually been used as a weight. The other two are confirmed weights. Weight **5137** is a limestone sphendonoid that is chipped, but not badly and the chip may have been intentional to stop the weight from rolling in a balance pan as it is directly in the center of the piece. It weighs 77.0 grams and the loss of weight from the chip is not likely to have been more than a gram or two. It was therefore probably a weight of 10 shekels of around 7.8 grams each. The other is a small hematite sphendonoid (**3195**) that weighs 2.6 grams. It is ⅓ of a shekel, but that shekel then calculates to 7.8 grams. Inaccuracies in evaluating this small of a weight could mean that it was intended to be somewhat heavier, but a 0.05-gram difference would not bring its base shekel into the range for the southern standard. This means that, just as with the 9.4-gram northern Mesopotamian shekel, a very small number of weights may have been calibrated to the Eblaite standard. In the overall analysis of weights from Woolley's excavations, a few weights of a low standard shekel were also possibly indicated, but even fewer than the northern Mesopotamian 9.4-gram standard (Hafford 2012: 37).

The method of selecting likely multiples or fractions of a shekel is somewhat subjective and other methods must be used in conjunction with it. The best method of checking the intended ancient unit weight is by examining pieces that were marked by the ancients themselves as to their correct multiple or fraction. Only one of the weights found in the new seasons of excavations at Ur bears such markings.[25] This weight, (**1962a**) weighs 24 grams and bears three engraved vertical lines, making for a unit shekel of 8.0 grams. This is at the lowest end of tolerance for the standard 8.4-gram shekel, but one edge is chipped, thus it must have been heavier than 24 grams, approaching 24.5 or 25 g, making for a potential shekel as high as 8.15 or 8.33 grams and placing it much more firmly within the expected range.

Markings make for the most reliable discovery of intended ancient standards and they help us calculate the accepted scale tolerance in Mesopotamia by looking at variance around the norm.[26] This informs our choice of multiples and fractions for unmarked weights, but it cannot be the only additional method we rely on. A more objective, statistical method of analyzing potential units is called cosine quantogram analysis.[27] Its mathematical formula tests a continuous string of possible base numbers against a known sequence (such as groups of measured weights) and returns error ratings that indicate how well that base number fits the sequence at various fractions and multiples.

As with all statistical methods, a large sample number is essential to returning reliable results. The number of weight measurements of unbroken examples from the recent excavations is relatively low—24 confirmed with an additional 15 possible, plus 4 confirmed weights that were broken but may have been prepared for reuse in antiquity. It would be helpful to split them up by time period, but this would reduce the sample too far. The best we can do is split off the confirmed weights to show the best possible fit and then compare that to the results for confirmed + possible weights (see **Fig. 24**).

The 8.4-gram standard and its major fractions are clearly indicated in the graph of the function for confirmed weights.[28] Significant peaks occur at 1.4, 2.1, 2.8, 4.3, and 8.3 grams, corresponding to ⅙, ¼, ⅓, ½, and 1 shekel. Beyond one shekel, the peaks widen and we see one centered around 13.5 and another around 16.1 grams. These correspond approximately with the Indus Valley standard and two Mesopotamian shekels respectively. Quantogram analysis is capable of filtering out different base numbers, but this can only be reliably done when there are large numbers of each unit within the sample. Here we have only one example of a 13.7-gram unit; however, the peak appearing around 13.5 grams may be a result of this weight combined with the fact that the value is approximately 1.5× the Mesopotamian unit.[29]

25 Marked weights are not overly common in the ancient Near East. For example, only around 10% of all weights reported from the early excavations at Ur were marked as to their unit (Hafford 2012: 40).

26 For a good discussion of the variance around a norm in ancient weights, see Ratnagar 2003: 81.

27 Also known as the Kendall statistic, as it was first used to analyze the 'megalithic yard' by David Kendall (1974). It was applied to Aegean length measures by John Cherry (1983) and to Aegean weights by Karl Petruso (1992). It is now in common use in the analysis of ancient weights in general, e.g., Ialongo *et al.* 2018. See any of these sources for the formula itself, which is also included in Hafford 2005 and Hafford 2012.

28 The standard here skews a bit low partially because of the low precision measures for the 2015 season weights, but note also that many Ur weights tend to a standard shekel around 8.2-8.3. See the analysis of weights from Woolley's excavations (Hafford 2012: 32-37).

