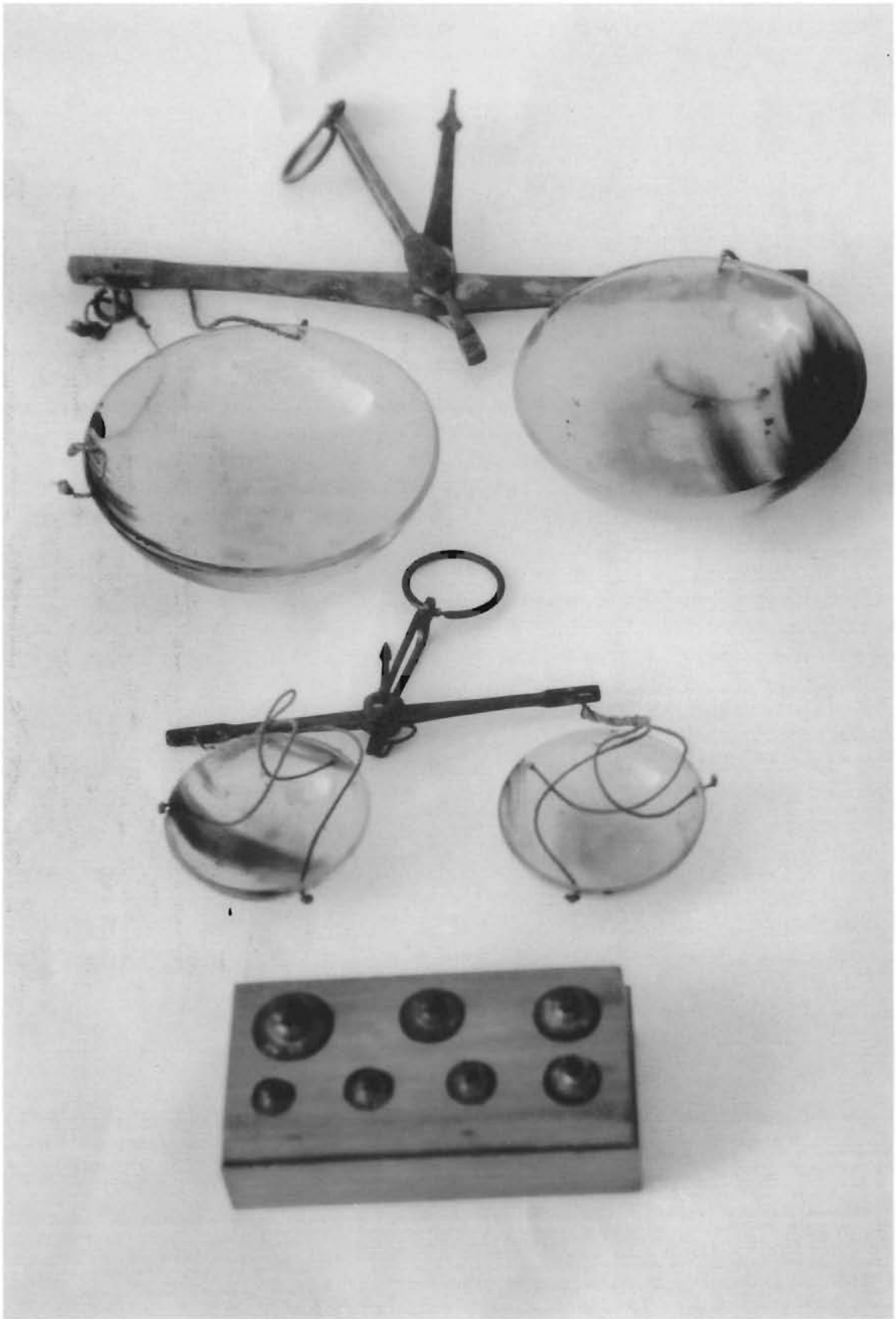

Small balances with two pans made of tortoise-shell (or sometimes entirely of bronze) were in use till recent times for the precise weighing of precious materials; the lower one –together with the balance weights in the box– was used for checking the weight of gold coins (collection of A. Michailidou). In ancient times the invention of balance weights will have been associated with the need to use them for the absolute measurement of gold.

RECORDING QUANTITIES OF METAL IN BRONZE AGE SOCIETIES IN THE AEGEAN AND THE NEAR EAST*

Anna Michailidou

INTRODUCTION

Metal is known to have circulated over a wide geographical area in standardised form and in large quantities: one has only to recall the large number of ox-hide or bun ingots of copper and tin in the Uluburun (*Ακρωτήριον*) shipwreck,[1] or the gold ring-ingots in the wall-painting depicting Nubians bearing offerings to the Pharaoh of Egypt.[2] The high value of the metals was due, of course, to the great demand for them as raw materials. Zaccagnini eloquently summarises the uses of metal: '*nei lavori agricoli, nei vari artigianati, in guerra, comme strumento dei tesaurizzazione, mezzo di scambio e di computo del valore dei beni*'.[3] That metals could be preserved –in contrast with grain and other products that deteriorate– and therefore easily stored and also recycled, are the main reasons that they had the greatest exchange value, especially for long-distance trade, in which 'the network of exchanges needs to be balanced at each stage by some commodity which is generally acceptable and can be both stored and adventitiously converted into different materials as occasion demands. This requirement is filled by metals, especially precious metals'.[4]

The feature of interest to the present study is that metals are measured by weight, since they are not fluid and cannot, therefore, be measured by volume.[5] It was necessary to measure the weight of metals both for craft-industry purposes and for trade, and it was not only raw materials whose weight was so measured, but also finished products; 'for an elite concerned with the movement of high-value materials, the notion of equivalence by weight is fundamental, and the wealth stored as plate, weapons and ornaments (my emphasis), including the added value of expert manufacture, represented a convertible reserve of value which could be mobilised for exchange'.[6] For this reason, any failure to find a vessel made of precious metal in an excavation is not an indication that it was actually absent, but demonstrates 'the extent to which it was

* My warmest thanks for the translation of the Greek text are due to David Hardy. I want also to thank Antigoni Zournatzi for the encouraging discussion during a Sunday lunch.

[1] More than 354 ingots of copper –that is, more than 10 tonnes– and about 1 tonne of tin, see Muhly 1996, 48, and especially Pulak 1998, 193-200, where all the shapes of ingots found are recorded. For the ancient name of Uluburun, see Lolos 1989.

[2] The wall-painting is in the British Museum: James 1985, fig. 23.

[3] Zaccagnini 1976, 325.

[4] Sherratt & Sherratt 1991, 360.

[5] Gold dust might have been an exception; in Egyptian wall-paintings it is stored in bags of equal size but, because of the nature of the material –leather or cloth– of variable capacity. So the balance will again have been essential for measuring this highly valuable material. It has been argued that 'weights and balances were first used for weighing gold dust' (Skinner 1954, 779).

[6] Sherratt & Sherratt 1991, 360 (cf. the views on 'social storage' by Halstead & O'Shea 1982).

retained in circulation and mobilised when necessary'.[7] The occasional depiction of a particular type of vessel in the iconography of different cultures indicates the degree of internationalisation of certain types that circulated in various directions as exchange value. With regard to the perceived value of metals, in particular, it should be noted that this varied both geographically and over time. A. and S. Sherratt, for example, notice that silver was regarded as twice as valuable as gold in Egypt, whereas in Mesopotamia it was one tenth the value, and in the Aegean gold probably had a higher value than silver; in the case of tin, they give the indicative ratio of tin to silver of 1.5:1, for Ebla.[8] The supplying of gold to Egypt by the mines of Nubia and of silver to Mesopotamia by Asia Minor undoubtedly played a role in establishing the 'value' of gold and silver in these regions. In addition to precious metals, however, copper, alongside its consumer value, 'occupied an increasingly strategic role as a material for weapons, and this required the movement of large quantities of metal'.[9]

For all these reasons, the interest of the 'palace' regimes in the concentration and movement of metals was to be anticipated, and the recording of metal artefacts in Mycenaean tablets and Near East archives comes as no surprise.[10] The main topics with which we are concerned here are: the nature of the metal that circulated (or was recorded at least), the forms in which it was moved, and above all the quantities that were distributed or owned. The sources used for the investigation are: the Mycenaean tablets (for the quantities recorded by the palace bureaucracy), the archaeological finds from Akrotiri, Thera (for the demands of urban ownership), and a selection of Near Eastern documents (for the technological and economic processes determining the quantities recorded in public and private archives).[11]

1. Metals In the Mycenaean Tablets

There is a large bibliography on Mycenaean tablets containing references to metal. Already, according to the introduction selected from the article by A. and S. Sherratt, we may anticipate records of precious metals and records of plates, weapons and ornaments, as was stressed above.

1.1. Gold

As is generally known to date, only the tablet **Jo 438** mentions quantities of gold –as a contribution to the palace of Pylos– and gold is otherwise referred to in the tablets as defining vessels,[12] or decorating various objects.[13] Since the sources of gold are not the concern of this

[7] Sherratt & Sherratt 1991, 360.
[8] Sherratt & Sherratt 1991, 377, notes 11, 12.
[9] Sherratt & Sherratt 1991, 360.
[10] For the Mycenaean tablets in particular, see the chapter by Dialismas in the present volume. I would like to thank A. Dialismas for his contribution in the *ΠΕΝΕΔ* Research Programme in the Centre for Greek and Roman Antiquity and his assistance to the present writer. But the first credit is due to D. Kriga who was the one that helped all members of the team to start the project.
[11] The comparative study of Near Eastern and Mycenaean texts, with all due caution, is steadily gaining ground. See by way of example Uchitel 1988, De Fidio 1992, Sheldmerdine 1998, 296-298 or Tournavitou & Sugerman in press.
[12] *Documents*, 351.
[13] See note 10 (Dialismas).

chapter, we may leave aside the theory that the word *ku-ru-so* is a Semitic borrowing,[14] or that *AUR* is derived from an Indo-European term,[15] and concentrate our investigation on the quantities of the metal recorded. From this point of view, interest attaches to the comments made some time ago by Bennett on the 'unusually small quantities with this ideogram in **Kn01**'[16] or the view expressed by Dialismas in the present volume that one would not have anticipated there to be only one inventory of gold in the Pylos archive.[17] Are the quantities in the tablet **Jo 438** (**Kn01**) really small? Godart appears to take a different view.[18]

1.2. Silver, tin and lead

We turn now to comments already made in connection with silver (sole reference as a material added during manufacture) and tin (dubiously identified in the word *ka-te-ro*, accompanied by the metrogram *L*, meaning for talent), in order to draw attention to the question of their absence in the tablets. A record of lead has survived in one tablet, at Knossos, mentioning quantities of 3 kilograms (the metrogram *M*) for each reference.[19]

1.3. Copper

The references to copper are much more numerous.[20] We will start with the comment made by J. Smith in her general presentation of the tablets of the **Jn** series: 'The metal referred to in the **Jn** series could be copper, bronze or both. Not only is it difficult to be certain of the composition of the metal listed in the **Jn** tablets, but also it is difficult to be certain whether it is in ingot form or the form of a scrap metal'.[21] We should also draw attention to Zaccagnini's useful observation that in general we may assume that metals were transported as whole ingots, fragments of ingots, scrap metal, and finished craft products.[22] As in the case of gold, the quantities of copper recorded have been considered to be small: 'the small sizes of the allotments suggests that workers probably did a service for the palace through the *ta-ra-si-ja* service in addition to working their crafts for customers other than the palace'.[23] Zaccagnini concludes from the evidence of the tablets of the **Jn** series that 'in most cases, copper handed over to the smiths was shaped in the form of oxhide ingots, since the figures reproduce the weight of one or more ingots (i.e. *ca.* 26/30 of a talent) and possibly also of half ingots',[24] and Smith concurs (at least in the case of ten tablets): '6 ingots were distributed to smiths in the south and more than 8 to smiths in the north'.[25] The quantities per coppersmith ranged from 12 kg. (*M* 12) to 1.5 kg. (*M* 1 *N* 2).[26]

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[14] Akkadian *hurasu*, Ugaritic *hrs*, Hebrew *harus* (Witczak 1992, 90).
[15] Witczak 1992, 91.
[16] Bennett 1950, 218.
[17] See note 10.
[18] Godart & Tzedakis 1992, 206: '*la quantité d'or traité est considérable*'. The same opinion by Chadwick 1976, 145.
[19] The bibliography on the above metals is assembled in the chapter by Dialismas.
[20] *Ibid.*
[21] Smith 1992-93, 173.
[22] Zaccagnini 1986, 414.
[23] Smith 1992-93, 180.
[24] Zaccagnini 1986, 415.
[25] Smith 1992-93, 191.
[26] Chadwick 1976, 140-141. *M* and *N* are the conventional names for the metrograms **117* and **116*, which denote quantities of 1,000 and 250 grams respectively.

