

A SELDOM USED PARAMETER IN POTTERY STUDIES: THE CAPACITY OF POTTERY VESSELS

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The state of the art in the field of pottery studies has nowadays reached an unprecedented degree of sophistication. Not only can the slightest typological/chronological variation be tracked down through a host of statistical procedures, but most details of manufacture, provenience and distribution come under close scrutiny through physical, chemical or petrographical analysis. It seems that the modern archaeologist is now able to acquire and publish any kind of information about her or his pots – except, in most cases, the quantity of goods, whatever they may have been, which these pots were intended to process, store or carry in Antiquity.

This parameter – the capacity of a pottery vessel – is however of paramount importance to understand its function, as much as peculiarities in shape (flat or rounded bottom, wide or restricted opening, presence or absence of handles etc.). For individual items, it will in most cases allow to decide between collective or individual use, short or long-term storage, the possibility of easily moving or carrying them when full for commercial purposes. In the case of full sets or assemblages of pottery, it is probably the safest test for specialization of pottery production and procedures of control over storage or long-distance trade.

Such observations do not reach very far beyond common sense and many scholars have also stressed the potential of the capacity of pottery vessels as a measure of the social and economic characteristics and even of demographic trends in the populations which produce and use them, as was conveniently summarized in a recent article by R.T. SCHAUB (1996, with relevant references), which awakened an old interest of mine for this topic. More generally, considering the wealth of informations which they

are liable to provide, it is most surprising that functional typologies are so seldom used (SCHAUB 1996: 231–235).

CALCULATING THE CAPACITY OF POTTERY VESSELS

I have found in recent literature very few studies concerned with such problems. In addition to the pottery studies from Bab edh-Dhra (SCHAUB 1987: 249; 1996), the most systematic one is probably the study by M. ROAF (1989) of the Ubaid “burnt house” at Tell Madhhur in the Hamrin. A full domestic assemblage was retrieved, and all vessels have been plotted on a plan of the house according to type and capacity (ROAF 1989: 121); but, surprisingly enough, few conclusions seem to have been derived therefrom. S. MAZZONI (1994) has measured drinking vessels from Ebla and A. MAEIR has plotted the capacities of juglets, jugs and bowls from tomb 1181 at Hazor on graphs which show some trends towards standardization of the first two types, but none for the latter (MAEIR 1997: 315–317 and note 80 for references to some other studies of palestinian material).

The reasons for this general lack of interest are easy to understand:

- Although not a rarity, whole or wholly reconstructed vessels, and especially large size jars, are far less common than sherds, and one must have a fair quantity of them in order to statistically assess *e.g.* trends towards standardization.

- Calculating the capacity of a pot from a section drawing is an operation simple in its principle, but which requires tedious measurements and calculations.

Different methods have been suggested (fig. 1) by approximating the general shape by means of elementary volumes such as spheres, cones, cylinders

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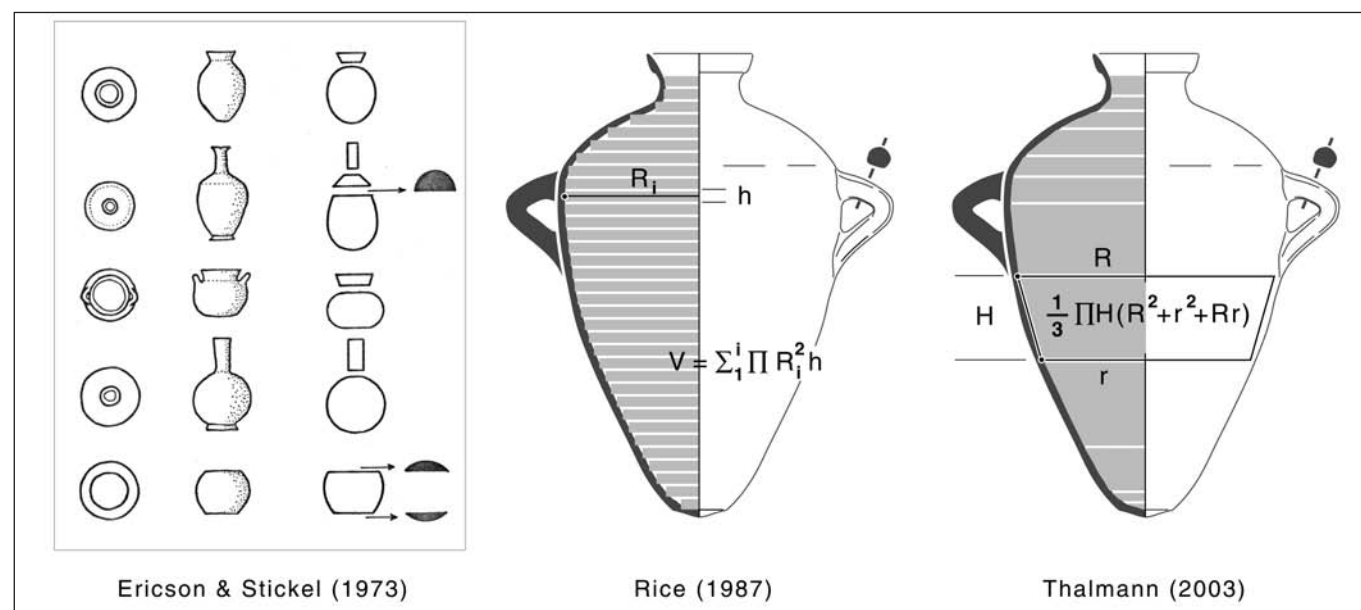


