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QUANTIFICATION AS A MEANS OF FUNCTIONAL ANALYSIS: SETTLEMENT POTTERY OF THE LATE MIDDLE KINGDOM AT TELL EL-DAB^C^A

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Introduction

The reconstruction of human behaviour and cultural processes at ancient sites, especially, in settlements, is based on the interpretation of the lay-out of the preserved architecture, the presence and nature of archaeological deposits[1] as well as connected finds of any kind (pottery, objects, residues, bones, waste products, raw materials, archaeo-botanic remains, etc). Only the combination of all these factors will lead to an informed approach.

There are, unfortunately, frequent shortcomings to this ideal situation, such as partial excavation, partial recovery of finds, site destruction, and also incomplete publication of archaeological reports and finds. Another impediment is that excavation reports do not always include the relevant finds as a group,[2] or part of the finds remains unpublished due to division of object type groups between several specialists. Whilst specialisation – necessarily – progresses further, a combined team effort provides good results.

Pottery almost always supplies the most numerous find group at Egyptian sites, especially vast quantities of fragments. Only relatively recently is this valuable primary source material being exploited comprehensively in Egypt and is now used to answer important research questions. Whilst not so long ago, only complete or intact pottery vessels were collected, today the vessel fragments are also taken into account. The large quantities of ceramic material excavated make it necessary to apply stringent methodology and use valuable resources in a considerate way to get useful results. Here quantification and statistics should be brought into the equation. Whilst there are several specialised works dealing with statistical theories in archaeology,[3] fewer scholars dealt with pottery and statistics.[4] The reason why pottery is complicated to quantify and use in statistical analyses is that the broken material has to be reconciled with complete vessels. A closely related problem is the comparison of the results of frequency distributions, for example, from contexts with a different rate of breakage, e.g. an undisturbed tomb with intact vessels and a settlement with mainly vessel fragments. More complications arise if a different use life of different vessel types, which is likely, needs to be taken into account.[5]

[1] Increasingly also on a microscopic level. See Weiner 2010.

[2] A recent notable exception Marchand and Soukiassian 2010.

[3] Fletcher and Lock 1994; Shennan 1997.

[4] Orton, Tyers and Vince 1993. Very valuable advice was given also by N.R.J. Fieller, from the Department of Probability and Statistics, Univ. of Sheffield, UK and also by F. Weninger, Department of Isotope Research, Univ. of Vienna.

[5] Orton, Tyers and Vince 1993: 166–167.

The first question to be asked is "Why quantify?" For the interpretation of a context, a group of contexts and eventually a site it is crucial to know the proportion of finds to each other and among them also how much pottery of the types present was found, respectively. Such data highlights the character of a context and eventually a site: was it a trade emporium, a settlement, a workshop area, a ritual context and so forth. Significant quantities of certain pottery types and proportional values between such types used in spatial analyses[6] can clarify functions or functional areas of sites in greater detail. But for recognising a significant quantity, quantification is a precondition.

The consideration of imported pottery may serve as example for the type of information to be gained. If it were known how much pottery was imported to a site, it might be possible to reconstruct the volume and scale of the trade, as well as if there were different trading partners and how much trading was done with each of them. A data collection from several phases will show if the trade patterns changed in any way, for instance, or whether one trading partner was replaced by another one, and so forth. There are innumerable questions that can be answered by quantifying material culture and pottery. Moreover, many of these questions are not immediately apparent during data collection, but will probably appear during analysis.

Generally statistical methods are used in archaeology to collect data, display it, analyse it and eventually interpret it, in order to obtain a clear overview of the material and generate new knowledge on which new hypotheses can be built. Beside a presence/absence analysis to show which pottery types are present at a site there are situations when it is useful or even crucial to know the proportion of one given pottery type in any sort of assemblage, e.g. to compare tomb contents with pictorial sources or concentrations of certain types within a settlement area. It has to be borne in mind, though, that not every site and every situation is appropriate for statistical analyses because it takes time. The choice of strategy will depend decisively on the size of the site and the context type: e.g. a settlement of a hitherto relatively unknown period, yet another fill of a substructure or tomb, material from under a temple of a well-studied period, or the completeness of the excavated area. Each of these situations demands a well thought out procedure.

Some issues becoming evident from first-hand experience with quantitative data need to be highlighted.[7] The decision to conduct a quantitative analysis and collect the necessary data involves several essential requirements: intention of complete recovery, careful retrieval and storage, and a realistic time horizon to conduct the pottery recording and data collection.

Statistics in pottery studies in Egypt have hitherto been used descriptively to produce frequency tables of various pottery vessel types or fabrics as they appear in certain units (graves, hearths, rooms, floors, etc.). Such frequency distributions are then compared from context to context, within strata or phases or between different sites.[8] As these frequencies characterise the context it is possible to interpret any meaningful developments or differences in quantity of any given pottery type. In cases of primary contexts they may help to define the original nature of the context (e.g. 80% of the total ceramic assemblage consisting of bread moulds suggests an interpretation as a bakery and expressed in hard numbers it supports an argument considerably, even if the nature of the oven installations is not so clear) or the dating or the development of the pottery itself.

So far statistical tools have been used as a means to test hypotheses with regard to particle distribution in Egyptian fabrics,[9] but not for testing inferences connected with quantities of pottery.

[6] Orton 1976.
[7] Bader 2009, 2010.
[8] E.g. Wegner, Smith and Rossell 2000: fig. 15, 20, 24.
[9] E.g. Ownby and Griffiths 2010.

Discussion of the Methods for Measuring Quantity

The basis for any statistical analysis of pottery is the measurement of its quantity. In the past several methods for quantification have been used, such as sherd count,[10] number of vessels represented,[11] surface measurement, displacement volume, or weight. These methods can be quite easily employed, and the results may be of some use, but some applications are either difficult to undertake or heavily biased.

From our present point of view probably the worst method is the sherd count as a sole basis for frequency distribution, as it is not a constant measurement (the sherds tend to break further into smaller pieces during storage) and it is biased towards thin-walled vessels, which break more easily than thick-walled ones. In considering the number of vessels represented, much thought has to be given to the completeness or brokenness of a vessel type, and if the level of the brokenness differs in the various contexts analysed. If an assemblage in a context is complete and the types are not very much broken up, the bias diminishes, but it is there. This method may be suitable for intact tomb contents, but makes consideration in a usual archaeological setting difficult.[12] In combination with other methods, e.g. weighing, however, it is still frequently used to identify the degree of brokenness.[13]

Measuring weight, the surface area and the displacement volume are all biased towards large vessels, because these methods will result in higher absolute numbers for larger than small vessels.[14] They can be used though, as they are constant measurements, for comparing proportions of the same ware/fabric or type in different contexts. Comparison of different wares and types with each other in the same or in different contexts results in invalid inferences as their weight depends on their wall thickness.[15] Of these methods weighing might be the most useful as it can be done fast and with simple means.[16] Methodological problems arise, if the sherds weighed are not completely dry. Measuring the surface area presents difficulties because most sherds show a curvature and are therefore not lying level on the graph paper or in the sherd yard unless they are very small. Measuring the displacement volume involves a fair share of calculation and needs a lot of complete vessels of one type in order to calculate an average.[17] For each of these methods comparative data of complete vessels need to be known. Thus, if sherds of hemispherical cups of the Middle Kingdom are weighed, it is necessary to know the weight of an average complete cup, the average surface area or the average displacement volume taken from a range of different cups. If no such data is present, no meaningful correlation can be made and no meaningful conclusion can be reached, except to state an absolute number and interpret fluctuations.

Quantification by means of "Number of Vessels Represented"[18] is feasible and useful provided the pottery is quite complete or almost completely restorable with only little additional sherd material preferably from a closed context such as a cache or pit or closed tomb

[10] Cf. Do. Arnold 1982: fig. 15, where type 8 – thin walled hemispherical cups – is most dominant.

[11] Do. Arnold 1992: 116, note 303.

[12] Orton, Tyers and Vince 1993: 21, 169–170.

[13] Puschnigg 2006; Strack 2011.

[14] See Orton and Tyers 1990: 84–88; Orton, Tyers and Vince 1993: 169–171.

[15] The typical example for the Middle Kingdom is comparing very thin walled and small hemispherical cups, which are very light, with heavy and large storage jars or beer/wine jars. On the other hand the comparison of the amount of hemispherical cups in different contexts might prove very worthwhile. Cf. Orton, Tyers and Vince 1993: 169; Bourriau 1991: 266. Cf. the example Orton 2000: 51–53.