The objects produced by working the copper were probably weighed on delivery.[27] And if account is taken of the likelihood that the adjective *qa-si-re-u* (in three tablets recording copper) refers 'to supervisors who oversaw metal allotments from the palace to individual smiths throughout the Pylian kingdom ... perhaps responsible for the return of finished products',[28] then the distribution pattern is possibly analogous to that of the Near Eastern tablets. (I cite by way of example the documents from Mari, in which Mukannišum is the official in charge of the royal workshops: see below, p. 93).

In the palace at Knossos the total quantities of copper recorded are not small: the 60 ingots weighing a total of 1,562 kilograms in tablet **Oa 730**[29] are consistent with the large numbers of ingots found in shipwrecks, though the number remains understandably greater than finds made so far in palaces or 'villas' (cf. the specimens in Herakleion Museum). For the problem of whether the Linear B ideogram **167* (for ox-hide ingot) refers to a standard quantity of copper or bronze (or even tin?),[30] the archaeological record to date has suggested copper for the ox-hide ingot (which is of standard form and weight),[31] and bronze for the bun ingot (which is standardised only with regard to its form, usually weighing from 1 to 5.5 kilograms), though this does not preclude the existence of bun ingots of copper (or tin).[32] Vandenabeele and Olivier regard the ideograms **167* and **167+PE* as certainly referring to ingots of metal, since the tablets record their weights. As for the *AES* (**140*) accompanying the ideogram **167+PE* in one instance, it is not clear whether it is used to define bronze or copper.

Smith holds the interesting view that when the total recorded in the tablets happens to be equal to or greater than 26 kilograms, then 'the similarity of this weight to the weight of a single oxhide-shaped ingot *ca.* 26 kg. suggests that smiths on these tablets received fragments of copper ingots'. In the case of other tablets recording totals of smaller quantities, e.g. 12 kilograms, she posits the distribution 'of ingots of bronze', possibly 'bun shaped', while for yet other tablets, in which no total is recorded, even if the individual allotments produce a large total, such as 26 kilograms, she assumes an allotment of 'scrap metal possibly of bronze'.[33] This is an ingenious hypothesis: we may imagine the palace sending an 'ox-hide ingot' to some place and fixing the quantities to be allotted to the individual craftsmen there. It remains a hypothesis, however, as does the possible distinction between copper and bronze in the above records. Even in the Near Eastern tablets, in which copper is distinguished from bronze by name (see below, p. 93) matters are not entirely clear.

1.4. Final picture

In summary, the picture emerging so far from the study of the –palace– Linear B tablets is that (a) we have only a single tablet recording quantities of gold and one mentioning lead,

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[27] As Chadwick 1976, 140. For a record of 1,046 kg. of copper (?) as total (tablet **Ja 749**) cf. *Documents*, 356 and Chadwick 1976, 140.

[28] Smith 1992-93, 182. But see the comments of Lindgren 1973, II, 126-130 and note 4; cf. also tablet **Jo 438**.

[29] Chadwick 1976, 142.

[30] Since the same standard shape is also attested for tin by some of the ingots from the Uluburun shipwreck; see the article by Bass 1997, 157. For other shapes also, see Pulak 1998, 199-200.

[31] For the metrologic significance of the standard shape(s) and weight(s) of the ingots, see Zaccagnini 1986, 413 (views of Muhly, Parise). There are also ox-hide ingots weighing less than a talent (cf. Pulak 1998, 194-195), though I believe that these too are of a standard form and weight (cf. ingots from Kyme, Euboia, e.g. *Mycenaean World*, no. 269 of 9.9 kg.).

[32] Smith 1992-93, 175; Bass 1997, 157. Pulak refers in general to copper bun ingots (1998, 193).

[33] Smith 1992-93, 185, 194, fig. 14.

virtually no inventories of silver and tin, while more frequent references to copper or bronze; (b) there are records of metals in the form of either ingots or objects (Sherratt's plates, weapons, and to some extent ornaments, though not jewellery);[34] and (c) the individual quantities of copper or gold recorded (whether for distribution or as a contribution) are considered small by scholars.

What of the Linear A tablets? The question, here, is why have we failed to identify records of metals in these. The sign L 8 (A 327), which is similar to the Linear B *AES*, occurs in isolation (on two occasions) only at Hagia Triada,[35] where it might be taken as an ideogram for copper. Even if we limit the recording of metals solely to the level of the palace, and only at the time of the centralised system reflected by the Linear B tablets, we cannot, of course, limit the circulation of the metals solely to these higher strata, for Limet, in his classification of goods into '*biens necessaires*', '*biens utiles*' and '*biens superflus*', very properly assigns metals to the second category.[36] For the period of Linear A script (and also that of Linear B), it would be useful to consult also the archaeological record with a view to documenting the written texts by archaeological evidence (though taking into account the parameters touched upon by Bennet in his relevant article).[37]

2. The Circulation of Metal

2.1. The circulation of metal within the community

Leaving aside the material deposited 'eclectically' in tombs as grave offerings,[38] I turn to a settlement dating from the period that saw the spread of Linear A script (where we noticed the 'absence' of metal recording) and having an urban character. The settlement in question is Akrotiri on Thera, where the volcanic destruction has reduced the factor of 'eclectic preservation' to the minimum, so that the site potentially provides interesting evidence for the circulation of metal within a city through the study of the 'household equipment' owned by the inhabitants.[39] This question was a matter of persistent concern to Zaccagnini in his study of records of metal in the Nuzi tablets (which, it may be noted, are roughly contemporary with the Mycenaean tablets): 'Once again, what did people do with these metals? Notice that there is practically no hint whatsoever for the circulation of metal in the form of finished objects: tin, copper and bronze were handed over exclusively as raw (or semi-elaborated) material... Through redistributive (and commercial?) mechanisms –that admittedly escape us– a certain amount of these metals found their way outside the sphere of the palace and circulated not only in the Arraphean socio-economic elite but also among the lower strata of the population, being essentially employed as exchange-goods and means of payment. It is quite possible that a percentage of this circulating mass of metals reverted to the palace, through fiscal mechanisms that, again, escape us'.[40] From the point of view of methodology, Akrotiri enjoys the advantage of not belonging directly to the Minoan palace system or to the later Mycenaean bureaucratic

[34] See the chapter by Dialismas in the present volume.
[35] Pope & Raison 1978, 14; Palaima 1988, 325; see also Watrous 1984, 130 and note 55.
[36] Limet 1977, 58.
[37] Bennet 1988.
[38] See, by way of example, Voutsaki 1997, 41-43.
[39] A paper on 'Household equipment in metals' was presented by A. Michailidou at the two-day conference celebrating 30 years of excavation at Akrotiri, Thera, held in Athens, 19-20 December 1997. It will be published in the proceedings of the conference, by the Archaeological Society at Athens.
[40] Zaccagnini 1984, 158, 159.

environment; we can therefore examine elements of the everyday use –and ownership– of metal in the economic life of a city that was less susceptible to the control of a palace, and which probably retained sufficient quantity of the original household equipment.

a) The first category to be established is the standardised form of raw material, which is still under investigation in the case of Akrotiri. (At another settlement, Gournia, small pieces of ingots have been identified retrospectively through metallography.[41] For obvious reasons I do not cite the examples from 'villas', but it is interesting that an entire 'ox-hide' ingot has been found in the area of the settlement of Poros-Katsambas).[42] One wonders if the strips of copper found in Δ 16 at Akrotiri[43] are purely functional, or whether they form part of the circulation pattern of smaller –standard– quantities of pure metal (see Table 1).

b) Of the other forms identified by Zaccagnini in the records of metals in Near Eastern tablets, the second category consists of amorphous scrap (that is, fragments that were deliberately kept by the owners) and disused objects, which could also be repaired or recycled. An example from Akrotiri is the repair to the bottom of a small copper tripod cauldron in the West House, together with the observation that one of its legs is incomplete (unless due to bad preservation). It reminds us of a palace record of a tripod cooking-pot 'with one leg' (*e-me po-de*) in tablet **Ta 641** from Pylos.[44] And also of the letter sent by an Old-Assyrian merchant from Kaniš in Asia Minor to his wife at Aššur, promising that he will bring a quantity of copper for a new cauldron, but that in the meantime she is to have the old one repaired.[45] This makes it easier to assess the third, and main form of circulation.

c) The main form in which metal was circulated was that of the complete finished product, with the embodied value (?) of the workmanship. Some of these products were luxury items. Two braziers have been found at Akrotiri,[46] for example, and I am aware of published examples from elsewhere in the Aegean: one with *repoussé* ivy leaves from the palace at Zakros, one undecorated (and much larger) from the tholos tomb at Vapheio, and one from the Unexplored Mansion at Knossos, which is larger than the vessels from Akrotiri but has the same *repoussé* spiral ornament. Others will be found, or have been found, but they are fairly rare.[47] Some finished products thus acquired great exchange value outside the borders of a city, and became merchandise that was transported in all directions. They ultimately acquired the characteristic of 'internationalisation' referred to at the beginning of this chapter, which is eloquently reflected in some wall-paintings in Egyptian tombs of the 18th Dynasty.[48]

Taking as given the view held to date, that even the metalworkers of the Pylos tablets worked in the place they lived (and also the theory that there were 'part-time smiths or smiths working on a seasonal basis')[49] I turn to the question of whether their work could have been also destined for local consumption. Having traced, albeit to a limited extent, the presence of metalworkers at Akrotiri,[50] I have attempted to identify their customers in the non-palace environment of the city, beginning with the 'household equipment', as it arises from the picture of the distribution of

[41] Betancourt *et al.* 1978, 7-8. But see the information in Fotou 1993, 29, 97, pl. XVII.
[42] Dimopoulou 1997, 435, pl. CLXXIa.
[43] Michailidou 1993-94, 173, pl. 24a, and Μιχαηλίδου 1997b.
[44] Hooker 1994, 214. More on the tripod cooking-pot from the West House, in the forthcoming publication of the metal artefacts from the house (Μιχαηλίδου in press).
[45] Dercksen 1996, 74. The merchant thus had a quantity of copper that he could use for his own home.
[46] *Thera V*, pl. 76; Μιχαηλίδου 1997b.
[47] They are cited here for this reason, despite the differences in date between them.
[48] Cf. wall-paintings from the tomb of Rekhmire: Wachsmann 1987, pl. XLI-XLIII.
[49] Killen 1979, 133-134.
[50] Michailidou 1993-94, 170ff.; Μιχαηλίδου 1997a, 647-648.

metals amongst the buildings of the settlement.[51] All the inhabitants of Akrotiri were customers of the coppersmith, for one reason or another –either for tools or for vessels used for household or professional purposes. A ready example is furnished by the fishhooks that were found in different parts of the settlement and outside it, sometimes *in situ* stored in pithoi, and sometimes retrieved by sieving the soil excavated, and in a wide range of sizes, suitable for catching anything from bream to swordfish. Fishing is not one of the professions recorded in the Mycenaean tablets, nor are fish mentioned,[52] but how did people get their fishhooks? We might also consider the variety of knives, the most useful tools in the household, agricultural, and craft-industrial spheres. The carpenter, too, of course, needed his tools, the saw and chisel, and the question of who owned tools has received great attention from scholars.[53]

2.2. Comparison with the Mycenaean tablets

The point shared in common, that makes it legitimate for select comparisons to be made between information recorded in the Linear B tablets and any corresponding archaeological evidence for the household equipment at Akrotiri, is that in both cases we are mainly dealing with the 'internal', regional circulation of metal, since 'Mycenaean texts provide almost no direct evidence for the management of extraregional trade, whether by sea or land'[54] and 'the mechanisms for exchange beyond the borders of the Pylian kingdom are not found in the existing Linear B tablets'.[55] Akrotiri is selected because of its good state of preservation,[56] while scales and balance weights discovered in the buildings attest to the fact that goods were measured on the spot. The Linear B tablets are a good source for what kinds of goods were weighed,[57] and for the units used in this purpose.