Fig. 1 Different methods for calculating the capacity of pottery vessels

etc. (ERICSON & STICKEL 1973) or of an array of small cylinders (RICE 1987: 220–222). But the former method is applicable only to very simple shapes. Moreover, it should be stressed that general approximations are not enough: volumes are a cubic function of size so that slight variations in diameter or the “flattening” of what would be taken for a more or less spherical body may result in wide differences of capacity. If we consider an “ideal” pot with a perfectly spherical body of, say 40 cm in diameter, it has a capacity of 33.5 litres; the same pot with a diameter of 50 cm will hold 65.5 litres, just twice as much! It is obvious that estimating capacity classes on the basis of similar sizes or proportions may result in wide-ranging errors: accurate measurements are absolutely needed.

The approximation of the shape by means of small cylinders is probably accurate enough only with a very large number of them, which anyway require too many measurements. It is much easier, quicker and more accurate to sub-divide the volume of the pot in a series of truncated cones (Fig. 1). The calculations for the volume of the truncated cones are not so straightforward, but, in the age of computers, this should not be a problem. I used at first an Excel chart, then designed a small standalone computer utility which requires only a few clicks to get the result (Fig. 2); it is freely available to all colleagues, for Mac and PC computers, on request at my e-mail address jp.thalmann@wanadoo.fr.

Even when computerized, the procedure is not so quick, and investigating the capacities and possible

standardization of *e.g.* MB and LB commercial jars from available publications will take time. Moreover, most published drawings of large vessels are at a much reduced scale, and usually provided with a much too small *graphic scale*: it is common for large jars to be published with a scale of 10 cm only, when the graphic scale on a plate of pottery should be at least the size of the largest pot represented, in order to allow for direct measurements. Unavoidable approximations in re-scaling such improperly published drawings may result in the kind of errors outlined above. For these reasons, I shall present here only a few preliminary results (*cf.* also THALMANN 2003) obtained using excellent drawings from Tell Arqa (Lebanon) and Tell ed-