[16] Cf. the study that Bourriau is undertaking with data derived from weight of sherds. Bourriau 1986: 22–23; Bourriau and Eriksson 1997: 103; Bourriau 2010: 7 for a planned study of residuality.

[17] Cf. Orton 1993.

[18] Orton, Tyers and Vince 1993: 169–171.

context. In such a case the use of the *estimated vessel equivalents* seems sometimes awkward, especially if data types need to be combined. But even then problems might arise if the vessel types present are ambiguous, e.g. several round bases were found and cannot be assigned to one type unequivocally.[19] The downside of this method is that frequently rim and base fragments are simply counted and each is taken to represent one individual vessel, regardless of wall thickness, vessel size etc., which is biased as discussed above.[20]

Estimated Vessel Equivalents

Many inherent methodological problems are avoided by the concept of *estimated vessel equivalents*, abbreviated *eves*, described in detail by Clive Orton. It is based on the premise that each sherd broken off an ancient vessel represents a certain proportion (or percentage) of a formerly complete vessel, regardless whether it is a body fragment, a base fragment, a handle (fragment) or a rim fragment.[21] This measurement represents the preserved part of a vessel and creates no bias, even if the vessels are thin- or thick-walled or large or small. While the measurements for bases can be termed base-*eves,* rim-*eves* could be used for rim fragments.[22] Because it is not always possible to measure the preserved proportion of the rim/base exactly the term **estimated** vessel equivalent is used.[23]

Specific vessel types, which are known to be oval rather than circular, such as oval platters[24] and some juglet forms,[25] may create problems in comparative analyses with circular types.[26] Specialised diameter charts and comparison with completely preserved examples facilitate the inclusion of such types. In some cases only the presence of the type can be ascertained in the quantification.[27]

Measuring the preserved parts of the vessels ("*Sektorenaufrechnung*") was introduced into Egyptian Archaeology by M. Bietak and others of the "Vienna Group" in the mid-1970s although it was not explicitly formulated.[28] Only relatively recently have several analyses using this information in Egyptian pottery studies been published.[29]

Body fragments of vessels can only rarely be attributed to any given type, except in a general way (closed/open shape of different fabrics), let alone be reliably measured. This is the reason for focussing on so-called "diagnostics" like bases and rims, which contain most information on the nature and appearance of an ancient vessel, so that an attribution to a type and the creation of a typology is possible although difficult with fragments. The identification of sherd material is often ambiguous as a given rim type could belong to more than one

[19] Cf. Bader, Kunst and Thanheiser 2009: 36–41. For a combination of bases and rims to enlarge the data pool see Strack 2011: 48.

[20] For further discussion and case studies see Bader 2004.

[21] Cf. Egloff 1973: 351–353.

[22] Orton 1975: 30–35; Orton and Tyers 1990; Orton, Tyers and Vince 1993: 21, 171–173.

[23] If rim fragments are not well enough preserved for obtaining a secure measurement of a rim diameter, no *eve* value can be given. Thus, to prevent such fragments from disappearing from the quantification altogether they were attributed a value of 0.01 *eve*. This was particularly important in type groups that contained only immeasurable fragments, which otherwise would have completely disappeared in the analyses.

[24] E.g. Bader 2001: fig. 16.

[25] Examples in Bader 2009: 327–328; fig. 194.41a; 378, 381, fig. 221.83a; 492–495, fig. 275.192.a.

[26] The nature of the result as an estimate has to be stressed because Egyptian pottery before the Late Period is rarely symmetrical and thus the exactness of the calculation cannot be taken for granted.

[27] Same procedure as in footnote 23.

[28] In the so-called second class material at Tell el-Dab^{c}a the quantity of each vessel type was measured by using a diameter chart, in order to reconstruct the diameter and at the same time measure the preserved proportion by means of the fractions of a circle (3/32, 1/16, etc.). Cf. Bietak 1991: 318.

[29] Bader 2006, 2009; Bourriau 2010; Bourriau and Gallorini 2012.

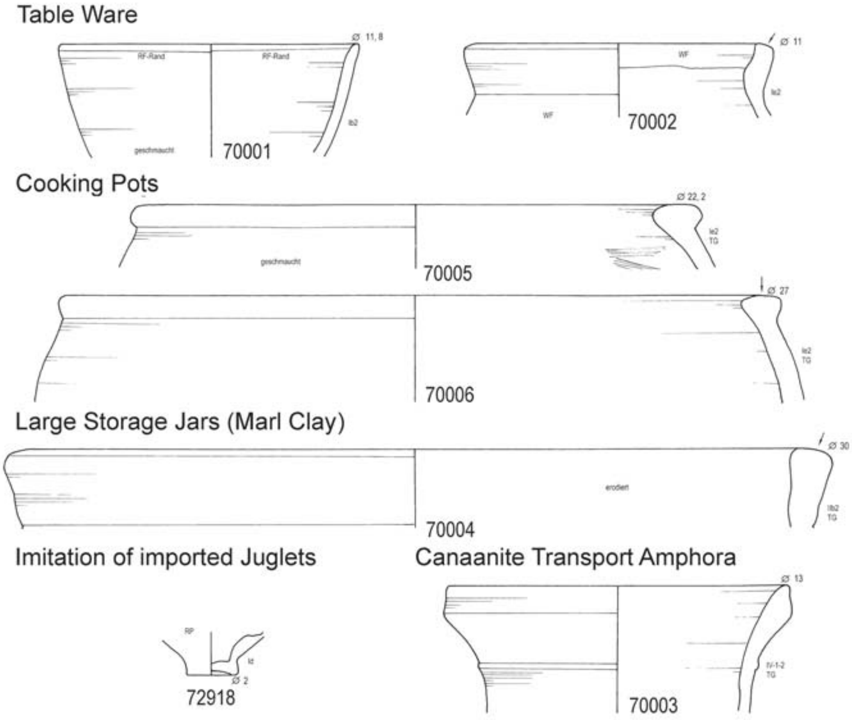

Fig. 1. Tell el-Dab^ca, area A/II, Context 446, scale 1:3.

complete vessel shape.[30] As it cannot be avoided, it has to be taken into account in the final analysis.

In Egyptian pottery studies, like in such analyses in other cultures, measurements are done by means of a (rim) diameter chart. Such a chart consists of concentric circles and its use is based on the idea that the rim (or base) is also forming a circle, when complete.[31] The measurement of the diameter enables the measurement of the preserved part of the vessel, because each of the circles is divided into segments, which provide a measuring device to determine the preserved size of the fragment. It looks similar to a pre-portioned cake.[32] These segments are created by dividing the diameter circles by means of a compass into 32 parts (any smaller is not really practicable) or by means of a protractor into 100 parts, marking every 5th in order to gain a percentage. Thus, each fragment measured is assigned a rim or base diameter and a percentage: for example: rim diameter 20.0 cm, 1/4 of rim preserved (or 25% preserved, can also be expressed as 0.25, see below). This data is collected very quickly and it will disclose the quantity of the pottery in the end, sorted by type, fabric, unit or any other criterion the analyst is interested in.

A problem that cannot be solved with quantification by *estimated vessel equivalents* is to provide a correlation between rims and/or bases and special body sherds (painted, imported, etc.). If no diagnostics of such special pottery are found a quantity cannot be estimated. In

[30] Cf. Bader 2010: fig. 8–10; Storage jar types 57d and e cannot be told apart by means of the rim only, cf. Bader 2001: 163–168.

[31] See note 21.

[32] Orton, Tyers and Vince 1993: fig. 13.2; Rice 1987: 222–224; see also Egloff 1973: fig. 1.

most cases this will reflect the overall situation – special pottery is exceptionally rare – but no numbers can be attached to this statement.