To summarise: the scanty nature of the references to gold and silver in the tablets is reflected in the archaeological record (though in the latter case it is completely explicable). On the other hand, lead occupies a different position –most of the metal objects left at Akrotiri are made of lead, a clear indication of the low value attached to this metal– while tin, of course, is invisible in the archaeological record. As for the nature of the objects (recorded or found) we are well informed by the book by Vandenabeele and Olivier identifying ideograms with archaeological finds. At first sight, it is apparent that the palace's record was selective and referred only to certain types: there is no mention of most tools (apart from fire-tongs and dubious and indirect references to saws),[58] while weapons are in the majority. I believe that the difference in the social (and chronological) context of the sources (the Akrotiri settlement and the palace Linear B archives) will help us to a better understanding of both. For example, what might be the significance of the record of 50 daggers (or swords) in a single tablet from Knossos (Fig. 1), and the discovery of three or four daggers at Akrotiri? The first explanation that comes to mind, of

[51] Μιχαηλίδου 1997b.
[52] Palaima 1991, 284.
[53] E.g. Μιχαηλίδου 1997b. Of the workers at Deir el-Medina in Egypt, Bierbrier writes (1989, 42) that 'several workers owned their own expensive copper tools, quite distinct from those provided by the government'.
[54] Palaima 1991, 276.
[55] Smith 1992-93, 213. Shelmerdine (1998, 291) has observed that 'the Mycenaean documents do not contain any direct evidence for foreign trade, an omission which continues to surprise and attract various explanations'.
[56] We should not overlook Gournia or Malia, for example.
[57] See Μιχαηλίδου 1990, 72-75, and Michailidou 1999.
[58] For the saw, see Hiller 1992, 309 and note 32, where the relevant bibliography is cited.

course, is that arms production was mainly of interest to the palace,[59] in support of which I cite a comment by Gates,[60] for the Old Assyrian colony at Kaniš in Asia Minor: here, in addition to the usual copper smithies, was found a workshop that, according to the excavator, 'specialized in weapons, although never swords, which were apparently reserved for the palace –that at least is the only place where they have been found.' He thus hints at three levels, at least, of copper production (general production - weapons - swords). The view that the palace controlled the production of weapons has also been expressed by Liverani, in his commentary on letter EA 77 from Amarna, in which the ruler of Byblos declares himself unable to send to Pharaoh certain copper objects, called *šinnu*, which are interpreted by Liverani as arrow- or spear-heads, or blades.[61] Control of weapons-production by the Mycenaean palaces may be supported by Gregersen's observation that '*ka-si-ko-no* and *pi-ri-je-te* both seem to be producing weapons[62] and receive payment in kind, but the smiths *ka-ke-we* are never registered for payment in kind'.[63] The question then arises as to the significance of the daggers found in the settlement (e.g. Fig. 3): are we to deduce a specialised local production, or suggest elite recipients/owners or recipients/distributors of imported weapons?[64]

3. Recording the Quantity of Metal

With regard to the quantities of metal recorded by the palace and those that can be identified in the archaeological context, Ventris and Chadwick already commented that of the most frequently recorded allotments to coppersmiths, the greatest quantity –5 kilograms of copper– was enough to make 14 swords (average weight 357 gr.), and the smallest –1.5 kilograms– enough for 1,000 arrow-heads (average weight 1.5 gr.).[65] This leads us to the following picture:

Pylos palace → Quantity of copper *M* 1 *N* 2 → 1 craftsman → ability to produce: 1,000 arrows.

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[59] See the chapter by Voutsa in the present volume. I would like to thank K. Voutsa for her contribution in the *ΠΕΝΕΔ* Research programme in the Centre for Greek and Roman Antiquity, and for her assistance to the present writer.

[60] Gates 1997, 257.

[61] Liverani 1997, 4, 122-123: 'Byblos seems to have been an active copper-producing center, exporting processed items like weapons to other cities nearby (Tyre, cut away from its hinterland, was probably short of fuel for metal working) as well as to Egypt. Metal working, and especially weapons production, was carried on under royal control, and organized into "quotas" to be completed and delivered by individual artisans or groups of artisans to the Palace (to be exported therefrom).' He notes that the word *mahβsu* in the text of the letter probably refers to the hammering that followed casting, the final process carried out by the craftsmen before delivering the finished product to the king.

[62] The identification of *ka-si-ko-no* with sword-maker was made long ago and is generally accepted. The interpretation of *pi-ri-je-te* continues to occupy scholars; see, e.g., Lindgren 1973, 74 (*ka-si-ko-no*) and 117 (*pi-ri-je-te*); Hooker 1994, 153 (*pi-ri-je-te*); Hiller 1992, 309, note 32 (*pi-ri-je-te*).

[63] Gregersen 1997, 401. Palatial control of weapons-production may also be indicated by the description of *e-te-do-mo* (= armourer?) as *wa-na-ka-te-ro* (= of the King), see Palaima 1997.

[64] For the question of weapons at Akrotiri, see also Kilian 2000. The possibility that many daggers were removed from the settlement, taken away by their owners when they fled, does not interfere with the question of their original availability as weapons. Cf. discussion on weapons in LM I tombs and in the Warrior graves, especially by P. Warren in Driessen & Schoep 1999, 401.

[65] *Documents*, 356, where also the weight 695 gr. is given for the copper helmet from an LM II tomb in the area of Knossos (Hood & De Jong 1952, 256).

Interestingly, many copper arrow-heads have actually been found together at Pylos.[66] I note in this context the letter by the king of Mari to Mukannišum, the official responsible for his workshops, with an exclusive order for 1,000 arrow-heads, the weight of each defined as about 2 gr.:

'*mille fleches en bronze de ¼ (de sicle) chacune, avec le bronze rouge ... dont tu disposes*'.[67]

This means that the king was aware that the official (still?) had 2 kilograms of bronze at his disposal (this would be written *M* 2 in Linear B).

Similar records in the Mycenaean tablets refer to totals of 50 swords (Fig. 1) or 42 spears or 6,010+2,630 arrows (Fig. 2). For these many arrows, it has been calculated that a total quantity of 13 kilograms of copper would have been required.[68] Chadwick's calculation that 5 kilograms would produce 14 swords of 357 gr. per sword demonstrates that even the smallest quantity despatched, 1.5 kilograms per craftsman, was not very small, since it was enough for at least four swords.

3.1. Documentary evidence from the Near East

A search in the Near Eastern texts for evidence for quantities of metal, reveals that the smaller quantities of copper include those used to give textiles and leather a green colour: the Isin archives, for example, contain the information that 33-34 gr. of copper were needed to dye a goatskin[69] (the corresponding Linear B record would have been *P* 1 *Q* 4).[70]

a) If we have recourse to the earlier tablets of Ur-III period (approx. 2150-2000 BC) on the grounds that these very often record not only the number, but also the weight of finished metal products, we may note:

Records of tools. For example '*1 ciseau en bronze, d'1/3 de mine, 1 ciseau en bronze de 17 sicles, 1 ciseau en cuivre, metal durci, de 2 mines et 15 sicles*'.[71] The weight for each chisel is respectively 167 gr., 142 gr., 1 kilogram and 126 gr., with the further provision in the last case that it might be of hammered copper.[72] Limet comments[73] in the case of carpenter's chisels that, whether of copper or bronze (there are different words for these in Sumerian, *URUDU* for copper and *ZABAR* for bronze), the weights recorded vary, from ½ shekel (a mere 4.2 gr.) to 17 or 20 or 28½ shekels, as well as the above-mentioned example of 2 minas and 15 shekels.[74] It is notable that many more kinds of tool are recorded in the Ur-III tablets than in the Mycenaean tablets. For example, one copper sledge weighs 3 minas[75] (1,500 gr., or *M* 1 *N* 2 in the Mycenaean script). Also eight hoes, brought by the craftsman himself, have a total weight of 4 and 2/3 minas and 5 shekels[76] (that is, a total of *M* 2+), while elsewhere, seven hoes weighed 2 and 2/3 minas

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[66] Blegen & Rawson 1966, I, 325, II, fig. 317.

[67] Translation by Rouault 1977, 29-31. There are cases in which heavier arrow-heads are ordered (40, 24, 16 and 8 gr. each, in smaller quantities, of 50 to 200 arrow-heads), see Dalley 1984, 63.

[68] *Documents*, 361.

[69] van de Mieroop 1987, 30.

[70] These are the Linear B metrograms **115* (*P*) and **114* (*Q*), for weights of about 20 and 3.6 gr. respectively.

[71] Limet 1960, 39. I retain the French, English or German text, depending on the translation provided for the Mesopotamian document by each individual author. See *UET III* 735 (Legrain 1947, 227).

[72] Cf. Limet 1960, 185.

[73] Limet 1960, 221.

[74] Mina, *Maneh* = about 500 gr. and Shekel, *Sicle* = 1/60 of a mina, that is, about 8.40 gr. (though there are different values for the above units in the general area of the Near East).

[75] *UET III* 735 (Legrain 1947, 227); see also note 71.

[76] Limet 1960, 172.

(that is, a total of *M* 1 *P* 16). Weights are also recorded for axes: one axe weighs 2/3 mina and 4 shekels (that is, 334+32 = 366 gr., about *P* 18), and axes in general (of copper or bronze) usually weigh 1 mina (500 gr.) each (though some examples weigh two minas).[77]

Records of vases. The Ur-III tablets record great weights: for example, '*1 copper vessel pisannu nasbu of 44 1/3 maneh weight, from the treasury, 1 copper vessel of 18 1/2 maneh weight from the Sabru treasurer, Ur-(d)-Nigal the smith received*'[78] (probably for repair), and also the heaviest: '*one copper kettle weighing one-half talent* (as pledge)'.[79] Smaller weights are also recorded: for example, a vessel of pure copper weighing 23 shekels and 2/3 shekel. Frequent mention is made of a special copper vessel for storing oil (!) weighing 1 mina or 2/3 mina or 1/2 mina. A bronze washing bowl has a weight of 1/2 mina and 5 shekels,[80] a broad vessel that Limet calls a krater usually weighs between 1/2 and 1 mina (that is *N* 1 to *N* 2), and even a vessel that is described as smaller (!) weighs 5 minas (that is, 2,500 gr., or *M* 2 *N* 2).[81] The capacity of a vessel is frequently stated: for example 1,842 litres.[82]

One interesting object (*hu-bu-um*) recorded is made of bronze and ranges in weight from 1/2 to 10 minas; Legrain asserts that this is a 'wheel cover', while Limet comments: '*il s'agit du bandage de la roue, puis par dérivation, d'un anneau de métal*'.[83] This recalls the description of *ka-ko de-de-me-no* for wheels in the Mycenaean tablet **PY Sa 794**.

b) In Hittite tablets, especially in the so-called 'Metal Inventories', the weight of the axe is fixed at 2 minas (twice the weight normally found at Ur): 64 *HASINNU* are recorded with a total weight of 128 minas, and 46 *HASINNU* with a total weight of 92 minas, in the same inscription.[84] What is of importance is not so much this difference in itself, as the theory that has been advanced, that the weight of 2 minas was standard and represents a unit of weight for the metal used in its circulation.[85] (This recalls of the Mycenaean metrogram *M*, equivalent to two minas.) In the same tablets, there is reference to the breaking of an actual ingot of copper, weighing 1 talent, and its division into minas; and also to the manufacture of 10 daggers from 7 minas and 20 shekels of copper.[86] Two daggers from Akrotiri weigh about 163 gr. and 303 gr., as compared with the average of *ca.* 350 gr. for the daggers in the above-mentioned Hittite document. Again, the smallest allotment of copper in the Mycenaean tablets, 1.5 kilograms, would have been enough for at least four daggers. Account has to be taken, of course, of the percentage of metal lost during manufacture, cf. the relevant evidence, again from Near Eastern texts, referring to the refining of copper or silver: '*I refined the silver and from five minas (only) 3 1/3 minas came out (of the kiln)*'.[87]

c) It would be useful to note at this point that the Mari archives are a valuable source for the metalworking processes of the 18th century BC, as well as for comparisons of the weights of

[77] Limet 1960, 247.
[78] *UET III* 305 (Legrain 1947, 211).
[79] See Salonen 1966, 252 (from Stevenson, CIS II.1, no. 65).
[80] Limet 1960, 222.
[81] For all these, see Limet 1960, 198ff.
[82] Salonen 1966, 252. On page 253 he gives the different examples of *Kessel* (of bronze or copper) ranging from a capacity of 1 litre to a weight of 15 kilograms.
[83] Legrain 1947, 225; Limet 1960, 198ff. See for instance the technical study of the wheel of the royal Assyrian chariot; the wheel has a diameter of 0.90 m. and is reckoned to have a metal tie: Spruytte 1994, 38.
[84] Kempinski & Košak 1977, 91-93.
[85] Otten 1955, 128.
[86] Kempinski & Košak 1977.
[87] *CAD, s.v. kaspu* (CCT 1).

metal products. I refer, by way of example, to one –of the various– tablet from Mari (*ARM* XXV, 719), for the alloys perscribed for the manufacture of particular items:

'1 1/2 mine 2 sicles de cuivre pur d'Alasia, 5 1/3 sicles d'étain, pour 1 vase ... et 1 poignard de bronze de 7 sicles.

1 mine de cuivre pur, 10 sicles d'étain, pour 1 hache.

2 mines 5 sicles de cuivre, 2 1/3 sicles d'étain, pour 2 houes de cuivre...'.[88]

Also to tablet *ARM* XXV, 354, for a detailed record of the quantity used during the manufacture of the item:

'2 1/3 mines 4 [sicles] de cuivre lavé, pour 24 étoiles diverses, de chacune 6 sicles, pour diverses portes...'.[89]

3.2. Comparison with the Mycenaean tablets

If we transpose to the above Near Eastern sources the data taken from the Mycenaean tablet **Jn 658**, which records despatches of a quantity of copper *M* 5 (five kilograms) to each craftsman (that is, 10 –Babylonian– minas or 600 shekels), we may imagine what the craftsman would be able to manufacture from this quantity:

10 axes (or 5 at least Hittite axes), since each axe weighed about 1 mina (Hittite axe 2 minas, possibly of lighter weight)

or

from 16 to 26 hoes, of average weight 36 or 23 shekels, respectively

or

from 10 to 20 kraters (does this perhaps mean cauldrons?), weighing ½ to 1 mina, or just two large vessels, each of 5 minas weight

or

from 20 to 30 chisels weighing 28 or 20 shekels, respectively

or

more than 14 daggers, etc.