29 It is actually much closer to 1.666x, but there is a duck weight from Ur that is marked 1 ½ that weighs 13.51 grams. It has plausibly

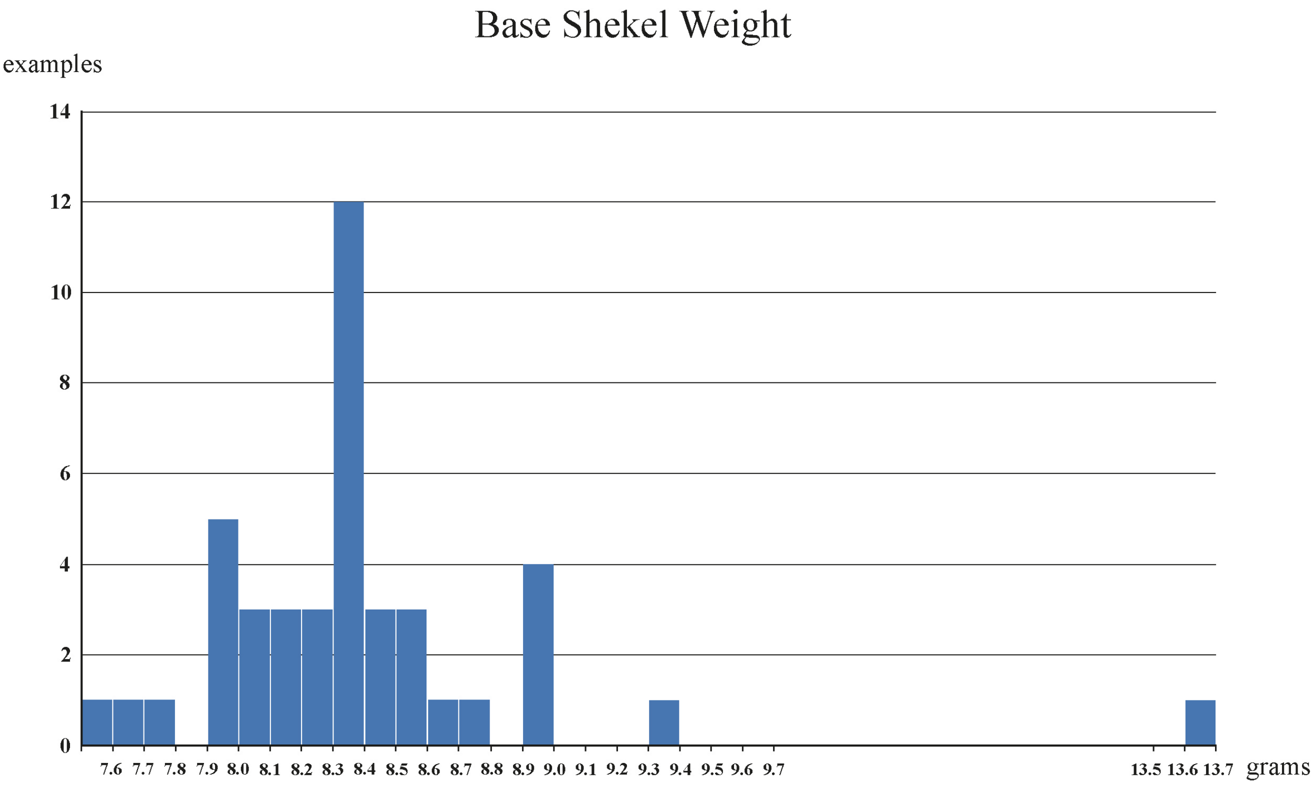

Fig. 23: Mass units indicated by weight finds from SUNY / LMU excavations

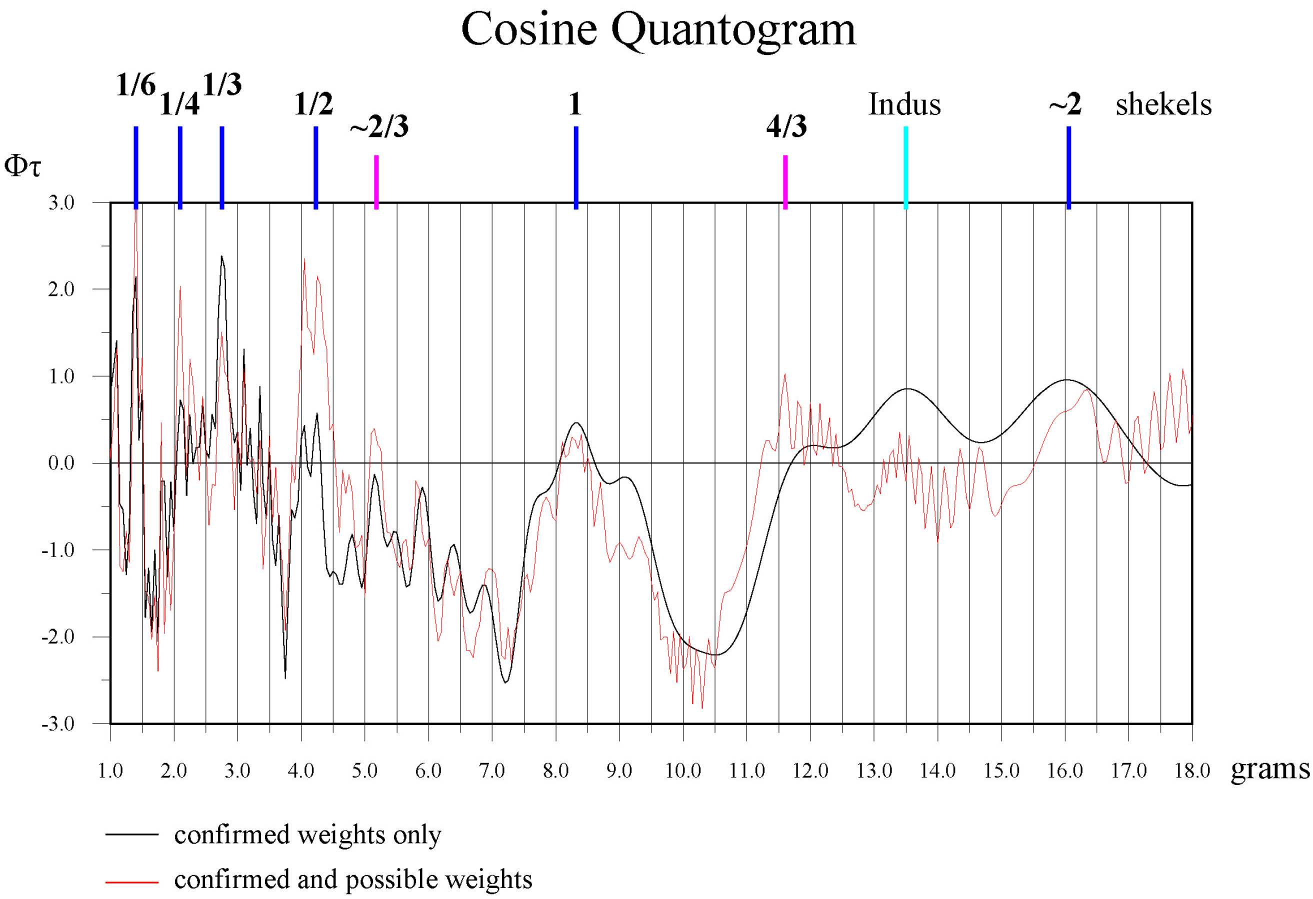

Fig. 24: Cosine quantogram graph of indicated mass units from SUNY / LMU excavations

The graph of all possible and confirmed weights combined is noticeably 'noisy.' This is due to the inclusion of less well-defined weights (and a few that were probably not weights at all) and by the gap between the large number of small weights and the small number of large weights.[30] Nevertheless, the main peaks are still visible, with two additional peaks that do not readily show in the confirmed weights. These new peaks are highest at 5.2 and 11.1 grams. A peak at 5.6 would be expected, as this is a common value at ⅔ of the southern Mesopotamian shekel. The peak at 5.2 may be a skewed version (just as the 2-shekel peak is skewed low), but it is lower than expected. The 11.1-gram peak shows a great deal of noise, but is likely indicative of 1 ⅓ shekels (11.1-11.2 grams).[31]

While the graph shows that the possible weights also tend to the southern Mesopotamian system, this alone does not confirm them as weights. Many of them are likely to have been used in this fashion, but the confirmation of possible weights is dependent on many factors besides correspondence to a known mass system, such as form, material, and association with known weights. The reliability of the various aspects of these weights has been analyzed and is listed in the appendix.

Broken weights could not be included in the statistical analysis, with the exception of ones that appear to have been prepared for reuse after breakage.[32] The four weighed examples of this type found in recent excavations appear to have been filed down to half their original size after breakage and the broken end polished so that they might have been acceptable in trade at one half their original mass. One broken weight that was clearly not used after its breakage, and therefore not included in numerical analysis, is nonetheless of great interest. The weight is a suspension form, its suspension