By means of a mathematical transformation[33] the estimated vessel equivalents can be transformed into numbers that have the same statistical properties as counts, which is an important aspect in using such data for further statistical analysis. Because the data obtained are not natural numbers, they would behave differently in the formulae used. There are several statistical analyses that can be conducted with this data including the determination if an assemblage is similar to another or not by purely mathematical means.[34]

For illustration of the principle of presenting the data, a conveniently small context of the late Middle Kingdom at Tell el-Dab^{c}a (phase G/3–1)[35] is shown here (Fig. 1) with the spread sheet of quantities of each pottery type found (Table 1–2).[36]

Sherd no	Fabric/Ware	Part	Diameter*	Pres. %	Type Group
70001	I.b.2.02	Rim	118	7	22a1
70002	I.e.2.D1	Rim	110	11	52b
70003	IV.1.2.01.00.00.25	Rim	134	23	800
70004	II.b.2.01	Rim	300	3	67c
70005	I.e.2.01	Rim	220	7	51b
70006	I.e.2.01	Rim	270	3	51c
72918	I.d.06.01	Base	19	100	100

Table 1. Raw data of Context 446, simplified with absolute frequencies, as measured (preserved percentage). * Rim or base diameter in millimetres.

In this example the focus is on the frequency of the vessel types, but consideration of other aspects such as fabric or ware may also be interesting in the analysis, depending on the research questions asked.

Table 2 exemplifies that it is not of vital importance in which way the frequency raw data is displayed. They mean the same in each case. For using a computer and computer programmes it seems best not to use fraction numbers, because they multiply the calculation work and are not easy to handle. Using the display mode of *eves* in percentages[37] was sometimes wrongly conceived as the percentage of a "real" relative proportion (see Table 3). Therefore it seems preferable to use the decimal number, but this suggestion is purely based on a desire for clarity.

Another remark seems necessary concerning the example above (Fig. 1): The frequency data of bases and rims cannot simply be summed up in a quantification study, but should be kept separate. Otherwise the quantities of types with bases will appear larger than they really are and double quantification occurs (see below, Table 3). It was proposed to use as measurement for 'one unit' not 360° of a full circle but 720° for full circles of base and rim in order to enlarge the data pool.[38] The assignation of rims and bases to the same type is only reasonable in well enough preserved vessels, but extremely difficult if there are only rim and

[33] Orton, Tyers and Vince 1993: 174. The EVES are transformed into PIEs (pottery information equivalent) and the technique is called 'PIE-slicing'. Collaboration with G. Puschnigg on a comparative study of this technique on settlement pottery from Middle Kingdom Egypt and Merv on the Silk Road promises interesting results. Note that the actual numbers in this transformation change, meaning that the transformation is not solely virtual.

[34] Orton, Tyers and Vince 1993: 173–175.

[35] It belongs to L307a in Area A/II, finely layered debris from an alleyway, which includes a number of other contexts. For demonstration's sake this small context was chosen.

[36] For larger contexts see Bader 2009: 76–78, 83–147.

[37] The data in this form was used for a while, because it seemed easier to calculate with natural numbers.

[38] Cf. Strack 2011: 48.

base sherds. In the Middle Kingdom several pottery types exist with the same base type (e.g. ring bases). Moreover, the crucial problem to recognise bases and rims deriving from the same vessel and, thus, being counted doubly, cannot be solved.

Types\Absolute Frequency	**Rim *eves* in natural numbers (%)**	**Rim *eves*, decimal numbers**	**Fractions**
Rims:			
Table ware: bowls, 22a1	7	0.07	1/16
Medium jars, 52b	11	0.11	1/8
Cooking pots, 51b and 51c	10	0.1	3/32
Storage Jars, 67c	3	0.03	1/32
Imported Transport Amphora, 800	23	0.23	7/32
Grand Total (= n)	54	0.54	17/32
Bases:	**Base *eves* in %**	**Base *eves***	**Fractions**
Imitation juglets, 100	100	1	1/1
Grand Total (= n)	100	1	1/1

Table 2. Summation of Types in Context 446.

Illustration of frequencies

One of the main uses of statistics in Egyptian pottery studies is to present frequency distributions of wares or types etc. in different units. Thus, it is crucial to present them as clearly as possible. Well readable and informative handbooks help to decide which data types (nominal, ordinal, interval or rational)[39] are best displayed in various charts and graphs.[40]

Utilising the example above, it is possible to display the table of observations/measurements (Table 1) in a better understandable form and convert the absolute "counts" or measurements into relative proportions (Table 3, two columns to the right). This enables the analyst and later user to compare frequencies of various contexts more easily, no matter if the contexts are large or small as the focus is on the proportion of the elements in the unit. But it is advisable to also show the absolute frequency in order to allow an insight into sample sizes.[41] A simple example explains the reason. If a context consists of three rim sherds of 0.20 *eves* each, and each belonging to a different type, each type amounts to a proportion of 33.33 %. The same can be said about a context with 90 rim sherds (n= 6.00 *eves*), three groups of 30 rim sherds (each at 2.00 *eves*) belonging to three different types. Thus, the proportion of one type is also 33.33 %. If in the first case only the relative proportions are considered without mentioning that there were altogether only three pieces, it remains unclear, that any conclusion based on this proportion should have less weight than the second example because it rests upon a very small sample size.

39 Fletcher and Lock 1994: 2–5; Shennan 1997: 8–12. Nominal data have no ordering or numeric value. The data represents categories with arbitrary "names" or codes. Ordinal data has an inherent ordering, but it contains no fixed distance between the categories. Interval data represents a sequence with fixed distances and ratio data contains fixed distances with a datum point, e.g. measurements of which kind ever.

40 Fletcher and Lock 1994: 14–30; Shennan 1997: 21–33 with additional bibliography.

41 Fletcher and Lock 1994: 14–16. Some studies state the sample size as "n=" Cf. Wegner, Smith, Rossell 2000: fig. 15. Unfortunately it is not clear, if the number of fragments constitute the sample size "n=" in this example, but probably so, because the thin walled vessels make the largest proportion in the figure.

Types\Frequency	Rim *eves*, decimal numbers (= Frequency)	Percent (only rims)	Percent (including base)
Table ware: bowls, 22a1	0.07	13 %	4.6 %
Medium jars, 52b	0.11	20.4 %	7.1 %
Cooking pots, 51b and 51c	0.1	18.5 %	6.5 %
Storage jars, 67c	0.03	5.6 %	2 %
Imported transport amphorae, 800	0.23	42.5 %	14.9 %
Grand Total (=n)	0.54	100 %	
	Base *eves*		
Imitation juglets, 100	1		64.9
Grand Total (=n)	1.54		100 %

Table 3. Proportions of pottery types in Context 446.

Table 3 exemplifies the reason given above for dividing the rim quantification from that of the bases, because bases of vessels are, at least in Egyptian pottery, either better preserved than the rims, thus dominating the picture or not very well recognisable (e.g. the round bases of cooking pots type 51b and c). In this case it is known that juglets, imitated or imported, do not occur as frequently in settlement layers as in tombs and therefore this type would seem to be overrepresented in the right hand column result, whilst cooking pot bases are totally missing, mainly because they are so hard to recognise.

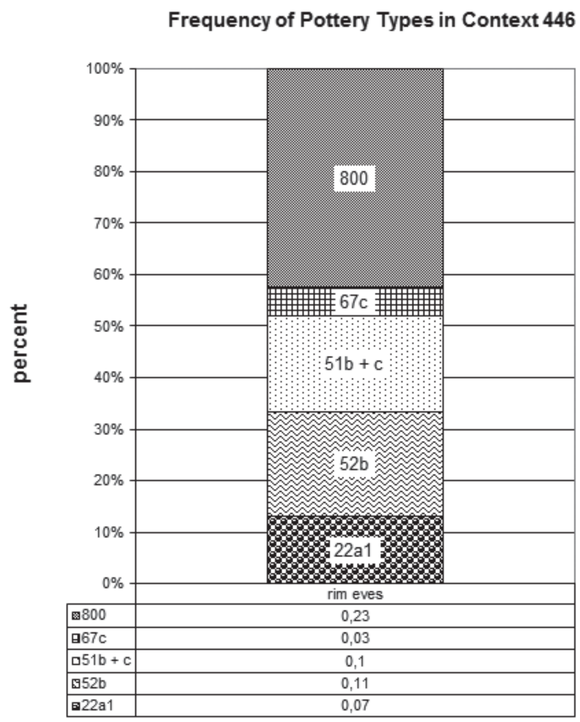

Fig. 2. A possibility for showing frequency distributions.

The possibilities for pictorial display of relative proportions in combination with the absolute frequencies (raw data) are facilitated by computer programmes. The example given in Fig. 2 just treats one attribute - the type.