The output per mina (that is, the weight *N* 2 in Linear B) might be reckoned at 1-2 kraters or two 'oil vases' or an axe or a hoe or a dagger, though with a smaller usable (?) excess, indicating that the smallest quantity allotted in the Mycenaean tablets is quite properly *M* 1 *N* 2, equivalent to 3 minas.

It may be concluded from the above that, at the opposite process recorded in tablet **Jn 829**, the copper contributed to the palace, which is grouped together in quantities of *M* 2 (4 minas), *M* 3 *N* 3 (7½ minas) and *N* 3 (1½ minas) might have taken the form of finished products, whether still functional or not. The smallest quantity of copper found to date in a Linear B tablet is *N* 3; according to the standards of the Near Eastern sources, therefore, every *po-ro-ko-re-te* could theoretically contribute 1 axe and two hoes together, or 2-3 chisels, or one large and one small cauldron, and so on, for recycling in order to manufacture the weapons recorded in the same tablet. This might better account for the ownership of copper in this case: that is, it was owned in the form of vases or tools. The great value attaching to ownership of metal objects is apparent from a document from Deir el-Medina, relating to the trial of a woman who stole a chisel that someone had buried beneath the threshold of his house;[90] or from a statement in a

[88] Limet 1986, 218.

[89] Limet 1986, 113.

[90] Rommer 1984, 79.

tablet from Ugarit relating to a Hatti merchant who confessed that he had stolen two copper vases and had been sentenced to pay three times their value to their owner.[91]

In any case, the conclusion to be drawn with regard to the large or small quantities of copper in the tablets depends on who the final recipient of the artefacts was. In other words, on whether or not the palace expected the copper to be returned by the coppersmiths of Pylos in the form of finished products, or (and) supplied the raw material to meet the needs of the district. Most importantly of all, we are still unaware of the frequency of the supply within a single year. If the palace wanted to control the production of weapons, it would theoretically have to control not only the supply of copper, but also all forms of ownership of it, though it seems to me that this would have been difficult. Was the only recourse open to it therefore to control the know-how in weapons-manufacture[92] (possibly even to ban their production)? One answer might be that the palace enjoyed a monopoly of tin, in which case ordinary people would only be able to recycle the bronze from vessels and tools. Control of tin by the palace, combined with control over the spread of technology, might restrict the ability of private individuals to manufacture weapons, at least in significant quantities.

The answer to the question of the absence of tin from the Mycenaean tablets may thus lie in the nature of the documents at our disposal, which related to the internal circulation of goods, between the palace and its subjects, or between the palace and its region.[93] As already mentioned, the Mycenaean documents do not deal with international relations, and do not therefore record the despatch of tin (as at Mari, for example –though it should be noted that Mari was a transit centre in the distribution of tin).[94] If *ka-te-ro* means tin, we have a record of 4 talents kept in the palace storerooms (tablet **KN Og 5515 + 5518 + 5539**). If, however, tin is not mentioned at all in Linear B, does this mean that the palace never supplied tin to meet the requirements of the settlements (and never made payment in tin, as in certain situations in the Near East)?[95] Craftsmen might be able to procure the necessary tin by blending in recycled bronze. Proof of this might possibly be furnished by investigation of the, probably constant, quantity of tin used in daggers (with the acceptance that these were made only in palace workshops), in contrast with the great variation observed in the percentage of tin in tools, such as chisels.[96] So, would the palace have sent only copper, or rather a combination of copper and bronze, for the needs of the regions? And if so, what were these needs in terms of bronze or copper?

4. The Requirements of a Settlement: Quantities of Copper

The requirements of the inhabitants of a settlement might be calculated by measuring the weight of actual objects of household equipment, and to this end finds from the excavation of

[91] From Rainey 1963, 321, see note 78. The same penalty was imposed in an Egyptian document for the same offence, though it is not clear whether three times the weight in copper is meant, or three times the value: see Janssen 1975, 410.

[92] Cf. also views by Driessen & Schoep 1999, 396-397.

[93] This simply implies the existence of other type of documents for recording the overseas exchange of the specialised products recorded in the tablets. Tin belongs to the 'materials and goods of high prime or convertible value' traded by 'formal, high-level exchange procedures' (Sherratt 1999, 179).

[94] See Heltzer 1989, 10-12, 13-14, 24 and note 23 for the publication and interpretation of the document A 1270 from Mari, which refers to the despatch of tin, destined for Cretan recipients, amongst others.

[95] See, by way of example, Dalley 1984, 64 (VII 218).

[96] See Μιχαηλίδου 1997a, 646.

Akrotiri, Thera, have been weighed.[97] I append a number of measurements that I believe are indicative of the small quantities of copper required (Table 1):

Table 1. Copper/Bronze Artefacts from Akrotiri (Thera) with their weight-values.

METAL ARTEFACT	PRESERVATION	WEIGHT (grams)
Fish-hooks	Complete	0.9 or 4.6 or 12.2
Needle	Complete	2.2
Hinges	Complete	1.2 or 2.5 (each)
Pin	Complete	7.1
Pin	Almost whole, oxidized	4.3
Balance pans	Complete	13 or 16.2 or 52.5 (each)
Miniature dagger	Complete	9.9
Knife	Almost whole	42.8
Miniature laver	Complete	94.7
Miniature pitcher	Complete, oxidized	55.6
Daggers (Fig. 3)	Complete	163 or 303
Chisels (Fig. 4)	Almost whole	129.7 or 272.8
Tripod cauldron	Incomplete	Estimated *ca.* 2,000
Laver	Incomplete	Estimated *ca.* 1,500
Bands or strips One strip	Complete	A cluster of them: 9.5. Of standard size maybe (9 cm. x 4 mm.): 1.5

The two chisels weighed at Akrotiri have weights of 129.7 gr. (Fig. 4) and 272.8 gr. (the latter value corresponds with the weight of chisels in the Ashmolean Museum).[98] Each of the above chisels falls within the range of the smallest quantity of *M* 1 *N* 2 = 1.5 kg. in Linear B, from which each craftsman could make at least 5 chisels weighing 300 gr., or 10 chisels weighing 150 gr. (cf. also the relevant weights in the Ur-III tablets cited above).

Another way of estimating the quantities of metal in circulation in a certain settlement would be to consult the records of metal if any were found inside the settlement. To this end, the best evidence comes from Egyptian sources:

For Egyptian chisels, we have references on *ostraca* (inscribed potsherds and limestone flakes) and papyri from the workmen's village at Deir el-Medina: '*...[sc]ulptor Amen<nakh>te (?), one chisel of six deben, complete for the crew*'.[99] This weight (6 x 91 gr. = 546 gr.) seems to be standard for the chisel that in this case had to be heavy enough for use by stone-masons working on the construction of tombs in the Valley of the Kings.

The above weight is that of a tool that was issued by the central authority; three types of tool –the cold chisel or spike (*h3*), the mortising chisel (*md3t*) and the hoe (*krdn*)– are frequently

[97] Unfortunately, it has not been the practice so far to give the weights of bronze objects in publications of excavation material, and it is not possible at present to compare the Akrotiri figures with Mycenaean copper objects.

[98] Evely & Northover 1995, 97, 100.

[99] Eyre 1980, 110.

recorded together and seem to have formed the basic equipment of stone-masons who worked on tombs.[100] The person responsible for issuing tools to these workers, and also for taking them to the coppersmith for repair, was a kind of 'warehouse-keeper'. One such official, named *Karo*, is said to have been in correspondence with the general *Pi'onkh* about copper to be collected and issued to coppersmiths: the general asked for spears needed in the ongoing fighting in Nubia, so in place of tools, the coppersmiths were making arms.[101] Interesting evidence is also supplied by a special category of the inscribed potsherds or stone flakes, functioning as counter weights, one example being marked as '*Weight of copper of Menna*', which means that instead of noting the exact weight in *deben* or *kite (qedet)*, a stone of equal weight and suitably inscribed was kept as evidence.[102]

As we have already seen, the inhabitants of this village also had their own tools that they used for private work. The tool *'nt* for example, is the carpenter's adze, frequently depicted in representations in art (Fig. 5), though not included in the documents referring to the distribution of tools at Deir el-Medina. One *ostracon* records the loan of a *'nt* to make Menna's wooden bed and three spoons. The weight of this tool is defined as 4 *deben* (4 x 91 gr. = 364 gr.) by one reference.[103] Another tool, the axe, is frequently qualified as a 'carpenter's axe', and the record of 5-7 *deben* on the *ostraca* may indicate its value, though it will certainly not have been far removed from its actual weight?[104] The axes used by shipbuilders are expected to be heavier: the *Reisner II* papyrus (dating from the Middle Kingdom) gives a weight for them of 40 to 50 *deben*.[105] At this earlier period, though, *deben* meant the unit for gold equivalent of 12-14 gr., and the above higher weight values would in fact correspond with 6-7½ *deben* of the New Kingdom. In the same papyrus from the shipyard some axes weigh only 19 Middle Kingdom *deben*, or about 3 New Kingdom *deben*, making them even lighter than the axes of the Deir el-Medina sherds.[106] The different theory advanced by Vercoutter should be noted here, however: that in the Middle Kingdom a special *deben* of copper was used, that was twice the value of the *deben* of gold, that is 27.5 gr., a value that in fact gives the shipbuilder's axe a considerable and appropriate weight.[107] Another tool, the *wp*, translated as 'carver' by Gardiner, has a weight of two *deben*.[108] Finally, the only weapon recorded on the ostraca is the *niw*, which is thought probably to mean spear; the references in papyri to 2 *deben* for each one of the eight large and to 1½ *deben* for each one of the nine small ones indicate their weight, and must therefore refer to the heads of the weapon.[109]

In the case of vessels, I refer to an interesting source for the distribution of copper amongst private individuals: papyrus *P. Cairo* 65739 (period of Rameses II), in which a woman, *Erknofre*, lists amongst the goods she gave in exchange for a slave-girl, some copper vessels she had acquired from her neighbours, citing first their weight in copper and then their value in silver.[110]

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[100] Janssen 1975, 312-319.
[101] Černy 1973, 159.
[102] Peet 1930, 160.
[103] For all this information, see Janssen 1975, 321.
[104] Janssen 1975, 322-323. Metal objects invariably present this problem.
[105] Simpson 1965, 25.
[106] Janssen 1975, 323.
[107] Vercoutter 1977, 444.
[108] Janssen 1975, 324.
[109] Janssen 1975, 326.
[110] Gardiner 1935, 142. The problem of the translation with the word 'bought', or of the concept of the 'value' of goods is not dealt with in the present chapter, but is reserved for a special study (see by way of example Michailidou 2000, 198ff.).

'*...Bought from the citoyenne Kafy, 1 g3y-vessel of hsmn-bronze, makes 18 deben, makes 1 2/3 kite of silver.*

Bought from the head of the storehouse Pyiay, 1 g3y-vessel of hsmn-bronze, makes 14 deben, makes 1 1/2 kite of silver.

Bought from the wkb-priest Huy-(10)Pinhas, 10 deben of beaten copper, makes 1 kite of silver.

Bought from the wkb-priest Aniy, 1 g3y-vessel of hsmn- bronze, makes 16 deben, makes 1 1/2 kite of silver; 1 mnt-vessel of honey, makes 1 hekat, makes 5 kite of silver.

Bought from the citoyenne Tjuiay, 1 cauldron of hsmn-bronze, makes 20 deben, makes 2 kite of silver.

Bought from the steward of the house of Amun, Teti, 1 kbt-vessel of hsmn-bronze, makes 20 deben, makes 2 kite of silver;...'.

Gardiner comments on this document: 'Copper vessels or corn passed in Ramesside times as regular currency, their value (here given in terms of silver) being assessed by weight... Much more probable is the conjecture that one or other of the articles given [to the merchant] was already in her possession when he approached her, and that in the deed of sale which she gave him was merely recorded the price she had previously paid for the article in question, and the person to whom she paid it. Indeed, it is conceivable that a prudent housewife might keep by her a little stock of goods belonging to and priced by her neighbours which she did not desire for her own use, but might keep handy for such unexpected barter as we are here considering'. He naturally notes the ratio of 100:1 between copper and silver in the 16th year of Rameses II. Gardiner continues: 'This ratio is given in l. 10 where a weight of 10 *deben* (or 100 *kite*) of beaten copper is valued at 1 *kite* of silver. Further indirect confirmation is provided by the values attached in the adjacent lines to objects of *hsmn*-bronze. We do not know the exact distinction between *hsmn* and copper, but the former is doubtless an alloy of the latter and not so very different from it. Of the five vessels of *hsmn* here mentioned, two have a silver-value exactly one-hundredth of their actual weight. The other three are priced at either a little less or a little more than this proportion. The fluctuation may have depended partly upon the condition and workmanship of the articles, and partly upon the comparative keenness of buyer and seller'.[111]

I note that the cauldron of 20 *deben* has a weight of 20 x 91 gr. = 1,820 gr. –slightly less than that calculated for the tripod cauldron from Akrotiri (Table 1). The quantity of 10 *deben* of beaten copper may refer to a fragment of a vase or fragments of vases, given that vases were often manufactured from a pure copper sheet. These are thus Zaccagnini's categories b and c, mentioned at the beginning of this chapter (p. 90) as forms in which copper circulated.