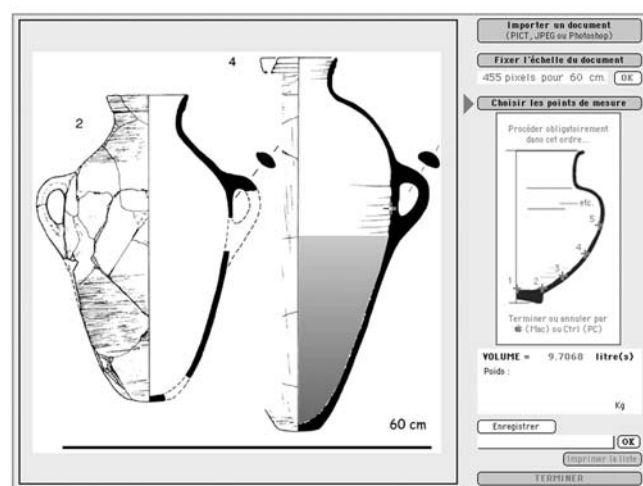


Fig 2 Measuring jars from Tell ed-Dab'ea on the computer

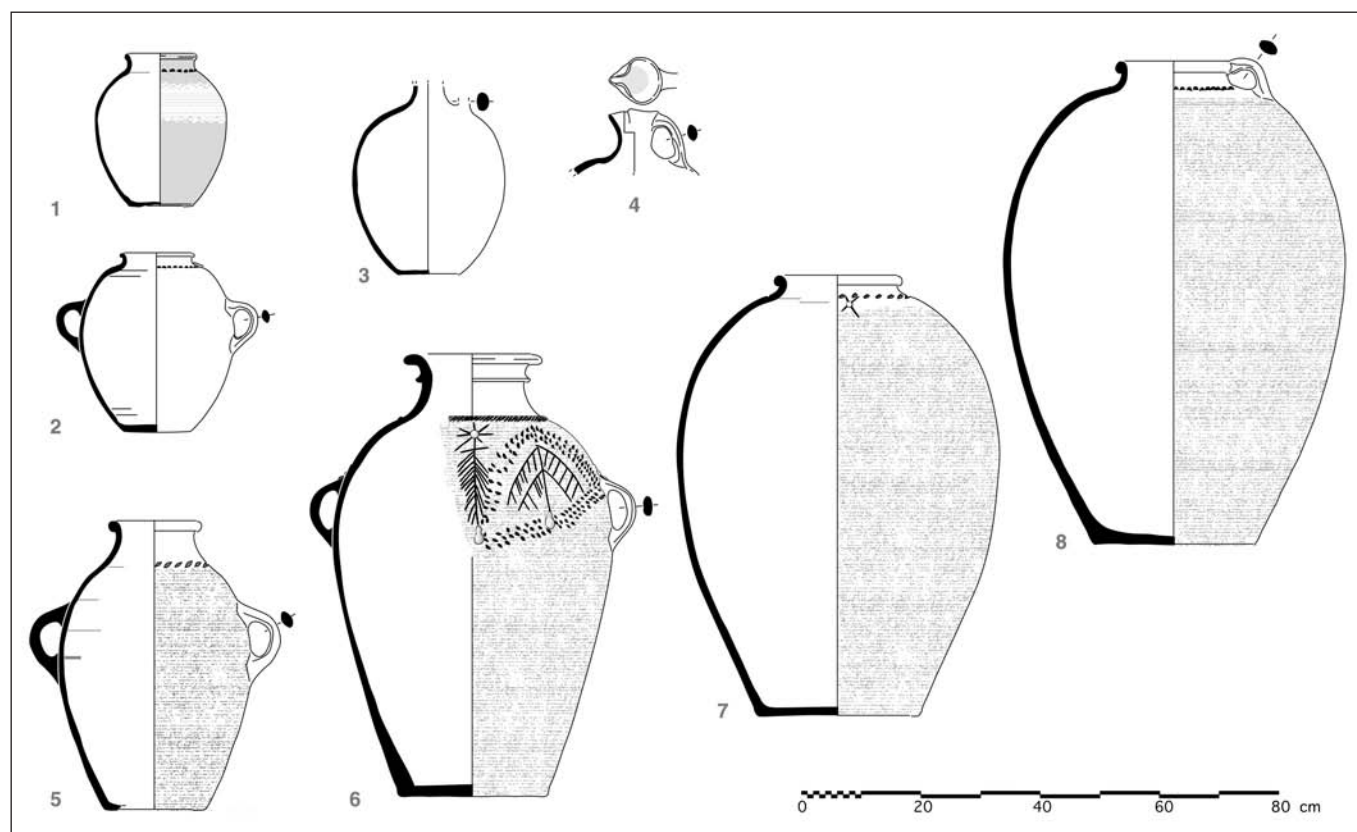


Fig. 3 Jars from Arqa Phase P (EB IV)

Dab^a, in order to illustrate the potential of vessel capacity in pottery studies.

SOME OBSERVATIONS ON STORAGE AND COMMERCIAL CONTAINERS

The excavation of Tell Arqa (North Lebanon), under the direction of the author (THALMANN 2000; 2002; forthcoming), has produced a large number of complete or wholly reconstructible pots, mainly from late EB IV (Phase P) to MB I (Phase N) *i.e.* from ca. 2200 to 1800 BC, which provide a sound preliminary basis for further capacity studies. They range from small-sized “domestic” jars to medium-sized jars probably intended for short-term storage and transport (most types have a version without and a version with handles), and finally to very large storage vessels (Fig. 3, 5). When sorted out by capacity, they fall into groups which correspond only loosely with the main types designed on the basis of general shape and proportions, but can be interpreted in functional terms and show an evolution in the production and use of such vessels from one period to the next.

Jars from Arqa Phase P

The capacity diagram (Fig. 4) shows five distinct groups, probably related mainly to functional specialization. The distribution of jars with (black and

grey dots) and without handles (white dots) is especially remarkable.