hole about half preserved at the top of its overall pear or teardrop form. Suspension weights are not overly common at Ur or the Near East in general, but confirmed examples are known. Small suspension weights are typically of the sphendonoid variety with a transverse drill hole at one end. These might have been worn like a cylinder seal. Larger suspension weights, however, are often in a more triangular or bulbous form. Such would work well for weighing heavy commodities as there is no need of a scale pan. The weight is hung from one end of a balance beam with rope while the commodity is hung from the other end, perhaps in a basket. However, there are many suspension objects that were not calibrated to a weight system, only meant to hold something taut, such as loom weights, or cause it to sink, such as net sinkers. The largest and heaviest suspension stones were often used as anchors for boats.

The broken, pear-shaped suspension weight found at Ur (**365**, see **Fig. 25**) is likely to have been used as an actual balance weight before it broke. It currently weighs 350.9 grams and is broken roughly in half vertically, split from its suspension hole to its rounded bottom. In fact, just over half of the object remains, as a central dividing groove is still visible running vertically from just below the suspension hole. Reconstructing the overall shape of the weight is relatively simple since it must have been symmetrical and reflecting the preserved half suffices for a general idea of the form. The result is very similar to an inscribed suspension weight in the Ashmolean Museum (accession number AN1921.870).[33] The mass of this complete suspension weight is 680.5 grams, nearly twice the current mass of weight 365 at Ur.

been suggested to be a crossover weight, conceptualizing the Indus standard at roughly 1.5 Mesopotamian units (Hafford 2012: 43).

30 All but two of the entire sample weigh 20 shekels or less, with the remaining two weighing in at a hefty 600 shekels. This leaves a gap of more than 4,700 grams between the groups. The two 600-shekel weights have been left out of the confirmed graph to ensure a cleaner representation of the peaks, but they have been included in the confirmed + possible weight graph.