Frequency distribution of a late Middle Kingdom house

The late Middle Kingdom settlement in area A/II at Tell el-Dab^ca of Phase G/3–1, may serve as an example for utilising frequency distributions of pottery types aiding in the functional interpretation of several rooms of a compound in the middle of the excavated area (Fig. 3).[42] This information is not used exclusively but in conjunction with the other find categories made in this house: e.g. stone tools, stone vessels, animal bones. Unfortunately the contexts cannot be discussed in detail here due to space restrictions.

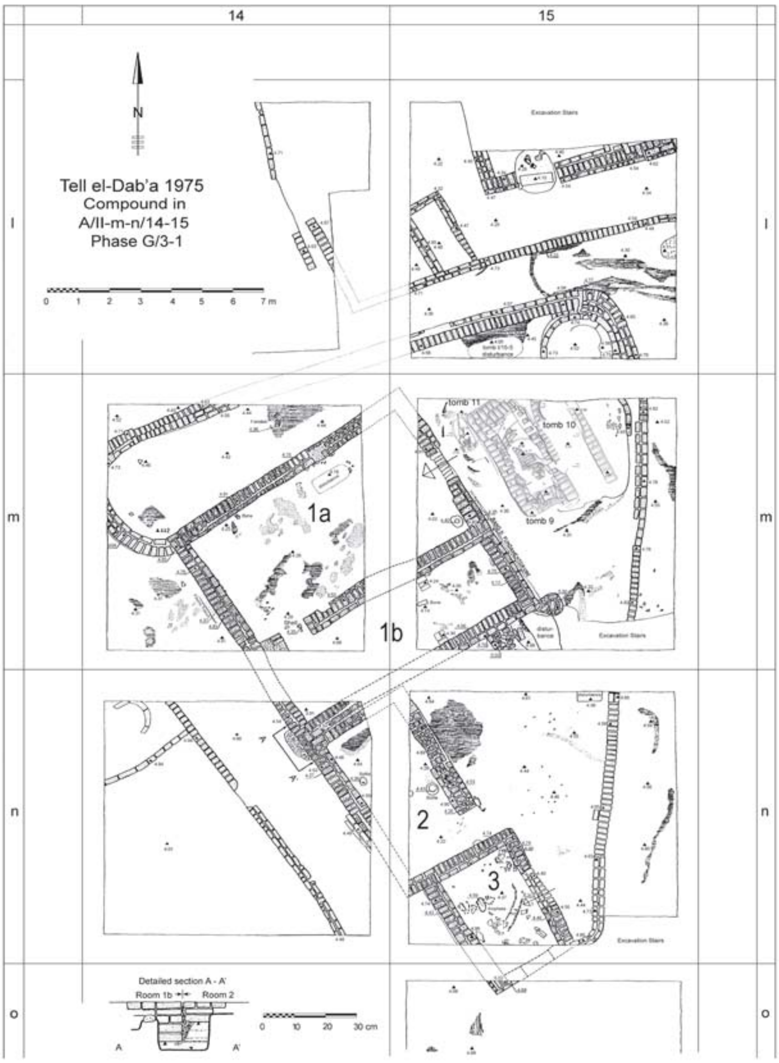

Fig. 3. Plan of Compound 1, after Bietak 1977, fig. 1.

[42] Work on this project was funded by the Elise Richter scholarship V147-G21 awarded by the Austrian Science Fund. Previous funding includes a Marie Curie Fellowship and an award of the Austrian National Bank. I would like to thank M. Bietak for entrusting me with this material.

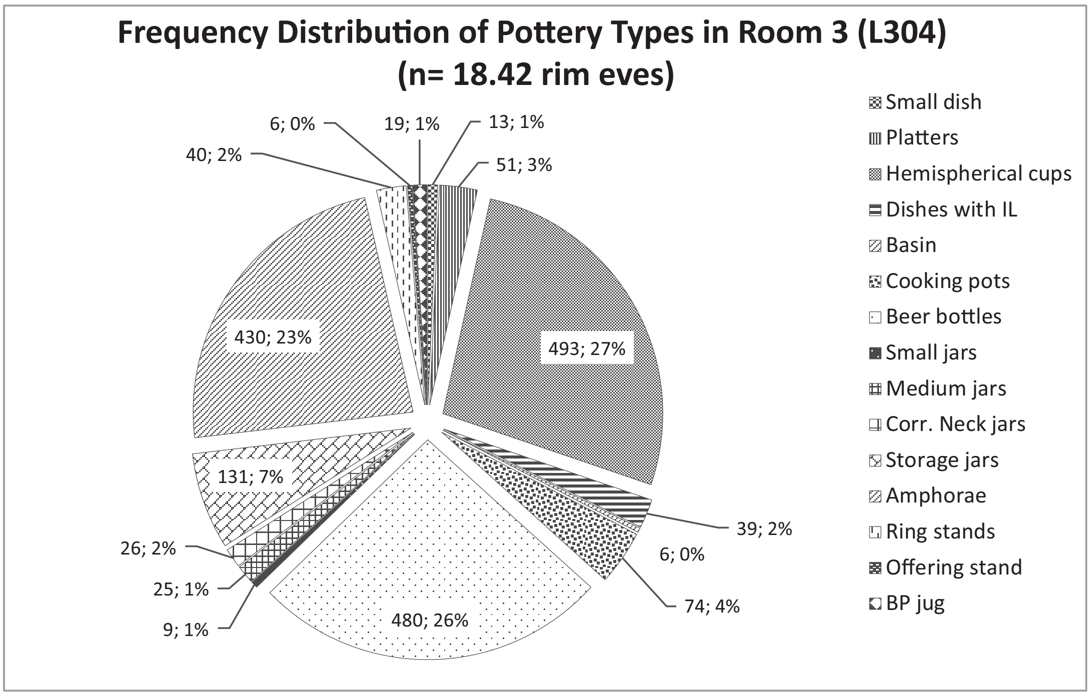

Fig. 4. Frequency distribution of pottery vessel types found on the floor of Room 3.

The settlement was excavated in the 1960s and 1970s by the Austrian Archaeological Institute under M. Bietak.[43] Due to the practice of those days the body sherds were discarded, after counting them according to fabric group. This gives at least a rough idea which pottery was originally present in each context, and even if it is not the method of choice, this information will be included in the final analysis of the settlement. During recording each fragment was given a unique number, a type, fabric, surface treatment etc., a diameter and the preserved portion of the rim (cf. Table 1).[44]

The compound is of roughly triangular shape, with alleyways running all around it (Fig. 3). The only securely identified entrance to the compound leads through the southern wall of Room 3, which was discovered when the baulk was removed. Other access routes may have existed, but remain unclear. Another entrance might be expected in the middle of the eastern boundary wall in the baulk.

Room 3 represents the southernmost room of Compound 1 and seems to be the latest addition to the building. On the floor of this room the largest *in situ* find assemblage in the G/3–1 phase of the settlement in area A/II was discovered. The grand total of rim *eves* amounts to 1842 or 18.42, which is much more than in any other context. Whilst it would be incorrect to state that in total some ‘18 and a half’ vessels were found, it allows to build up an empirical record of what to expect in a settlement. After collecting a range of similar data it may be possible to decide what signifies a ‘normal’ settlement context. Beside non-ceramic finds of quern stones, mortars, grinders, a flint tool (sickle blade), and a moderate amount of bones of cattle, pig, and sheep/goat, the pottery included a large variety of different vessel types (see Fig. 4 for the list, Fig. 8–9 for some examples). The frequency distribution of the

[43] Bietak 1977.

[44] Currently there are 68324 entries in the pottery database. The recording system used is closely related to that at Memphis designed by J. Bourriau, which was also used to compare the two sites, Cf. Bader 2009; Bourriau 2010.