Group 3 is comprised of jars with handles only, and capacities ranging from 20 to 25, exceptionally 30 litres (Fig. 3: 5). Such jars weighing about 30 kilos when full would probably not be difficult to carry, although the position of the handles or the large flat bases are not well suited for this use. The vertical handles are attached low on the body, *i.e.* close to the center of gravity of the vessel, as is usual in the Levant during the EB (AMIRAN 1969: 59, 63, 66, 67) and still at the beginning of the MB period (AMIRAN 1969: 104; ASTON 2002: figs. 1–4). This makes it easy to move the jar or to tilt it for pouring when it rests on the ground, but does not insure verticality when carrying it by hand. Such jars would therefore be better considered as short-term storage vessels, which for this reason had to be frequently displaced within the dwelling area, rather than as transport or “commercial” containers.

In a significant manner, during MB and LB, handles will be attached higher and higher on the shoulder, well above the center of gravity, and pointed or stump bases will replace the flat ones. Capacities are then frequently more important; the jars can be carried in a vertical position by two men or handled for pouring, using one handle and the stump base, by

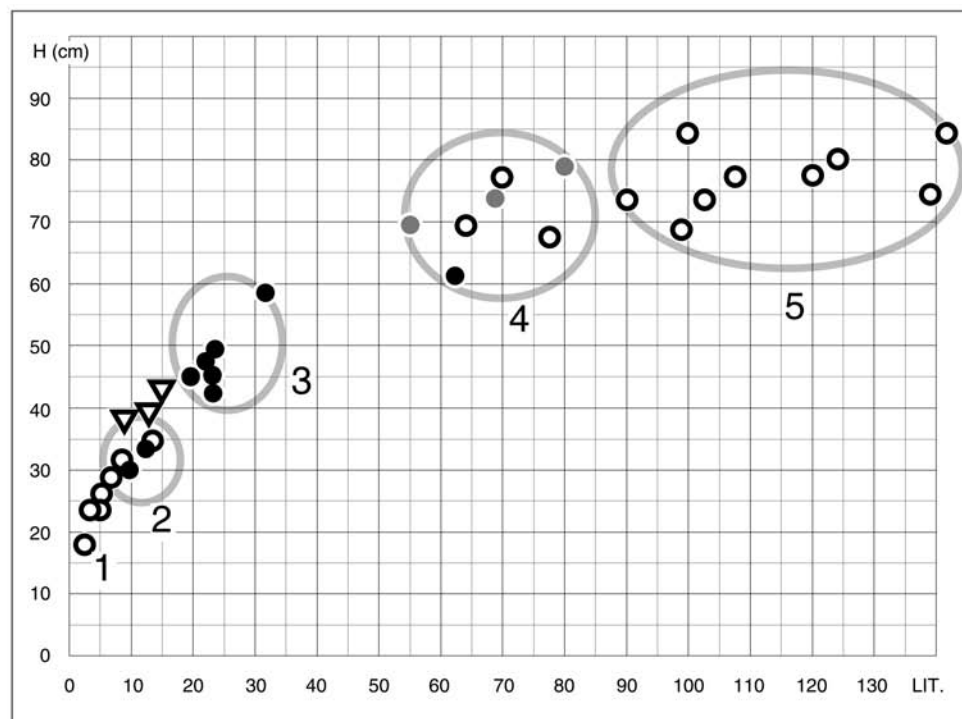


Fig. 4 Capacity diagram for Phase P

one. One of the earliest examples of this morphological adaptation of jar handles to the logics of transport, and especially of maritime trade, is to be found in the group of jars from the Royal Tombs at Byblos (TUFNELL 1969: fig. 6); their average capacity is 40 to 45 litres, nearly twice as much as the jars of Arqa group 3.

Groups 4 and 5, with capacities ranging respectively from 55 to 75 and 90 to 120 litres, are clearly distinct, although the sheer consideration of general size and proportions, as noted above, would not allow to set them apart. Because of their weight, all such jars (Fig. 3: 6–8) must be non-movable storage vessels, and indeed most of them were found filled with cereals in both destruction layers of Phase P. The two groups may correspond to the storage of different kinds of products (liquid/solid) or to different conditions (middle-range or long-term storage).