31 There is also the possible 'Anatolian' or 'Hittite' standard of 11.75 grams (Zaccagnini 2019: 73; Mederos and Lamberg-Karlovsky 2004: 208), but it is not common, if it even exists in the Bronze Age, and it is not indicated here. Its concept is mainly derived mathematically from the belief that the 'western' mina of around 470 grams might be divided by 40 for a shekel of 11.75, by 50 for a shekel of 9.4, or by 60 for a shekel of 7.83 grams in different regions. Many ancient people were aware of other mensuration systems and did know how to convert them, but modern mathematical derived connections can be taken too far and must be investigated carefully.

32 It is possible to recreate a complete weight from a broken one so long as the original form was symmetrical, as almost all were, and the material density is known. It can be done with 3D modeling, which will give the total volume once the missing area is digitally reconstructed, then a calculation of the density of the stone can result in an overall mass. This is time-consuming, however, and has not been conducted here.

33 The online record for Ashmolean AN1921.870 is: https://collections.ashmolean.org/object/560476. It states that the object was purchased in 1921, and gives the find spot as the surface of Tell Brak (Syria), along with a very broad date range of 2000-300 BCE. The publication of the object (Langdon 1921: 575) states that it was donated to the museum from the collection of a former army officer (who had presumably served in the Middle East in the first World War), but gives no find spot. It also places the date of the weight much earlier.

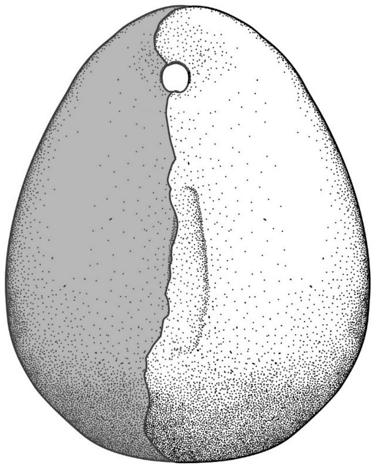

Fig. 25: Extrapolated shape of weight 365, in the form and probable mass unit of wool mina

The mass 680.5 grams does not fit well into the 8.4-gram system,[34] but the Ashmolean example bears an inscription that makes its use as a weight certain. It reads: "One mana of wages in wool. Dudu the high priest" (Langdon 1921: 575).[35] This has led to the conclusion that there was a heavy mina specifically for the evaluation of wool at the time the weight was in use (Powell 1971: 275; Zaccagnini 2019: 57). That time period appears to have been around 2400 BCE, as there are references in the time of Entemena at Lagash to a prominent man named Dudu who was the Sanga priest of Ningirsu.

If weight 365 were broken precisely in half, its total original mass would have been 701.8 grams. It appears to be just slightly over half preserved, however, and therefore its mass is more likely to have been just under this figure, making it very close to the Dudu wool weight. It seems that the heavy mina for wool may have been in use here at Ur in the Third Dynasty. Moreover, the weight was found in Area 5, in an open space in use in the Ur III period, perhaps as an area for assessing materials coming into the city. Alongside this open space were small rooms interpreted as parts of a building for storage and other economic purpose. Perhaps wool was originally stored within, having been assessed in the open area after being brought to Ur from the hinterlands.

34 Though it is approximately 80 shekels, or 1 ⅓ minas, in the Mesopotamian system and 50 units in the Harappan system. Zaccagnini (2019: 57) links it to one half of a 'Dilmun' mina, or 50 'Dilmun' shekels of 13.4 grams each.

35 The actual transliteration shows that Langdon added the 'wages' portion of his translation. The transcription, shown in Powell 1971: 255, is ma-na siki du-du sanga, so more simply: 'wool mina of Dudu, the temple administrator'.

Conclusions

The southern Mesopotamian standard of weight mensuration was clearly the primary system in use at Ur. The weights from the most recent excavations support this conclusion already indicated by the large number of weights from Woolley's 12 years of excavation (Hafford 2012). Other standards may have been in use, but were not common. The clearest example of a foreign standard from the recent excavations is the presence of an undeniable Indus Valley weight (**2111**). Many exotic goods flowed into Ur from the Indus civilization and so it is no surprise that some weights of the standard might be found here. The real surprise is that so few have been found. Woolley reported a yellow carnelian cube from the Royal Cemetery area, but did not recognize it for what it was.[36] Much later, Shereen Ratnagar (1981: 186) examined this piece in the Iraq Museum and confirmed that it was indeed a one-unit (13.5 gram) weight with an exact parallel at Chanhu-daro. Woolley also found a duck weight (U.18699E) that weighs 13.5 grams but is marked 1 ½ units. This weight may be an Indus standard mass with a Mesopotamian form and marking to show its rough equivalence in the Mesopotamian system (Hafford 2012: 43).