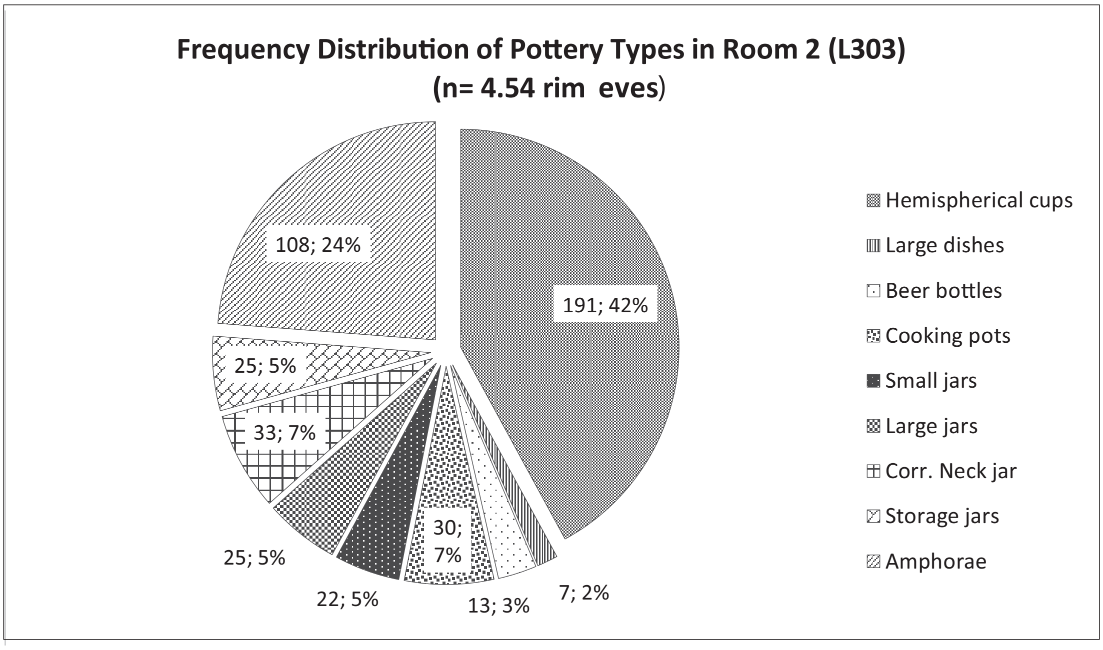

Fig. 5. Frequency distribution of pottery vessel types found on the floor of Room 2 (L303).

pottery calculated from the rim-*eve* values shows that about 33% of the vessels belong to open shapes, such as small dishes (Fig. 8.e), platters (Fig. 9.a–b), hemispherical cups (Fig. 8.a–c), dishes with inturned lip (Fig. 9.d) and possible basins (Fig. 9.c). Closed vessel types, represented by 'beer bottles' (Fig. 8.h), small (Fig. 8.d) and medium jars (Fig. 9.j) in Marl C, corrugated neck jars (Fig. 9.i) and storage jars of Marl C (Fig. 9.g) as well as amphorae (Fig. 9.h), are providing 60% of the assemblage. Minor groups consist of 4% of cooking pots (Fig. 9.e) and 3% of non-containers such as stands (Fig. 9.m) and offering stands. Some pottery types found in Room 3, namely two larger body fragments of ovoid jugs (Fig. 8.g) of Middle Bronze Age type and a very rare imported biconical jug with extravagant handle design and a very sharp carination (Fig. 8.i) remain outside this quantification, because only one rim fragment of a jug was found (Fig. 8.f). Whilst this may seem worrying at first, it should be stressed that such pottery does not disappear from the analysis, because quantification is used as an additional tool to gain as much information as possible. Special material needs to be analysed separately, e.g. in a presence/absence study. Thus, it becomes clear that such jugs are very rare and clear analytical numbers can be allocated as corroboration.

Room 2, to the north of Room 3 and slightly larger, shows a conspicuously different frequency distribution of pottery vessel types although quern stones, mortars and a fragment of a stone vessel were found. The animal bones included cattle, pig, sheep/goat, fish and wild boar. The assemblage, also found on the floor of the room *in situ*, shows a reduced variety of pottery types and clearly less *eves* (Fig. 5). Open vessel types provide 44% of the assemblage, whilst closed vessels amount to 49% with a clear majority of the imported amphorae (Fig. 9.h) and cooking pots 7% (Fig. 9.e).

The narrower part of the core building of Compound 1 was termed Room 1b (Fig. 3). The fragment of a rectangular siltstone palette was found here. In this room the variety of vessel types and the number of *eves* in the assemblage appears even more reduced (Fig. 6), which results from the fact that the mostly broken ceramic material came out of the floors of the room and, thus, represents remains of activity carried out in this space, but not the last use of the room, with the inventory left behind. Only five different pottery types were encoun-

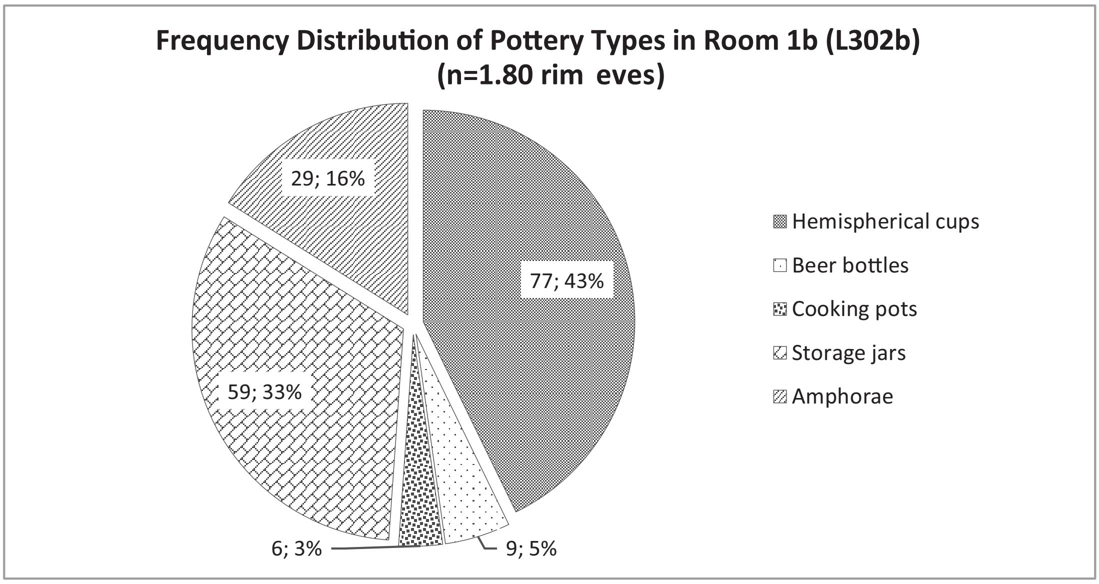

Fig. 6. Frequency distribution of pottery vessel types found in the floors of Room 1b (L302b).

tered, 43% of open shapes entirely represented by hemispherical cups (Fig. 8.a–c), 54% of closed vessel types for storage like 'beer bottles' (Fig. 8.h), storage jars of Marl C (Fig. 9.g) and imported transport amphorae (Fig. 9.h). Only 3% of cooking pots (Fig. 9.e) show that cooking did not play a major role in this area.

In contrast to Room 1b, the larger Room 1a, besides showing some sort of bench installation and two fire places, yielded a larger variety of pottery types although the constituents are very similar to before (Fig. 7). The ceramic material comes again from the floors of the room, signifying activity within it but not the last use of the room. This also explains the smaller size of the ceramic sample from Rooms 1a and 1b. The finds can be characterised as follows: 16% of open vessel types, 78% of closed vessel types and a small amount of restricted bowls (4%) and cooking pots (2%). Interestingly the cooking pots here are divided between Middle Bronze Age type[45] (Fig. 9.f) and Egyptian type (Fig. 9.e). No amphora rims were located, although numerous body sherds of such vessels were recorded originally. In addition an *astragalus*, a certain bone of sheep or goats used for gaming, was also found.

At last the frequency distribution of an ashy area to the east of Room 2 (Fig. 3) will be discussed (L305b), where only four different vessel types are represented: large dishes (11%; 0.6 *eves*), corrugated neck jars (25%; 0.13 *eves*) and amphorae (58%; 0.44 *eves*) and a straight sided and flat based Middle Bronze Age cooking pot[46] (6%; 0.3 *eves*) (cf. Fig. 9.f). The ashy deposit may be derived from dumping ash outside of Room 2 in the courtyard, due to the fact that such a small assemblage of pottery was found there (n=0.53 *eves*) without a significant amount of cooking pottery. The contexts discussed before contained mainly cooking pottery with round base and thickened rim, handmade with turned rim, a variety that has been ascribed to Egyptian derivation (cf. Fig. 9.e).[47] The other contexts of Compound 1 did not contain cooking pottery in larger quantities than up to 8%, thus, no strong evidence can be put forward to assume that cooking actually took place there. The ash deposits east of Room 2 might

[45] Unfortunately, the piece could not be located and thus it remains unclear whether an import to the site or a local imitation was present. The type is straight sided and flat based. Cf. Bader 2009: fig. 234.105a for the type.