Surprisingly, handles are occasionally found on jars from these groups. A few jars of group 5, all above 100 litres, have a small loop handle from the top of the shoulder to the rim (Fig. 3: 8): while unpractical to tilt such large vessels for pouring, the handle would be well suited to attach with a rope a wooden stopper for instance, if the jars had to be frequently opened and closed. For this reason, they could be interpreted as water containers – the type is rare, and one or two such jars only were necessary in each house.

Some jars of group 4 (grey dots) have vertical

handles, similar in position and shape to those of group 3 jars (Fig. 3: 6): for reasons given above, they were certainly very ill-suited for carrying the jars when full. The group is very homogeneous, characterized by the profiling of the rim, but above all by the incised and impressed decoration on the upper part of the body (Fig. 3: 6). They are found at Arqa from level 16B to level 15A, a period of about two centuries. With the exception of a few fragments from sites close to Arqa and a unique fragment from Byblos (*BYBLOS II*: 16572), I know of no parallels to this type of decoration and consider it most probably the work of one or two families of local potters over a few generations.

Apart from the possible symbolic connotations of a part of the decoration (“suns” or “stars” and stylized vegetal elements), the overall pattern seems to be derived from a practical device of ropes or basketry, comparable to our modern *dames-jeannes*. The wide “arches” of impressed dots are “attached” to a row of similar impressions on the maximum diameter of the body, to the handles and to small lugs which are otherwise part of the applied decorative elements. It is impossible to know whether such a system, which would permit to carry easily the large jars and may also have been used on their smaller counterparts of group 3, was actually used in the Levant by the end of the IIIrd millenium. It is however such a simple device that the probability is high; it would have been

later abandoned with the above-mentioned evolution of pottery containers specifically adapted to trade. Representations of such devices, probably on handleless jars only, exist on cylinder-seals at the end of the Uruk period (e.g. LE BRUN 1978: fig. 8: 5; LE BRUN and VALLAT 1978: fig. 6: 4, 9, fig. 7: 12), but I know of no later ones.

Finally, some puzzling questions arise from the capacity diagram. None of the smaller jars of group 1 (5 to 13 litres, Fig. 3: 1, 2), either because they are handleless or have too wide and short necks, appear to be adapted to the carrying of water for daily use. Everywhere in the Middle East, and especially at Arqa, where the river flows in a deep gorge at the foot of the tell some 40 to 50 m below the settlement, this was a painstaking but important task, for which one would expect to find specially designed containers. In the whole assemblage of Phase P, only very large jugs (9 to 15 litres, triangles on the diagram, Fig. 3: 3, 4), with restricted neck and trefoil mouth, meet the necessary requirements. They are too large for pouring water for individual use into the small cups and goblets which are the standard drinking vessels of the period. But they could be easily carried on the shoulder or on the head, while the restricted neck prevented the spilling out of water. This type is frequent, as can be expected for vessels with a high probability of

breakage, and very many of them were probably necessary in every single house.

Jars from Arqa Phase N

The capacity diagram for Phase N shows a very different picture (Fig. 6). It is obvious that pottery production is much more specialized and standardized: only three groups. Jars with (black dots) and without handles (white dots) are represented in the first (12 to 17 litres) and the second one (20 to 30 litres), while all larger jars in group 3 (40 to 60 litres) are handleless; the very large containers with capacities of 90 litres and more seem to have disappeared. This is probably in part due to the fact that the Phase N assemblage is derived from the potters' quarter and workshop (THALMANN 2000: 47–50; 2002: 368–369), not from an ordinary dwelling quarter. It is however noteworthy that, if large jars of about 100 litres were in use elsewhere in the settlement during Phase N, they were manufactured in a different location and by different potters; this was certainly not the case in the preceding period, when all groups of jars exhibited a strong technical homogeneity (THALMANN 2000: 44).

The jars with handles of group 2 (Fig. 5: 3) differ in shape from their counterparts of Phase P, group 3, and with the same range of capacities may have served the same purposes for short-term storage. But