5. The Palace Again: Quantities of Gold

Of the quantities of gold recorded in the Linear B script, Petruso has well observed that 'they amount from one double mina down to –incidentally– a weight equivalent to our unit of *ca.* 61 grams',[112] I do not agree, however, with the view that the reference in tablet **Jo 438** to the quantity *P* 3 is a fortuitous coincidence with the basic unit of 61 grams on Petruso's system. This was the way of recording the old 'Minoan' unit in the Mycenaean talbets; it has been calculated that the total quantity in this tablet does not exceed 6 kilograms[113] recorded as follows: one

[111] Gardiner 1935, 145-146. The values of the vessels do not all conform exactly with the ratio 1:100, as Janssen notes (1975, 106, note 28).

[112] Petruso 1992, 64.

[113] Chadwick 1976, 145.

contribution of 1 kilogram (*M* 1), at least eight contributions of 250 gr. (*N* 1), one of 500 gr. (*N* 2), four of 61 gr. (*P* 3), two of 80 gr. (*P* 4), four of about 100 gr. (*P* 5), and five of 122 gr. (*P* 6). In my view, these quantities are not small, but are related to the form in which the raw material was in circulation: as is evident from Egyptian wall-paintings (Fig. 6) gold might be stored (a) as gold dust in bags, (b) as ingots or nuggets, and (c) as ring-ingots. I note by way of example that 124 gr. is the average weight of gold ring-ingots (of the Chalcolithic period?) found at Samaria.[114]

Weights of gold artefacts are recorded in the Near Eastern tablets, beginning with very small quantities. The process of manufacture is described as follows in an Ur-III tablet:

'*1 feuille (?) d'or fin,*
dont le poids est d' ½ sicle
a été fondue;
6 grains de cuivre ont été melangés
l'alliage d'or a été produit
pour (faire) 2 boucles d'oreilles'.[115]

Earrings normally weighed 1/3 shekel each, though there are also references to gold earrings weighing 1/4 or 1/6 shekel (giving 2.8 gr., 2 gr. and 1.4 gr. –weights smaller than 3.6 gr., the estimated value of the Linear B metrogram *Q*). Another example of a small weight is provided by the reference to a gold vase for the New Year ritual, which weighed 2 and 2/3 shekels (about 22 gr., the equivalent of the Linear B metrogram *P*).

I believe that the quantities contributed to the palace of Pylos in tablet **Jo 438** are far from small, when account is taken of the view that in a Middle Assyrian letter 2 shekels of gold (about 17 gr.) are sent with a commission to organise a banquet.[116] It would be interesting to take into account the measurements of weights made on intact Mycenaean vessels by E. Davis[117] (see Table 2, where the equivalence to the 'Minoan unit'[118] is given in the column under the heading *M*).

Table 2 reveals the following possibilities with regard to the quantities recorded in tablet **Jo 438** from Pylos.[119] The record of a donation of gold weighing *M* 1 could represent the gold goblet inv. no. 351 in the National Archaeological Museum, Athens (Fig. 7), weighing 1,004 gr. The contribution of a quantity of *N* 1 (at least by eight people) could have been made in the form of the cup no. 629 in the National Archaeological Museum (Fig. 11), weighing 253.6 gr.

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[114] See Gopher 1995, 79, for the gold rings in a Chalcolithic (?) context in the Qanah cave. They have been considered cast products that were then beaten and form '*ingots ainsi préparés pour en faciliter le transport*', and attributed to a mine in Nubia. Cf. also *Documents*, 359 for what has been written so far on the weight of gold rings from the citadel at Mycenae, but see also the objections by Petruso 1992, 12-13.

[115] Limet 1960, 45, from where the French translation of the Akkadian text is taken; cf. Legrain 1947, *UET III* 452.

[116] van Driel & Jas 1991, 65.

[117] Davis 1977. E. Davis was the first to take weight into account in studying metal vases; cf. her intervention in the paper read by Michailidou 1990, 419.

[118] Of 61 gr. (Petruso 1992, 60), 65.5 gr. (according to Evans, Caskey and Parise), 68 gr. (Weingarten 1994).

[119] Webster has already pointed out that the contributed amounts of gold in **Kn01** (**Jo 438**) fall within the range of weights shown by cups from the Mycenae shaft graves, and might be designed as such (see *Documents*, 359).

Table 2. Gold Mycenaean vessels.

A	IM	P	W	D	M	B
Miniature pyxis with lid (gold)	EAM 85	Mycenae Shaft Grave III	9.95		1/6 (-) unit	Davis 1977, 241, no. 94.
Miniature vessel with lid (gold)	EAM 84	Mycenae Shaft Grave III	12.4			Davis 1977, 243, no. 96 (restored).
One-handled cup (gold)	EAM 220	Mycenae Shaft Grave II	26.55	2 (13.3)		Davis 1977, 139, no. 32.
Conical cup (gold)	MM 61.71		28	2 (14)	1/2 (-) unit	Davis 1977, 326, no. 145.
One-handled cup (gold)	EAM 912	Mycenae Shaft Grave VI	28.1	2 (14)	1/2 (-) unit	Davis 1977, 137, no. 31.
One-handled cup (gold)	EAM 627	Mycenae Shaft Grave V	35.2	2½ (14)		Davis 1977, 190, no. 33.
Miniature vessel with lid (gold)	EAM 83	Mycenae Shaft Grave III	44.95	3½ (12.8)	2/3 unit	Davis 1977, 242, no. 95.
Ewer (gold)	EAM 74	Mycenae Shaft Grave III	47.85	3½ (13.6)		Davis 1977, 237, no. 91.
One-handled cup (gold)	EAM 392	Mycenae Shaft Grave IV	60	5 (12)	1 unit	Davis 1977, 174, no. 58.
One-handled cup (gold)	EAM 73	Mycenae Shaft Grave III	65.5	5 (13.1)	1 unit	Davis 1977, 235, no. 89.
One-handled shallow cup (gold)	EAM 6441	Marathon Tholos Tomb	66.7	5 (13.3)	1 unit	*Mycenaean World*, 121 (59); Davis 1977, 304.
One-handled cup (gold)	EAM 393	Mycenae Shaft Grave IV	66.5	5 (13.3)	1 unit	Davis 1977, 175, no. 59.
One-handled cup (gold)	MH 758	Hag. Ioannis Grave	68	5 (13.6)	1 unit	Davis 1977, 109, no. 19.
Kantharos (gold)	MM 07.286.126		71.5	6 (11.9)		Davis 1977, 324, no. 143 (restored).
One-handled cup (gold)	BM 1900.7.27.1		72	6 (12)		Davis 1977, 323, no. 142.
Pyxis with lid (gold)	EAM 72	Mycenae Shaft Grave III	81.4			Davis 1977, 240, no. 93; *Mycenaean World*, 82 (12).
Cup (gold)	EAM 442	Mycenae Shaft Grave IV	96.2	8 (12)	1½ unit	Davis 1977, 172, no. 56.
One-handled semi-globular cup (gold)	EAM 8743	Dendra Chamber Tomb 10	95.7	8 (12)	1½ unit	*Mycenaean World*, 92-93 (22); Davis 1977, 267.
One-handled cup (gold)	EAM 441	Mycenae Shaft Grave IV	101.2			Davis 1977, 172, no. 55.
Shallow one-handled cup (silver with gold)	EAM 1875	Vapheio Tholos Tomb	117.6			*Mycenaean World*, 102 (31); Davis 1977, 260.
One-handled goblet (gold)	EAM 656	Mycenae Shaft Grave V	127.7	10 (12.7)	2 units	Davis 1977, 165, no. 52; Βασιλικού 1995, 45, fig. 19.

Table 2. (Continued).

A	IM	P	W	D	M	B
One-handled cup (gold)	EAM 313	Mycenae Shaft Grave IV	169.5	13 (13)		Davis 1977, 173, no. 57; *Myceanaean World*, 81 (11).
One-handled cup (gold)	MC 2634	Peristeria Tholos Tomb III	175.5	13 (13.5)		*Mycenaean World*, 109 (41); Davis 1977, 251.
One-handled cup (gold)	EAM 628	Mycenae Shaft Grave V	176.7	13 (13.6)		Davis 1977, 140, no. 34; Βασιλικού 1995, 45, fig. 17.
One-handled semi-globular cup (gold)	EAM 7341	Dendra Tholos Tomb	195	15 (13)	3 units	Βασιλικού 1995, 130, fig. 98; Davis 1977, 276.
Kantharos (gold)	EAM 440	Mycenae Shaft Grave IV	205.2	15 (13.7)	3 units	Davis 1977, 175, no. 59; Βασιλικού 1995, 46, fig. 20.
Lidded vessel (gold)	EAM 391	Mycenae Shaft Grave IV	216	16 (13.5)		Davis 1977, 176, no. 61.
One-handled cup (gold)	EAM 629	Mycenae Shaft Grave V	253.6	20 (12.7)	4 units	Davis 1977, 141, no. 35; Βασιλικού 1995, 45, fig. 18.
Vapheio cup (gold)	EAM 1759	Vapheio Tholos Tomb	280.5	21 (13.3)		Βασιλικού 1995, 126, fig. 92, 93; Davis 1977, 256.
Vapheio cup (gold)	EAM 1758	Vapheio Tholos Tomb	276	21 (13.1)		Βασιλικού 1995, 127, fig. 95, 96; Davis 1977, 257.
Two-handled 'Nestor's cup' (gold)	EAM 412	Mycenae Shaft Grave IV	295.8	22 (13.4)		Davis 1977, 183, no. 63; Βασιλικού 1995, 46, fig. 22.
Two-handled goblet (gold)	EAM 959 (957-960)	Mycenae Akropolis	314.7	24 (13.1)	5 units	*Mycenaean World*, 69 (1); Davis 1977, 291-293.
Kantharos (gold)	EAM 7381	Kampos, Kalamata	336.6	25 (13.5)		*Mycenaean World*, 108 (40); Davis 1977, 305.
Vapheio type cup (gold)	EAM 630	Mycenae Shaft Grave IV	339.5	25 (13.6)		Davis 1977, 144, no. 38.
One-handled goblet (gold)	EAM 427	Mycenae Shaft Grave IV	449.5	35 (12.8)	7 units	Davis 1977, 220, no. 84.
Lion rhyton (gold)	EAM 273	Mycenae Shaft Grave IV	633	50 (12.7)	10 units	Davis 1977, 179, no. 62.
One-handled goblet (gold)	EAM 351	Mycenae Shaft Grave IV	1,004	80 (12.6)	16 units	Davis 1977, 204, no. 82; Βασιλικού 1995, 46, fig. 21.
One-handled goblet (electrum, gold, niello)	EAM 390	Mycenae Shaft Grave IV	1,057	84 (12.6)	17 units	Davis 1977, 208, no. 83; Βασιλικού 1995, 49, fig. 24.

A: Artefact; IM: Inventory of the Museum; P: Provenance; EAM: Athens, National Archaeological Museum; MM: Metropolitan Museum (New York); MH: Museum of Herakleion (Crete); BM: British Museum (London); MC: Museum of Chora (Pylos); W: Weight in grams; D: Egyptian *deben* of gold (12-14 gr.); M: 'Minoan' unit (60-68 gr.); B: Bibliography.

The contribution of a quantity of *P* 5 (four records) could have taken the form of the gold cup no. 441 in the National Archaeological Museum, weighing 101.2 gr. The donation of a quantity of *P* 3 (four records) could have been in the form of the gold cup no. 73 in the National Archaeological Museum (Fig. 9), weighing 65.5 gr., and so on. Of course, the majority of the vases in Table 2 are of an earlier date than the Linear B tablets at our disposal, but they are helpful in indicating the possible size or form of the circulating gold.[120] Besides, some forms are recognizable in Linear B ideograms, e.g. the vases in Fig. 17-18.