[46] Cf. Bader 2009: fig. 234.105a for the type. Unfortunately it must remain unclear whether this specimen represents a real import or a local imitation, because the original fragment was not located.

[47] Cf. discussion in Bader 2009: 403–409.

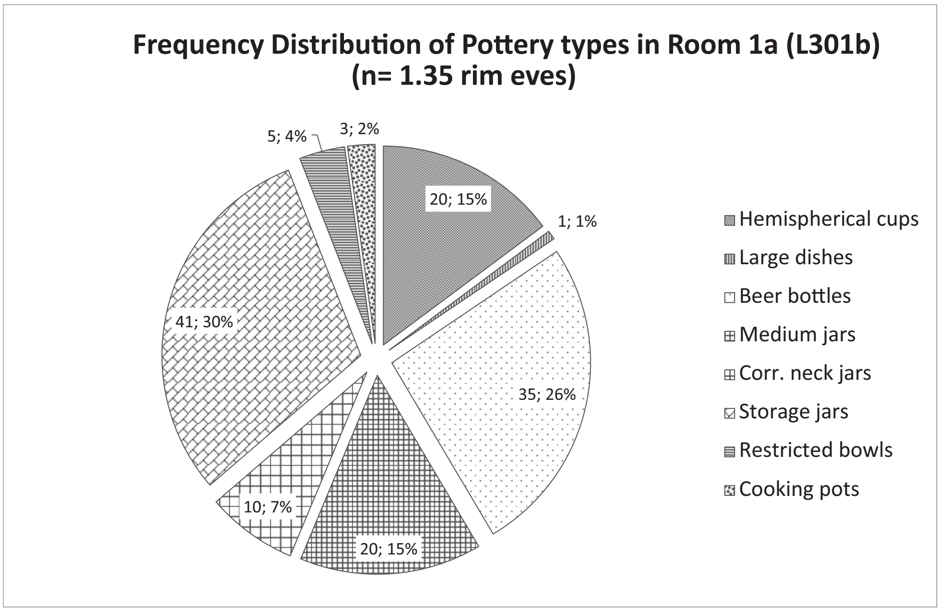

Fig. 7. Frequency distribution of pottery vessel types found in the floors of Room 1a (L301b).

therefore derive from fire places, such as that in the south east and north east corner of Room 1a and in the south west corner of Room 3.[48] As explanation it may be suggested that the cooking activities took place elsewhere, perhaps even in a centralised place. Further, frequency distribution of the small amount of cooking pottery demonstrated that most of it seemingly belongs to the Egyptian tradition with a minor proportion of Levantine cooking pottery tradition. If the quantitative information had not been provided, it would be very easy to over-interpret the occurrence of Levantine type cooking pots within this compound.

A preliminary interpretation of functional areas in Compound 1 may be summarised as follows. The southernmost Room 3 (L304) shows a clear majority of various closed vessel types and in conjunction with the other finds of a sickle blade, querns, mortars and rubbing stones it is most likely to represent a storage area, although the function of the fire place in the south west corner appears to suggest a more varied functional range. Noteworthy are the uniquely high number of rim *eves* and the wide variety of different vessel types. Room 2 (L303) also contained a similar assemblage of finds as Room 3, but the proportion of open and closed vessel shapes are about equal. Unless the table ware (exclusively open, hemispherical cups) was also stored in Room 2, a multipurpose area may be expected. The core of Compound 1, Rooms 1a and 1b, also shows no clear preference for any one type although in Room 1b the variability of types is restricted to five. This may mean that Room 1b was used for several purposes including consumption of goods but also a certain amount of storage, perhaps short term. Room 1a contained remarkably little pottery for consumption of food and a higher variability of types (nine different ones), including medium jars and restricted bowls. The lower number of rim-eves and the relatively balanced proportion of pottery types may be connected to the fact that they were trodden into the finely layered floor sequence of Room 1a and 1b contrasting Rooms 2 and 3. The ashy deposit east of Room 2 seems to represent a waste disposal area from fire places (Rooms 1a, 3), rather than a feature connected to cooking/food preparation, because of the small amount of pottery found there, and the even

48 Found in the baulk at a later stage.

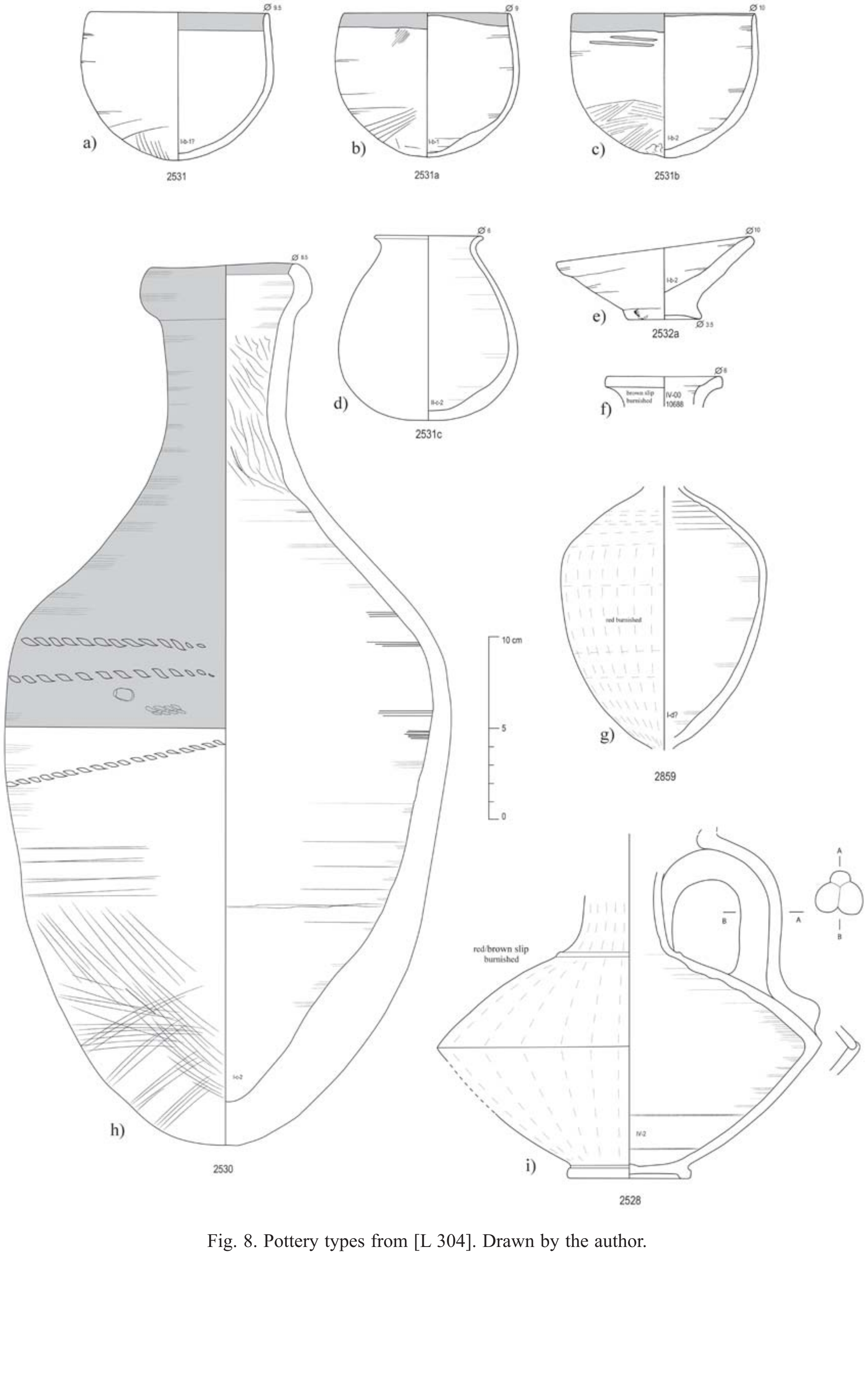

Fig. 8. Pottery types from [L 304]. Drawn by the author.

smaller amount of definitive cooking pottery. Of course, a regular cleaning regime might be the reason for that. Future analysis will have to clarify this point. The contemporary tomb group in the courtyard belongs to this compound as an integral part.[49] Finally the round silo in the north of the compound did not yield pottery, but this feature most probably represents a local storage facility for staple foods.