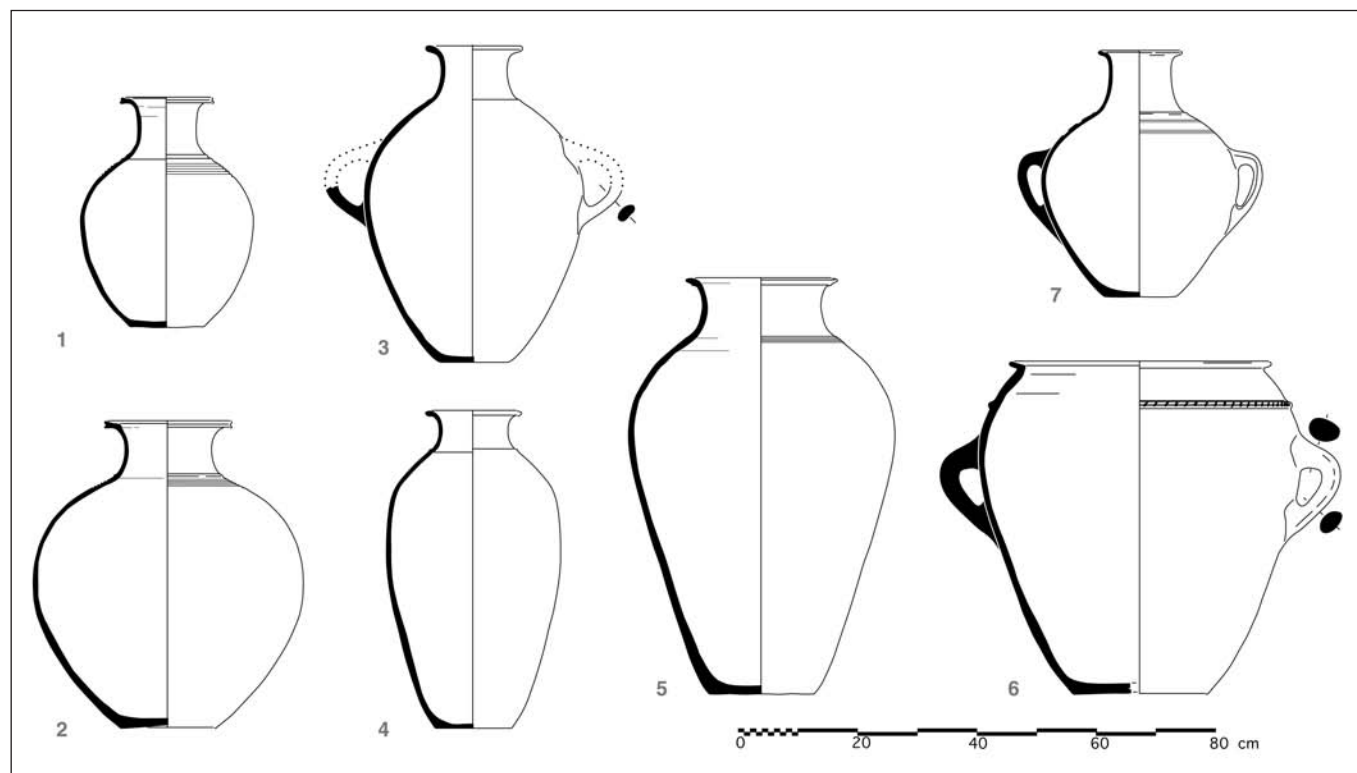


Fig. 5 Jars from Arqa Phase N (MB I)

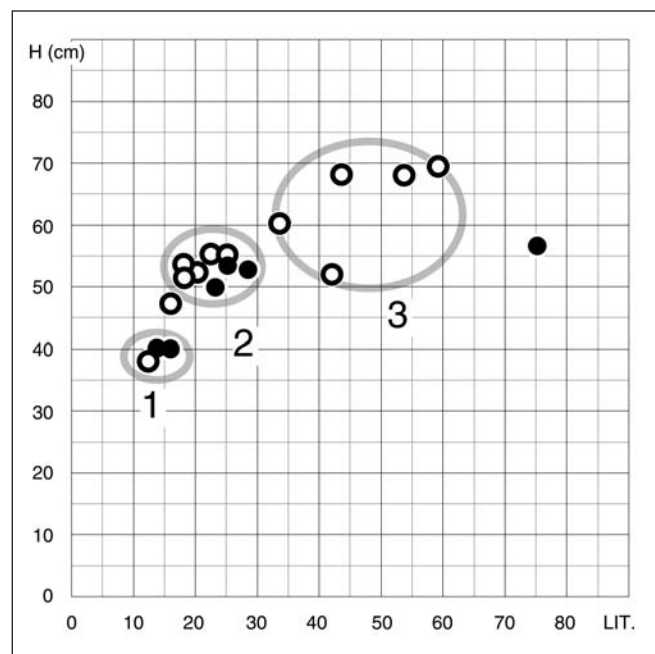


Fig. 6 Capacity diagram for Phase N

they are also probably more specifically designed for transport, because there now exists a number of handleless jars in the same group, which are equally well suited for short-term domestic storage, but of course not for transport. A further indication is that we have from Phase N a number of non-local jar sherds, probably originating from the Byblos area or southern Lebanon, what can be inferred from their limestone tempering *vs.* the strong basaltic component in the temper of all local wares.