In the larger dataset of Woolley's excavations, the northern Mesopotamian 9.4-gram standard was potentially visible, though in very small numbers. Only one weight from the recent excavations indicates the possible presence of this standard; the few others that might are problematic and can be called into question. Similarly, a low standard around 7.8 grams is possible for one or two objects, but these additional standards were not at all common at Ur where there was a definite preference for its own, southern standard as indicated by the vast majority of the weights from old and new excavations.

What is more obvious from the recent work is the preponderance of weights in use in domestic areas. Although Woolley uncovered well over 400 weights, about 100 had no information as to find spot. Around another hundred had only very general find locations, i.e., major regions of the site, outside the site, or the extremely general location, 'Ur'. Of the over 200 that had more helpful find information, 73 came from the Roy-

36 Although Woolley reports it as yellow carnelian, it is probably actually chert. Furthermore, his notes place it near the northwest annex of the Ur III mausoleum in the Royal Cemetery area. Though it seems to be rather deep here, perhaps it was in use in the Isin-Larsa/Old Babylonian housing located on the ruins of the Ur III mausolea.

al Cemetery, while only 64 came from domestic areas. This gives a false impression that the primary context for weights at Ur was funerary (Hafford 2012: 47–49). Only 33 of Woolley's documented domestic weight finds came from Area AH, and his bias toward recording find information from graves rather than from buildings is especially clear here, as 17 of these came from a single grave beneath the floor of No. 1B Baker's Square (Woolley/Mallowan 1976: 199).

The current excavations at Ur reveal that weights were extremely common in houses, particularly of the Old Babylonian period. We must therefore conclude that many of the weights with no find information from Woolley's excavations actually came from domestic areas, with many more coming from Area AH than he recorded. In fact, all five of the trenches excavated in the three recent seasons at Ur have produced weights from domestic contexts.[37] Many of these are isolated or scattered and, though in some cases they may have been part of packing between floors, their presence and likely usage within houses cannot be denied. They were quite possibly used in the courtyards or an immediately adjoining room, evaluating household products or goods meant for trade. Where other primary usage or storage is indicated, weights appear to be either buried with the dead or stored above such tombs in domestic chapels or more likely a small room off the chapel where archives were also typically kept. This might indicate use of weights to confirm payments, loans, or debts, as many of the related tablets are receipts or otherwise having a bearing on economic activities. A few weights have been found with potential evidence of tools and stone working; their connection to crafting is thus also likely in some cases.

The Old Babylonian period appears to be the most prolific in the use of weights. However, this is the period best represented and most explored across the site overall, especially as regards domestic occupation. The majority of exposed architecture in Areas 1, 2, 3 and 5 come from this period and they have produced the majority of weights in this report. Nevertheless, some weights have been found in Neo-Babylonian, Kassite, early Isin, and Ur III contexts, showing that weighing was relatively common in all of these periods.

South of the house of Sîn-nādā (Area 5), in an open area that dates to the Ur III period, large weights were found along with what may be buildings associated with the storage and handling of goods and the planning of construction work. The finds include a large domed weight and a broken suspension weight that may have been specifically used for the evaluation of wool. Grain processing appears to have been one of the activities conducted here and it may be that this area just inside the city wall was a processing or evaluation area for goods (like wool, grain, stone, and perhaps metals) coming into the city.

Further evidence for this is the cylindrical weight stone 8089 weighing 20 shekels of 8.4g which was found together in the Ur III building with a tablet mentioning the merchandise of Carnelian from Meluhha.[38] Additionally, this fits well with the Indus valley weight mentioned above. Since these objects were found in the 2022 season, when this article had been already finished, this needs further evaluation.

Although the number of Ur III and Kassite–Neo-Babylonian weight stones is rather small in the assemblages studied in this article, it is nevertheless interesting to note a difference in material between the Ur III, the Old Babylonian and the later periods. While iron oxide is by far the most common stone used in the Old Babylonian period (Melein 2018), other material such as limestone, serpentinite, marble, quartz and gabbro are common in the 3rd and late 2nd/early 1st millennium BCE.

On the other hand, another lesson can be drawn from these observations: if one were to systematically weigh every pebble and every stone object on excavations in southern Mesopotamia, where stone is rare and must basically have been brought in, many more weight stones would appear in the archaeological record.

Weights and weighing were very important at Ur, even in the everyday life of most households. Analysis of weights in context is vital to this kind of understanding. The impression from the somewhat haphazard recording of these seemingly minor objects in early excavations was that they were primarily in use by the state or as funerary goods; yet, close investigation of weight finds from recent excavations has clearly revealed their connection to household activities and domestic record keeping.

37 The 2022 season has also found a confirmed weight in a building, possibly domestic, around 200 meters east of the city wall and a second possible pendant weight from another trench on that east mound outside the city.

38 We thank Dominique Charpin for the reading of the tablet. The study of the results of the 2022 campaign is presently under way, but could not be included in this article.

Appendix
(explanation of columns in Table 1)

ID = Lot number from excavation used to identify the artifact.