Summary

Quantification of pottery helps to interpret the archaeological record and hopefully this article will act as an incentive to provide more and more varied case studies on this topic in order to produce, over time, a comparative corpus of frequency distributions especially in settlement areas, which then could be used as a gauge. Hitherto it remains unknown what represents a 'normal' frequency distribution at any one period in settlements and interpretations are frequently restricted to stating the obvious.

It is clear that all methods presented above have their shortcomings, and even the theoretically soundest concept, namely the quantification by means of *estimated vessel equivalents*, has its limitations, e.g. in the quantitative integration of important body sherds.[50] It is in theory possible to record the body sherds as vessel equivalents but whether the effort expenditure is justified by the results must remain an open question at this point. Also the integration of the quantification of rims and bases poses problems. It is important though, that quantitative aspects of pottery must not be neglected although it may easily be the most time consuming task in the analysis. The recording of frequency data, as *eves*, however, only takes a split second longer in the recording process by means of a segmented diameter chart, whilst to retrieve such data later is much more elaborate and time consuming. It must be made clear that quantification cannot replace other methods of pottery analysis[51] but will give valuable additional information for tapping pottery as a primary source.

Catalogue of selected pottery vessels

Fig. 8.a) Reg.no 2531 (MC), hemispherical cup. [L304].[52]

TG	I-b-1?	f.	W1	Bd. gesp.g.	ox	2–3

Rd.= 9.5–10.2 (rim 0.90 *eves* preserved); max.D.= 10.0–10.6; wd.= 0.4; H1= 8.2; (Base 1.0 *eves* preserved) VI 129.3. Surface colour: 2,5 YR 5/4 reddish brown; Section: dark grey core with thin oxidation zones; Red slipped rim band inside, ca. 1 cm wide; Fabric finely levigated, dense and hard.

Fig. 8.b) Reg.no 2531a, hemispherical cup. [L304].

TG	I-b-1	f.	W1	Bd. gesp.g.	ox	2–3

Rd.= 9.0 (rim 0.31 *eves* preserved), max.D.= 10.0; wd.= 0.3–0.6; H1= 7.9; (base 1.0 *eves* preserved); VI 126.9. Surface colour: 2,5 YR 6/4 light reddish brown; Red rim band and burnished horizontally; Section: thin violet core with oxidation zones.

[49] Bader 2011; Forstner-Müller 2008.

[50] Cf. Strack 2011: 51–52.

[51] Here the combination of quantification of pottery with random sampling can only be mentioned in passing. Cf. Bader 2009: 64–74; Bourriau 2010: 7–8.

[52] Format and description of pottery after Bietak 1991: 317–333.

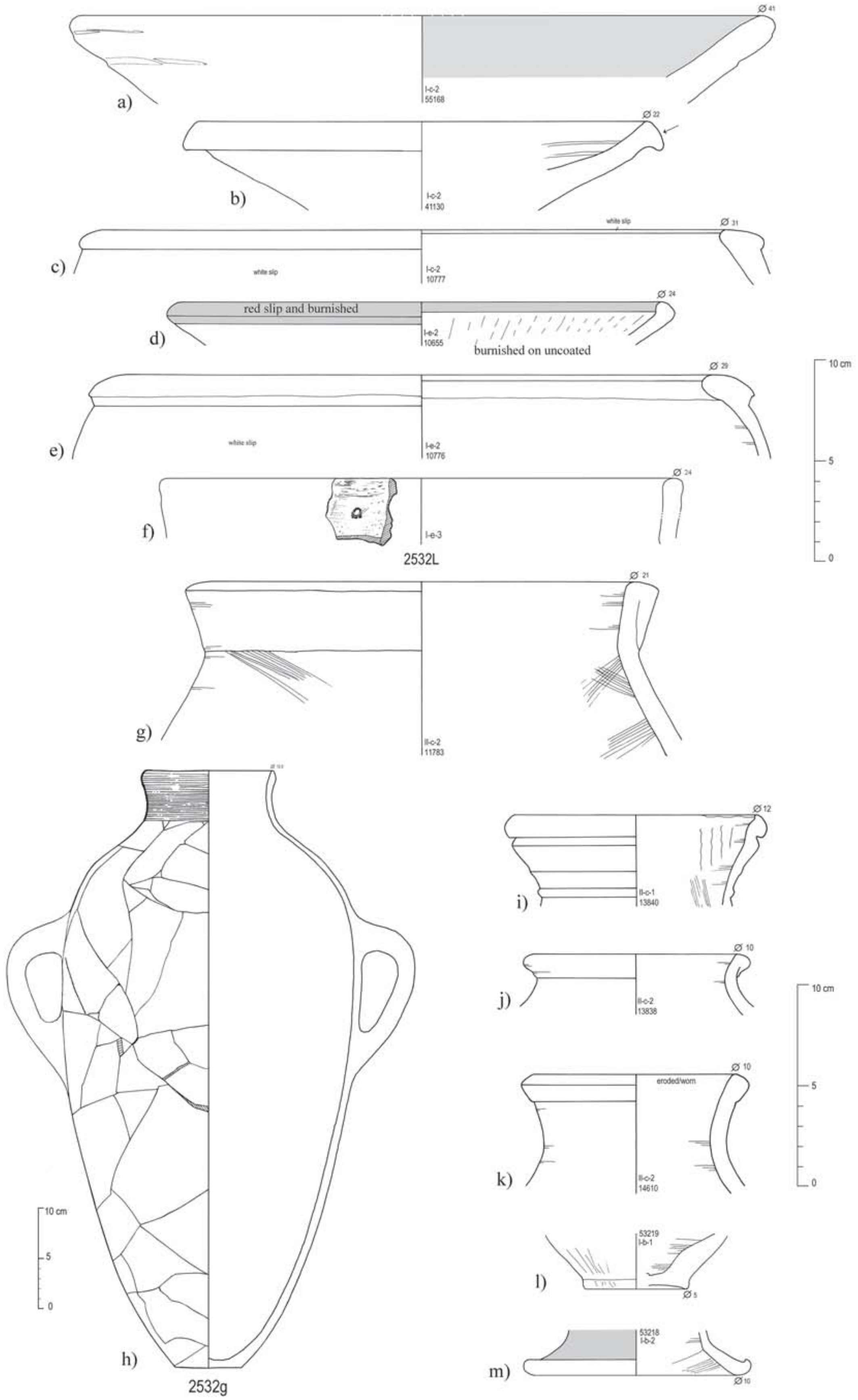

Fig. 9. Pottery types from [L 304], [L304aa], [L303] and [L301b]. Drawn by the author.

Fig. 8.c) Reg.no 2531b, hemispherical cup. [L304].

TG	I-b-2	f.	W1	Bd. gesp.g.	ox	2–3

Rd.= 10.0 (rim 0.26 *eves* preserved), max.D.= 10.2; wd.= 0.4; H1= 8.0; (base 1.0 *eves* preserved), VI 127.5. Surface colour: 2,5 YR 5/4 reddish brown; Red slipped rim band: outside 1.0 cm wide, inside 0.2 cm wide; Section: red core with reddish brown oxidation zones.

Fig. 8.d) Reg.no 2531c, small jar. [L304].

TG	II-c-2	m.	W1	Bd. abg.g.	ox	2–3

Rd.= 6.0, (rim 0.09 *eves* preserved); nd.= 5.2; max.D.= 9.8; wd.= 0.4-0.5; H1= 10.2; (base 1.0 *eves* preserved). Surface colour: 10 YR 8/3–4 very pale brown; Section: uniform pale red. The surface is covered in a thick scum.[53]

Fig. 8.e) Reg.no 2532a, small flat based dish. [L304].

TG	I-b-2	f.-m.	W1	Bd. abg.g.	ox	2–3

Rd.= 10.0, (rim 0.13 *eves* preserved), max.D.= 11.0; bd.= 3.8, (base 1.0 *eves* preserved), H1= 3.2–4.6. Surface colour: 5 YR 6/4 light reddish brown; Section: dark grey core, red and brown oxidation zones. Vessel extremely warped. Base cut off with string and subsequently scraped with a tool.

Fig. 8.f) Reg.no 2530c6, rim of jug/juglet (sherd no. 10688). [L304].