From the point of view of manufacture, some of them clearly fall within the 'Minoan' unit, but since a smaller unit was surely needed for the weighing of gold, and A. Evans has considered the Minoan unit as a 5th multiple of the Egyptian *deben* of gold (12-14 gr.)[121] in the column under the heading D, I have tried the equivalences to this unit, which was predominant during the Middle Kingdom and still attested in the beginning of the 18th Dynasty in the time of Amenophis I at least (1551-1524).[122] They seem to fit well in this system. Of course, the range in the value of *deben* is most convenient, but I have tried to use the one closer to the optimum of 13.6. And I am aware of the discussion such an equivalence may rise again on the subject of the provenance of the gold of the Shaft Graves. I must add that the purity of the gold of the vessels is another matter; also that bronze wires in the handles or other copper reinforcements[123] would influence the total weight. In other cases, like the kantharos from Kalamata (EAM 7381) or the vase from Mycenae (EAM 656) of Fig. 16, no such reinforcements are reported, and the weight of 25 Eygptian deben of gold (of the optimum value of 13.5 gr.) for the former and the weight of 2 'Minoan' units (of the value of 63.85) for the latter, might therefore be considered as pre-determined quantities of gold. For those vessels in the Table 2, that are of a later date than the Shaft Graves contents, the estimation of value could be calculated according to the New Kingdom *deben* of 91-93 gr.: for example the cup from the tholos tomb at Dendra (EAM 7341) is equivalent to 2 *deben* (and as noticed by Davis is twice the weight of the cup EAM 8743 in Fig. 19, coming from a chamber tomb at Dendra).

6. Quantities of Silver: Palace and Private Individuals

Why is silver not recorded in the Linear B tablets? And what about lead (since silver was produced in the Aegean by cupellation of lead)? In the case of the tablets in the **KN Og** series the view has been advanced that they probably contain records of metals;[124] I mention this here purely as a possibility, precisely because in these tablets the commodity –the nature of which escapes us– was measured in units of weight. In the Near East, silver is usually recorded in minas and copper in talents.[125] Of course this is not so in instances of quantities of copper smaller than a talent; for example in some texts from Mari recording the loss during the process of refining copper, the calculation is made in minas for obvious reasons: '*12 m URUDU.KUR* (mountain copper) *washed, loss of 2 m., result 10 m mesü* (refined copper)'.[126] The interesting

[120] See also the hypothesis (Palaima 1999) that the gold vessels recorded in the tablet **Tn 316** were heirlooms.
[121] Evans 1906, 345.
[122] From the 18th Dynasty onwards it is replaced by the *qedet* unit of 9.1 gr. resulting to the New Kingdom *deben* of 91-93 gr.: Cour-Marty 1990, 23.
[123] E.g. Davis 1977, 334-337.
[124] See, e.g., the chapter by Dialismas in the present volume.
[125] In the Hittite 'Metal Inventories' (Kempinski & Košak 1977), for example, I note that copper is reckoned in talents and silver and gold, and also tin, in minas.
[126] Dercksen 1996, 112. *m* = mina.

feature of the **Og** tablets is that the quantities of the unknown commodity recorded are not converted into talents (*L*) even when they are of more than one talent (or 30 *M*). We have, for example, weights –possibly of metal– not only of 30 *M*, but also of 80 and 130 *M*. If the commodity recorded is the same in all these tablets, this feature argues in favour of its being gold or silver, especially when the same commodity is recorded in small subdivisions such as *P* 4 (cf. the weight of the golden vessel inv. no. 72 in Table 2 above), and particularly when it is recorded in multiples of the type *P* 20 (tablet **KN Og(1) 7432**), without the quantity being converted –as one would expect– into *N* 1 *P* 8. The impression given is that the record was made in the same way as the actual measurement –that is, in units of *P* (around 20 gr.) or *M* (1,000 gr.). As for the equivalence of *M* to 2 minas, this recalls the Hittite reference to 2 minas of silver in eagle weight, which seems to indicate that silver was measured with a weight in the shape of an eagle and weighing 2 minas. In the context of a possible correlation of the metrogram *P* (**115*) to a basic unit for measuring silver, it is perhaps not fortuitous that the Linear B term *ta-to-mo* coexists on the same sealing,[127] as the sign *143*, which Chadwick associated with silver,[128] in view of the similarity between the signs *143* and **115*. The weights of objects made of silver in the Near Eastern tablets vary, but silver rings (which may have been another form of ingot) in the Ur-III period were made with a weight of 5 or 10 shekels, that is about 42 gr. (*P* 2) or 84 gr. (*P* 4). The Mycenaean record *P* 20 could thus –theoretically– refer to 10 or 5 rings of silver of the corresponding standard weights. (We have already seen that gold earrings normally weigh 1/3 of a shekel, that is 2.8 gr., less than *Q* 1.) In the Near East, silver is usually recorded in small quantities, but Lambert believes that it circulated at all social levels as early as the Ur-III period.[129] I do not deal here with the view that silver serves as a kind of capital[130] for commercial exchanges, an example being the well-known loans of various quantities of silver ranging from 2.66 gr. to 500 gr., recorded in private archives of the Old Babylonian period.[131] Small quantities are also recorded for craft-industry use –the quantity of 2.8 gr. of silver, for example, is given for the sheathing of a rivet on a dagger.[132] In the Mycenaean tablets there is only one possible reference of this kind.[133] We might also note the weight of 261 gr. (around *N* 1) of a silver cup found in Chamber tomb 78 of Mycenae (Fig. 15). Is it possible that *ku-ru-so-wo-ko* is a general name for a craftsman in precious metals (like *ku-dim* in the Near East), and that these craftsmen worked only in palace workshops? Or that they were supplied with the gold or silver when they were summoned to the palace for some specific job (see Homer)?[134]

In the case of the single reference to lead, it might be claimed that the Mycenaean palace did not take an interest in the distribution of this metal, which had a less varied use. At Mari,

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[127] Killen 1985, 149-152.

[128] *Documents*, 51.

[129] Lambert 1963, 86.

[130] In the form of rings, moreover. See, by way of example, the rendering of the word for silver ring *HAR KU.BABBAR* in a document from Mari (*ARM* X, no. 114, 9) which is translated 'ring money', in contrast with the gold 'earrings' regarded as jewellery in the same phrase of this document. The phrase is contained in a letter written by a prominent woman to the queen, to whom she complains that she has fallen victim to theft; the interpretation given to the items stolen is that they consist of jewellery and money (Malamat 1998, 179 and note 11, with the relevant bibliography). But I think we should be more cautious in using the term 'money'.

[131] van de Mieroop 1992, 204.

[132] Limet 1960, 154.

[133] *Documents*, 346-347; see Μιχαηλίδου 1997a, 646.

[134] *Odyssey*, iii 432-438: Nestor gives gold to the 'coppersmith' who has come to his court in order to gild the horns of a sacrificial ox.

however, things are different (possibly because in Mesopotamia lead was often used in an alloy with copper, to make it easier to cast). A document makes it clear that Mukannišum, the head of the workshops, '*s'occupait également de plomb: dans la lettre XIII no 3 il annonce au roi qu'il va lui faire porter immédiatement 10 talents de plomb, poids de 20 kubdu de 30 mine chacun, ce qui (represent) 1/3 de mine d'argent*',[135] Rouault therefore draws the conclusion that *kubdum* = ingot.[136] It would be highly interesting if the half-talent weight of lead discovered at Akrotiri (weighing precisely 30 minas) represented the weight of a *kubdum*, that is the quantity used in the distribution of lead (= *M* 15 in Linear B). It is now time, therefore, to turn to the implements used to measure weight –that is, the balance weights. The reference in a Hittite text to a two-mina weight in the shape of an eagle, has already been mentioned. Repeated references in the tablet **Og 1527** to a quantity of lead of *M* 3 (= 3 kilograms) is consistent with the discovery at Akrotiri and Thebes of actual lead weights in the form of discs weighing 3 kilograms (which have been identified with the *LANA*, the special Linear B weight unit used for wool).[137] The objects recorded in the Near Eastern tablets are often weighed by officials, but balances and weights were also privately owned.[138]

Returning now to the question of private ownership, we may note that the list of items owned by a Sumerian includes metal vessels, grain, clothes, fruit, furniture, and wooden objects, and also a copper-sheathed weighing scale with copper discs.[139] Evidence may also be derived from documents recording dowries. From Ur in the Old Babylonian period, for example, a document from the private archive of Tab-ilisu records the substantial dowry brought by his wife, Rubatum: 1.5 kilograms of silver (that is, *M* 1 *N* 2 in Linear B), five slaves, and many pieces of furniture and household vessels.[140] We may also note wills, like the one from house no. 2 in Church Lane in Ur of the Old Babylonian period, the text of which is preserved in tablet *UET* V, no. 112:[141] five brothers share a roofed area of 143 square metres, a demolished house of 60 square metres, two slaves, 276.25 gr. of silver (that is, a little more than *N* 1 in Linear B) and a large number of items of different materials. The movable property includes twelve doors, five beds, ten chairs, two buckets and a vessel holder, all made of wood or palm-fibre. The metal objects recorded in this list are six bronze knives, five bronze vessels, one copper container, half a kilogram of copper (that is, *N* 2 in Linear B), seven scales, and two vessels for measuring capacity. The stone items are one vessel, five plaques of lapis lazuli, three millstones and three mills for cress. The brothers also shared three spoons, three balances, a reed item and four baskets. Balances, then, were an appreciable part of the household equipment. Metals, too, mainly copper/bronze, though also silver, circulated (in a variety of forms) not only in the palaces but also in an urban environment. The example of the will indicates that they were also recorded in private documents. The existence of private documents in the Aegean is still disputed, but I believe that the preceding discussion has demonstrated that metals were owned in by no means negligible quantities by various social strata.

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[135] Rouault 1977, 164.
[136] Rouault 1977, 164.
[137] Petruso 1986; Αραβαντινός 1995.
[138] See also Michailidou 1999.
[139] Limet 1960, 196.
[140] Limet 1960, 144 (from *UET V*, no. 793).
[141] van de Mieroop, 1992, 226.

EPILOGUE

The introduction to this chapter began with the sentence 'Metal is known to have circulated over a wide geographical area in standardised form and in large quantities'. Its main theme has been to seek out the quantities recorded in documents or attested by excavation evidence. We have sought these quantities of metal in archives and documents of various kinds, and we have measured them in ancient objects. We have ranged widely not only geographically but also chronologically, in the belief that the use value and the exchange value of metals were similarly combined in the substructure of the advanced Bronze Age societies from the Aegean to Mesopotamia, since these societies all belong to the pre-coinage level of economy. We exploited any relevant evidence that looked promising to our aim, which was to form as broad as possible a picture of the place occupied by quantity in the circulation and recording of metals.

Hitherto, research into the ancient world has sought, with the aid of specialisation, to establish chronological and geographical parallels. The world of Akrotiri at the time of the Linear A script is of course different from the world of the Mycenaean palaces of the period of the Linear B script, and is even further removed from the multi-faceted world of the Near East. However, it is through these differences that we may better approach the mechanisms by which metal circulated, thereby forming a picture that might perhaps escape us if the evidence is viewed only from the fragmented perspective of specialisation. Most importantly, this method establishing differences between cultures, gives rise to further questions. Research should progress from a specialist to a synthetic approach, to the formation of a global picture, and then turn again to new –specialised– problems.

Something of the desired picture with regard to quantity –the factor we set out to examine– has perhaps emerged from this chapter.[142] The important thing is not so much that –for example– the axe recorded in Ur-III documents mostly weighs 1 mina, while in Hittite texts it has a weight of 2 minas, for there will undoubtedly have been a range of different weights for all categories of object.[143] What is important is that in both cases, the weight is accurately recorded, whereas in Mycenaean documents it is not recorded at all: so far, we have records either of the weight of the raw material, or the name of the end product, but not the two together.

Of course there is the circumstance that the texts have been preserved selectively, new Linear B tablets may be expected to fill the gaps mentioned. But if we ignore this convenient –though also probable– factor, one explanation of the absence of the concept of weight for artefacts in the tablets might be that some of the Mycenaean coppersmiths were not expected to return the finished products after they had taken receipt of the copper/bronze from the palace. In this case we would be obliged to abandon the idea that any smith receiving raw material from the palace belongs to the dependent personnel. The palace needed to know where the copper/bronze went, so what was recorded were the names and places of the receivers and the quantities supplied for the requirements of the settlements –and we have seen the uses to which these quantities might be put. In this case, however, the coppersmiths of the tablets in question (**PY Jn** series) would not have been those working for the needs of the palace;[144] this would explain why

[142] In comparison with Tournavitou & Sugerman (in press), I am more hopeful in using the data from the Orient. We need not try to find an answer (or a model) ready for transportation to our specific investigation.

[143] Depending on the occasion of recording: e.g. in the Hittite Laws the manufacture of a 2-minas weight bronze axe and of 1-mina copper axe are both mentioned, in regard to the different corresponding 'wages' to the smith (Hoffner 1997, 128).