Handleless storage jars are more or less evenly distributed (which can also be checked from fragments) between groups 2 and 3, and two morphological types only: a plump one with rounded body (Fig. 5: 1, 2) and a tall slender one (Fig. 5: 4, 5). Probably as for the jars of Phase P, this corresponds to different products and conditions of conservation, but the repertoire of Phase N and the capacity groups show a much higher degree of standardization and specialization.

Jars with handles in group 1 (ca. 15/16 litres, Fig. 5: 7) are equally interesting, as they probably are the counterparts of the large jugs of phase P for carrying water. Jug types in the assemblage of Phase N are numerous (THALMANN 2000: figs. 44, 46b; 2002: fig. 8), but they are all of small size and belong to what may properly be termed “tableware”. On the contrary, the jars of group 1, with their moderate capacity and their shape (rounded body, “low” handles and tall restricted neck) meet all the require-

ments for easy carrying on the head or shoulder; the handles attached at center of gravity level are especially well suited for pouring when holding the vessel with both hands.

Only one large vessel with a capacity of 75 litres could be reconstructed (Fig. 5: 6), but fragments of rims of a similar shape are numerous. The wide opening and the two strong handles do not match the usual types of contemporary storage jars, handleless and with a restricted neck, easy to seal with a clay stopper. This could well be also a specialized shape, new to Phase N, for storing domestic water: the wide opening allows for drawing up water with pots of all shapes and sizes, and the vessel can be held by the handles and tilted down for pouring when it is half or nearly empty.

Evolution of the repertoire in later periods

For later periods, the number of complete shapes available from Arqa is too low for significant capacity calculations. But new trends in the production and use of medium and large size containers are nevertheless apparent.

Very large storage vessels or *pithoi* (150 litres and more) appear only with Phase M (MB II) and different types of similar capacity are also produced during Phase L (early LB). Medium-sized jars are numerous and, much more than during the preceding phase N, some of them are of non-local origin.

Most of these jars, so far as can be inferred from fragments, probably fall within a capacity range between ca. 30 and 40 litres. Is this possibly a more or less standard capacity for many MB II jars, as noted above in the case of the Byblos jars? It should be necessary to accurately measure a wide sample from many Levantine sites to get the beginning of an answer. One of the few complete jars from Arqa, very similar in shape to the Byblos specimens and ascribed to the very beginning of phase M, holds 33 litres. On the other hand, it is probably not by chance that very few rims or large body fragments can be ascribed to the “intermediate” capacity group of 60/80 litres, which was well represented, although in somewhat different ways, in both preceding phases P and N.

It seems therefore that the specialized production of different types of storage vessels and the standardization so apparent in the Phase N repertoire was not continued during phase M. This may be related to the widespread circulation along the Levantine coast, especially from the beginning of MB II, of the true “commercial” jars, well adapted as noted above to the constraints of maritime trade, but which could

also be re-used when empty for all kinds of local storage. At least for the manufacture of medium and large size containers, a trend in the de-specialization of local pottery manufacture, *vs.* the higher specialization of fewer workshops which produced the “commercial” jars, probably began at Arqa during MB II with the wider availability of imported vessels; it becomes more visible in later periods, in all classes of pottery including tableware.

Canaanite jars from Tell ed-Dab^a

Capacities were calculated for some 20 jars from Tell ed-Dab^a, all Canaanite “commercial” jars dating to MB IIA probably originating from southern Palestine (ASTON 2002 : figs. 1–4 ; SCHIESTL 2002 : fig. 12), and plotted on the graph Fig. 7. Most surprisingly, it shows that there is no preferred or standard capacity, all intermediate values between ca. 14 and 25 litres being represented. It is obvious that these jars, at first glance rather standardized because they are all very similar in shape, size and proportions, did not however correspond to any standard capacity or system of measures as containers.

Although they have elongated bodies and restricted, slightly convex bases, most of them still retain archaic characteristics such as the « low » position of the handles placed on the body rather than on the shoulder. It is possible that a capacity of ca. 25 litres or a weight of about 30 kilos when full was, as in the case of group 3 jars from Arqa Phase P, a practical limit posed by the possibility of easily handling and carrying them – or by the mode of

stacking in the ships used for transport. Whether it may be considered as an early stage in the technologies related to maritime trade, in comparison with the possibility to transport more important quantities of goods in containers of higher capacity (but of only slightly larger size !), such as the above-mentioned jars from Byblos which are chronologically hardly earlier than the Jars from Dab^a – this should be investigated on the basis of a large database of jar capacities from all sites in the Levant, and well into MB II and LB.