Type = Overall shape of the object:
Cube = square plan and square or somewhat rectangular section. This type is very common in the Indus Valley, but not in Mesopotamia.
Cylinder = circular section with little or no tapering; most are not perfectly cylindrical. This type is not a common shape for weights and may be unfinished cylinder seal. Nonetheless, some do appear to be used as weights, especially ones that are squat, essentially thick disks.
Disk = circular in plan, but not terribly thick so that it is essentially a short cylinder. This is not a common form for weights and is more typically found as a token or counter. Nevertheless, they can be used as weights.
Dome = round plan with domed upper surface. Not always perfectly circular in plan. The type is not common in Mesopotamia, but is found in Egypt and the Levant.
'*Duck*' or '*Goose*'= oval in plan and with a domed upper surface on which is carved the neck and head of a duck or goose. The eyes, bill and even the tail can at times be embellished. This is a very common weight form in Mesopotamia; it should rather be named 'Goose' (see article Otto – Chambon, this volume).

ID	Type	Material	Length	Mass	Multiple	Unit	Area	Date	Reliability	Condition
72	pebble	goethite	18	4	1/2	8.0	1	Isin-OB	fair	complete
530	sphendonoid	hematite	25	5			1	OB	confirmed	broken, incomplete
970	sphendonoid	hematite	20	3	1/3	9.0	1	UrIII-Isin	confirmed	complete
973	sphendonoid	hematite	48	47	5	9.4	1	UrIII-Isin	confirmed	complete
1058	sphendonoid	basalt	55	?			1	UrIII-Isin	confirmed	broken, complete
307	sphendonoid	gabbro	61	81	10	8.1	2	OB	confirmed	complete
317	sphendonoid	hematite	16	?			2	Isin-OB	confirmed	complete
641	dome	quartz	25	?			2	Akk-Ur III	fair	complete
732	sphendonoid	marble	38	?			2	Akk-Ur III	very good	complete
900	sphendonoid	hematite	28	?			2	Isin-OB	confirmed	complete
1953	sphendonoid	hematite	25	2	1/4	8.0	2	surface	confirmed	broken, complete
1962a	sphendonoid	gabbro	47	24	3	8.0	2	OB	confirmed	complete
1962b	sphendonoid	hematite	45	25	3	8.33	2	OB	confirmed	chipped
1962c	cylinder	amphibolite	40	57	7	8.14	2	OB	good	partial drill hole and chipped
					6	9.5				
150	sphendonoid	hematite	14	?			3	Kassite-NB	confirmed	complete
551	dome	amphibolite	57	?			3	OB	good	complete
559	sphendonoid	hematite		?			3	OB	confirmed	no photo
909	cylinder	quartz	24	6			3	surface	fair	broken, incomplete
1439	sphendonoid	hematite	24	?			3	UrIII-Isin	confirmed	broken, polished
1786	sphendonoid	hematite	53	83.5	10	8.35	3	Isin-OB	confirmed	complete
1801	sphendonoid	hematite	29	5.6	2/3	8.4	3	OB	confirmed	complete
2111	cube	chert	25	27.4	2	13.7	3	OB	confirmed	complete
2155	sphendonoid	basalt	26	4.16	1/2	8.32	3	Isin-OB	confirmed	broken, polished
2384	suspension	amphibolite	110	?			3	OB	poor	complete
2549	sphendonoid	marble	50	16.5	2	8.25	3	Isin-OB	confirmed	complete
2578	pebble	basalt	42	?			3	Isin-OB	fair	complete