[144] I agree with De Fidio's comment for '*une interaction complexe entre palais et communautés*' (De Fidio 1992, 189).

there are –as yet– no records of copper tools, which would have been produced by them locally for the needs of the population and therefore were not recorded by the palace. If this was the case, we are obliged to posit the existence of other coppersmiths, working for the palace and delivering the products of their work directly, possibly without recording them on clay tablets.[145] If we assume that there was such a clear distinction between two categories of coppersmiths, to which category did the tax exemption (mentioned in the tablets **PY Ma** and **Na**) apply? Comparison with weavers might be of assistance here; like the coppersmiths, they were also involved in the *talasia* system, though in their case the weight of both the raw material and the finished product was indicated: when the textiles were delivered, their weight was often recorded, depending on the type of fabric. We might also contemplate where we should classify the coppersmiths of the Potnia, and also wonder about the status of the jewellery maker in Linear B period: if the latter was the same artisan as the *ku-ru-so-wo-ko*, who is possibly assigned to the palace, and if we assume in consequence that jewellery produced *in situ* was not recorded (we have noted the absence of jewellery from the tablets so far), then we need to wonder what was the mechanism for the distribution of jewellery, which was by no means limited in scale. Obviously, answers to the above questions cannot be given solely from the point of view of the metals. The products and craftsmen of the Mycenaean documents should be considered together, as a whole. It might be useful, however, to summarise some of the differences –with regard to metals– that have emerged from comparison with the Near Eastern documents, for these differences have furnished us with a certain knowledge of what the Mycenaean metal records might have contained –and yet such details do not exist at present, or have not been identified, or were possibly written on other perishable material, that has not survived in the Aegean climate.

First, we may make the general observation that the Mycenaean tablets do not contain, for the metals mentioned above, the records of their weight at all stages in the process of manufacture. In Near Eastern societies, in contrast, the weight is recorded in the process of metalworking, invariably in great detail, at the stage of control, and at every level of distribution.

We may then move on to the more specific observation that there is no record of tools, at least on a broad scale, or of jewellery.

In the case of gold vessels, recorded as ritual offerings in the tablet **Tn 316** from Pylos, the type is indicated by the appropriate ideogram, but not their weight.

The impression given is that there were no documents –or at least no documents have been found– referring to the output of palace metal workshops, at least on the large scale of many of the Near Eastern documents.

There was an exception in the manufacture of weapons;[146] here we may add the fact that the tablet **R 4482** from Knossos, which records weapons, comes from the 'Arsenal' (so named after the tablets), where also a vast number of copper arrow-heads were found in wooden chests (which also contained the relevant sealings).[147]

The absence of silver, if not fortuitous, points to two things. First, that we have no record of silver-working, e.g. of the application of silver to the heads of dagger rivets (found in the

[145] And so we are in front of the problem: Who is today invisible for us, the craftsman working independently, not supplying the palace (as Tournavitou 1997, 31 logically infers) or/and the directly connected artisan working perhaps inside the palatial environment and not mentioned in tablets?

[146] For the attention that the Linear B tablets of Knossos lay to weapons-production, cf. Driessen & Schoep 1999, 393ff. 'Were these items then manufactured by palace workshops to serve as alliance gifts?' (Driessen & Schoep 1999, 395).

[147] Evans 1935, 836-840; Palmer 1963.

Aegean, e.g. Fig. 3),[148] and this may perhaps be interpreted in terms of the direct dependence on the palace of the *ku-ru-so-wo-ko* (worker in precious metals). Second, that silver may not have been provided by the palace to its subjects as 'capital'. It is possible, however, that a record of this kind may have taken a less makeshift form than that of the tablets. It should not be forgotten that the Aegean tablets, of unfired clay, had a much more ephemeral function than those of the Near East, where they were fired in special furnaces. The transference of a precious material such as silver may conceivably have been recorded on more enduring material.

The failure to identify tin in the tablets has been noted already and has been attributed to the fact that the Linear B tablets so far discovered are associated with the internal circulation of goods between the palace and its subjects.[149] However, among the so-called loan-contracts at Nuzi, there is the category of the 'interest-bearing' loans, where tin occupies first place along with the other metals, though here too we are dealing with the internal circulation of goods and with private documents, so Zaccagnini's concerns are understandable: 'Quantities of conveyed metals add up to *ca.* 70 talents of tin, 25 talents of copper and only 21 minas of bronze. What is the meaning of these loans, especially in relation with the loans of subsistence commodities (e.g. barley)? In other words, what did these people do with these metals?'.[150]

The feeling that much is escaping us in the Aegean as a result of our failure to discover private documents is discouraging. We can form some picture of what we might expect, again from Nuzi, for example: 'Sales, sale-adoptions, real adoptions, marriage contracts, testaments, loans of various kinds with or without securities, exchanges of real estates, merchant agreements for business ventures, etc.'.[151] If no private documents have been found, however, we cannot be certain that they did not exist. Are the tablets of unbaked clay found in a house of the settlement at Akrotiri, Thera, perhaps the first example?[152] In any case, even if we have no relevant documents, or if we decide that people in Aegean societies did not need them, we may still deduce the private ownership of metal in surplus quantities and qualities, as attested by finds and depictions in art throughout the entire Aegean. We thus come to the crucial question: despite the lack of relevant documents, is there any evidence of ownership of metal for its exchange value in the Aegean too? First, metal vases from the Aegean may have played a corresponding role to the copper, silver and gold vessels of the eastern documents referred to in the preceding sections; one has only to compare vases from Table 2 with similar vases in the tablet **PY Tn 316**,[153] recording ritual offerings of gold vessels (see also Fig. 17-18). Reference has already been made to the fact that copper vessels could be exchanged with other goods (p. 99), and the great variety of copper items in the Aegean could also indicate an exchange value alongside its use value. Vessels made of precious metal might function as a form of currency, along with other forms, such as rings (e.g. the gold rings or the gold bracelet from the Aegina treasury[154] are comparable with the ring-ingots in the wall-painting of the Nubians, with regard to the practice of making a notch on the ring so as to insert one inside the other).[155] I would like to add some silver rings from Akrotiri, Thera, which weigh 2.8 gr., that is about 1/3 of the Babylonian shekel.[156]

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[148] Μιχαηλίδου 1997a, 646.
[149] See above pages 91, 96 and note 55.
[150] Zaccagnini 1984, 147.
[151] Zaccagnini 1984, 141, note 7.
[152] *Prakt* 1993, 183; Μιχαηλίδου 1997b; Boulotis 1998; Michailidou 2000.
[153] Vandenabeele & Olivier 1979, 210-211; and Palaima 1999.
[154] Higgins 1979, no. 38 and 11.
[155] James 1985, fig. 23.
[156] *Thera V*, pl. 17b. This issue forms part of a more specialised and extensive study by A. Michailidou (in preparation).

The societies of the eastern Mediterranean, at least as far east as Mesopotamia, shared a common perception of the value of metal,[157] despite any differences in the purposes and methods of recording it. As to the mechanism of the circulation of metal, weight was everywhere and at all times the primary and most important factor. As Parise has shown,[158] the metrical systems of Western Asia were at times interconnected in such a way that they were able to function at an interregional level. It remains to determine whether there was an internationally recognised metrical system, in much the same way that the Babylonian language (in cuneiform script) formed the international language of correspondence. For example the value of the gold of the two Vapheio cups could, if necessary, be estimated as 3 New Kingdom *deben* (of 93 gr.) or 30 Syrian shekels of 9.3 gr. And a similar 'international' estimation can be applied to the vessels of Fig. 18-19.

Despite the risk of anachronism on our part, we have to pose the question of whether value was measured only on the basis of weight, or also on that of the added labour. The Near Eastern documents frequently give detailed descriptions of vessels –especially when they were made of more than one material– followed by the weight of the precious metals used for the individual parts of the artefact. Of the Aegean examples, it is useful to consider the two cups of the same craftsmanship and weight (of 1 'Minoan' unit) in Fig. 14. And especially the goblet of Fig. 17 which though exceptional nevertheless belongs to a set of four similar ones possibly forming a hoard. It may be that fine workmanship was not assessed separately but was taken for granted when such vessels were sent as taxes or compulsory exchange gifts; their elegance was an element that projected the prestige and preserved the dignity of the (obligatory) donor.[159]

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[157] Even though at one period (e.g. the Fara period) copper and at another (e.g. the period of the Cassite dynasty) gold played the role normally reserved for silver. For copper as '*métal d'échange par excellence*', cf. Limet 1972, note 1.

[158] Parise 1984.

[159] See, by way of example, Liverani 1990. Of course, concerning non-metallic merchandise, I think S. Sherratt is right for the gradual development of production to other export-oriented items 'whose sole value lies in the added value of manufacture' e.g. pottery or faience (Sherratt 1999, 176). For a broader discussion on how value is created, see Voutsaki 1997.

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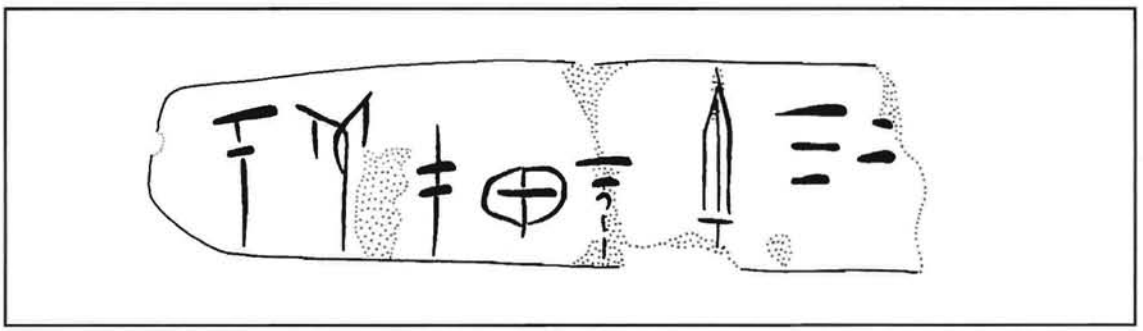

Fig. 1. Tablet **KN Ra(1) 1540** recording a total of 50 swords (after *CoMIK* II).

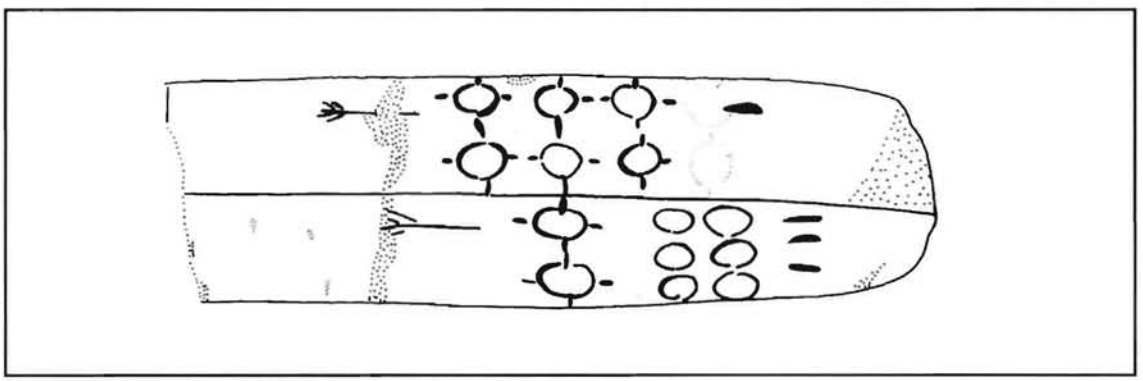

Fig. 2. Tablet **KN R 4482** recording 6,010 and 2,630 arrows (after *CoMIK* II).

Fig. 3. The dagger inv. no. 7318 from Akrotiri (Thera) of 303 gr. weight.

Fig. 4. The chisel inv. no. 3606 from Akrotiri (Thera) of 129.7 gr. weight.

Fig. 5. Carpenter at work: fragment of a wall-painting from an Egyptian tomb. 15th century BC (Berlin, Ägyptisches Museum).

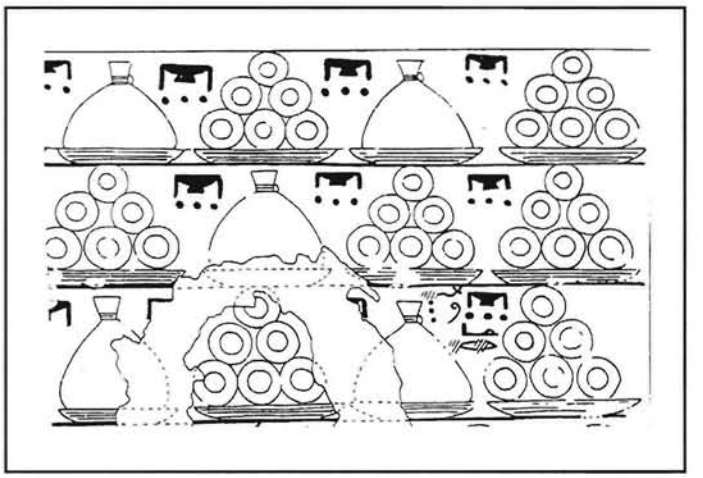

Fig. 6. Gold rings and bags with gold dust (cf. the Hieroglyphic sign of gold above them); detail of wall-paintings in an Egyptian tomb (after De Garis Davies 1933, pl. XXIV).