CONCLUDING REMARKS

No definite conclusions can be derived from such a limited sample, but it illustrates the wide range of problems which may be tackled through systematic investigation of vessel capacities. The case of the storage/transport jars at Arqa is perhaps especially clear because the earlier of the periods considered (Phases P and N) is there characterized, as everywhere else in the Northern Levant, by a general trend in handicraft specialization ; and because there is a strong contrast between Phases P and N, when no or limited interaction occurred between local productions and imported vessels, and Phase M or later, when such interactions became more frequent. The proposed model could probably be easily tested on sites where local wares are readily distinguishable from imported ones ; but the excavation of a workshop specialized in the production of specifically “commercial” jars is still lacking.

Calculations of capacities made only in a cursory

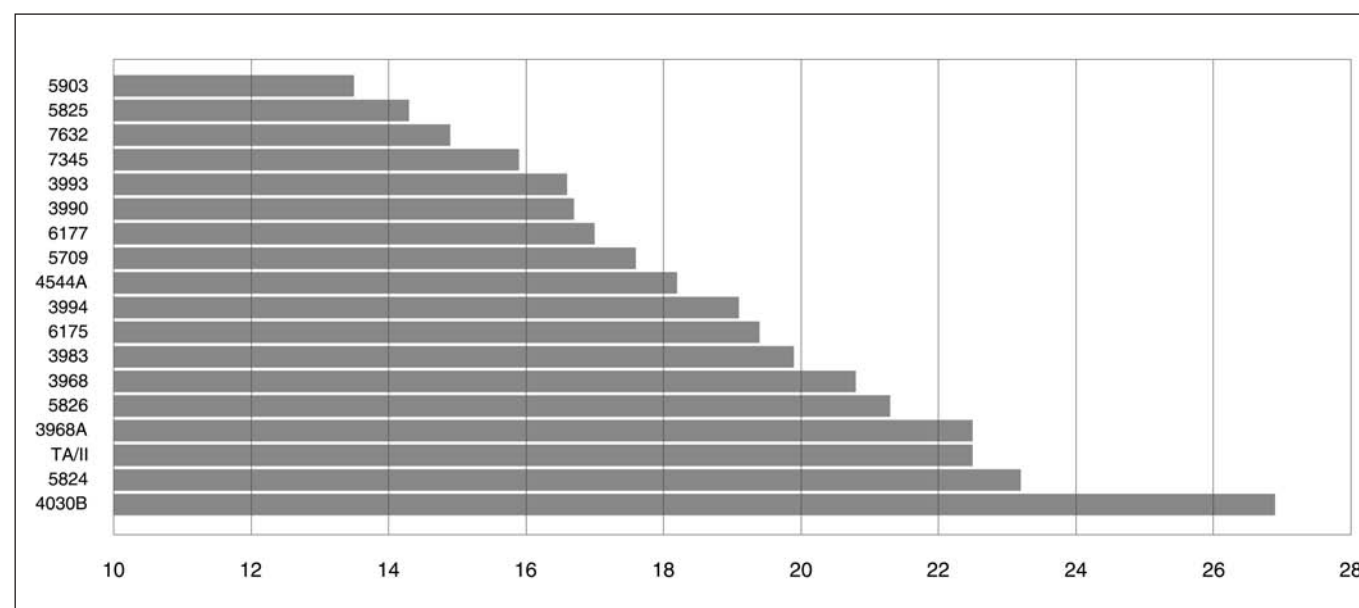


Fig. 7 Capacities of some MB IIA jars from Tell ed-Dab^a

manner on publications of MB II and LB levantine jars lead to the supposition that different classes of capacity did exist – for different products? different systems of “weights and measures”? short or long-distance trade? The test on the jars from Tell ed-Dab‘a shows that it was not always and everywhere the same : different chronological “stages” in the development of maritime trade may be an explanation, but many others are of course possible.

Before even preliminary results can be obtained, it is clear that the painstaking compilation of a large database is necessary, taking into account accurate measurements only : no too small or approximately scaled drawings should be used. It is however hoped that increased interest in capacity calculations and wider reliance on easy-to-use computer utilities such as the one proposed above will give significant results in a not too far future.

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