Table 1: Table of weights from the 2015 – 2019 (2022) seasons at Ur

ID	Type	Material	Length	Mass	Multiple	Unit	Area	Date	Reliability	Condition
2998	sphendonoid	hematite	37	16.6	2	8.3	3	Isin-OB	confirmed	complete
3043a	sphendonoid	hematite	66	?			3	OB	confirmed	complete
3043b	sphendonoid	hematite	49	?			3	OB	confirmed	complete
3106	cylinder	goethite	15	?			3	OB	good	partial drill hole, broken
3124	sphendonoid	hematite	32	4.2	1/2	8.4	3	OB	confirmed	complete
3231	sphendonoid	?	?	?			3	OB	confirmed	?
3242a	sphendonoid	hematite	30	8.35	1	8.35	3	OB	confirmed	complete
3242b	sphendonoid	hematite	23	2.12	1/4	8.48	3	OB	confirmed	complete
4560	sphendonoid	hematite	22	?			3	UrIII-Isin	confirmed	complete
4655	sphere	serpentinite	12	2.8	1/3	8.4	3	EDIII-UrIII	good	complete
1173	pebble	goethite	25	?			4	Kassite	fair	broken, incomplete
1864	sphendonoid	quartz	37	?			4	Kassite-NB	confirmed	broken, incomplete
2487	large sphend.	gabbro	63	162.3	20	8.115	4	NB	good	complete
2641	cylinder	marble	40	32.25	4	8.06	4	Isin-OB	fair	chipped
2718	pebble	quartz	40	22.5	3	7.5	4	Kassite	fair	complete
2740	loaf	quartz	33	12.57	1 1/2	8.38	4	OB	fair	complete
2746	cylinder	serpentinite	24	25.0	3	8.33	4	OB	fair	chipped
3974	loaf	marble	33	?			4	UrIII-Isin	good	complete
4532	sphendonoid	quartzite	39	25.5	3	8.5	4	Isin	confirmed	complete
5137	sphendonoid	limestone	60	77.0	10	7.7	4	UrIII-Isin	confirmed	chipped
15	cylinder	marble	32	21.1	2 1/2	8.44	5	Ur III or OB	good	complete
66	sphendonoid	goethite	26	5.7	2/3	8.55	5	OB	confirmed	complete
153	loaf	marble	48	34.4	4	8.6	5	OB	poor	complete
154	sphendonoid	hematite	23	4.2	1/2	8.4	5	OB	confirmed	complete
277	pebble	quartzite	38	36.0	4	9.0	5	OB	fair	complete
365	suspension	limestone	96	350.9			5	UrIII	very good	broken, incomplete
367	suspension	corund	12.3	191.1			5	UrIII	fair	chipped
368	dome	limestone	140	4907.2	600	8.18	5	UrIII	confirmed	chipped
502	disk	limestone	27	8.6	1	8.6	5	OB	fair	complete
505	duck	limestone	45	34.9			5	UrIII	confirmed	broken, incomplete
525	shell	hematite	20	4.4	1/2	8.8	5	NB-Persian	confirmed	broken, polished
2006	sphendonoid	hematite	13	0.9	1/10	9.0	5	OB	confirmed	complete
2256	sphendonoid	hematite	15	1.7			5	OB	confirmed	broken, incomplete
2277	sphendonoid	hematite	18	4.5	1(?)	8.4?	5	OB	confirmed	broken in half, polished
3044	suspension	limestone	89	158.3	20	7.915	5	OB	poor	accretion
3149	sphendonoid	hematite	27	16.6	2	8.3	5	OB	confirmed	broken, polished
3195	sphendonoid	hematite	21	2.6	1/3	7.8	5	OB	confirmed	complete
4004	pebble	goethite	22	8.7	1	8.7	5	OB	good	complete
4149	sphendonoid	hematite	24	2.8	1/3	8.4	5	Ur III or OB	confirmed	complete
4189	sphendonoid	hematite	19	2.8	1/3	8.4	5	Ur III or OB	confirmed	complete

Table 1 (continued): Table of weights from the 2015 – 2019 (2022) seasons at Ur

ID	Type	Material	Length	Mass	Multiple	Unit	Area	Date	Reliability	Condition
5063	disk	serpentinite	0.8	0.5	1/16	8.0	5	OB	good	complete
8089	dome	olivine-gabbro	4.8	171.0	20	8.4	5	Ur III	confirmed	complete
509	duck, large	gabbro	195	4836.7	600	8.06	x	surface	confirmed	chipped
510	sphendonoid	granite	166	2197.0			x	surface	very good	broken, incomplete

Table 1 (continued): Table of weights from the 2015 – 2019 (2022) seasons at Ur

Loaf = rectangular in plan with a domed upper surface so that the ideal form looks something like a modern loaf of bread. The upper is not always high, however, and this form can be essentially a rounded rectangle.
Pebble = natural stone that might have been used as a weight due to its general shape and its proximity to a standard mass (make-weight). These types of weights definitely exist, but are hard to confirm because they are unworked. The only way to truly confirm them is if they are found in association with confirmed weights.
Sphendonoid = 'sling bullet shaped,' i.e., similar to ovoid, but symmetrical. May be elongated and thin or short and thick. May have flattened ends or rounded ends, and at times has a flattened area on one side to act as a base. This is by far the most common form for weights throughout Mesopotamia.
Sphere = spherical or near spherical worked stone. This type is not common but does exist, though it will typically have one side flattened somewhat so that it will sit in a balance pan. If the base is flattened enough, it becomes a dome weight (i.e. hemispherical).
Suspension = holed stone intended for suspension from a rope or twine. Confirmed suspension weights are typically sphendonoid in shape with one end pierced, but other forms are known, especially more triangular or pear-shaped.

Material = rocks or minerals (minerals are pure forms, rocks are combined of many minerals) from which the object is made. Stones have not been tested for true geological identification; instead, they have been identified by sight, and—in case of iron oxide stones—by streak. This means that the identification is only an estimate. The characteristics used to identify the stones listed in the appendix are explained below:
Amphibolite (rock) = metamorphic rock bearing amphibole minerals like hornblende and actinolite as well as plagioclase feldspar; deposits containing dolomite often metamorphose into amphibolite; typically has a grainy or flaky appearance mixed dark and light, colors may be black, gray, or green with white grains interspersed.
Basalt (rock) = igneous rock formed from rapid cooling of lava; fine-grained, relatively low in silica and high in plagioclase feldspar, augite and pyroxene minerals. Typically dark grey to black in color; often has vesicles (bubbles). If a weight is made of fine grained, gray stone it is typically called basalt here; however, vesicles are rarely if ever noted and many of them appear actually to be made of fine-grained limestone that has been heat treated giving it a gray color.
Chert (rock) = sedimentary rock consisting of micro crystalline quartz; occurs as nodules in limestone and dolomite. Because it is cryptocrystalline, it breaks conchoidally and can be struck into blades. Weights are rarely made of this material in Mesopotamia, but are frequently made of it in the Harappan culture (Indus Valley).
Dolomite (rock) = sedimentary rock closely related to limestone but harder and less soluble; typically light in color from white to brown. Dolomite may be finer grained than limestone and certainly occurs in weight making, but only limestone has been identified here.
Gabbro (rock) = igneous rock containing amphiboles and thus similar in outward appearance to amphibolite; typically contains olivine and so will tend to have a greenish hue, though it has a mix of dark and light colors and often a somewhat larger granular structure than amphibolite. Gabbro or amphibolite is a common material for large weights in Mesopotamia.
Goethite (mineral) = $HFeO_2$, sometimes has a browner appearance than hematite. If the stone seems slightly less dense and browner, and if the streak test proves to be brownish, it has here been identified as goethite over hematite.
Granite (rock) = igneous rock containing feldspar, quartz, mica, and amphibole minerals in a roughly equi-granular matrix; multi-colored grains, some dark and some light, may include pink, red, brown, black, white.