Fig. 7. EAM 351. Mycenae, Shaft Grave IV. Height 15 cm. Weight 1,004 gr. (after Βασιλικού 1995, fig. 21).

Fig. 8. EAM 220. Mycenae, Shaft Grave II. Height 6.6 cm. Weight 26.5 gr. (2 *deben* of 13.3 gr.) (after *Τροία, Μυκήνες, Τίρυνς, Ορχομενός*, no. 210).

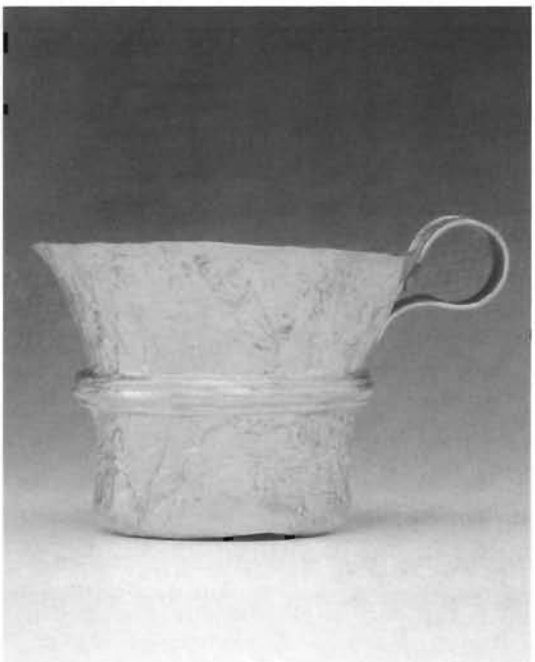

Fig. 9. EAM 73. Mycenae, Shaft Grave III. Height 8.1 cm. Weight 65.5 gr. (5 *deben* of 13.1 gr. or 1 'Minoan' unit) (after *Τροία, Μυκήνες, Τίρυνς, Ορχομενός*, no. 215).

Fig. 10. MC 2634. Peristeria, Tholos tomb. Height 12.5 cm. Weight 175.5 gr. (13 *deben* of 13.5 gr.). Date: LH I (after *Mycenaean World*, no. 41).

Fig. 11. EAM 629. Mycenae, Shaft Grave V. Height 10.5 cm. Weight 253.6 gr. (19 *deben* of 13.3 gr. or better 20 *deben* of 12.7 gr. = 4 'Minoan' units of 63.4 gr.). This weight value is later recorded as *N* 1 in Linear B tablets (after *Τροία, Μυκήνες, Τίρυνς, Ορχομενός*, no. 257).

Fig. 12. EAM 440. Mycenae, Shaft Grave IV. Height 9.2 cm. Weight 205. 2 gr. (15 *deben* of 13.68 gr.) (after *Τροία, Μυκήνες, Τίρυνς, Ορχομενός*, no. 237).

Fig. 13. EAM 7381. Kampos, Kalamata. Height 9.6 cm. Weight 336.6 gr. (25 *deben* of 13.5 gr.). Date: LH I (after *Mycenaean World*, no. 40).

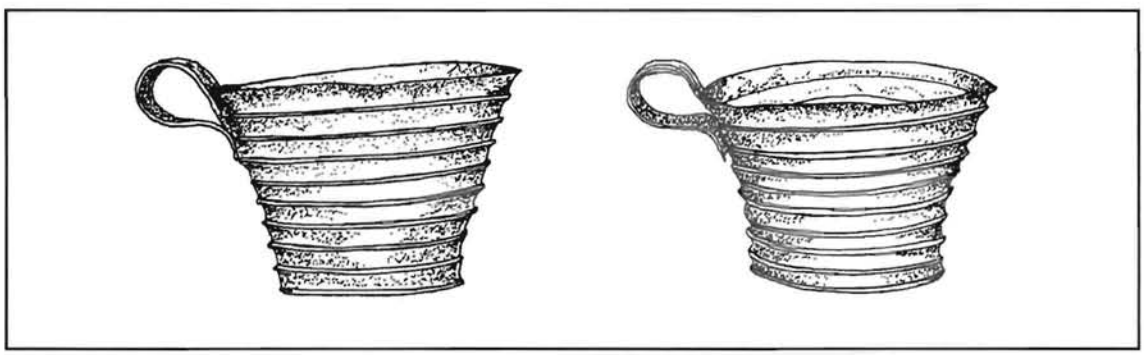

Fig. 14. EAM 392, 393 (by P. Kalogerakou). Mycenae, Shaft Grave IV. Same size (height 7.2 cm.), same craftsmanship, weights respectively 60 gr. (5 *deben* of 12 gr.) and 66.5 gr. (5 *deben* of 13.3 gr.). They are evidence for the fluctuation in the value of the *deben* and demonstrate a degree of tolerance in the value of the 'Minoan' unit of at least 6.5 gr.

Fig. 15. EAM 3122 silver cup. Mycenae, Chamber tomb 78. Height 7.7 cm. Weight 261 gr. (20 *deben* of 13 gr. = 4 'Minoan' units of 65.25 gr.). Date: LH II-III A:1. Record of weight in the Linear B script: *N* 1 (after *Mycenaean World*, no. 18).

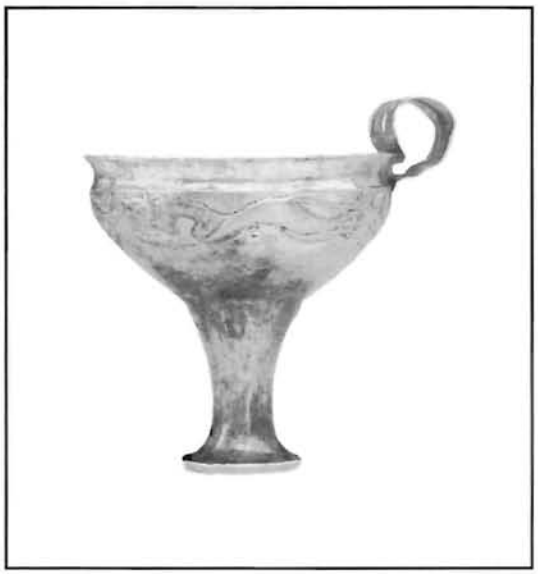

Fig. 16. EAM 656. Mycenae, Shaft Grave V. Height 10.8 cm. Weight 127.7 gr. (10 *deben* of 12.7 gr. = 2 'Minoan' units of 63.8 gr.) (after Βασιλικού 1995, fig. 19).

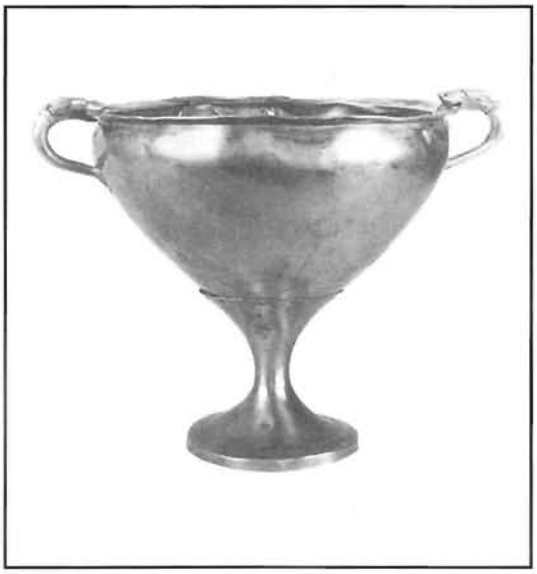

Fig. 17. EAM 959. Mycenae, Akropolis. Height 13.5 cm. Weight 314. 7 gr. (24 *deben* of 13.1 gr. or 25 *deben* of 12.6 gr. = 5 'Minoan' units of 63 gr.). Possible date: LH II-IIIA:1. Related to shape with Linear B ideogram of vase **215* (Vandenabeele & Olivier 1979) ; could be recorded as *N* 1 *P* 3 or *P* 15 in Mycenaean texts (after *Mycenaean World*, no. 1).

Fig. 18. EAM 6441. Related with the Linear B ideogram of vase **221* (Olivier & Vandenabeele 1979). Marathon, Tholos tomb. Height 3.7 cm. Weight 66.7 gr. (5 *deben* of gold of 13.3 gr. = 1 'Minoan' unit). Since it is of a LH III date, its value in weight of gold could be also estimated as 7 Egyptian *qedet* or 7 Syrian shekels of 9.5 gr. and it could be recorded as *P* 3 (if *P* = 22 gr. cf. below) (after *Mycenaean World*, no. 59).

Fig. 19. EAM 8743. Dendra, Chamber tomb 10. Height 5 cm. Weight 95.7 gr. Approx. 1 $^{1}/_{2}$ 'Minoan' unit of 63 gr. But since it is of LH II-III A:1 date, its value of gold can be estimated as 1 New Kingdom *deben* or 10 Syrian shekels (of 9.5 gr.) and recorded in Linear B script as *P* 4 *Q* 2 (if *P* = 22 gr.) (after *Mycenaean World*, no. 22).

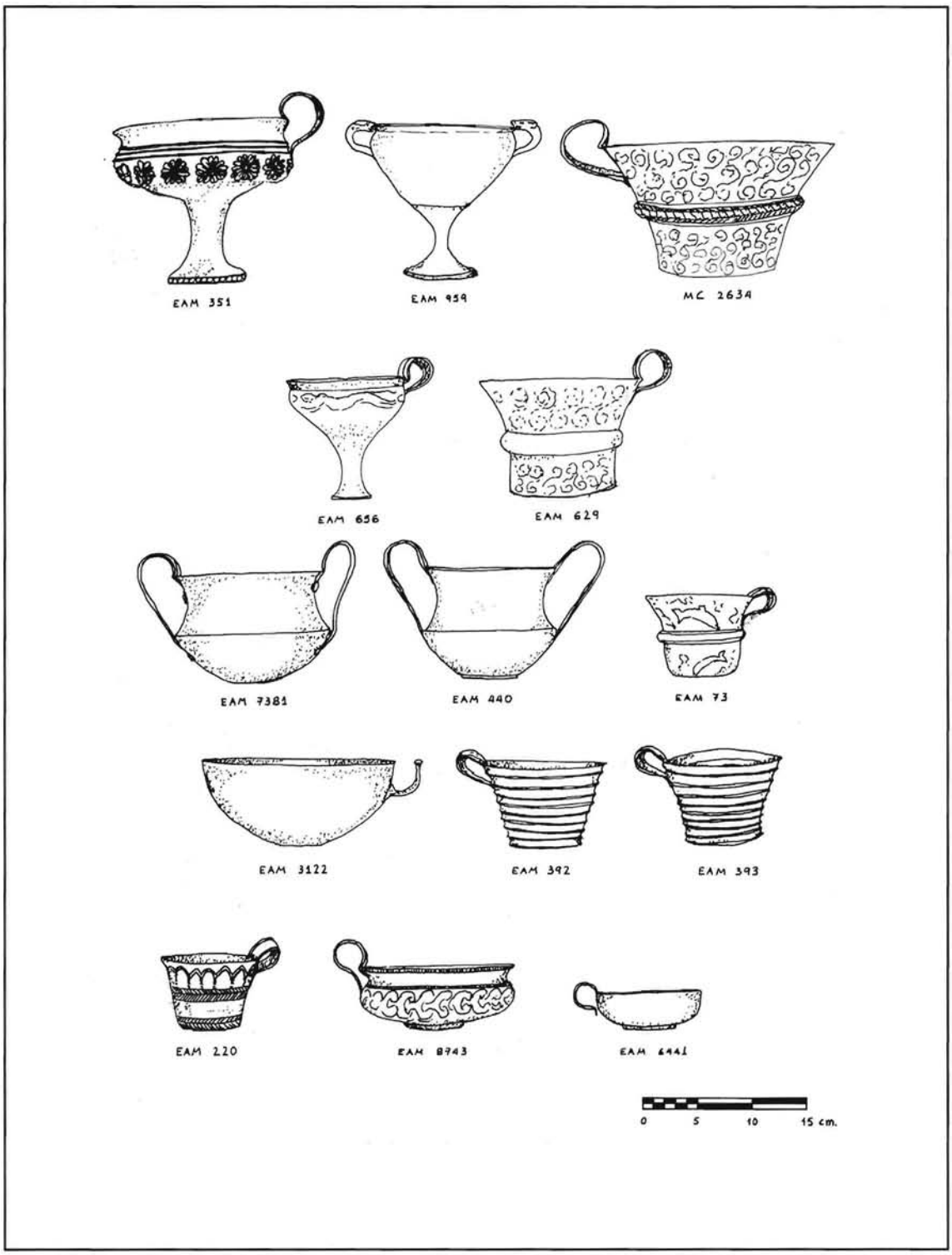

Fig. 20. The vessels of Fig. 7-19 ranged in order of height (by P. Kalogerakou).