BP	IV-0		W1-2	0	mi-re	3–4

Rd.= 6.0; (0.19 *eves* of rim preserved); H1= 1.7+x. Brown slip and vertical burnishing outside, BP: 5 YR 6/3 light reddish brown; Section: uniform dark brown.

Fig. 8.g) Reg.no 2859 (AS 4252[54]), body of ovoid juglet. [L304].

RP	IV-2?	f.–m.	W2	0	mi	3

Nd.= 2.2; max.D.= 11.3; wd.= 0.5; H1= 14.4+x. Surface colour: red slip and burnished 7,5 R 4/6 red; Section: grey inside beige outside zone. Vertical and horizontal burnishing, but not well preserved. White encrustations inside, unclear if content or depositional. Abundant small quartz particles in sand size. Unclear if I-d[55] or IV-2. The neutron activation analysis result suggested Nile alluvium, JH 330.[56]

Fig. 8.h) Reg.no 2530 (AS 4055), beer jar. [L304].

RF	I-c-2	m.-r.	W1	Bd.gesp.g.	ox	2–3

Rd.= 8.5 (1.0 *eves* of rim preserved); nd.= 7.5; max.D.= 27.5; Base 1.0 *eves* preserved; wd.= 0.85-1.0; H1= 54.8. Surface colour: uncoated 2,5 YR 6/6 light red; red slip (on upper body of vessel) 10 R 5/6 red; Section: dark grey core inside with light red oxidation zone outside. Neck turned out of the body. Base coiled and turned on wheel afterwards, and scraped. Bottle was made at least in three parts; three rope lines are visible that held the base of the bottle together. Lots of quartz in sand size noticeable in the fabric.

[53] Cf. Ownby and Griffiths 2010.

[54] This and the other vessels with AS numbers are housed in the Kunsthistorisches Museum, Vienna. I would like to take the opportunity to thank R. Hölzl and M. Hüttner for enabling and facilitating the drawing and study of this pottery even under difficult circumstances in 2011.

[55] The original fabric classification made was I-d, which is equated with Nile D in the Vienna System, cf. Bietak 1991: 324, 326.

[56] Cf. McGovern 2000: 130, there wrongly assigned to a burial.

Fig. 8.i) Reg.no 2528[57] (AS 4054), red/brown polished biconical jug without rim. [L304].

B/RP	IV	m.	W2	Bd. W	ox	3	3RST

Nd.= 4.2; bd.= 5.6 (1.0 *eves* of base preserved); max.D = 21.0; wd.= 0.5; H1= 18.8+x. Surface colour: Red/brown polish outside 10R 4/8 red; uncoated inside: 5 YR 6/6 reddish yellow; uncoated outside: 7,5 YR 7/6 reddish yellow; in places brown polished 7,5 YR 6/6 reddish yellow; Irregular burnishing on the underside of the base; Section: reddish yellow oxidation zones beige core; the fabric looks different in places with thinner walls. Large limestone inclusions, fossils of foraminifera, quartz. The handle has three strands and is attached to the exterior of the jug as application. The lower part of the topmost strand ends a short way above the body of the vessel. At the top of the vessel the topmost strand also ends before reaching the neck of the vessel. It is possible some figurative decoration was intended. The surface of the vessel is very badly preserved. The burnishing traces go vertical in most places even on the shoulder of the vessel. The carination is exceedingly sharp and in some places the technology is visible (cf. detail in the drawing). Neutron activation analysis for sample BNL 372, resulted in an origin from southern Palestine.[58]

Fig. 9.a) Sherd (convolute) 1951/55168, top part of large dish. [L303].

TGRF	I-c-2	m.-r	W1	-	ox	

Rd.= 41.0 (0.07 *eves* of rim preserved); H1= 4.4+x.
String impression on exterior.

Fig. 9.b) Sherd (convolute) 1128/41130, rim of medium dish with folded rim. [L304].

TG	I-c-2	m.-r	W1	-	ox	

Rd.= 22.0 (0.13 *eves* of rim preserved); H1= 4.5+x.
Edge of rim was trimmed with a tool.

Fig. 9.c) Sherd (convolute) 480/10777, rim of restricted bowl. [L304].

WFTG	I-c-2	m.-r	W1	-	ox	

Rd.= 31.0 (0.06 *eves* of rim preserved); H1= 2.7+x.
White slip on the exterior of the vessel and the inside of the rim. The rim of the vessel was turned over onto itself and wheel turned. The top of the rim was trimmed with a tool.

Fig. 9.d) Sherd (convolute) 470/10655, rim of dish with inner lip. [L304].

TG	I-e-2	m.	W1	-	mi	

Rd.= 24.0 (0.06 *eves* of rim preserved); H1= 2.2+x.
Red rim band on exterior and interior of vessel, burnished horizontally on the rim and vertically on interior.

Fig. 9.e) Sherd (convolute) 480/10776, rim of restricted bowl with folded rim. [L304].

WFTG	I-e-2	m.	W1	-	mi	

Rd.= 29.0 (0.13 *eves* of rim preserved); H1= 4.2+x.

57 Also illustrated with an old drawing in Aston 2002: 80–81, fig. 14.5; Aston 2004: cat.no 349; vol. 1, 124; vol. 2, pl. 107 and Kopetzky 2012: 105 and fig. 6.47. It should be noted that the fabric description of Aston 2004 in the plates volume (as Nile D) is clearly a printing error, as is obvious from the catalogue entry and Aston 2002 where the piece is unequivocally identified as Levantine import (IV-2-b).

58 McGovern 2010: 133. His results lost credence in general through a second study based on petrography. Cf. Cohen-Weinberger and Goren 2004: 69–100.

Fig. 9.f) Reg. no 2532L, rim of straightsided cooking pot. [L301b].

TG	I-e-3 ?	-	Ha1	-	-	2–3

Rd. = 24.0 (0.03 *eves* of rim preserved); H1= 3.3+x. Surface colour: 10 R 6/6 light red. Section: dark grey wide core. Rim trimmed on top; slight groove on outside just underneath the rim. Pre-firing hole.

Fig. 9.g) Sherd (convolute) 518A/11783, rim of large storage jar. [L304].

TG	II-c-2	m.	Ha2	-	ox	

Rd.= 21.0 (0.10 *eves* of rim preserved); H1= 8.6+x.

Fig. 9.h) Reg.no 2532g, amphora. [L304].

TG	IV	m.	W1	Bd. H, M	ox	3

Rd.= 12.3, (1.0 *eves* of rim preserved); nd.= 12.5; max.D.= 29.4; wd.= 0.8; bd.= 7.0 (1.0 eves of base preserved); H1= 58.5. Surface colour: 2,5 YR 6/6 light red. Section: light grey core with light reddish brown oxidation zone on the outside. Surface probably combed at least partly. Neutron activation analysis sample number JH 022 resulted in an origin from Southern Palestine.[59]

Fig. 9.i) Sherd (convolute) 556/13840, rim of corrugated neck jar. [L303].

TG	II-c-1	m.	Ha2	-	ox	

Rd.= 12.0 (0.13 *eves* of rim preserved); H1= 4.6+x.

Fig. 9.j) Sherd (convolute) 556/13838, rim of closed vessel. [L303].

TG	II-c-2	m.	Ha2	-	ox	

Rd.= 10.0 (0.22 *eves* of rim preserved); H1= 3.1+x.

Fig. 9.k) Sherd (convolute) 575/14610, rim of closed vessel or stand. [L303].

TG	II-c-2	m.	W1	-	ox	

Rd.= 10.0 (0.25 *eves* of rim preserved); H1= 6.1+x.

Fig. 9.l) Sherd (convolute) 1240/53219, base of open vessel, [L304aa].

TG	I-b-1	f.-m.		Bd. H	ox	

Bd.= 5.0 (0.40 *eves* of base preserved); H1= 2.8+x.
The actual ring was created by pinching with fingers.

Fig. 9.m) Sherd (convolute) 1240/53218, base of a ring stand. [L304aa].

RFTG	I-b-2	m.		Bd. W1	ox	

Bd.= 10.0 (0.19 *eves* of base preserved); H1= 2.3+x.
Fabric contains more sand than usual. Inside of base scraped with a tool.

Abbreviations:
Bd.=Base diameter, H1=Height of vessel; max.D.=maximum Diameter; Nd.=Neck diameter; Rd.=Rim diameter; Wd.=wall thickness

[59] McGovern 2000: 116, cf. note 58.

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