Hematite (mineral) = Fe_2O_3, typically dark gray to black, hematite can have a brown or red appearance due to the iron content; also can be polished to a silvery sheen. The streak test results in a more reddish color than Goethite. It is very hard and dense and is the most common material used to make small weights (up to 10 shekels) in Mesopotamia.
Limestone (rock) = sedimentary rock containing calcite and aragonite minerals (calcium carbonate, mostly from marine organisms) with variable amounts of silica (chert); typically light in color from white to brown. This material (or related dolomite) is common for large weights in Mesopotamia, but rarely for small precision weights, since it is rather soft.
Marble (rock) = metamorphosed limestone or dolomite (sedimentary carbonate rocks); fine-grained and sometimes multi-colored in bands. Can be solid white through black, can have reds or browns.
Quartz (mineral) = (SiO_2), a translucent or even transparent mineral that is very common in rocks of all types. Veins of it can form as large crystals in limestone (as well as other rocks). When in its most transparent form it is often identified as rock crystal. The examples of quartz here are not confirmed as weights. Though it can be used for this purpose it is not common.
Quartzite (rock) = metamorphic rock made primarily of quartz. In its granularity and even in some cases its color, it can resemble granite, but without the dark speckling of feldspar.
Serpentinite (rock) = metamorphic rock mostly made up of serpentine minerals (often olivine and pyroxene). These minerals give it a dark green appearance. When highly polished, it can look like nephrite or jadeite (i.e., dark green and glassy).

Length = Longest dimension of the object in its current condition, measured in millimeters.

Mass = Weight in grams measured on an electronic scale. The scales available in the 2015 season had a precision of only 1 gram. Any mass listed in this column without a decimal place is a 2015 find. The following seasons had scales with 0.1 gram precision available and occasional access to 0.01 gram precision scales. However, in all seasons objects from Areas 1-4 were not consistently weighed; therefore, many entries show only '?', meaning the mass is unknown.

Multiple = Suspected multiple or fraction of a unit mass. Except in the case where there are markings on the stone telling the multiple, these are intuited from the overall mass, calculated to make a reasonable shekel weight. The typical shekel weight in southern Mesopotamia is 8.4 grams, and typical divisors or multiples are in a base 60 system. If the mass does not fit with a good fraction or multiple, then another base shekel might be indicated or the object may not have been a balance weight.

Unit = The unit shekel weight calculated by multiplying the measured mass by the presumed multiple or fraction. If a weight is broken, its potential shekel is not known and is therefore left blank, but for those few pieces that have polished breaks and may have been reused, a potential calculation is included. In one case (1962c) two possibilities are shown since the multiples are not overly satisfactory.

Area = Excavation unit in which the artifact was found. These units range from 1-4 (SUNY excavations), 5 (LMU excavations), and 'x' (found on surface away from the excavation units).

Date = Date of the object according to the stratigraphic positioning in which it was found. The dates are sometimes broad, depending on the certainty of the stratigraphy:
Akk (Akkadian); *UrIII* (Third Dynasty of Ur/Neo-Sumerian); *Isin* (early in Isin-Larsa/OB sequence); *OB* (Old Babylonian, could potentially come from the Larsa period before); *Kassite*; *NB* (Neo-Babylonian); *surface* (found on or very near the modern ground surface and not attributable to stratigraphic date).

Reliability = Certainty of identification as a weight, considering its form, material, likely multiple or fraction in a known system of weighing, and proximity to confirmed weight finds:
confirmed (definite weight); *very good* (very likely weight); *good* (likely); *fair* (possible); *poor* (not likely).

Condition = Notes on completeness of the artifact: *complete* (as originally made, might have very minor chipping); *broken*, *complete* (broken but all pieces are present); *broken*, *incomplete* (broken and only a portion is present); *broken*, *polished* (weight is broken but the broken end has been smoothed out as if for reuse at a new fraction); *chipped* (small amount of mass has been lost); *accretion* (has some material adhering to the object, making the mass slightly heavier than originally intended).

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